Jean-Claude Givel
Neil James Mortensen
Bruno Roche *Editors*

Anorectal and Colonic Diseases

A Practical Guide to their Management

Third Edition

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Jean-Claude R. Givel
Service de Chirurgie Viscérale
Centre Hospitalier Universitaire Vaudois
1011 Lausanne
Switzerland
Email: jean-claude.givel@chuv.ch

Neil Mortensen
Department of Colorectal Surgery
The John Radcliffe Hospital
Headington
Oxford OX3 9DU
UK
Email: neil.mortensen@nds.ox.ac.uk

Bruno Roche
Responsable de l'Unité de Proctologie
Hôpital Cantonal Universitaire de Genève
Rue Gabrielle Perret-Gentil 4
1211 Genève 14
Switzerland
Email: bruno.roche@hcuge.ch

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Foreword

Anorectal and Colorectal Diseases was first published in 1989 under the editorship of Marc-Claude Marti and Jean-Claude Givel. Its success has now resulted in a third edition, which has an expanded chapter list to take into account the many developments that have occurred in coloproctology during the last 20 years. The editors have chosen an international group of authors who are authorities in their field. They have themselves contributed extensively to a work that comprises 49 chapters dealing with all aspects of colorectal disease. The book is divided into four sections. Section I contains 18 chapters on topics that include basic anatomy, physiology, clinical methodology and investigations. Sections II and III deal with anal and perianal diseases and colorectal diseases, respectively. Finally, Section IV contains seven chapters that describe other disciplines that touch upon colorectal disease, including obstetrics, gynaecology, paediatrics, plastic surgery, radiation bowel disease and sexually transmitted diseases. The overall effect is a comprehensive and authoritative account of the whole field of colorectal practice. The layout is attractive, making the text easy to digest, and the illustrations are well chosen and helpful. The bibliography of each chapter is in itself an impressive feature of the book; there are, for example, over 200 references in Chapter 34, "Management of Malignant Tumours".

Anorectal and Colorectal Diseases will be of immense value to hospital-based specialists in the fields of digestive surgery and gastroenterology. It should also appeal to specialist nurses and undergraduates. The book will serve both as a reference source of major importance and as a guide to clinical practice.

John Nicholls

Emeritus Consultant Surgeon, St Mark's Hospital, London, and Visiting Professor of Surgery, Imperial College, London, UK

June 2009

Preface

This book was first published in 1989. At that time the speciality of coloproctology was still in its early days. It has since become one of the leading fields in medicine and surgery. Several major new developments and technologies for the management of both colonic and proctological diseases have emerged. This evolution is demonstrated by the huge number of societies, meetings and publications dedicated to the subject. Indeed, coloproctology covers some of the most common human conditions, as well as more rare and unusual diseases. This important and rapid period of change called for a third edition to include all aspects of our multidisciplinary speciality.

Anorectal and Colonic Diseases – A Practical Guide to Their Management has 49 chapters divided into 4 sections, all written by international experts in their field: principles, anal and perianal diseases, colorectal conditions, and specialist conditions. Each chapter finishes with a self-assessment quiz. A DVD is also provided, offering readers the opportunity to observe practical procedures and refine their technical skills. We are particularly greatful to Karel Skala for his efforts in putting together the video material. Altogether, this material should offer practitioners, surgeons, gastroenterologists and all those interested in the field, updated and practical knowledge in the realms of diagnosis and the medical or surgical treatment of the full range of colorecto-anal diseases.

This preface is also the place to pay a great tribute to the late Professor Marc-Claude Marti (1941–2001). It was he who first conceived the book in 1989 and took the initiative to produce a second edition in 1998. Marc-Claude Marti was a real pioneer in both the scientific and political development of coloproctology in Switzerland, as well as in Europe. We would like to dedicate this third edition to him, in recognition of his particular contribution to the creation of a new speciality.

We wish to thank all of the authors for their contributions. A debt of gratitude is also owed to our dear friend John Nicholls from London for agreeing to write the Foreword. The publisher, Springer-Verlag, again enthusiastically supported the idea to edit this volume and provided us with outstanding assistance.

Jean-Claude Givel
Neil Mortensen
Bruno Roche

Lausanne, Oxford and Geneva
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Contents

Contributors

Chahin Achtari
Département de Gynécologie-Obstétrique
Centre Hospitalier Universitaire Vaudois
1011 Lausanne
Switzerland
Email: chahin.achtari@chuv.ch

Felix Aigner
Department of General and Transplant Surgery
Innsbruck Medical University
Anichstrasse 35
6020 Innsbruck
Austria
Email: felix.aigner@i-med.ac.at

Iain D. Anderson
Department of Surgery
Hope Hospital
Salford
Manchester M6 8HD
UK
Email: iain.anderson@srft.nhs.uk

Cor G.M.I. Baeten
Department of Surgery
University Medical Center
PO Box 5800
6202 AZ Maastricht
The Netherlands
Email: c.baeten@mumc.nl

Rebecca A. Barnetson
Colon Cancer Genetics Group
University of Edinburgh
School of Molecular and Clinical Medicine and MRC
Human Genetics Unit
Western General Hospital
Edinburgh EH4 2XU
UK
Email: rebecca.barnetson@hgu.mrc.ac.uk

Willem A. Bemelman
Department of Surgery
Academic Medical Center
PO Box 22700
1100 DE Amsterdam
The Netherlands
Email: w.a.bemelman@amc.uva.nl

Jacques Bille
Institut de Microbiologie
Centre Hospitalier Universitaire Vaudois
Bugnon 48
1010 Lausanne
Switzerland
Email: jacques.bille@chuv.ch

Steven R. Brown
Department of Coloproctology
Northern General Hospital
Herries Road
Sheffield S5 7AU
UK
Email: steven.brown@sth.nhs.uk

Tim Brown
St. Mark's Hospital
Watford Road
Harrow HA1 3UJ
UK
Email: tjbrown55@hotmail.com

Peter Buchmann
Facharzt Chirurgie FMH
Schwerpunkte Viszeral-/Thoraxchirurgie
Gladbachstrasse 95
8044 Zürich
Switzerland
Email: buchmann.chirurgie@hin.ch

Nicolas C. Buchs
Service de chirurgie viscérale et de transplantation
HUG
1211 Genève 14
Switzerland
Email: Nicolas.C.Buchs@hcuge.ch

Yannick Cerantola
Service de Chirurgie Viscérale
Centre Hospitalier Universitaire Vaudois
1011 Lausanne
Switzerland
Email: yannick.cerantola@chuv.ch

Dimitrios Christoforidis
Service de Chirurgie Viscérale
Centre Hospitalier Universitaire Vaudois
Rue du Bugnon 46
1011 Lausanne
Switzerland
Email: christoforidis@chuv.ch

Eva Csatár
Private Surgery of Gastroenterology and Proctology
Margit krt.5/b
1024 Budapest
Hungary
Email: csatar.eva@gmail.com

Christopher Cunningham
Department of Colorectal Surgery
The John Radcliffe Hospital
Headington
Oxford OX3 9DU
UK
Email: chriscunningham@nhs.net

Lukas Degen
Gastroenterologie
Universitätsspital
4031 Basel
Switzerland
Email: lukas.degen@unibas.ch

Nicolas Demartines
Service de Chirurgie Viscérale
Centre Hospitalier Universitaire Vaudois
1011 Lausanne
Switzerland
Email: demartines@chuv.ch

Andre D'Hoore
Department of Abdominal Surgery
University Clinics Gasthuisberg
3000 Leuven
Belgium
Email: guido.vanermen@uz.kuleuven.ac.be

Malcolm G. Dunlop
Colon Cancer Genetics Group
University of Edinburgh
School of Molecular and Clinical Medicine and MRC
Human Genetics Unit
Western General Hospital
Edinburgh EH4 2XU
UK
Email: malcolm.dunlop@hgu.mrc.ac.uk

Graeme S. Duthie
Academic Surgical Unit
University of Hull
Castle Hill Hospital
Castle Road
Cottingham
East Yorkshire HU16 5JQ
UK
Email: g.s.duthie@hull.ac.uk

Anne Edwards
Oxford Genitourinary Medicine
The Oxford Radcliffe Hospitals Trust
The Churchill Hospital
Oxford
UK
Email: aedwards@oxford-pgmde.co.uk

Anton Emmanuel
GI Physiology Unit
University College Hospital
235 Euston Road
London NW1 2BU
UK
Email: anne.edwards@orh.nhs.uk

Jian Farhadi
Cancer Reconstructive Service
GKT Plastic Surgery
St. Thomas' Hospital
Lambeth Palace Road
London SE1 7EH
UK
Email: jian@farhadi.com

Paul Finan
Leeds General Infirmary
Great George Street
Leeds LS1 3E
UK
Email: p.finan@doctors.org.uk

Ian Finlay
Royal Infirmary
16 Alexandra Parade
Glasgow G31 2ER
UK
Email: ian.finlay@northglasgow.scot.nhs.uk

Bruce M. Fox
Derriford Hospital
Plymouth PL6 8DH
UK
Email: bruce.fox@phnt.swest.nhs.uk

Helga Fritsch
Division of Clinical and Functional Anatomy
Department of Anatomy, Histology and Embryology
Innsbruck Medical University
Muellerstrasse 59
6020 Innsbruck
Austria
Email: helga.fritsch@i-med.ac.at

Jean-Patrice Gardaz
Service d'Anesthésiologie
Centre Hospitalier Universitaire Vaudois
1011 Lausanne
Switzerland
Email: jean-patrice.gardaz@chuv.ch

Angela B. Gardiner
Faculty of Health and Social Care
University of Hull
Cottingham Road
Hull
East Yorkshire
UK
Email: a.b.gardiner@hull.ac.uk

Laurence Genton
Nutrition Clinique
Hôpitaux Universitaires de Genève
1211 Genève 14
Switzerland
Email: genton-laurence@diogenes.hcuge.ch

Bruce D. George
Department of Colorectal Surgery
The John Radcliffe Hospital
Headington
Oxford OX3 9DU
UK
Email: brucegeorge@doctors.org.uk

Olivier Gié
Service de Chirurgie Viscérale
Centre Hospitalier Universitaire Vaudois
1011 Lausanne
Switzerland
Email: olivier.gie@chuv.ch

Jean-Claude R. Givel
Service de Chirurgie Viscérale
Centre Hospitalier Universitaire Vaudois
1011 Lausanne
Switzerland
Email: jean-claude.givel@chuv.ch

Wim Hameeteman
Department of Gastroenterology
Academic Hospital
PO Box 5800
6202 AZ Maastricht
The Netherlands
Email: wha@sint.azm.nl

Syed A. Hyder
Department of Colorectal Surgery
The John Radcliffe Hospital
Headington
Oxford OX3 9DU
UK
Email: hydersa@yahoo.com

Simon A. Jackson
Derriford Hospital
Plymouth PL6 8DH
UK
Email: simon.jackson@phnt.swest.nhs.uk

Michael E.D. Jarret
Department of Upper GI
The John Radcliffe Hospital
Headington
Oxford OX3 9DU
UK
Email: michael_jarrett@btinternet.com

Myles Joyce
Department of Colorectal surgery
Digestive Disease Institute
Cleveland Clinic Foundation
9500 Euclid Avenue/A30
Cleveland
Ohio 44195
USA
Email: joycem3@ccf.org

Paul R.B. Kitchen
St. Vincent's Hospital
Melbourne
Victoria 3065
Australia
Email: p.kitchen@unimelb.edu.au

Klaus Krogh
Neurogastroenterology Unit
Departments of Hepatology and Gastroenterology V. and Surgery P
Aarhus University Hospital
Aarhus
Denmark
Email: krogh@as.aaa.dk

Søren Laurberg
Department of Surgery
Aarhus University Hospital
8000 Aarhus
Denmark
Email: soeren.laurberg@as.aaa.dk

Ian Lindsey
Dept of Colorectal Surgery
The John Radcliffe Hospital
Headington
Oxford OX3 9DU
UK
Email: lindseyilinz@yahoo.com

Marc-Claude Marti†

Walter R. Marti
Klinik für Chirurgie
Kantonsspital
5001 Aarau
Switzerland
Email: walter.r.marti@ksa.ch

Klaus E. Matzel
Chirurgische Klinik mit Poliklinik
Universität Erlangen-Nürnberg
Maximiliansplatz
91054 Erlangen
Germany
Email: klaus.matzel@chir.imed.uni-erlangen.de

Sylvain Meyer
Service de Gynécologie-Obstétrique
Ensemble Hospitalier de La Côte
1110 Morges
Switzerland
Email: sylvain.meyer@chuv.ch

Blaise J. Meyrat
Service de Chirurgie Pédiatrique
Centre Hospitalier Universitaire Vaudois
1011 Lausanne
Switzerland
Email: blaise-julien.meyrat@chuv.ch

Neil Mortensen
Department of Colorectal Surgery
The John Radcliffe Hospital
Headington
Oxford OX3 9DU
UK
Email: neil.mortensen@nds.ox.ac.uk

P. Ronan O'Connell
University College Dublin
St. Vincent's University Hospital
Elm Park
Dublin 4
Ireland
Email: ronan.oconnell@ucd.ie

Angie Perrin
Colorectal Nursing Department
The John Radcliffe Hospital
Headington
Oxford OX3 9DU
UK
Email: angie.perrin@orh.nhs.uk

Claude Pichard
Unité de Nutrition
Hôpitaux Universitaires de Genève
1211 Genève 14
Switzerland
Email: claude.pichard@medecine.unige.ch

Guy Prod'hom
Institut de Microbiologie
Centre Hospitalier Universitaire Vaudois
Bugnon 48
1010 Lausanne
Switzerland
Email: guy.prodhom@chuv.ch

Joan Robert-Yap
Unité de Proctologie
Hôpital Cantonal Universitaire de Genève
Rue Gabrielle Perret-Gentil 4
1211 Genève 14
Switzerland
Email: joan.robert@hcuge.ch

Bruno Roche
Responsable de l'Unité de Proctologie
Hôpital Cantonal Universitaire de Genève
Rue Gabrielle Perret-Gentil 4
1211 Genève 14
Switzerland
Email: bruno.roche@hcuge.ch

David A. Ross
Cancer Reconstructive Service
GKT Plastic Surgery
St. Thomas' Hospital
Lambeth Palace Road
London SE1 7EH
UK
Email: david.ross@gstt.nhs.uk

Daniel J. Royston
Department of Cellular Pathology
The John Radcliffe Hospital
Headington
Oxford OX3 9DU
UK
Email: djroyston@doctors.org.uk

Brian P. Saunders
St. Mark's Hospital
Northwick Park
Watford Road
Harrow HA1 3UJ
UK
Email: b.saunders@imperial.ac.uk

David Sebag-Montefiore
Clinical Oncology
Cookridge Hospital
Leeds LS16 6QB
UK
Email: david.sebag-montefiore@leedsth.nhs.uk

Asha Senapati
Department of Surgery
Queen Alexandra Hospital
Portsmouth PO6 3LY
Hampshire
UK
Email: asha.senapati@porthosp.nhs.uk

Andrew J. Shorthouse
Department of Coloproctology
Northern General Hospital
Herries Road
Sheffield S5 7AU
UK
Email: shorthouse@doctors.org.uk

Karel Skala
Unité de Proctologie
Hôpital Cantonal Universitaire de Genève
Rue Gabrielle Perret-Gentil 4
1211 Genève 14
Switzerland
Email: karel.skala@hcuge.ch

Julian Stern
St. Mark's Hospital
Northwick Park
Watford Road
Harrow HA1 3UJ
UK
Email: julianstern@hotmail.com

Urs E. Studer
Klinik für Urologie
Inselspital
CH 3010 Bern
Switzerland
Email: urs.studer@insel.ch

Antje Teubner
Intestinal Fistula Unit
Salford Royal Hospital Foundation NHS Trust
Manchester M6 8HD
UK
Email: antje.teubner@srft.nhs.uk

Kumaran Thiruppathy
GI Physiology Unit
University College Hospital
235 Euston Road
London NW1 2BU
UK
Email: kum@doctors.org.uk

Michael R. Thompson
Department of Surgery
Queen Alexandra Hospital
Portsmouth PO6 3LY
Hampshire
UK
Email: michael.thompson@porthosp.nhs.uk

Simon Travis
Gastroenterology Unit
The John Radcliffe Hospital
Headington
Oxford OX3 9DU
UK
Email: simon.travis-sec@orh.nhs.uk;
helen.small@orh.nhs.uk

Cédric Vallet
Service de Chirurgie
Ensemble Hospitalier de la Côte
1110 Morges
Switzerland
Email: cedric.vallet@ehc.vd.vh

Julien Vaucher
Service de Médecine Interne
Centre Hospitalier Universitaire Vaudois
1011 Lausanne
Switzerland
Email: julien.vaucher@chuv.ch

Henri A. Vuilleumier
Service de Chirurgie Viscérale
Centre Hospitalier Universitaire Vaudois
1011 Lausanne
Switzerland
Email: henri.vuilleumier@chuv.ch

Bryan F. Warren
Department of Cellular Pathology
The John Radcliffe Hospital
Headington
Oxford OX3 9DU
UK
Email: wbf7warren@aol.com

Dirk Westermann
Klinik für Urologie
Inselspital
CH 3010 Bern
Switzerland
Email: dwesti@web.de

Alastair Windsor
University College London Hospitals
235 Euston Road
London NW1 2BU
UK
Email: alwindsor@mac.com

Patrick Yves Wüthrich
Service d'Anesthésiologie
Centre Hospitalier Universitaire Vaudois
1011 Lausanne
Switzerland
Email: patrick.wuethrich@insel.ch

Philippa L. Youd
The Wolfson Unit
St. Mark's Hospital
Watford Road
Harrow HA1 3UJ
UK
Email: youd2@hotmail.com

Abderrahim Zouhair
Service de Radio-Oncologie
Centre Hospitalier Universitaire Vaudois
1011 Lausanne
Switzerland
Email: abderrahim.zouhair@chuv.ch

Section I Principles

1 Anorectal and Colonic Anatomy

Felix Aigner and Helga Fritsch

CONTENTS

1.1 Introduction

The anatomy of the large intestine has been well described elsewhere. The emphasis of this chapter will be on the more complex and controversial aspects of the pelvic floor and the anorectum. The pelvic floor forms the supportive and caudal border of the abdominal cavity. A detailed anatomical understanding of its complex architecture is mandatory for the pelvic surgeon, who is confronted with both anorectal and urogenital dysfunctions, as different anatomical systems join here.

Anatomical studies on fetal and adult specimens have demonstrated that the pelvic connective tissue can be divided into three compartments: the anterior, middle, and posterior compartment. Recent studies have highlighted the supportive function of the pelvic floor muscle systems as well as their impact on continence function and defecation. In general, sexual differences in the morphology of the muscular components already exist in early fetal stages. A thorough knowledge of the topographical relationship between the various organ systems, neurovascular structures, and connective-tissue compartments of the pelvic floor is therefore indispensable for clinical routine to improve and optimize surgical treatment for both benign and malignant conditions.

1.2 Basics of Embryological Gut Development

1.2.1 Overview

The primitive gut is a portion of the incorporated endoderm-lined yolk sac cavity. It constitutes a blind-ending tube whose sections are the pharyngeal gut, the foregut, the midgut, and the hindgut. It exhibits a sagittal position, with the mobile dorsal mesentery and respective arteries already visible around the sixth postcoital week. The celiac trunk contributes to the blood supply of the caudal part of the foregut which terminates at the entry point of the adult bile duct into the duodenum. From there, the superior mesenteric artery supplies the midgut which comprises the majority of the small intestine and the adult right hemicolon to the distal center of the forthcoming gut rotation: the region of the left (splenic) colic flexure. The midgut forms a loop in the sagittal plane, the umbilical loop, with its apex in the area of the later terminal ileum and cecum.

Extensive growth takes place during postcoital weeks 6–12, especially of the proximal portion of the umbilical loop (jejunum and ileum; Fig. 1.1). Subsequently, the gut rotates 270° counterclockwise around

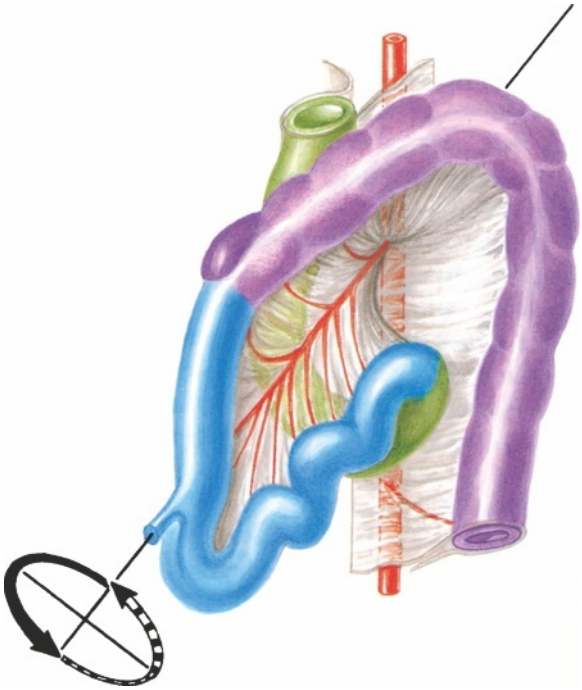


Fig. 1.1 Part of the gut rotation (postcoital weeks 6–12) 180° counterclockwise around the axis of the superior mesenteric artery (*arrows* indicate direction). This step is characterized by extensive growth of the proximal parts of the umbilical loop (jejunum and ileum). Reprinted from Von Lanz et al. (2004) [28] with kind permission of Springer Science and Business Media

the axis of the superior mesenteric artery, with the cecum describing an extended course from the level of the umbilicus to the area of the pylorus, further to the lower surface of the liver, and finally to the right iliac fossa. Elongation of the gut is accompanied by expansion of the dorsal mesentery which in some places fuses secondarily with the parietal peritoneum, thus forming the ascending and descending mesocolon. The mesoappendix, and the transverse and sigmoid mesocolon, remain unfixed like the mesentery of the jejunum and the ileum. No mesentery exists for the rectum, which lies mainly extraperitoneally.

The hindgut extends from the left third of the transverse colon to the cloacal membrane, which constitutes the transitional border between the endoderm and ectoderm. The hindgut gives rise to the distal third of the transverse colon, the descending colon, the sigmoid, the rectum and part of the anal canal, and is supplied by the inferior mesenteric artery. The connective tissue and muscles of the hindgut are derived from splanchnic mesoderm.

1.2.2 Details of Anorectal Development

The embryology of the anorectal region has confused morphologists, surgeons, and students alike for the past 100 years. The two most likely reasons for this confusion have been noted in recent papers:

1. Observations have been made in various species (human, mice, rat, pig) without recognizing their inherent differences [20].
2. Observations have been restricted mainly to conventional histological sections of some selected stages without taking into account the fact that morphogenesis is a four-dimensional process [29] during which some structures migrate and others change only their position as a result of differential growth [12, 19].

These critical papers have shed new light on the confusion surrounding the development of the anorectal region, and thus on the development of the human embryo.

The early embryo (Carnegie stage 13, 5 weeks) has a cloaca, which consists of a ventral diverticulum, the allantois, a dorsal diverticulum, the embryonic hindgut, and a common cloacal cavity, and is lined with endoderm (Fig. 1.2a). The cranial border is marked by the mesodermal urorectal septum (URS). The opposite ventral border is identical to the cloacal membrane, where the internal endoderm is covered by an outer layer of ectoderm. Ventrocaudally, the cloacal membrane extends from the genital tubercle anteriorly to the tail groove posteriorly.

In the older embryo (Carnegie stage 19, 7 weeks) the tip of the URS appears close to the cloacal membrane, but these structures never fuse. The cloacal membrane flattens and vanishes [17, 27], creating two openings: an anterior one for the urogenital sinus and a posterior one for the anal canal. The tip of the URS has now reached the surface and forms the future perineal region. Soon after the cloacal membrane vanishes, the lumen of the anal canal is closed off by the proliferating epithelium. Initially, this closure which is identical to the anal membrane described in older literature [14, 25] is situated at the epithelial border between the ectoderm and endoderm, where epithelial proliferation creates the anorectal line (synonymous with the pectinate or dentate line, Fig. 1.2b). Then, in the 8-week-old embryo, it is situated

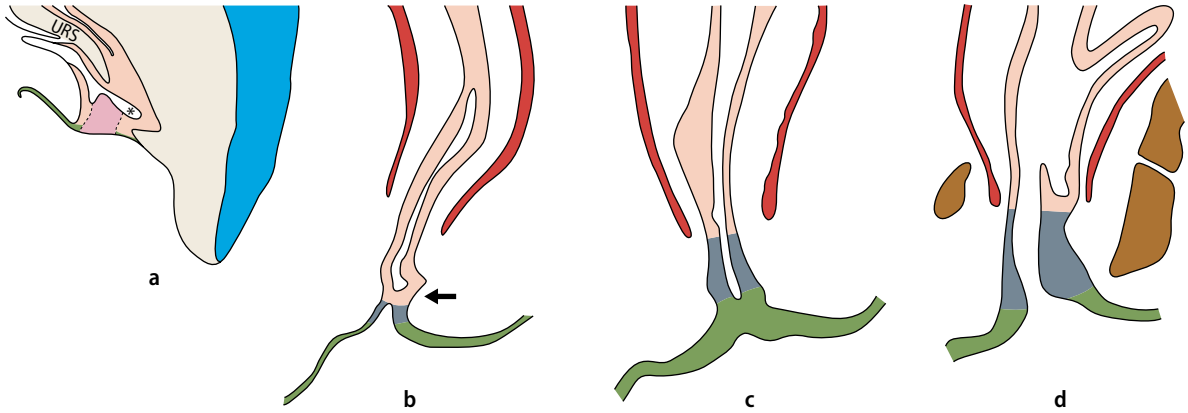


Fig. 1.2a–d Schematic illustration of the anorectal development in the early fetal stages (see Sect. 1.2.2). **a** Postcoital week 5. The cloaca (*asterisk*) is shown with the cloacal membrane (*purple*). Endoderm (*pink*), ectoderm (*green*), urorectal septum (*URS*), mesenchyme (*beige*), spinal column (*blue*). **b** Postcoital week 7. The cloacal membrane has vanished and the lumen of the anal canal is closed off by the proliferating epithelium (*arrow*) at the epithelial border between the ectoderm and endoderm (anorectal line). Future keratinized ectoderm (*green*), nonkeratinized ectoderm (*grey*), and endoderm-related smooth sphincter muscle (*red*). **c** Postcoital week 8. **d** Postcoital week 9. The anal orifice is recanalized. Mesoderm-related striated sphincter muscle can be seen (*brown*)

more caudally in the intermediate zone and at the anocutaneous line, where the ectodermal epithelium differentiates and proliferates (Fig. 1.2c). In the 9-week-old fetus the anal orifice is recanalized and remains open throughout fetal life (Fig. 1.2d).

The smooth-muscle layers of the hindgut develop from the surrounding mesenchyme, but are closely related to the developing endodermal epithelium. They may therefore be considered as endoderm-related muscles. In the 7-week-old embryo (Carnegie stage 17, 7 weeks) the smooth circular muscle layer surrounds the rectum, but already stops short of and above the epithelial anorectal line. In the 8-week-old embryo both the circular and the longitudinal muscle layers can be differentiated; these end at the anorectal (pectinated) line. In postcoital week 7 smooth-muscle cells derived from the longitudinal layer start to spread into the anlagen of the neighboring external sphincter and the levator ani, which develop from the surrounding mesenchyme of the tail region behind the rectum and from the URS at the front of the rectum.

The striated muscles (i. e., the levator ani muscle and the external anal sphincter) are derived from the surrounding mesenchyme. The anlagen of these muscles can already be detected in the 7-week-old embryo. The anlagen differentiate when the smooth-muscle cells of the gut wall start to spread out into both striated muscles, which may thus be considered mesoderm-related muscles.

1.3 Anatomy of the Colon and Anorectum

The large intestine extends from the ileocecal valve to the anal verge and comprises the cecum, ascending colon, right colic (hepatic) flexure, transverse colon, left colic (splenic) flexure, descending colon, sigmoid colon, rectum, and anal canal. The histology of the colon comprises mucosa with the typical intestinal glandular epithelium, the submucosa and internal circular and external longitudinal layer of the muscular coat, the subserosa, and the serosa.

The total length of the large intestine can be up to 1.5 m, and the macroscopic characteristics of the colon are taenias, haustras, semilunar folds, and omental appendices. Both the ascending and descending colon and the two colic flexures are characterized by their unchangeable position due to the secondary fusion of their mesentery with the parietal peritoneum during gut rotation (see Sect. 1.2.1).

1.3.1 Cecum and Appendix

The cecum lies either intraperitoneally or retroperitoneally within the iliac fossa, with the appendix commonly in retrocecal position (~60%). Its mobility depends on the course of the mesenteric root and results in either a mobile intraperitoneal, or fixed retroperito-

neal cecum. The blood supply to the cecum and the appendix is provided by the ileocolic artery which divides into the anterior and posterior cecal arteries and appendicular artery. The latter lies within the free margin of the mesoappendix.

1.3.2 Colon

The ascending colon has a constant course that terminates at the right colic flexure, which varies in position and shape. The relatively short mesentery of the right part of the transverse colon is attached to the lower pole of the right kidney, the descending part of the duodenum, and the head of the pancreas. The left part of the transverse colon is connected to the greater curvature of the stomach through the gastrocolic ligament. The greater omentum originates from the greater curvature of the stomach and fuses secondarily with the transverse colon (omental taenia). The dorsal layer of the greater omentum fuses with the transverse mesocolon on its way to the omental bursa.

The descending colon passes over to the sigmoid colon in the left iliac fossa. The sigmoid is again characterized by its remarkable mobility due to the sigmoid mesocolon, which starts at the level of the iliac crest and terminates at the passage to the rectum, level with the third sacral vertebra. The root of the sigmoid mesocolon forms the intersigmoid recess which covers the left ureter at the back and contains the sigmoid arteries in the front.

Both mesenteric arteries provide the blood supply to the colon and join at the marginal arcade (arcade of Riolan) at the left colic flexure. The sigmoid arteries and the constant superior rectal artery (SRA) originate from the inferior mesenteric artery and share collateral anastomoses up to the point of Sudeck. Thus, ligation of the SRA distal to that point critically interrupts the blood supply to the rectum.

1.3.3 Rectum

The rectum can be discriminated from the sigmoid colon by typical colonic properties, such as taenias, haustras, and omental appendices that diminish on the level of the third sacral vertebra. From a topographical point of view the rectum can be divided into three portions: the upper third extending from the rectosigmoid junction to the peritoneal reflection, the middle third terminating at the level of the puborectalis muscle sling, and the lower third passing over to the anal canal at the dentate line (Fig. 1.3). Apart from a narrow segment of the ventral wall of the rectum, the terminal part of the hindgut lies totally extraperitoneally. This peritoneal coverage turns over to the apex and the back of the body of the bladder in the male and to the uterus and the posterior part of the vaginal fornix in the female, thus forming the rectovesical and the rectouterine pouch respectively (Douglas' pouch). The lateral border of this pouch is well demarcated by the rectouterine fold in the female, which contains the uterosacral ligament. In the male the rectovesical pouch is bordered laterally by a peritoneal fold that covers the autonomic pelvic nerve plexus (the inferior hypogastric plexus).

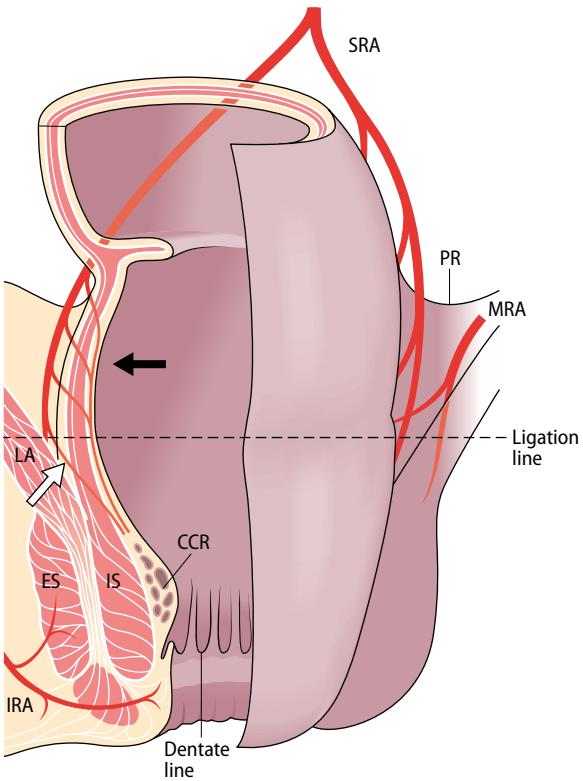


Fig. 1.3 Schematic illustration of the rectum and anal canal. The rectal wall was removed on the right side to demonstrate the transmural course of the branches of the superior rectal artery (*SRA*). The middle rectal artery (*MRA*), inferior rectal artery (*IRA*), corpus cavernosum recti (*CCR*), levator ani muscle (*LA*), internal sphincter muscle (*IS*), external sphincter muscle (*ES*), and peritoneal reflection (*PR*) are shown. The *black arrow* indicates longitudinal submucosal branches; the *white arrow* indicates transmural "perforating" branches of the SRA. The ligation line refers to the level of Doppler-guided hemorrhoidal artery ligation for the treatment of symptomatic hemorrhoids. Reprinted from Aigner et al. (2002) [1] with permission from Excerpta Medica

The rectum forms a slight curve to the left lateral side in an axial plane, resulting in a corresponding transverse fold of the rectum within the rectal lumen (the fold of Kohlrausch). In this region the extensible rectal ampulla enables the filling of the rectum which leads to urgency via the activation of rectal receptors. The rectum further takes an S-shaped course within the pelvic cavity, which can be seen when viewed in a sagittal plane: the sacral flexure, which adapts to the concavity of the sacrum, and the perineal flexure of the anorectal junction, which includes a 90° angle with the sacral portion of the rectum (anorectal angle). The perineal flexure is supported by the anterior and superior traction of the puborectalis sling. The anorectal angle increases during normal defecation (~130°).

1.3.4 Innervation

The endoderm-related large intestine is part of the asymmetric, visceral individual that is innervated autonomously by the sympathetic and the parasympathetic nervous systems [23]. The latter comprises the splanchnic branches of the vagus nerve as far as the left colic flexure. From there, the parasympathetic innervation of the gut is provided by the pelvic parasympathetic part, with the pelvic splanchnic nerves forming the superior and inferior hypogastric plexus. These plexuses contain mixed ganglia (ganglion pelvinum) of sympathetic as well as parasympathetic origin. The maple leaf-shaped inferior hypogastric plexus therefore consists of the parasympathetic pelvic and the sympathetic hypogastric plexus, which form a conjoined network of autonomic nerve fibers at the lateral pelvic wall (Fig. 1.4). The parasympathetic root originates from Onuf's nucleus, an accumulation of motoneurons in the lateral aspect of the ventral horn of the spinal cord between S2 and S3. Onuf's nucleus is the well-known source of innervation of the striated urogenital and anorectal muscles [18] and is known to be the origin of autonomic (pelvic splanchnic nerves) and somatic nerves (pudendal nerve and nerves to the levator ani), both of which innervate the smooth and the striated anal sphincter muscles (internal as well as external anal sphincter muscles), and the levator ani muscle. The pelvic nerves also contain afferent sensitive fibers from the distension receptors of the rectum ampulla terminating at the ganglion pelvinum and from pain receptors of the perineal region and the dentate line through the pudendal nerve.

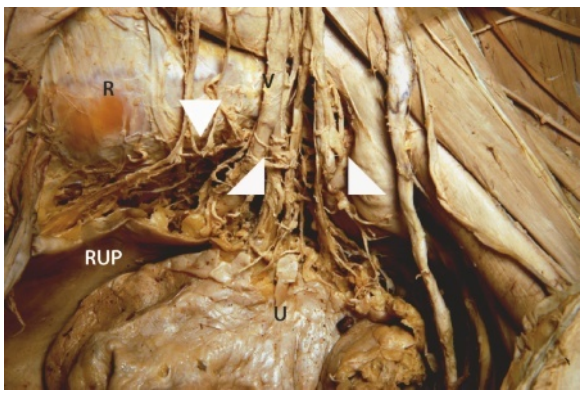


Fig. 1.4 The autonomic inferior hypogastric plexus (*arrowheads*) at the lateral pelvic wall adjacent to the iliac vessels (*V*) comprises the parasympathetic pelvic and the sympathetic hypogastric plexus. Cranial view. Rectum (*R*), uterus (*U*), rectouterine pouch (*RUP*). Reprinted with modifications from Fritsch (2006) [9]

The sympathetic innervation of the large intestine derives from the bilateral, sympathetic trunk ganglia Th6–L2 by which postganglionic sympathetic nerve fibers reach the hypogastric plexus through the right and the left hypogastric nerves.

The somatic innervation of the striated anal sphincter muscle is provided by the pudendal nerve from S2 to S3(4), with its motoneurons located within Onuf's nucleus. The nerve courses within a fascial envelope through the lesser sciatic foramen, curves around the ischial spine and the sacrospinous ligament, turns inward within Alcock's canal together with the pudendal vessels, and enters the ischioanal (or rather anorectal) fossa. There, the nerve splits into terminal branches, with motor fibers to the external anal sphincter muscles (inferior rectal/anal nerves) and sensory fibers to the perineum (perineal nerves). After passing Alcock's canal, the pudendal nerve and its terminal branches are closely attached to the lower surface of the pelvic diaphragm.

The striated levator ani muscle is innervated by direct branches of the sacral plexus (S2–S4) by which connecting fibers from the pudendal nerve reach the puborectalis component of this muscle.

1.3.5 Blood Supply and Lymphatics

The inferior mesenteric artery divides into the left colic artery, the sigmoid artery, and the SRA. The trunk of the SRA divides into two large branches, a left and a right one, at the rectosigmoid junction behind the rectum.

The right branch produces anterior and posterior divisions, and the left branch remains substantially single. Three to five terminal branches reach the rectal wall on each side between the proximal and middle sections of the rectum. The small subdividing branches enter the rectal wall along the whole length of the middle third of the rectal surface. The entrance points can be traced all the way down to the levator ani muscle (Fig. 1.5; i. e., to the muscular borderline between the supplying area of the superior and the inferior rectal arteries). Some subdividing branches continue their course longitudinally within the rectal submucosa. Many authors assign this course of the arterial branches to precisely defined positions in the rectal submucosa (3', 7', and 11', as viewed in the anatomical lithotomy position), corresponding to the clinical appearance of hemorrhoids [16]. However, it has been demonstrated that additional transmural vessels continue the course of the aforementioned extramural terminal branches by perforating the rectal wall in an axial plane close to the levator ani muscle. It is apparently impossible for these branches to be reached by hemorrhoidal artery ligation techniques (Fig. 1.3) [1].

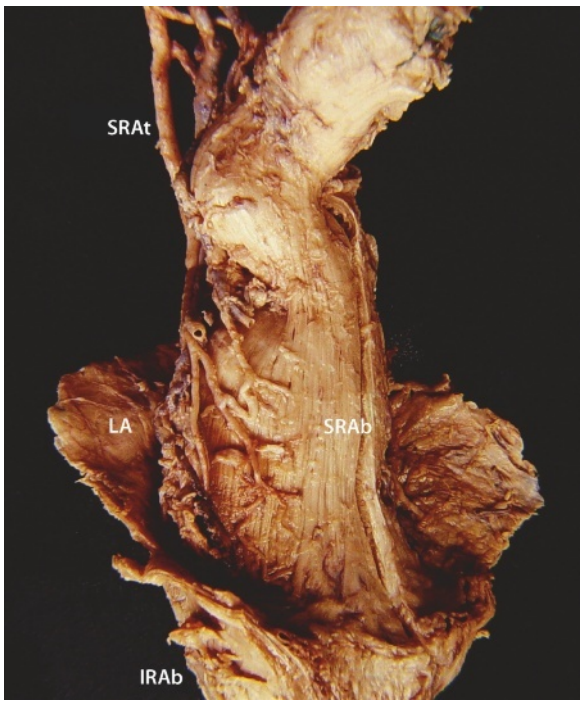


Fig. 1.5 Anterolateral aspect of the rectum and anal canal (female, 75 years) after removal of the mesorectum with levator ani muscle (*LA*), trunk of superior rectal artery (*SRAt*) and extramural branches (*SRAb*), inferior rectal artery (*IRAb*); embalmed specimen, ventral wall opened. Reprinted from Aigner et al. (2002) [1] with permission from Excerpta Medica

Venous drainage of the anorectum follows either the portal or the caval pathway, starting from the transsphincteric veins draining the corpus cavernosum recti (CCR; see Sect. 1.3.6.2). There are numerous intramural connections between the branches of the superior rectal vein which drains into the inferior mesenteric vein, and the veins draining into the inferior vena cava forming portocaval anastomoses, which are of clinical interest, particularly in terms of portal hypertension.

The lymphatic vessels of the gut follow the branching pattern of the mesenteric vessels, originating blindly in the respective tissue [23].

The pelvic lymphatics are characteristically spread within the pelvic connective-tissue compartments (see Sect. 1.4.1). The rectal lymphatic drainage is directed cranially along the superior rectal vessels. The perirectal lymph nodes are therefore located dorsolateral to the rectum and are missing ventrally where the mesorectal fascia fuses with the superior fascia of the pelvic diaphragm. Their location is therefore strikingly different from that of the other lymph nodes of the posterior pelvic compartment which are situated lateral and adjacent to the iliac vessels [11]. The oncological and radical treatment of rectal cancer involves resection of the rectum following the principles of total mesorectal resection [13] by "peeling off" the rectum and the surrounding adipose tissue with all of the lymph nodes and vessels.

1.3.6 The Anal Sphincter Complex

Knowledge of the components of the pelvic floor and of the anal sphincter complex in particular is indispensable for a functional insight into pelvic floor anatomy. The anal sphincter complex is characterized by arbitrary and involuntary mechanisms that ensure fecal continence; it consists of muscular, vascular, and nervous components and the notably extensible and sensitive skin of the anal canal (anoderm).

1.3.6.1 Muscular Components

The pelvic floor muscles that contribute to the anal sphincter complex are derived from two different embryological origins: the mesoderm and the endoderm.

The endoderm-related muscles are the smooth internal anal sphincter muscle (IAS) and the smooth longitudinal anal muscle or corrugator ani muscle. The mesoderm-related muscles are the striated external anal sphincter muscle (EAS) and the striated puborectalis muscle sling and other components of the levator ani muscle (pelvic diaphragm).

The Endoderm-Related Muscles

The IAS, which originates in the endodermal part of the hindgut, forms the distal continuation of the circular layer of the muscular coat of the rectum (Fig. 1.6). The endoderm-related smooth IAS belongs to the visceral individual described by Stelzner, which is unilaterally organized, innervated by the autonomic nervous system, and the main contributor to anal resting pressure and thus to fecal continence [23]. Sexual differences are not as obvious as in the EAS, apart from a thicker and more elongated internal muscle mass in the male individual. The length of the IAS is most often associated with the functional anal canal length or high-pressure zone, which can be measured by anorectal manometry or endoanal ultrasound, and corresponds to the density of its smooth-muscle fibers, being shorter in women (2.0–3.0 cm) than in men (2.5–3.5 cm) [15].

The IAS is innervated by the autonomic inferior hypogastric plexus. The inferior rectal nerves innervating the IAS originate from the inferior hypogastric plexus and are closely attached to the superior fascia of the pelvic diaphragm, which forms the superior coverage of the levator ani muscle.

The distal continuation of the longitudinal layer of the muscular coat of the rectum is formed by the intersphincteric longitudinal anal muscle or corrugator ani muscle (Fig. 1.6), which terminates within and wrinkles the perianal skin. The terminating fibers of this conjoined longitudinal anal muscle subdivide the subcutaneous portion of the EAS and split horizontally, forming a separating fascia between the cranial ischiorectal fossa and the superficial perianal adipose tissue (transverse perineal fascia).

The musculus submucosus ani or musculus canalis ani subdivides the CCR, an arteriovenous network within the rectal submucosa that is crucial for the development of hemorrhoids. Damage to the musculus canalis ani results in "gliding of the anal canal," which is morphologically associated with anal and hemorrhoidal prolapse [26].

The Mesoderm-Related Muscles

The EAS forms a clearly demarcated layer of circularly arranged striated muscle fibers and mainly comprises a deep, anorectal portion and a superficial, subcutaneous portion that intermingles with the smooth longitudinal anal muscle (Fig. 1.6). Together with the puborectalis muscle sling, which is continuous with the deep portion of the EAS dorsally, they form a complex "triple-loop structure" that is crucial for defecation and sustaining fecal continence. Three-dimensional reconstructions of histological sections of the pelvis have demonstrated that the deep portion of the EAS is not completely circular in its ventral position. At the level of the perineum, the EAS is ventrally complete, but turns inward dorsally and forms a muscular continuum with the smooth IAS and the longitudinal muscle. The EAS, as an arbitrary part of the anal sphincter complex, is innervated by the pudendal nerve (S2–S3).

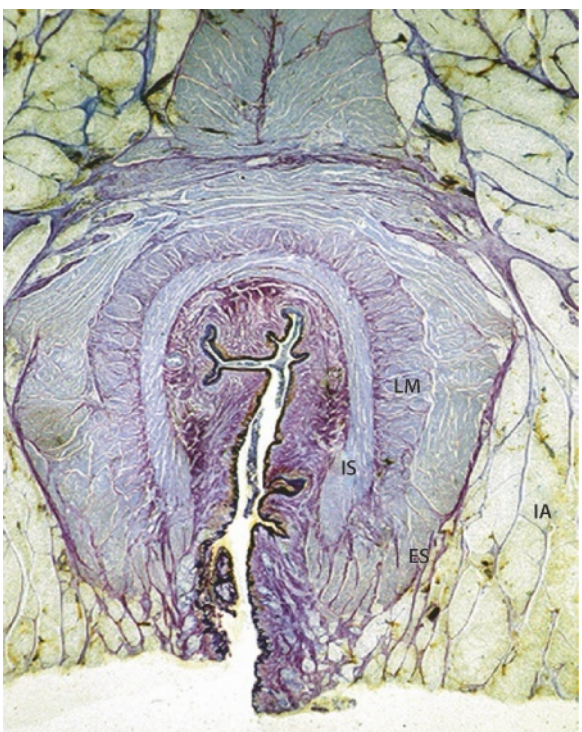


Fig. 1.6 Axial plastinated section through a male newborn pelvis at the perineal level. The striated external anal sphincter (*ES*) is ventrally complete and turns inward, forming a muscular continuum with the smooth internal anal sphincter (*IS*) and longitudinal anal muscle (*LM*) dorsally. *IA* Ischioanal adipose tissue

The pelvic floor proper is formed by the pelvic diaphragm, which consists of the various components of the levator ani muscle (Fig. 1.7): the puborectalis, the pubococcygeus, the iliococcygeus, and the ischiococcygeus muscles.

This striated, funnel-shaped muscle forms the caudal border of the pelvic floor connective-tissue compartments. It belongs to the somatic, bilaterally organized individual described by Stelzner and is a rudimentary tail muscle. The role of the striated levator ani muscles in fecal continence has been somewhat overestimated as most animals lack the pelvic diaphragm and are continent due to their sphincter muscles.

Almost all bilateral components of the levator ani muscle are connected to the contralateral component retrorectally by a raphe, apart from the puborectalis muscles, which form a continuous muscular sling behind the rectum at the level of the anorectal line, pulling the anorectal junction anteriorly and superiorly. The puborectalis muscle sling does not show any connection to the rectum, an important fact when performing low anterior resection of the rectum. This muscle originates at the back of the pubic bone as well as the anterior part of the obturator fascia, the tendinous arch of the pelvic fascia, and fuses with the deep portion of the EAS in a posterolateral or coccygeal position (Fig. 1.7). The pubococcygeal muscle originates from the anterior part of the tendinous arch of the pelvic fascia. The medially oriented fibers partly intermingle with the longitudinal layer of the muscular coat of the rectum and join the contralateral portion of the same muscle through a raphe, in a midline position behind the rectum. The laterally oriented fibers of the pubococcygeus course straight to the coccygeal bone. The pubococcygeus and the puborectalis muscles are more or less continuous in the craniocaudal direction, although the different components can be clearly distinguished in early fetal life [10].

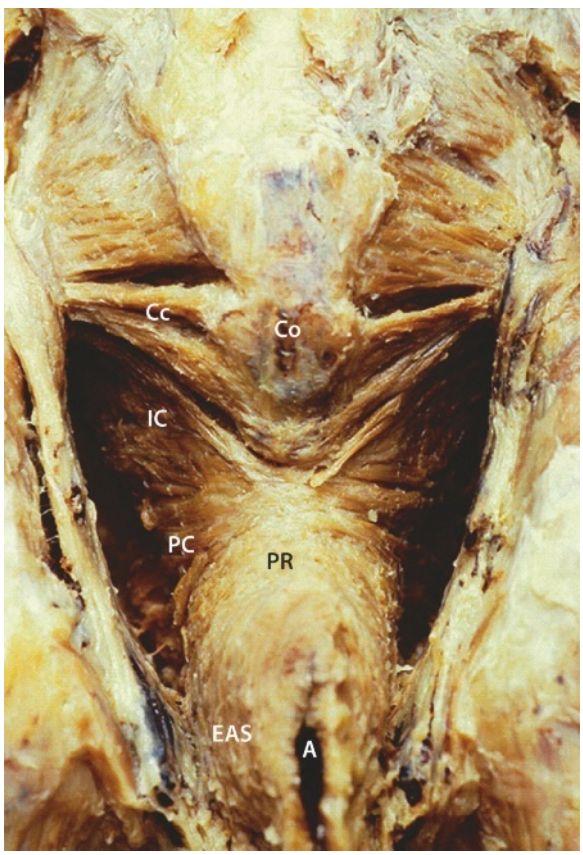


Fig. 1.7 Striated, funnel-shaped pelvic diaphragm (levator ani muscle). Dorsocaudal aspect. *A* Anal orifice, *Co* coccygis, *Cg* coccygeus, *PR* puborectalis, *PC* pubococcygeus, *IC* iliococcygeus, *EAS* external anal sphincter muscle. Reprinted from Fritsch et al. (2004; p 18) [11]

The iliococcygeus is interposed between the puborectalis and the pubococcygeus, originating from the lateral-most part of the obturator fascia, and terminates at the coccygis. It forms the supportive component of the pelvic floor, preventing the pelvic organs from prolapsing.

All components of the levator ani muscle are innervated by direct branches of the sacral plexus (S3–S4), which lie below the superior fascia of the pelvic diaphragm.

1.3.6.2 The CCR and Anal Canal

The CCR (Fig. 1.3) is described as an arteriovenous cavernous network without interposition of a capillary system [24], located within the rectal submucosa above the dentate line at about 3–5 cm from the anal verge, which is already visible in the early fetal stages [1]. It is covered by the transition zone, which consists of simple or multilayer, but never by keratinized cylindrical epithelium. It is filled functionally – but not nutritively – by terminal branches of the SRA that contribute exclusively to the arterial blood supply of the CCR. The filling of the CCR results in a gas-tight closure of the anal canal. A second nutritive vascular system exists within the rectal muscle layers with collateral anastomoses between the SRA and the inferior rectal artery. This might explain why even short rectal stumps are sufficiently vascularized after resection of ultralow rectal cancers shortly

above the dentate line; namely, they receive sufficient blood supply from the inferior rectal artery.

Drainage of the CCR is provided by the transsphincteric portal veins of the anal canal. The CCR is further intermingled by smooth-muscle fibers (the musculus canalis ani) that stabilize the CCR and are torn apart during vascular hyperplasia of the CCR in hemorrhoidal disease. The shape of the CCR in the axial plane depends on the course of the terminal branches of the SRA and is thicker in dorsolateral and thinner in the ventral position. It is also enlarged in the elderly persons. The CCR extends from the anorectal (pectinated, dentate) line to the anorectal junction and is adjacent to the upper half of the internal anal sphincter (Fig. 1.3).

The CCR is responsible for the appearance of the anal columns and the adjacent anal sinuses. The excretion ducts of the anal glands terminate within the anal crypts at the dentate line. As described in the developmental part of this chapter (see Sect. 1.2), the epithelial border between the ectoderm and endoderm is situated where epithelial proliferation creates the anorectal (pectinated, dentate) line.

1.4 Pelvic Floor Topography

1.4.1 The Pelvic Connective-Tissue Compartments

According to the classical literature, the pelvic connective tissue is subdivided into several peri- and paravisceral spaces or subcompartments, which contain various ligamentous structures that are considered important for the fixation of various organs. This subdivision agrees with neither the clinical nor the functional requirements, nor with the developmental origin of the various structures. Working from the embryological background of the pelvic region [5, 7, 11], a new morphological subdivision into three connective-tissue compartments can be created: a posterior compartment, a middle compartment that exists only in the female, and an anterior compartment (Fig. 1.8). All of these compartments join caudal to the perineal body.

1.4.1.1 Posterior Compartment

This compartment can be further divided into two subcompartments. A narrow presacral subcompartment, situated in front of the sacrum, is covered by the pelvic parietal fascia (presacral fascia), and contains the presacral veins. The large perirectal subcompartment is arranged around the rectal wall. It is broad dorsally and laterally, and in most cases thinner ventrally according to the course of the terminal branches of the SRA (Fig. 1.9). It diminishes in the craniocaudal direction and ends before the levator ani wraps around the anorectal junction. The perirectal subcompartment contains the rectal adventitia (i. e., the connective and adipose tissue that develops in the neighborhood of the superior rectal vessels and the rectal lymph nodes; Fig. 1.9). The clinical term for the rectal adventitia is "mesorectum," and was coined by Heald et al. [13]. An outer lamella of dense connective tissue covers the rectal adventitia and is called "rectal fascia" [6]. Laterally, the rectal fascia is accompanied by the uterosacral ligaments in the female (Fig. 1.9), whereas in the male the inferior hypogastric plexus is attached directly to the rectal fascia. Ligamental fixation structures to the lateral pelvic wall ("lateral stalks") do not exist. At the ventral border the rectal fascia is joined by dense connective tissue, bundles of smooth-muscle cells and nerves constituting the so-called rectogenital (rectoprostatic/rectovaginal) septum.

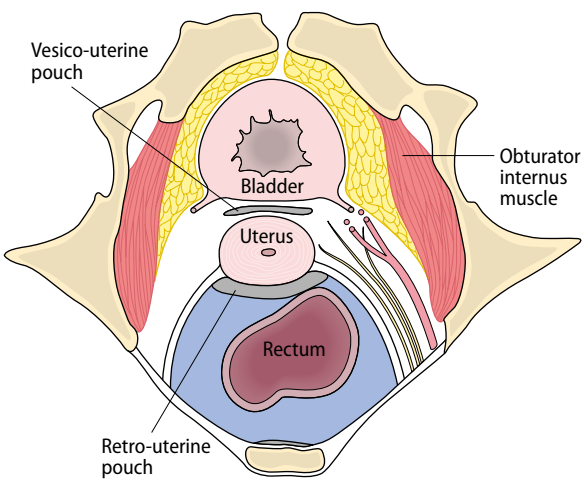


Fig. 1.8 Pelvic floor connective tissue compartments (anterior, middle and posterior). The nerve–vessel plate for the urogenital organs is located medial to the paravisceral fat pad (*yellow*). The perirectal tissue subcompartment or mesorectum (*blue*) forms an envelope around the rectum and contains the rectal vessels, nerves, and lymphatics Reprinted with permission from Fritsch (2005; p 274) [8]

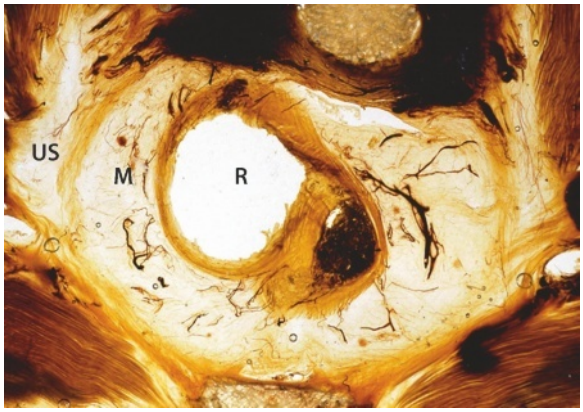


Fig. 1.9 Axial plastinated section through a female adult pelvis showing the mesorectum (*M*) and the uterosacral ligament (*US*) closely attached to the mesorectal fascia. The uterosacral ligament extends from the perivaginal/pericervical connective-tissue compartment to the area of the sacrospinous ligament. *R* Rectum. Reprinted with permission from Fritsch (2005; p 274) [8]

1.4.1.2 Anterior Compartment

The predominating structure within the anterior compartment is a large paravisceral fat pad (Fig. 1.8) situated between the obturator internus muscle laterally, and the bladder and urethra medially. This fat pad develops in situ and is not subdivided by dense connective-tissue structures. The nerve–vessel plate is situated on the medial side of the fat pad.

The neck of the bladder is connected to the pubic bone by the pubovesical or "puboprostatic" ligament, which contains a mixture of dense connective tissue and smooth muscle fibers [4].

1.4.1.3 Middle Compartment

The middle compartment is interposed between the anterior and posterior compartments only in the female pelvis. It contains adventitial tissue covering the uterus and vagina, and the uterosacral ligament, which runs in a dorsolateral direction from the mesometrium to the level of the sacrospinous ligament. A cardinal or transverse uterine ligament does not exist, as demonstrated in our developmental studies [11].

1.4.2 The Rectogenital Septum

The anterior border of the posterior pelvic compartment is clearly marked in both female and male pelves by the rectovaginal or rectovesical fascia (Denonvilliers' fascia) [3]. The morphology and innervation of the "rectogenital septum" develop by mesenchymal condensation in the early fetal stages (postcoital week 9). It constitutes an incomplete ventrocranial partition between the rectum and the urogenital organs and is completed caudally by the perineal body. The septum can easily be separated from the muscular components of the rectovesical/rectouterine pouch cranially, and a close relationship with the fascial structures of the lateral pelvic wall is not demonstrable at any level. The density of these collagenous fibers increases throughout fetal development, and smooth muscle cells are integrated into the coronal plate in front of the rectal wall (Fig. 1.10). These longitudinally oriented smooth-muscle fibers can be easily traced back to the ventral rectal wall, level with the middle transverse fold of the rectum (fold of Kohlrausch), splitting into muscle fibers located between the sphincter muscles on the one hand, and covering the anal sphincter muscles in the ventral position on the other (Fig. 1.11). The muscle fibers do not show any morphologic proximity to the external urethral sphincter, but form instead a septal unit with the connective tissue as part of the rectogenital septum [2, 21]. The fibers terminate within the perineal body.

Autonomic nerve fibers originate from the inferior hypogastric plexus at the lateral pelvic wall (see Sect. 1.3.4) and form a complex of interlacing postganglionic sympathetic, preganglionic parasympathetic, and afferent pelvic nerve fibers of variable dimensions between the fibrous connective tissue of the septum medially and the pelvic parietal tissue laterally (Fig. 1.12a). Behind the bladder, the nerve fibers are located between the septal structures ventrally and the ventral rectal wall dorsally. More caudally, the rectogenital septum moves toward the capsule of the prostate in the male pelvis, and the back of the vagina in the female pelvis, whereas a respective amount of nerve fibers reaches the urogenital organs by following the septum. A close relationship between the nerve fibers attached to the rectogenital septum and the intrinsic enteric nervous system of the rectum (longitudinal and circular muscular plexus) suggests a possible "coinnervation" of both rectal muscle layers and the longitudinal muscle bundles of the septum (Fig. 1.12b). These

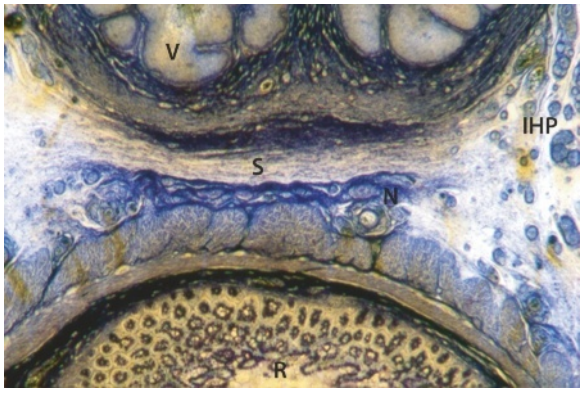


Fig. 1.10 Axial plastinated section through a female fetal pelvis (postcoital week 24). Magnification ×5. The rectogenital septum (*S*) in close proximity to the ventral rectal wall is demonstrated, with nerve fibers (*N*) arising from the inferior hypogastric plexus (*IHP*) and joining the septum. *R* Rectum, *V* vagina. Reprinted with permission from Aigner et al. (2004; p 135) [2]

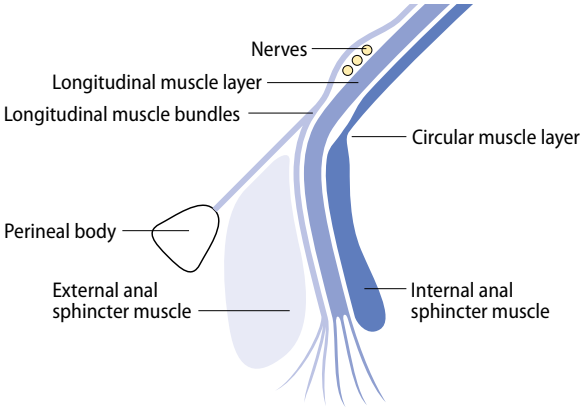
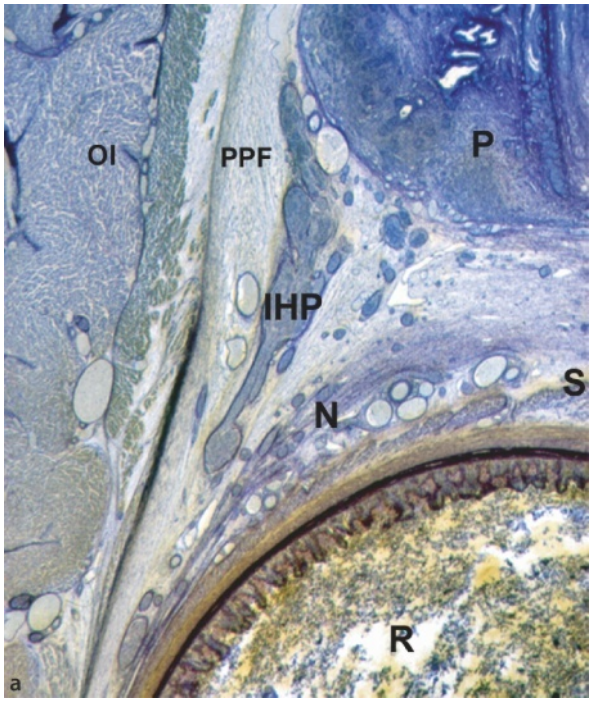


Fig. 1.11 Schematic illustration of a sagittal section through the ventral rectal wall. The muscular coat of the rectum consists of a circular (*dark blue*) and a longitudinal (*mid-blue*) layer. Additional longitudinal muscle bundles (*light blue*) are shown on the one hand splitting into muscle fibers located between the sphincter muscles, and on the other covering the anal sphincter muscles in the ventral position. The latter contribute to the rectogenital septum and terminate in the perineal body. Reprinted with permission from Aigner et al. (2004; p 134) [2]



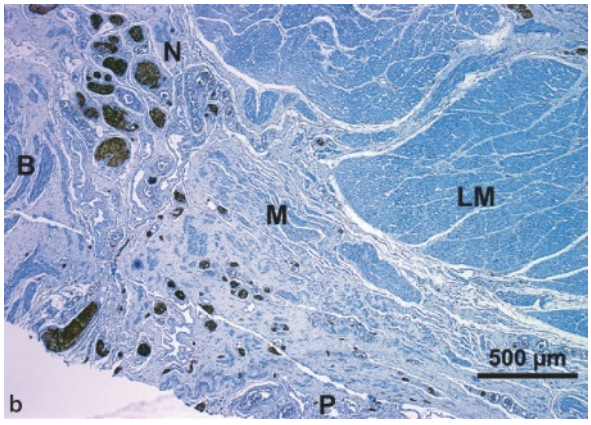


Fig. 1.12 **a** Axial plastinated section through a male fetal pelvis (postcoital week 24). Magnification ×5. Autonomic nerve fibers (*N*) are shown arising from the inferior hypogastric plexus (*IHP*), coursing toward the rectogenital septum (*S*). *R* Rectum, *P* prostate, *PPF* parietal pelvic fascia, *OI* obturator internus muscle. **b** Immunostaining for protein S-100 (*brown*) in autonomic nerve fibers (*N*) passing through the rectogenital septum, with the prostate (*P*) and bladder (*B*) located ventrally, and the rectum, with the longitudinal muscle layer (*LM*), located dorsally. Male (6 years) sagittal, paraffin-embedded section, magnification ×5. Longitudinal muscle bundles within the rectogenital septum (*M*). Reprinted with permission from Aigner et al. (2004; pp 131–140) [2]

longitudinal muscle bundles and their ramifications hypothetically play a physiological role as an "anal dilator" system capable of foreshortening and opening the anal canal during defecation, similar to Dorschner's description of the musculus dilatator urethrae [4]. Thus, the intrinsic sensory innervation of the rectogenital septum might be crucial for rectal filling and asymmetric rectal distension.

Improvements in the results of potency- and continence-preserving rectal resections (where the caudal portion of the ventral rectal wall including the septum is left undissected) [22] underscore the clinical importance of the rectogenital septum. Maintaining the integrity of the distal rectogenital septum may prevent a later development of low rectoceles and midrectoceles [2].

1.4.3 The Perineal Body

The perineal body consists of dense connective tissue and separates the urogenital from the anal hiatus. It is intermingled with numerous originating and inserting muscles (subcutaneous or superficial portion of the EAS, longitudinal anal muscle, bulbospongiosus and superficial transverse perineal muscle), along with the longitudinal smooth muscle fibers of the rectogenital septum (Fig. 1.13). It should be considered a tendinous center for those muscles with no bony origin or attachment. There is no doubt that it is to some extent an important region for absorbing the intrapelvic (intra-abdominal) pressure. Stretching or any other injury to the perineal body (e. g., obstetric trauma) may result in rectal and genital prolapse. Thus, the perineal body is regarded as an integral component of both the urinary and fecal continence mechanisms.

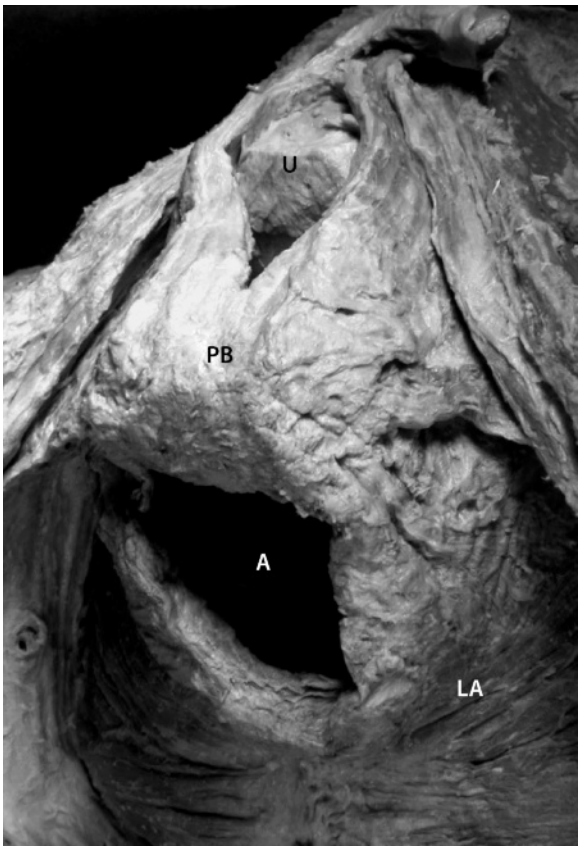


Fig. 1.13 Dissection specimen of the perineal body (*PB*), situated between the urogenital (*U*) and the anal hiatus (*A*). *LA* Levator ani muscle. Its tendinous center serves as the insertion area for all pelvic floor muscles that have no bony origin or attachment. Reprinted with modifications from Fritsch (2006; p 2) [9]

1.5 Conclusion

In conclusion, a thorough knowledge of the topography of the abdominal cavity and the pelvic floor, including anorectal anatomy and the development and subdivision of the pelvic floor connective tissue, is mandatory for the pelvic surgeon to understand the functional mechanisms of the anorectal continence system. The anatomical borders, which are already visible in the early fetal stages, serve as landmark structures during continence- and potency-preserving resections.

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Self-Assessment Quiz

Question 1

The cranial border of the embryonic cloaca is formed by:

a. The ectodermal urorectal septum
b. The mesodermal urorectal septum
c. The rectogenital septum
d. Does not exist
e. The cloacal membrane

Question 2

Which of the following nerve structures does not belong to the pelvic autonomic nerve system?

a. Celiac plexus
b. Inferior rectal nerves
c. Hypogastric nerves
d. Inferior hypogastric plexus
e. Pelvic plexus

Question 3

The arterial blood supply to the corpus cavernosum recti (CCR) is provided mainly by terminal branches of:

a. The inferior rectal artery
b. The middle rectal arteries
c. The superior rectal artery
d. The obturator artery
e. The common iliac arteries

Question 4

Which of the following statements is correct?

a. The anal sphincter complex comprises the mesoderm-related external anal sphincter muscle and the ectoderm-related internal anal sphincter muscle.
b. The anal sphincter complex comprises the endoderm-related levator ani and external anal sphincter muscle.
c. The anal sphincter complex comprises endodermal as well as ectoderm-related muscles.
d. The levator ani muscle consists of supportive and sphincteric components.
e. The internal anal sphincter muscle belongs to the bilaterally organized mesoderm-related portion of the anal sphincter complex.

Question 5

Which of the following statements regarding the rectogenital septum is incorrect?

a. The rectogenital septum consists of dense connective tissue and longitudinal smooth muscle fibers.
b. The rectogenital septum develops locally when the density of mesenchymal tissue increases between the urogenital organs and the anorectum.
c. The rectogenital septum is attached to the lateral pelvic wall and prevents prolapse of the anorectum.
d. The rectogenital septum is an important landmark structure for the pelvic surgeon during low anterior resection of the rectum.
e. Groups of parasympathetic ganglia can be found within the lateral borders of the rectogenital septum and indicate intrinsic innervation of the septum for defecation.

1. Answer: b
Comment: The embryonic cloaca consists of a ventral diverticulum, the allantois, a dorsal diverticulum, the embryonic hindgut, and a common cloacal cavity, and is lined with endoderm. The cranial border is marked by the mesodermal urorectal septum. The opposing ventral border is identical to the cloacal membrane, where the internal endoderm is covered by an outer layer of ectoderm. Ventrocaudally, the cloacal membrane extends from the genital tubercle anteriorly to the tail groove posteriorly.
2. Answer: a
Comment: The celiac plexus belongs to the abdominal autonomic nerve system attached to the celiac trunk and is therefore not located within the pelvis. The inferior rectal nerves originate from the autonomic inferior hypogastric plexus and contribute to the innervation of the smooth internal anal sphincter muscle. The bilaterally organized hypogastric nerves contain postganglionic sympathetic nerve fibers that supply the inferior hypogastric plexus at the lateral pelvic wall. The pelvic plexus is the parasympathetic component of the inferior hypogastric plexus.

3. Answer: c
Comment: The CCR is filled functionally – but not nutritively – by terminal branches of the superior rectal artery that contribute exclusively to the arterial blood supply of the CCR. The inferior rectal artery contributes mainly to the blood supply of the anal sphincter muscles and the perineum. The middle rectal artery is remarkably variable and often appears only unilaterally.
4. Answer: d
Comment: The internal anal sphincter muscle forms a continuation of the circular layer of the muscular coat of the rectum and therefore belongs to the unilaterally organized, endoderm-related components of the anal sphincter complex. The striated external anal sphincter and levator ani muscles form the bilaterally organized, mesoderm-related part of the anal sphincter complex.
5. Answer: c
Comment: The rectogenital septum is easily separated from the muscular components of the rectovesical/rectouterine pouch cranially. A close relationship between the fascial structures of the lateral pelvic wall is not demonstrable at any level. The density of these collagenous fibers increases through fetal development, and smooth muscle cells are integrated into the coronal plate at the rectal wall.

2 Anorectal and Pelvic Floor Physiology

Søren Laurberg and Klaus Krogh

CONTENTS

2.1 Introduction

Normal continence and defecation is achieved through a complex interaction between peroral intake, the upper gastrointestinal tract (digestion, secretion and propulsion), and colorectoanal function. Accordingly, continence and defecation can be severely disturbed secondary to abnormal eating patterns or disturbed digestion and propulsion in the small bowel. This is, however, outside the scope of the present chapter. In clinical practice anorectal function cannot be interpreted without considering colonic function, which is therefore included in the following discussion.

The main functions of the colorectum are absorption (water, electrolytes, and short-chain fatty acids), transport, and storage. Absorption occurs mainly in the right colon. The main function of the left colon is storage of stools and, together with the rectum, the pelvic floor, and the anal canal, it is responsible for continence and defecation. The mechanisms underlying continence and defecation are interdependent, and in the majority of patients with functional problems both are affected to a varying degree.

2.2 General Aspects of Colorectal Motility

2.2.1 Colonic Motility

Contractions are either phasic or tonic [16]. Phasic colonic contractions last a few seconds and cause elevated intraluminal pressure [16, 26]. They are single, nonpropagating contractions or mass contractions. Single, nonpropagating contractions occur very frequently and include shorter or longer segments of the colon [8, 31]. The main function of these contractions is to mix the colonic luminal content, thereby promoting absorption, or to move the colonic content over a small distance [8]. The mass contractions are high-amplitude propagating contractions that only occur a few times a day, usually originating in the right colon, and span

large parts of the colon, propelling the content distally [4, 8, 17]. Mass contractions are generated mostly in the daytime and especially upon awakening or after meals (the gastrocolic response) [17, 33]. The main function of mass contractions is colonic transport.

The tonic contractions are less well-defined, longer lasting – usually several minutes – and may not be associated with increased luminal pressures [16, 26]. Movements of colonic contents are often not associated with detectable pressure changes and may be due to changes in colonic tone [8]. Two types of tone have been described: a tetanic tone that is generated by fused phasic contractions, and a specific tone that is regulated mainly by chemical processes [16].

2.2.2 Rectal Motility

Rectal motility resembles the colonic pattern, with some colonic mass contractions progressing to the rectum, often initiating defecation [17, 32, 33]. There are, however, some differences. The main difference is the powerful phasic contractions, termed rectal motor complex (RMC), which occurs approximately every 60–120 min [13, 17, 33]. They have a frequency of 3–10 contractions per minute and last for several minutes [33]. They are very similar to phase three of the migrating motor complex within the small bowel. RMCs are often restricted to a single short segment of the rectum, but they may propagate either orally or anally, and they are often associated with contractions of the colon [33] and the anal canal [13]. Accordingly, their main function may be to prevent defecation.

2.3 Generation and Control of Colorectal Motility

Smooth muscle cells within the circular and longitudinal colorectal muscle layers are arranged in bundles that are connected by gap junctions. Bundles fuse at many points and thereby function as a syncytium. The resting membrane potential of the smooth muscle cells undergoes small undulating changes called slow waves. These are generated by the pacemaker cells (interstitial cells of Cajal) [9]. The slow waves do not cause contractions, but they do influence the frequency of spike potentials. During spike potentials, calcium enters the smooth muscle cell causing contraction of the colorectal wall.

Many factors, including neuronal, mechanical, hormonal, and immunological, influence the occurrence of spike potentials and thereby colorectal motility. However, the interactions are not fully understood. Colorectal motility is controlled by the nervous system, hormones, and the immune system. The neuronal system modifies colorectal motility at four levels [41]:

1. The enteric nervous system (ENS)
2. The prevertebral sympathetic ganglia
3. The parasympathetic and sympathetic systems within the brainstem and spinal cord
4. The higher brain centers

2.3.1 The Enteric Nervous System (ENS)

The ENS contains about the same number of neurons as the spinal cord and its function is only vaguely understood. Its sensory neurons are specialized for the detection of mechanical stimuli, temperature, and chemical properties. Through multiple interneurons, such stimuli affect the motor neurons that finally stimulate or inhibit smooth muscle cells. The interneurons also integrate stimuli from other parts of the ENS, the autonomic system, and hormones [41]. The ENS integrates several local reflexes (i.e., the distension reflex where distension registered by mechanoreceptors causes contractions orally and relaxation distal to the site). These reflex patterns can be modified by the autonomic nerve system via interneurons. Many different neurotransmitters either stimulate (e. g., acetylcholine, histamine, serotonin, cholecystokinin, motilin, gastrin) or inhibit (e. g., dopamine, noradrenalin, glucagon, vasoactive intestinal peptide, enkephalin, somatostatin) motility. Moreover, receptors for several of these transmitters (e. g., histamine and serotonin) have been divided into several subgroups, and specific agonist and antagonist have been developed that have, or in future may have, a clinical role.

2.3.2 The Prevertebral Sympathetic Ganglia

The second level of integration and control is within the prevertebral sympathetic ganglia and nerves [41]. These are considered to be the most important mediators of the gastrocolic response mediating colorectal phasic and tonic activity after a meal.

2.3.3 The Parasympathetic and Sympathetic System Within the Brainstem and Spinal Cord

The oral part of the colon approximately to the left flexure receives parasympathetic innervation from the vagal nuclei in the brainstem, while the distal colon and rectum are innervated from parasympathetic neurons in the sacral segment of the spinal cord. Parasympathetic activity stimulates colorectal motility, and if it is lost, colorectal reflex activity becomes severely reduced [22]. A clinical example of major importance is a lesion of the cauda equina that leads to severe defecation problems due to reduced reflex activity and tone in the left colon and rectum [22, 23].

Sympathetic activity reduces colonic phasic activity and tone [6]. The sympathetic fibers to the colorectum originate in segments T9–L2 and reach the mesenteric ganglia through the sympathetic chain, and from there postganglionic fibers reach the bowel. Observational studies suggest that they have only a minor effect on colorectal transport.

2.3.4 Higher Brain Centers

The frontal cortex, the stria terminalis, the amygdala, and the hypothalamus supply information that is integrated in the autonomic system [41]. Little is known about this interaction, but the action of higher brain centers is probably mainly inhibitory. Thus, patients with supraconal spinal cord lesions have increased left colonic and rectal reflex activity and tone [12, 22].

2.3.5 Colorectal Sensibility

Nonconscious sensory information is mediated via parasympathetic afferents in the vagal nerve to the brainstem or through the splanchnic nerve to the sacral spinal cord [41]. Painful stimuli are mediated through sympathetic afferents to the spinal cord [41]. Apart from inflammatory and chemical stimuli, the colon and rectum are only sensitive to stretch [34]. The subjective experience of rectal distension is a feeling of rectal fullness and the urge to defecate, while colonic distension produces pain and colic [15]. The location of rectal stretch receptors is controversial and it has been suggested that they are located outside the rectal wall in the adjacent pelvic structures.

2.3.6 Hormonal- and Immune-System Control of Colorectal Motility

Thyroid hormones stimulate colorectal motility and epinephrine reduces it. Once the immune system in the bowel wall becomes sensitized to a specific antigen, a second exposure will cause release of histamine and other messengers from the mast cells. The histamine will stimulate electrolyte, water, and mucus secretion, and promote strong contractions called power propulsions. These span large distances of the bowel [41], thereby quickly clearing potentially harmful antigens from the lumen.

2.3.7 Colorectal Transit Time

The total and segmental colorectal transit times are highly variable, and colonic transit time may be up to 4 days in asymptomatic subjects. The transit time is usually longer in the right colon than in the left colon and rectum [2], reflecting the fact that the main function of the left colon and rectum is storage.

In healthy subjects stool frequency and consistency correlates better with the rectosigmoid transit time than with the total transit time, while stool volume correlates with total colonic transit time. Stool weight in the Western world is usually 100–150 g/day, while it in rural Uganda its upper limit is as much as 500 g/day. This is most likely a reflection of the much higher intake of dietary fibers in Uganda, mainly bran, that do not undergo fermentation and thereby retain water.

2.4 The Anal Canal

The main functions of the anal canal are to maintain continence and to allow the passage of flatus and feces at an appropriate time and place. In the anal canal the somatic, intrinsic, and autonomic nervous systems are intimately linked.

The internal anal sphincter (IAS) is a direct caudal continuation of the circular muscle layer of the rectum and it consists of smooth muscles cells. Its main function is to contribute to the anal resting pressure [24, 30]. The anal resting pressure decreases with age, and in women also with increasing number of childbirths. The pressure is not constant, but undergoes undulating changes, the so-called slow waves, with low amplitude and a frequency of 10–20/min [37, 40]. Superimposed,

there are contractions and relaxations associated with changes in rectal pressure and diameter. The IAS is not under voluntary control, but is innervated by sympathetic fibers via the splanchnic nerves, and from parasympathetic fibers from the second to fourth sacral segments of the spinal cord. The sympathetic nervous system stimulates the IAS, while the action of parasympathetic nervous system is unclear.

The external anal sphincter (EAS) muscle is composed mainly of slow-twitch striated muscle fibers. It contributes to the resting anal pressure, but its main function is to generate the anal squeeze pressure [24, 30]. The EAS is partly under voluntary control via Onuf's motor nucleus in the spinal cord [29]. The nerves reach the muscle through the pudendal nerve and the perineal branch of the fourth sacral nerve.

Contraction of the puborectalis muscle creates the anorectal angle, and it is supposed that this creates a valve mechanism, which contributes to anal continence [30].

2.4.1 Anal Sensibility

Specific sensory receptions are numerous through the anal canal, and in contrast to the rectum, the anal canal is extremely sensitive to touch, temperature, and movement within its lumen [15, 34].

2.4.2 Rectoanal Reflexes

The pressure within the anal canal is related to the status of the rectum by several reflexes [37]. The anal sampling reflex consists of a regularly occurring, short-lasting relaxation within the upper anal canal, with a simultaneous contraction of the upper rectum and relaxation of the distal rectum [11]. Thus, contents can be moved from the rectum into contact with the mucosa of the upper anal canal and it is assumed that sensory receptors therein can determine the nature of the content (solid stool, liquid stool, or gas). After a short time the anal pressure is normalized and the content is forced back to the rectum [11]. The clinical relevance of this reflex remains to be established.

Another reflex is the rectoanal inhibitory reflex, which mediates relaxation of the IAS during a rectal distension (Fig. 2.1) [10, 22]. It is a local reflex that is conducted through intramural nerve fibers [10]. It is absent in Hirschsprung's disease.

2.5 Defecation

Defecation is normally preceded by colonic mass movements that bring fecal colonic contents into the rectum. The distention of the rectum further stimulates contractions of the colon via a reflex mediated by the ENS and by the parasympathetic defecation reflex [14]. This leads to a phasic contraction and an increase in rectal tone, thereby changing the rectum from a capacious reservoir into a conduit.

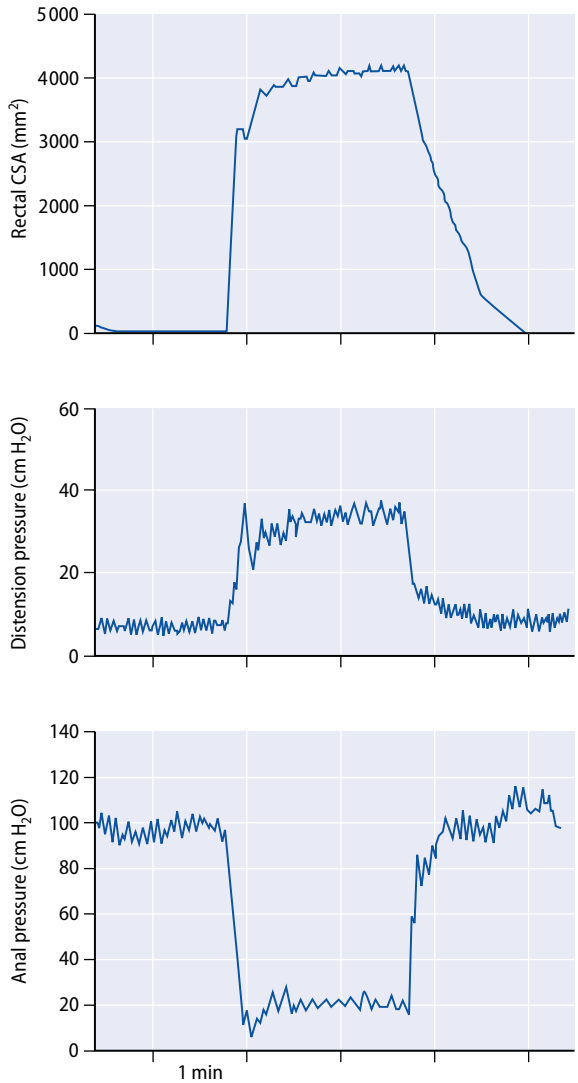

Fig. 2.1 The rectoanal inhibitory reflex. During rectal distension the rectal cross-sectional area (*CSA*; *top*) and pressure (*middle*) increase while the internal anal sphincter muscle and the anal pressure decrease (*bottom*)

The distention of the rectum stimulates the rectoanal inhibitory reflex, leading to a relaxation of the IAS [10, 22]. In addition there may be a direct coloanal reflex, whereby the IAS is relaxed simultaneously with colonic mass movement. The process in enhanced by increasing the abdominal pressure through a Valsalva maneuver [14]. The puborectalis voluntarily relaxes to increase the angle, and the external sphincter relaxes to open the anal canal. The defecation process can be blocked by voluntary contraction of the EAS and puborectalis, and the defecation reflex will gradually subside and the rectal compliance increase [14]. If the defecation reflex is interrupted due to damage to the reflex between the left colorectum and sacral spinal cord, defecation is severely disturbed, with a prolonged and incomplete evacuation, as seen in patients with cauda equina lesions [23].

2.6 Methods to Study Anal, Rectal, and Colonic Function

A variety of tests has been developed to study different aspects of colorectoanal function. Some of these tests are used in everyday clinical practice, while others have been used mainly for research in order to increase our understanding of the normal function and the pathophysiology of various diseases [5]. None of the tests are useful outside a clinical setting, which must include a detailed history, objective evaluation, and a diary regarding the patient's bowel function. There is generally a substantial overlap between normal subjects and patients. Furthermore, there are substantial inter- and intraindividual variations for the majority of the tests. The normal range depends upon age and gender. Therefore, the outcome of all tests must be considered in association with the patient's symptoms and interpreted with caution.

2.6.1 Anal Manometry

Various techniques (closed, open perfused, chip transducer, vector manometry) have been developed to measure the anal resting and squeeze pressures in order to estimate the function of the IAS and EAS [27, 36]. The normal range is dependent upon the methods used, age, and gender. The rectoanal inhibitory reflex is present if a balloon dilatation of the rectum leads to a reduction in resting anal pressure [10, 22].

2.6.2 Electrophysiology

These tests have been developed to improve our understanding of the mechanisms underlying sphincter weakness and dysfunction. The pudendal nerve terminal motor latency measures the latency from the stimulation of the pudendal nerve just distal to the ischial spine to the contraction of the EAS (Fig. 2.2). It is an indirect measurement of the conduction velocity of the nerve supplying the EAS. This latency may be prolonged secondary to traction or compression damage to the pudendal nerve [18, 19]. Using either conventional electromyography or single-fiber electromyography, the underlying neuropathic damage with denervation followed by reinnervation can be demonstrated. It is also possible to study the latency in afferent fibers. The electrophysiological test is used primarily in a scientific setting.

2.6.3 Transanal Ultrasonography and MRI

Transanal ultrasonography has been used increasingly to investigate the integrity of the IAS and EAS (Fig. 2.3). The investigation is quick and easy to perform, and the

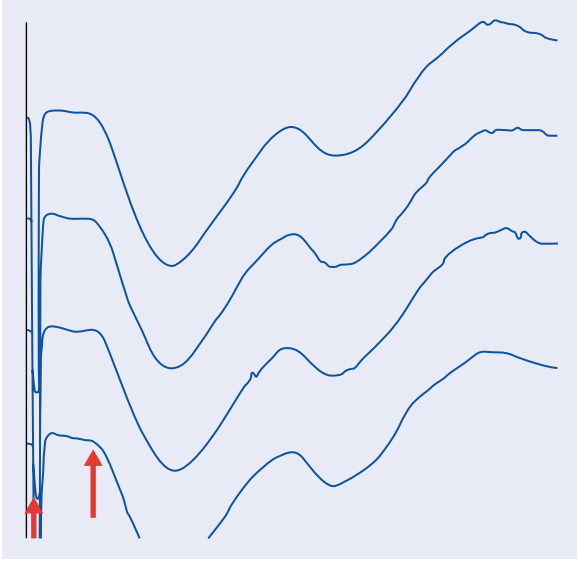

Fig. 2.2 The pudendal nerve terminal motor latency measures the latency from the stimulation of the pudendal nerve just distal to the ischial spine (spike due to electrical stimulation, *short arrow*) to the contraction of the external anal sphincter muscle (*long arrow*)

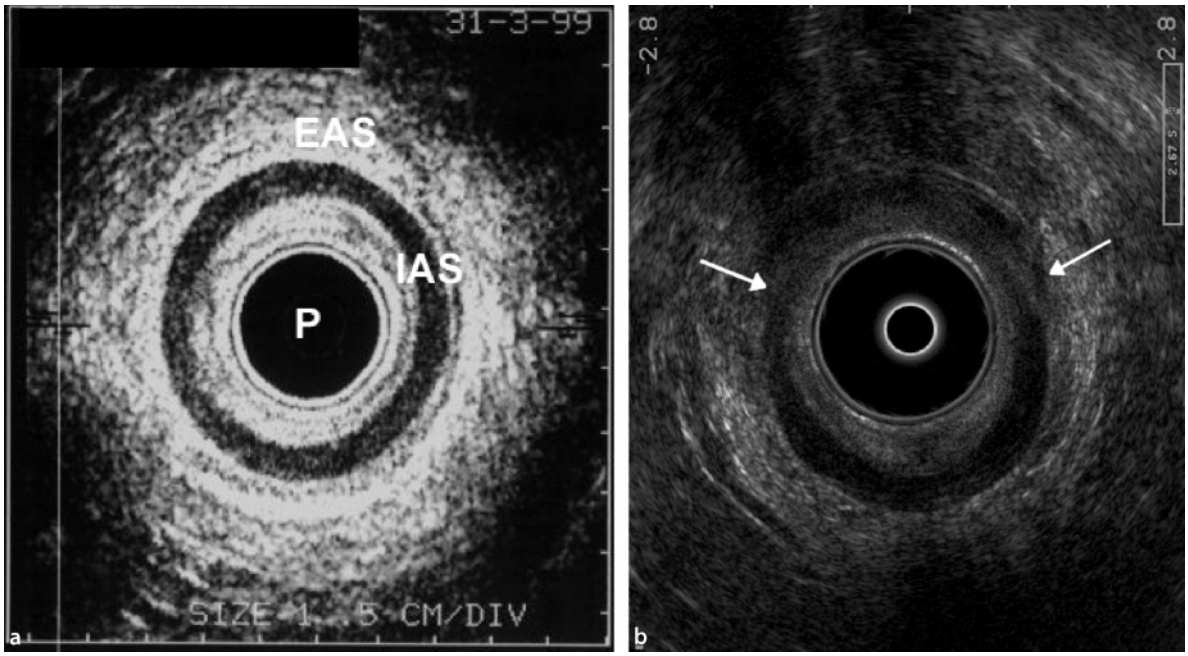

Fig. 2.3a,b Transanal ultrasonography. **a** Intact internal anal sphincter muscle (*IAS*) and external anal sphincter muscle (*EAS*). The *central dark spot* is the probe (*P*). **b** Anterior lesion (*arrows*) of the internal and external anal sphincter muscles (*bottom*)

dimensions of the anal sphincters can be measured simultaneously [3, 38]. A competitive technique is magnetic resonance imaging (MRI) of the sphincters. MRI can also detect atrophy of the EAS muscle and pelvic floor [35]. However, MRI is much more expensive and it is not available at all institutions.

2.6.4 Rectal Capacity, Distensibility and Compliance

Rectal distensibility and capacity can be measured using an air- or water-filled bag [7, 21, 25]. Rectal compliance during distention can be calculated from the pressure–volume curve. During the filling, the thresholds for first perception, desire to defecate, and maximal tolerated capacity is recorded. The test has the same limitations as anal manometry and, due to differences in techniques used, the normal range varies by up to 300% between centers [25].

2.6.5 Anal Sensation

The sensitivity within the anal canal can be measured by determining the threshold for sensation following electrical stimulation. It is a simple and reproducible test, which has been used primarily in a scientific setting.

2.6.6 Colorectal Transit Time

In clinical practice, total and segmental colonic transit times are most often determined by means of radiopaque markers (Fig. 2.4) [1, 2]. These can be counted either in the stool or on plain abdominal x-rays. In its most simple form, 24 markers are taken as a single dosage followed by one plain x-ray after a fixed time interval – often 5 days. It is thus possible to distinguish patients with prolonged transit time, but the test does not provide any quantitative information about the total or segmental colorectal transit times. The total and segmental transit times can be determined if repeated markers are taken on consecutive days [1], but this increases the cost. The information obtained is only valid if the number of days when markers are taken exceeds the gastrointestinal transit time. Compliance is a problem, since patients have to take markers each day [1].

Scintigraphy can also be used for the determination of transit time. It is superior to radiopaque markers for the determination of gastric and small-bowel transit,

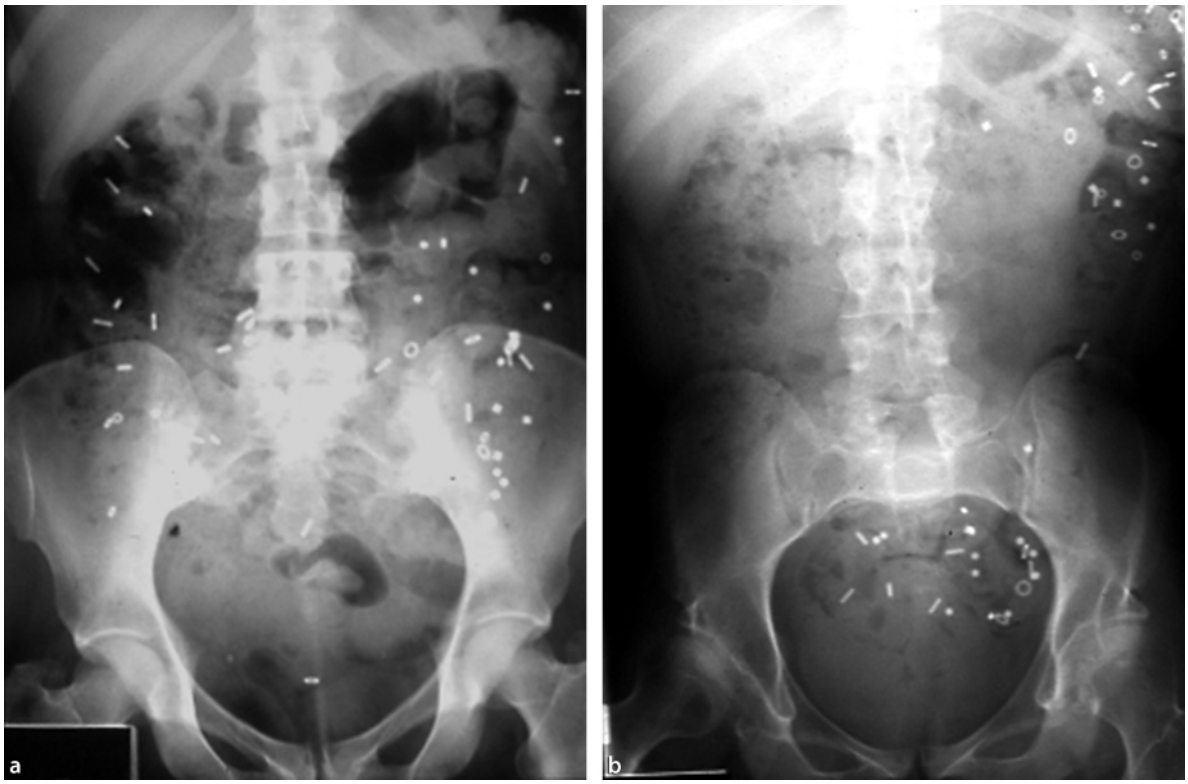

Fig. 2.4a,b Segmental colonic transit time determined by means of radiopaque markers. Generalized slow-transit constipation (**a**) and left-sided constipation (**b**)

but it does not provide better information about colorectal transit time. Furthermore, it is more expensive and gives a higher irradiation dose.

Interindividual variations in colonic transit times are large, and it is a concern that many patients with subjective complaints of constipation have a normal transit time. Moreover, the markers could behave differently from the bowel content and the content may not be homogeneous.

2.6.7 Colorectal Emptying

Various tests have been developed to study colorectal changes during defecation. In anal physiology laboratories, a balloon expulsion test has been used. A party balloon is placed in the rectum and inflated with 50 ml of warm water. The electromyographic (EMG) activity of the EAS is recorded with a cutaneous electrode. The patient is placed in a sitting position and asked to expel the balloon. It is recorded whether the patient can expel the balloon; the change in EMG activity is recorded simultaneously. A typical patient with paradoxical puborectalis contraction during defecation cannot expel the balloon and shows increased EMG activity in the EAS. Difficult evacuation during defecation can also be accessed by means of defecography.

A more physiological test is the defecation scintigraphy test. The patient ingests radioisotopes and when radioactivity can be detected in the left colon and the rectum, the activity is quantified before and after a normal defecation (Fig. 2.5) [23]. The test is expensive and cumbersome and therefore generally used only for research.

2.6.8 Defecography

Defecography is a dynamic imaging of the rectum. The barium mixture is instilled in the rectum, and lateral radiographs are obtained while the subject is at rest, while cuffing, during a Valsalva maneuver, and during evacuation of the barium. Various measurements can be obtained. During defecation in a typical patient with

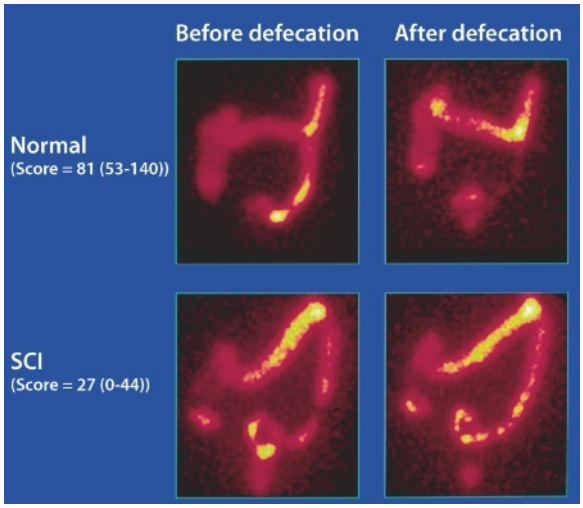

Fig. 2.5 Colorectal scintigraphy after oral intake of isotopes. Scintigraphy in a healthy subject before (*top left*) and after (*top right*) defecation, showing emptying of 81% of the contents of the rectosigmoid. Scintigraphy in a patient with disturbed defecation due to a traumatic lesion of the cauda equina before (*bottom left*) and after (*bottom right*) defecation, showing emptying of 27% of the content of the rectosigmoid

puborectalis paradox, there is a prolonged and incomplete emptying of the rectum, no descent of the pelvic floor, and the anal canal does not open up. Abnormal pelvic floor descent, rectocele, and rectal intussusception can also be recorded (Fig. 2.6). The main problem with both the balloon expulsion test and defecography is that they are unphysiological, without any normal call for defecation. Furthermore, there is a substantial overlap between healthy subjects and patients. Also, rectocele and rectal intussusception can be found in many subjects without any symptoms. Dynamic magnetic resonance defecography has recently been introduced to replace conventional defecography [28], whereby patients are not exposed to radiation, and the bladder, internal genitals, small bowel, and rectal wall are much better delineated. However, it has the same inherited problems as conventional defecography.

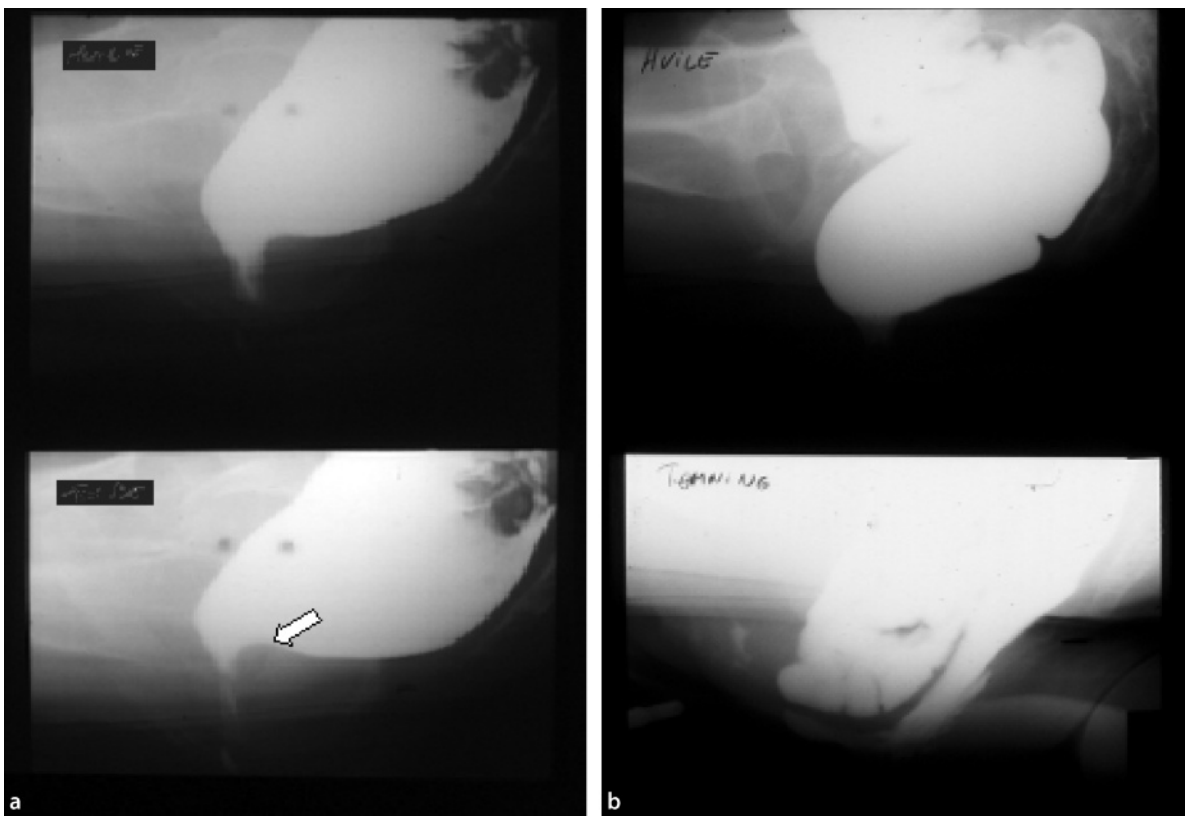

Fig. 2.6a,b Defecography. **a** Patient with obstructed defecation before (*top*) and during (*bottom*) rectal evacuation. Notice the closed anal canal and the increased impression of the puborectal muscle (*arrow*). **b** Patient with enterocele before (*top*) and during (*bottom*) rectal evacuation. Notice the enterocele (small bowel filled with barium) obstructing the rectum

2.7 Anal Continence and Normal Bowel Movements

Principally, the same factors are involved in achieving normal continence and normal bowel function. The key factors causing anal incontinence and constipation/obstructed defecation are:

1. IAS:
   a. Incontinence: mechanical lesions or atrophy
   b. Constipation: lack of the rectoanal inhibitory reflex
2. EAS and puborectalis muscle:
   a. Incontinence: mechanical lesions or atrophy
   b. Constipation: lack of relaxation during defecation
3. Rectal volumes and threshold:
   a. Incontinence: low volumes (low compliance) or high threshold
   b. Constipation: high compliance and high capacity
4. Colorectal motility:
   a. Incontinence: short transit or incomplete evacuation
   b. Constipation: slow transit or difficult evacuation

For incontinence and constipation/obstructed defecation, inappropriate function of one or more of these factors might be partly or completely compensated by other factors (i.e., mechanical lesions of the IAS or EAS may cause severe incontinence in some, but hardly any symptoms in others) [31].

2.8 Practical Guidelines for Use of Tests of Incontinence and Constipation

It is difficult to propose strict guidelines since there is no simple relationship between patients' symptoms and test results, and no test can predict the outcome of any intervention. Therefore, the test used in individual laboratories is to a large extent based on tradition. The following tests are, however, used in the great majority of laboratories treating patients with fecal incontinence or constipation.

2.8.1 Fecal Incontinence

1. Transanal ultrasonography to determine the integrity of the IAS and EAS.
2. Anal manometry to provide a baseline measurement of the strength of the IAS and EAS.
3. Rectal thresholds and compliance to provide an indication as to whether the rectum is a low- or highly compliant organ.
4. Defecography in selected cases, particularly if there is clinical suspicion of a deep rectal intussusception or an unproven full-thickness rectal prolapse.

2.8.2 Constipation or Obstructed Defecation

This is a very common problem, and the great majority of patients should only be treated by conservative means [20, 39]. Physiological tests are only indicated in highly selected patients.

1. Total colonic transit time to see if it is prolonged. In selected cases, segmental transit time may be indicated.
2. Anal manometry. The rectoanal inhibitory reflex, which for practical reasons excludes Hirschsprung's disease. Measurements of sphincter strength if colectomy is considered.
3. The balloon expulsion test is a cheap and simple test for puborectalis paradox, but it should be interpreted with caution.
4. Rectal volumes to see if there are increased thresholds and maximum tolerated volume.
5. Defecography to demonstrate difficult evacuation and rectal intussusception – but the pathology must be interpreted with caution.

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Self-Assessment Quiz

Question 1

The rectoanal inhibitory reflex:

a. Mediates relaxation of the internal anal sphincter during rectal distension
b. Mediates relaxation of the external anal sphincter during rectal distension
c. Inhibits rectal contractions during anal distension
d. Inhibits rectal contractions during external anal sphincter contraction
e. Inhibits rectal secretion during colonic mass movements

Question 2

Pudendal nerve terminal motor latency may be prolonged:

a. In spinal-cord-injured patients
b. In irritable bowel syndrome
c. In Hirschsprung's disease
d. After traction or compression damage to the pudendal nerve
e. In various connective-tissue diseases

Question 3

The following method is useful for the detection of rectal intussusception:

a. Anal manometry
b. Transanal ultrasonography
c. Colorectal transit time assessed by radiopaque markers
d. Defecography
e. Colorectal scintigraphy

Question 4

Transanal ultrasonography is mainly used for:

a. Detection of internal or external anal sphincter muscle lesions
b. Assessment of paradoxical puborectalis contraction
c. Assessment of rectal emptying after defecation
d. Computation of anal resting and squeeze pressures
e. Detection of Hirschsprung's disease

Question 5

Lesions of the cauda equina cause:

a. Increased rectal tone
b. Reduced rectal reflex activity and tone
c. Reduced rectal compliance
d. Paradoxical puborectalis contraction
e. No clinically significant changes in anorectal function

1. Answer: a
Comments: The rectoanal inhibitory reflex mediates relaxation of the internal anal sphincter during rectal distension. The reflex is mediated via intramural nerve fibers from the rectum to the internal anal sphincter muscle. It is absent in Hirschsprung's disease.
2. Answer: d
Comments: Observational studies have shown an association between prolonged pudendal nerve terminal motor latency and traction or compression damage to the pudendal nerve, usually due to childbirth.
3. Answer: d
Comments: Rectal intussusception can be detected by defecography; the intussusception is usually seen when the intra-abdominal pressure increases during staining.
4. Answer: a
Comments: Internal or external anal sphincter muscle lesions can usually be detected by transanal ultrasonography. It is important to note, however, that fecal incontinence due to anal sphincter insufficiency can be present in spite of normal findings at transanal ultrasonography. Furthermore, many subjects with anal sphincter lesions detected by transanal ultrasonography do not suffer from fecal incontinence.
5. Answer: b
Comments: Lesions of the cauda equina or the conus medullaris interrupt the reflex arch between the left colon and rectum, and the sacral spinal cord segments 2–4. This interrupts parasympathetic stimuli, thereby reducing rectal (and left colonic) reflex activity and tone (answer b). This usually leads to severely compromised rectosigmoid emptying at defecation.

3 Colonic Motility and Physiology

Kumaran Thiruppathy and Anton Emmanuel

CONTENTS

3.1 Introduction

Although the colon is not an organ essential for survival, it contributes in a major fashion to physical well-being. It plays an important role in three key homeostatic functions: (1) absorption of water and electrolytes, (2) absorption of nutrients and (3) storage and controlled evacuation of faecal material. Approximately 90% of the whole gut transit time is accounted for by colonic transit time. This prolonged transit is essential in permitting the colon to fulfil these functions. The colon can be divided functionally into two portions, the right and left colon. The right colon (caecum and ascending colon) plays a major role in water and electrolyte absorption and fermentation of undigested sugars, and the left colon (descending colon, sigmoid colon and rectum) is predominantly involved in storage and evacuation of stool.

3.2 Colonic Physiology

3.2.1 Water and Electrolyte

Absorption of water and electrolytes is a primary function of the colon. The majority of the absorption occurs in the right and transverse colon. Under normal physiological conditions approximately 90% of fluid entering the colon will be reabsorbed, with up to a maximum of 4.5 l being reabsorbed in a day if require [1, 2]. Under normal circumstances approximately 2 l of fluid passes in to the proximal colon, from which only 150–200 ml of fluid will be expelled with the faeces [2].

This efficient absorption of water is made possible by the ability of the colon to uptake electrolytes, thus creating the osmotic gradient required for water absorption. Active transport of sodium by the Na^+/H^+ ATPase pumps, which transfer this cation across the luminal wall into the intracellular space, creates this osmotic gradient. The average concentration of sodium ions entering the colon is 130–140 mmol/l and through active uptake only 40 mmol/l is excreted in faeces [1, 3]. Potassium is secreted in exchange for sodium ions. There is also an exchange of anions, with chloride being exchanged for bicarbonate, the latter being secreted into the lumen to neutralise organic acids that are produced.

Absorption of water and electrolytes is highly influenced by humoral, paracrine and neural regulatory pathways. Aldosterone, which is secreted from the adrenal glands, exerts an important effect on the colon in upregulating sodium and water absorption [4, 5].

3.2.2 Digestion and Salvage of Nutrients

The colon has the greatest concentration of bacteria in the body, with over 400 species, the majority of which

are anaerobes. These bacteria play an important role in the digestion and breakdown of complex carbohydrates and proteins that are resistant to digestion in the upper tract [6].

During transit in the colon, the ileal effluent is mixed with the bacteria, resulting in fermentation of the luminal content. Complex carbohydrates and proteins are broken down into short-chain fatty acids (SCFAs) – more than 90% of SCFAs are produced and absorbed in the colon. Digestion of complex carbohydrate occurs predominantly in the right colon, while protein degradation occurs in the left colon [7].

The colonic mucosa is unable to nourish itself from the bloodstream. Its nutritional demand must be met from the lumen, where different nutrients, SCFAs, amino acids, polyamines, vitamins and antioxidants are produced [8]. SCFAs, and in particular butyrate, are the preferred substrate for energy generation by colonic cells, providing up to 500 cal/day of overall nutritional needs. Not only is SCFA production and absorption closely related to the nourishment of the colonic mucosa, it influences sodium and water absorption. In pathological terms, it is thought to have an impact on the mechanisms underlying diarrhoea and neoplasia formation. The importance of the role of luminal nutritional support is evident in patients who develop diversion colitis, antibiotic-associated diarrhoea, and possibly in pouchitis (of ileoanal pouches) [9].

3.2.3 Colonic Motility

The other aspect of colonic physiology to consider is colonic motor function. This is considered in a separate section since it is the basis of the two other colonic functions, namely nutrient and water homeostasis.

The large intestine is approximately 1.5 m long. It is saccular, an evolutionary development that serves to enhance bacterial fermentation and breakdown of complex substrates. The caecum is the widest part of the large intestine, acting as a reservoir to accommodate the large volume of inflow from the small bowel. The lumen size gradually diminishes toward the rectum, where there is a considerable increase in width. Movement of substances through the colon by peristalsis is a slow process that usually occurs over several hours (between approximately 16 and 48 h); however, in cases of slow transit it can exceed 1 week. Functionally, the contraction pattern in the right colon causes significant mixing, which also facilitates absorption. In the left colon, however, the contractions slow the movement of the formed stool, acting as a reservoir until a suitable time for evacuation.

3.2.3.1 *Neural Control of Motility*

Regulation of bowel function is largely autonomous, with the main neural control being orchestrated by the enteric nervous system [10]. The enteric nervous system is comprises a complex network of intrinsic neurons. They integrate sensed luminal information, process it and then, through a system of interneurones and efferent neurones, affect secretory or motor function. The enteric neurones are categorised broadly into two main ganglionated plexuses: myenteric (Auerbach's) and submucosal (Meissner's).

The myenteric plexus lies between the longitudinal and circular muscles that run the entire length of the gut. This plexus is responsible for the motor innervation of the two muscle layers, coordinating peristalsis and the secretomotor innervation of the mucosa. In patients with Hirschsprung's disease, developmental abnormalities of this plexus result in an aganglionic segment of bowel. Thus, this segment of bowel remains contracted and can result in an obstruction. The submucosal plexus plays an important role in secretory control and submucosal blood flow.

Even though control of colon function is largely autonomous, the influence of extrinsic control is key to normal colonic physiology. The extrinsic control of bowel function is effected via two main mechanisms:

1. Neurotransmitter and hormonal control. The pathways and mediators involved in the chemical control of gut function are still poorly understood. Chemical control is mediated through the activity of neurotransmitters (inhibitory sympathetic transmission via noradrenalin and excitatory parasympathetic transmission via cholinergic neurotransmitters) and hormones. Hormonal control of the bowels is extremely complex, with some chemical mediators being released directly from the central nervous system (such as corticotrophin releasing hormone) and others directly from the gut (like gastrin and cholecystokinin). They influence the inhibition or propagation of gut motility via the central nervous system, autonomic nervous system or directly at gut level.
2. Extrinsic nervous system. The extrinsic nervous system exerts its influence over the colon through the

parasympathetic, sympathetic and somatic nerves. The vagus nerve provides parasympathetic input from the oesophagus to the splenic flexure of the colon [10]. The pelvic nerves carry parasympathetic fibres from S2–S4 to the rest of the colon and rectum. Sympathetic innervation is supplied by the superior and inferior mesenteric (T9–T12) and hypogastric (T12–L2) plexuses [11]. The impact of the extrinsic nervous system on bowel function is demonstrated by vagotomies, which markedly attenuate bowel motility, and in spinal-cord-injured patients, where the level of transaction of the spinal cord determines the degree of motility dysfunction [12].

Sensory transduction from the gut is initiated by stimulation of mechano- and chemoreceptors in the bowel. These receptors take the form of Pacinian corpuscles (which detect pressure and stretch) in the mesentery, interganglionic laminar endings (which act as stretch, tension and proprioception receptors) and afferent nerve fibre endings (which respond to chemicals and other neurotransmitters) [13, 14]. These receptors convey information via parasympathetic and sympathetic afferents fibres to the central nervous system, where the information is integrated and processed, leading to reflex sensory and motor responses and to the conscious perception of visceral stimuli [15]. Parasympathetic fibres are thought to convey non-noxious sensation to the brainstem [16]. This information does not elicit a conscious response. In contrast, noxious stimuli such as visceral pain are conducted through sympathetic afferents to the spinal cord [16].

3.2.3.2 Motility Pattern

Peristaltic activity is regulated by the enteric nervous system, which coordinates smooth muscle activity to create receiving and propulsive segments. In the receiving segment, the longitudinal muscles "ahead" of the intraluminal bolus contract and the circular muscles relax, causing the lumen to expand and receive the bolus. Circular smooth muscles in the propulsive segment "behind" the bolus contract and the longitudinal muscles relax.

A variety of gut motility patterns has been described. Radiological studies have identified rhythmic segmental contractions, receptive relaxation, and anterograde and retrograde mass movement. Some of these motility patterns are similar to those of the small bowel. However, the most robust and commonly used classification system, which encompasses other previous observations, was created by Bassotti and colleagues. They describe contractile events as either:

1. Segmental: they may be either single contractions or bursts of contractions, and can be either rhythmic or erratic.
2. Propagated contractions: they may be either low-amplitude (LAPC) or high-amplitude propagated contractions (HAPC).

Segmental contractions occur typically at a rate of 3 cycles/min and represent the majority of colonic motility. On average, segmental contractions create pressure changes of between 5 and 50 mmHg. These contractions may occur as single events or as a group of waves. It is thought that less than 6% of segmental contractions are rhythmic, the rest being uncoordinated or arrhythmic [17]. Even though the net effect of these uncoordinated segmental contractions is propulsion in an aboral direction, boluses can be propelled in a retrograde manner over short segments. This haphazard pattern of movement is the basis of the prolonged colonic transit time, allowing extensive exposure of the luminal content to the mucosa, optimising absorption by the colon.

LAPCs occur approximately 100 times a day, causing pressure changes in the bowel of less than 50 mmHg. The probable main function of these contractions is the transport of liquid luminal content and flatus through the colon. LAPCs are thought to be initiated by distension of the colonic lumen, occur more frequently after meals, and are also closely related to sleep–wake patterns [18, 19].

HAPCs are infrequent contractions occurring approximately six times per day, generating pressures of greater than 100 mmHg. The main function of these contractions is to shift large quantities of content along long segments of the colon. Greater than 95% of propulsion occurs in an aboral direction. The propulsion of these large volumes in an aboral direction can be a defaecatory stimulus, with the large pressure gradient potentially resulting in a defaecatory urge [20].

Whilst the majority of colonic motility patterns are sporadic and uncoordinated, rectal motility is more directed. Faeces propelled into the rectum as a consequence of aboral propulsion may be followed by a desire to defaecate. If not, the desire is voluntarily suppressed, and receptive relaxation occurs. Rectal motor complexes (RMCs) have been described in the rectum,

and in the distal segments, periodic colonic motor activity (PCMA) has been described [21]. RMCs are frequently occurring, low-amplitude rectal contractions, as compared to the less frequently occurring but more powerful PCMA activity [21, 22]. As most cycles are either segmental or are propagated retrogradely, they serve as an intrinsic brake, preventing incontinence in a healthy individual.

3.2.3.3 Diurnal Variation in Colon Function

Colonic motility in healthy individuals varies considerably through the course of a day. Studies have shown the colon to be quiescent for long periods, interrupted by bouts of spontaneous activity [23]. Twenty-four-hour electromyogram (EMG) studies have shown two factors in particular to have a significant impact on gut motility: (1) sleep–wake patterns and (2) meals (Fig. 3.1).

Effect of Sleep

Sleep has a important inhibitory effect on both segmental and propagated contractions of the colon [24]. Colonic activity during sleep is dramatically reduced and can disappear for long periods of time. Between 10 pm and 6 am, bowel motility is at its most quiescent. Emerging evidence shows that during the rapid eye movement phase of sleep, arousal or sudden awakening, there is an increase in bowel activity. The central nervous system directly influences colonic motility via the autonomic nervous system, providing a plausible explanation of how emotional states and phases of sleep influence gut motility [19]. Soon after waking, colonic contractions increase threefold (explaining the urge to have a bowel action that some people experience on waking) before reaching a basal level by afternoon [24]. During the course of the daytime, the transverse to descending colon demonstrates greater levels of motor activity than the rectosigmoid.

Effect of Meals

Ingestion of food is a major physiological stimulant of colon motor activity (Fig. 3.2). Meals increase both segmental and propagated contractions in the colon, and also increase overall smooth muscle tone. There are two phases to this postprandial increase in colonic motility:

1. The gastrocolic (early) phase, when the increased colonic motor activity starts directly after, and possibly even before, ingestion (1–3 min).
2. The intestinal (late) phase, which correlates to the intestinal phase of digestion, occurring at least 1 h after eating.

The degree of motility initiated in the gastrocolic phase is increased with large-volume intake (via a mechanism involving increased gastric distension) [25]. A high

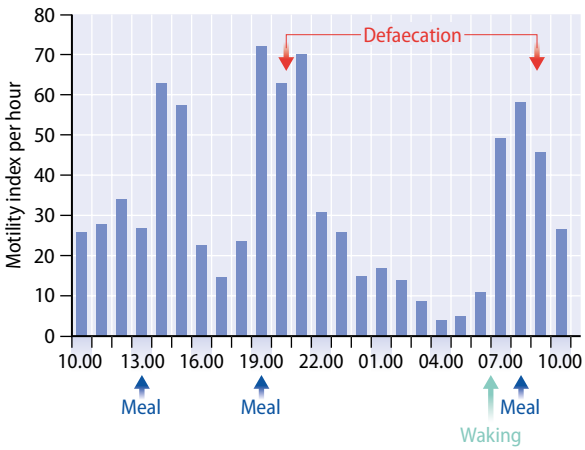

Fig. 3.1 Whole gut motility index in a healthy 37-year-old with ambulatory colonic manometry over a 24-h period. Note the increase in bowel motility patterns with waking and after meals. From Kumar and Wingate [53]

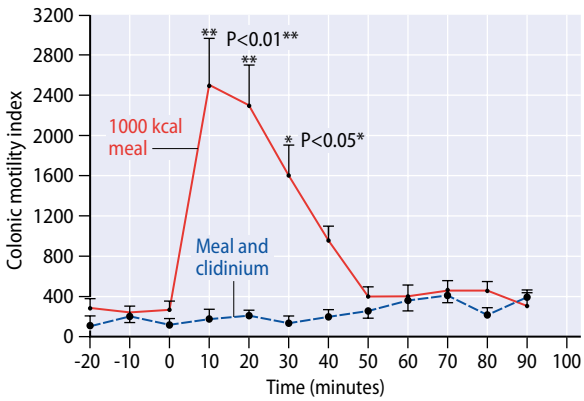

Fig. 3.2 Almost immediately after ingestion of a meal, there is an increase in colonic motor activity (*solid line*; expressed as a motility index) that persists for nearly 1 h. This is mediated via cholinergic neural pathways, being abolished by pre-treatment with clidinium (an atropine-like drug; *dotted line*)

calorie intake and fatty content of the meal increases the intestinal phase of motility, while meals with high amino acid and protein content decrease it.

The mechanism by which ingestion exerts its effect on the colon is not fully understood. Neither an intact stomach nor nervous system is required to elicit this response. The physiological changes are thought to be initiated by mechanoreceptors and chemoreceptors on the gastroduodenal wall. An intricate interaction of neurohumeral mediators then acts to elicit a response from the colon. The mediators of the response are thought to include vagal cholinergic pathways, regulatory peptides (protein peptide YY – PYY, gastrin, cholecystokinin, neurotensin), prostaglandins and serotoninergic pathways. There is growing interest in PYY and its influence on the gut. It is released in response to bile, fat, glucose and amino acids detected in the terminal ileum. PYY acts to alter gut transit time and is thus named the "ileal brake" [26, 27].

Effect of Stress

Physical and psychological stress can profoundly influence gut function. Whilst external stressors induce gastric stasis, they accelerate colonic transit. In particular, stress promotes prolonged propagated contractions across several sections of the colon. This effect occurs in the absence of an autonomic response, the effect being mediated via the release of corticotropin-releasing factor released from the hypothalamus. This peptide hormone stimulates colonic motility directly via modulation of vagal and sacral parasympathetic outflow [28]. Interestingly, the motility effect outlives the psychological stressor, providing a possible explanation for how psychological stress may influence long-term colonic functional symptoms.

In contrast to psychological stress, physical stress induces simultaneous contractions, defined as pressure waves occurring in several areas of the colon. Again, in contrast to psychological stress, physical stressors tend to be associated with a systemic autonomic response, and colonic motor activity ceases after the stress has ceased [29].

3.3 The Rectum as Storage Conduit

The rectum acts as a conduit for storage prior to defaecation. Faeces that are propelled from the distal colon into the rectum increase the rectal volume, eliciting a desire to defaecate. This can be voluntarily suppressed if required. In response, a receptive relaxation occurs and the rectal defaecatory contractions subside. This receptive relaxation allows the rectum to accommodate larger volumes without a significant rise in rectal pressure. The neural basis for rectal accommodation is thought to be via inhibitory nerves, which allow large rectal volumes to be stored without the urge to defaecate. There is a process of negative feedback with increasing rectal volumes such that gastric emptying is inhibited and the frequency of colonic propagated contractions is reduced, with the overall effect of prolonging stomach-to-rectum transit time [30].

Changes in rectal pressure with changes in volume can be quantified clinically by the assessment of "compliance". Compliance varies in several functional and organic disorders. For example, in patients who have had pelvic radiotherapy, compliance is reduced as the rectum becomes fibrotic and non-distensible. These patients tend to suffer with urgency to relatively small rectal volumes [31]. On the other hand, patients with a mega-rectum have increased compliance and are able to tolerate large volumes without the urge to defaecate [32]. In addition, rectal compliance can be the focus of therapy, such as in biofeedback, when faecally incontinent patients with urgency can undergo behavioural therapy to increase compliance and decrease urge perception [30].

3.4 Physiological Variability in Disease States

Appreciating physiological changes in disease states not only provides an understanding of normal colonic function, but also allows us to potentially target therapies. With regard to the former, knowledge of colonic motility in spinal cord injury and chronic intestinal pseudo-obstruction offers us insight into the neural control of gut function. Understanding colonic physiology in irritable bowel syndrome (IBS) and slow-transit constipation (STC) explains some patient symptoms and has offered a focus for potential treatments in these conditions.

3.4.1 Gut Dysfunction Following Spinal Cord Injury

Depending on the level and completeness of spinal injury, differing patterns of gut dysmotility can be

predicted. Lesions above T1 (the level of sympathetic input) tend to cause slowing of both small bowel and colonic transit, whilst lesions below this cause a delay in transit distal to the ileocaecal valve. Insults involving the cauda equina (resulting in loss of sacral parasympathetic connections to the gut) tend to cause loss of rectal tone and delays in rectal emptying rather than colonic transit [12]. In fact, rectal tone – or compliance – measurements are helpful in defining whether there is an upper or lower motorneurone-type injury to the gut. Cauda equina lesions tend to result in a flaccid rectum, whilst supraconal lesions result in a stiff, non-compliant rectum. These latter patients have an increased frequency of colonic segmental contractions and loss of the gastrocolonic response. This has pointed to a role of tonic descending inhibitory input from the brain in regulating colonic function in health. Loss of this tonic inhibition following spinal injury results in altered colonic motility, and hence explains the high prevalence of gut symptoms in this patient group. Constipation is the commonest symptom, with faecal incontinence occurring due to a mixture of laxative use, lack of anorectal sensation and loss of sphincter control. As well as helping shed light on normal gut physiology, understanding the reflex control of gut function in spinally injured patients has begun to point the way for potential nerve stimulation and modulation techniques to influence colonic and anorectal function, such as sacral nerve stimulation [12, 33].

3.4.2 Chronic Intestinal Pseudo-Obstruction

Chronic intestinal pseudo-obstruction (CIPO) is a condition that is characterised by symptoms of bowel obstruction, affecting the small or large bowel, in the absence of an obstructive anatomical lesion. The diagnosis is mainly clinical and can be confirmed by radiological exclusion of mechanical causes as well as confirmation of distended bowel loops. It is characterised by intestinal dysmotility (predominantly attenuated motility), which may be regional or generalised. The aetiology may be either neurogenic or myogenic in origin [34, 35].

Nausea, vomiting and weight loss are predominant symptoms when affecting the upper gastrointestinal tract, whereas diffuse abdominal pain, severe distension and constipation are suggestive of the disease primarily affecting the distal gut. Colonic pseudo-obstruction can occur as part of a generalised CIPO picture or as an isolated entity. Colonic disease must be recognised and treated with early decompression to prevent caecal or colonic perforation [36].

Dysmotility patterns are variable. In neuropathic CIPO, contractions are uncoordinated but of normal amplitude. Conversely, in myopathic forms, intestinal contractions are coordinated but of low amplitude, if detectable [36]. These patterns can also be observed, however, in a normal healthy bowel [37]. Delayed intestinal transit predisposes towards bacterial overgrowth, which in its own right prolongs transit and can exacerbate the condition [36].

3.4.3 Slow-Transit Constipation

Constipation affects up to a quarter of the general population. It can be broadly categorised as occurring due to pelvic floor dysfunction, slow whole-gut transit or a combination of these two.

In patients with constipation due to pelvic floor dysfunction, the predominant problem is an inability to completely evacuate the contents of the rectum. STC implies delayed colonic transit resulting from disordered colonic motor function. This prolonged colonic transit time allows for greater water absorption, and hence stools are hard and can make evacuation difficult [38]. As such, a significant proportion of STC patients report coexisting rectal evacuation difficulty. Nevertheless, approximately two-thirds of hospital referrals with constipation have rectal evacuation difficulty as their primary problem [39], and it is likely that this prevalence is even greater in the community.

STC patients exhibit an overall pattern of decreased colonic motility, which includes decreased segmental and propagated contractions. Even though the diurnal variation persists, there is a blunting of the postprandial surge in colon motility [40]. Segmental contractions in the proximal colon can be reduced by up to a half in these patients [17]. There is a correlation between increasing colonic transit time and a decrease in the amplitude and duration of HAPCs, to the extent that severely constipated patients have an absence of contractions. These contractions play a major role in the anterograde propulsion of colonic content to the rectum. With a reduction in the HAPCs it also becomes more difficult to evacuate, since they play an important role in both eliciting the urge to defaecate and in the mechanics of defaecation. STC patients exhibit an increase in uncoordinated RMC activity. These contractions resist the propulsion of colonic content in to the rectum.

Of the variety of aetiologies that have been proposed for STC, neurogenic causes have been the best studied [41]. Such neurogenic abnormalities may be acquired as a result of pelvic nerve disruption (following pelvic surgery) or central nervous system lesions (spinal cord injury) [41]. Unconfirmed studies have also raised the possibility of a familial enteric neuropathy as a cause of symptoms in some patients with chronic idiopathic STC [42].

The incidence of constipation – and indeed slow transit – increases with age. This relates not only to a shift in the motility patterns of decreasing HAPCs, but also an increase in segmental contractions. Other factors such as changing dietary habits, polypharmacy, physical mobility and comorbidities also play an influential role. The change in motility pattern from peristaltic contractions to non-peristaltic contractions causes an increase in intraluminal colonic pressures. Age-related organic changes resulting from decreasing myenteric neuronal numbers, increased fibrosis and age-related changes of colonic smooth muscle contractility are thought to play a role in the motility changes [40].

3.4.4 Irritable Bowel Syndrome

The cardinal symptom of IBS is altered bowel habit (diarrhoea and/or constipation) in the context of abdominal pain. Other commonly occurring symptoms include faecal urgency and abdominal bloating. This variety of sensory and motor symptoms is reflected in the proposed pathophysiology of IBS, including visceral hypersensitivity, small- and large-bowel dysmotility, inflammation and abnormal autonomic innervation.

3.4.4.1 Gut Dysmotility in IBS Patients

Early observations identified a relationship between colonic stimulation (induced by meals or colonic distension) and abnormal colonic motility, and thence abdominal symptoms [43]. No specific colonic motility pattern is observed as being specific for IBS patients. However, in those with the predominant symptom of diarrhoea, there is an increase in small-gut transit (specifically increased migrating motor complexes), and an increase in colonic motility (with increased rates of HAPCs) [44]. This increase in HAPCs is further exaggerated after eating (a heightened gastrocolic response) and on waking. In conjunction with a decrease in rectal compliance, it provides a physiological substrate for the symptom of faecal urgency in IBS patients. Constipation-predominant IBS patients show a decrease in the rate of HAPC contractions and therefore delayed aboral propulsion of faeces [45].

IBS patients who complain of bloating do demonstrate an increase in abdominal girth. As the quantity and distribution of the gas remains constant between IBS and controls, the increase in girth is thought to be associated with a decrease in bowel tone. The reflux of gas from the distal to the proximal bowel (retrograde movement) is also common in these patients and may partly explain complaints of belching [46].

3.4.4.2 Hypersensitivity to Gastrointestinal Pain

The location, intensity and nature of pain vary in IBS patients. It may be increased during periods of stress, menses or in relation to diurnal patterns [43]. Patients commonly complain that abdominal pain is worse an hour or two after eating. In these patients, this pain has been temporally correlated with characteristic ileal and sigmoid contraction patterns. Rectal or sigmoid distension will recreate symptoms of abdominal pain/cramping in approximately 75% of these patients. It is clear that IBS patients have a lower pain threshold to luminal distension when compared to healthy individuals, and that their symptoms may be due to an abnormal perception of normal stimuli [47].

3.4.4.3 Psychological Factors

It has been shown that IBS patients tend to have higher anxiety and obsession traits than healthy individuals. Emotional states are known to influence colonic motility, compliance and visceral sensitivity [29]. Whether these psychological influences are the cause or effect of IBS cannot be proven; however, treatments for IBS that also involve attention to the patient/s psychological state have been shown to improve their symptom load [29, 48].

3.5 Conclusion

Even though the colon is not essential for life, it plays an important role in the social functioning of humans. It also makes an important contribution to water and

electrolyte homeostasis, salvage of nutrients and production of SCFAs, all of which play an important metabolic role. Motor abnormalities of the small and large intestine are commonly observed in functional and organic gastrointestinal disorders. However, the presence of some of these patterns of "dysmotility" in healthy controls, the absence of correlation with symptoms, and the poor response to treatments has raised questions as to whether these are epiphenomena rather than being pathophysiologically relevant. This is especially the case in functional disorders such as IBS and STC, where the direction of thinking has moved towards consideration of sensitivity and autonomic nerve factors. To date, the response of symptoms to treatments targeting motility for these conditions has remained disappointing. Recognition of the interplay between motility and sensory function in functional and organic gastrointestinal disorders is leading towards the development of novel pharmacological and physical therapies, including the corticotrophin releasing factor antagonists and electrical neuromodulation of spinal and gut reflexes.

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Self-Assessment Quiz

Question 1

Which of the following statements is TRUE with regard to neural control of gut function:

a. Afferent information from the gut is mediated exclusively through mechanoreceptors.
b. Acetylcholine is the primary inhibitory neurotransmitter.
c. Gut-released peptides like cholecystokinin exert an effect on colon motility locally and not at cortical level.
d. Hirschsprung's disease results from an abnormality of the myenteric (Auerbach's) plexus.
e. Excessive extrinsic parasympathetic activity results in paralytic ileus.

Question 2

Which of the following is TRUE with regard to colonic transit:

a. In health, colonic transit time is tightly distributed in the general population.
b. Colonic contractions subserve the same physiological function in the left and right colon.
c. Segmental colonic contractions typically exceed diastolic blood pressure.
d. High-amplitude propagated contractions (HAPCs) are rare events in health, and always result in the urge to defaecate.
e. Colonic peristalsis persists even during sleep.

Question 3

In spinal cord injury:

a. Cauda equina lesions result in increased tone of the colon and rectum, and hence difficulty with bowel evacuation.
b. Cervical lesions result in loss of vagal input to the colon.
c. Faecal incontinence can be avoided by avoiding laxative excess.
d. Slow colonic transit relates to reduced mobility rather than loss of neural control, since the enteric nervous system is not involved.
e. Electrical neuromodulation offers a possible treatment for some patients with bowel dysfunction.

Question 4

Which of the following are NOT physiological functions of the colon:

a. Providing nutrition for itself
b. Fluid balance
c. Electrolyte homeostasis
d. Thermoregulation
e. Releasing anti-inflammatory cytokines

Question 5

The gastrocolic response:

a. Is lost in spinally injured patients
b. Is dependent on an intact vagus nerve, being lost in patients who have undergone vagotomy
c. Can be elicited at the prospect of food, before actual ingestion
d. Is enhanced by release of the intestinal-derived peptide PYY
e. Is exaggerated with ingestion of high-fibre meals

1. Answer: d
Afferent information from the gut is encoded through mechano- and chemoreceptors. Noradrenalin is the primary inhibitory neurotransmitter (other inhibitory transmitters are nitric oxide and vasoactive intestinal peptide); acetylcholine and tachykinins are excitatory neurotransmitters in the gut [49]. Gut-derived peptides (like cholecystokinin, ghrelin and motilin) act both locally and centrally [50]. Ileus is thought to result from excessive intrinsic (enteric) parasympathetic activity [51].
2. Answer: e
Comments: Colonic contraction frequency, amplitude and transit time vary widely in health, being generally more prolonged in women than men [52]. In the right colon, contractions are

directed more towards churning and enhancing reabsorption than propulsion compared with the left. Whilst HAPCs may exceed systolic blood pressure, segmental contractions are of much lower strength. These HAPCs occur approximately a dozen times a day, and the majority do not induce a defaecatory urge.

3. Answer: e
Comments: Injury to the cauda equina results in a "lower motorneurone" type picture in the colorectum, with loss of tone and increased compliance [12]. Whilst immobility contributes to constipation, loss of extrinsic control of gut function means there is poor regulation of enteric nerve activity, and hence ineffective peristalsis. Faecal incontinence can occur as a primary symptom, even when the stools are formed (as a result of loss of anorectal sensation and loss of voluntary sphincter control) [12].
4. Answer: d
5. Answer: c
Comments: The colonic response to eating is a complex phenomenon, and is influenced by psychological anticipation, meal content (fatty meals being more excitatory than high-fibre ones) and state of gastric fullness. The response is mediated via a combination of endocrine (inhibitory PYY) and neural (excitatory parasympathetic) factors [25].

4 History-Taking and Symptoms

Jean-Claude R. Givel

CONTENTS

4.1 Introduction

Patients suffering from disorders of the colon, rectum, and anus often complain of vague symptoms. Those presenting with anorectal troubles usually experience great difficulty in describing them with delicacy and precision. It is important, however, to obtain a detailed description of the symptoms and of their location, to provide a basis for appropriate examination and a reliable diagnosis. Even without strong association with a particular location, numerous symptoms nevertheless evoke a probable site of origin and a potential diagnosis.

As in all fields of medicine, the assessment of the patient's history is the single most important piece of data that the physician can obtain. The circumstances under which a symptom appears, its localization, its development, the appearance of secondary associated complaints, and its precise characteristics should all be ascertained in detail. The interview may involve relatives; some questions are extremely personal and should be discussed on a one-to-one basis, in a place where there is privacy, available counseling, and a relaxed environment.

A distinction must be made between general symptoms and specific colorectal or proctologic disorders. Only the latter will be discussed in this chapter. In the domain of colonic, rectal, and anal pathology, there are limited pertinent questions to ask. They first of all concern symptoms such as bleeding, pruritus, pain, discharge, incontinence, diarrhea, constipation, and the false need to defecate. Other specific proctological symptoms that may also need to be explored include soiling, irritation, and prolapse.

Many patients present or are referred with complaints of "hemorrhoids," yet this can represent a constellation of problems ranging from true hemorrhoidal disease to an anal fissure, pruritus ani, or a more serious condition, such as cancer. To clarify the patient's initial complaint of, say, "piles," bleeding or a swelling may call for a great deal of questioning. To avoid much time-consuming and confusing circumlocution, particularly in a busy outpatient clinic, it is advisable to break one of the first rules of medical history-taking, and to ask the patient quite deliberately a series of leading questions about specific symptoms and their duration.

The ability to differentiate hemorrhoidal disease from other diagnoses is therefore essential. Several problems can be diagnosed on the basis of the patient history. In other cases it can help to narrow down the differential diagnosis, which will then be complemented by the regional examination.

4.2 Bleeding

Bleeding is a very common complaint and is always worrying to the patient. Although it is one of the most significant findings of colon cancer, it is also quite nonspecific. Most lesions of the alimentary tract and the anorectal region may bleed at some time. The phenomenon may be occult, appearing without the patient's knowledge, or apparent and symptomatic. It may happen at defecation or separate from it.

Massive bleeding from the colon and rectum is an uncommon event. Many of the patients who present with acute intestinal blood loss are elderly, who badly

tolerate periods of hypotension. The etiology and anatomical site of hemorrhage are usually difficult to establish. Bleeding may cease spontaneously and the site of origin remain unknown. Therefore such patients have frequently been admitted on many previous occasions with intestinal bleeding where no cause could be found.

The most common causes of bleeding are:

1. General: hematologic disorders including blood disorders, drugs, hepatic/renal insufficiency, and malabsorption
2. Local:
   a. Perianal: cutaneous lesion, fissure, prolapse, condyloma, tumor, trauma
   b. Anal canal: hemorrhoids, prolapse, ulceration, tumor, trauma, fissure
   c. Colorectal: polyp, angiodysplasia, inflammatory colitis (ischemic, infectious and parasitic, postactinic), diverticular disease, tumor, trauma
   d. Small bowel: Crohn's disease, Meckel's diverticulum, ischemia, tumor, trauma
   e. Gastroduodenal: mucosal erosion, ulcer, tumor, trauma

Bleeding of less than 50 ml/24 h originating from a source proximal to the splenic flexure cannot be detected macroscopically; it comes to light when examining the feces for occult blood. This complaint can be identified outside the clinical environment by a simple examination that patients may perform themselves (the Hemoccult test). Conversely, only a few droplets of blood in the toilet bowl can turn the water bright red, an alarming event for an unsuspecting patient.

The variable characteristics of rectal bleeding provide valuable information regarding the origin of the hemorrhage. The duration of the phenomenon, the color of the blood (bright red, melanotic, dark, or tarry), its quantity, frequency of emission, and possible relationship to defecation should be precisely determined. Ascertaining the presence or absence of blood clots and the amount of clot present is also helpful. Slight bleeding, isolated or repeated, is often encountered in adults of all ages. Many do not initially consult a physician and mention this symptom only during a systematic history. In contrast, major hemorrhages may sometimes be accompanied by shock.

In most cases, blood mixed with stools originates from a tumor of the rectosigmoid region. In general, blood that precedes defecation or is spontaneously discharged has accumulated in the rectal ampulla; a phenomenon of this kind is found in ulcerative colitis, for example. Rectal bleeding with pain in the left iliac fossa is often due to a sigmoidal lesion, which may be segmental colitis, diverticulitis, or a tumor. Bleeding associated with diarrhea is encountered in ulcerative colitis, colonic Crohn's disease, and tumors of the rectosigmoid junction. A dysentery-like syndrome associated with elimination of fragments of the colon wall may accompany cancer, sigmoiditis, or acute dysentery. Dark blood usually indicates a lesion situated in the colon or upper rectum, especially if it is mixed with the stools. The dark color in general indicates not only the localization of the hemorrhage, but also the duration of blood passage.

Blood originating from the lower rectum or anus is clearer, not mixed with the stools, but covering them, suggesting a wound as an origin. It can be observed in the toilet bowl after defecation. Although it generally originates from internal hemorrhoids, this location can be determined with some certainty only after exclusion of other potential etiologies. Diffuse proctitis may show similar symptoms.

A polyp, an adenoma, a villous tumor with slight secretion, and a minor, slowly growing cancer are examples of secreting lesions, which, when of small volume and at a sufficiently low location, may be the origin of blood observed in striae around the stools. It is rare, but not impossible, for an anal fissure to present a similar clinical picture. Blood observed on toilet paper or the underclothes originates from a distal site, below the sphincter, except when incontinence is present. It generally indicates a lesion of the anal verge or perianal region such as erosion, rhagade, prolapsed hemorrhoids, punctured perianal hematoma, fistula, fissure, or tumor. When associated with intense pain occurring during defecation and/or lasting a few hours afterwards, the presence of blood presents a picture typical of an anal fissure. Traces of blood and pain occurring after a certain time has elapsed are sometimes due to an incomplete fistula. Intermittent hemorrhagic prolapse of which the patient is unaware, with spontaneous remission, may also be encountered. An external open hemorrhoidal thrombosis, lesions due to scratching, pruritus ani, ulcerations with various causes, and marginal ulcerated tumors may also bleed.

The facts presented so far are by no means absolute, and exceptions exist. Thus, a lesion at a high location may be responsible for an episode of blood not mixed with stools, whereas a disorder of the lower tract may produce dark blood. Blackish coagulates may originate from a rectal lesion with prolonged discharge, while fresh blood may, if the passage is accelerated, be of

colonic origin. The age of the patient also plays a role and must be taken into account when investigating the cause of rectal bleeding.

A rare and frequently misdiagnosed cause of "bleeding" comes from eating beetroot. The main coloring matter in beets belongs to betacyanins, which are violet-red pigments that can mimic blood in the toilet water.

Massive hemorrhage of the distal gastrointestinal tract may be due to angiodysplasia or a diverticular disorder. It may also be caused by inflammatory conditions, tumors, or an ischemic lesion of the colon. Melena, characterized by the discharge of liquid, blackish, and putrid stools, is due to partially digested blood that has been in the bowel for at least 8 h. It usually originates from a site proximal to the hepatic flexure of the colon. Bleeding associated with perianal pain appearing during or after defecation, especially when the region is washed, is due to perianal infections associated with erosions or rhagades. A traumatic lesion of the rectum may give rise to isolated hemorrhages, which are usually extensive, sometimes starting during a motion, and subsequently repeated, with the emission of pure blood without any fecal evacuation. Injury due to an endorectal thermometer and postactinic proctitis are two examples of such lesions.

The general symptoms associated with bleeding, such as a modification of the habitual motions, abdominal pain, and disturbance of the general state of health (anorexia and loss of weight), suggest a systemic disorder in which an anal origin is highly unlikely. A discharge of mucus may be encountered in both anal and systemic conditions. An extensive discharge of mucus often accompanies a villous tumor.

4.3 Pruritus

Pruritus ani is a common and often disabling symptom. More frequently dermatologic or psychogenic rather than truly proctologic, it is nevertheless characteristic of numerous anorectal disorders. Distinct from pain and of variable intensity, it may be intermittent. Pruritus may occur at night and not infrequently disturbs sleep.

The fecal bacteria produce irritant metabolites. Perspiration and insufficient anal hygiene may thus result in maceration and cutaneous excoriations. Once the skin of the perianal region is damaged, a vicious circle is established. Itching gives rise to excessive scratching, which in turn aggravates the epithelial lesions. As soon as the natural resistance of the perianal skin to infection is lowered, it is vulnerable to attack by saprophytic bacteria and cutaneous fungi, resulting in dermatitis. A detailed description of the pathogenesis and pathological physiology of pruritus ani can be found in Chap. 25.

The most common causes of pruritus ani are:

1. Primary:
   a. Dermatosis: eczema, psoriasis, lichen planus, allergic eruption
   b. Contact dermatitis: local anesthetic, antibiotic ointment
   c. Perianal lesion: fissure, Crohn's disease, tumor
   d. Infection: fungus, worms, sexually transmitted disease
2. Secondary:
   a. Irritative cutaneous lesion: perspiration (inadequate anal hygiene, hirsutism), mucus (excessive production, prolapse), pus (anal fistula), stools (diarrhea, incontinence, inadequate anal hygiene)
   b. Systemic disorder: diabetes, infectious disease, obstructive jaundice, myeloproliferative disorder, lymphoma
   c. Psychogenic
   d. Idiopathic

The primary cause of pruritus ani may be local or secondary to incontinence. It may also be the manifestation of a systemic condition. Dermatosis, contact dermatitis, and various perianal lesions represent the most frequent causes of anal pruritus. The majority of cases are due to inadequate anal cleanliness, in particular after defecation. All conditions producing permanent perianal wetting may be a cause: hirsutism, excessive sweating, vaginal discharge, urinary incontinence, third-degree hemorrhoids, mucous prolapse, tags, condylomata acuminata, purulent discharge from a fistula or para-anal abscess, and frequent defecation, particularly with diarrheic stools. Excessive cleansing of the perianal region may also result in dermatitis leading to pruritus. Tightly fitting or synthetic clothing is sometimes responsible for this condition. Dietary factors are other important historical elements in nonspecific pruritus ani. In several cases, however, no causal factor can be found. Even though systemic disorders causing secondary cutaneous lesions rarely lead to anal pruritus, an attempt should be made to look for diabetes, intestinal helminthiasis, lice, anogenital herpes, molluscum contagiosum, a tendency to eczema, fungal infection, icterus, myelopathy, and blood disorders.

Pruritus occurring at night suggests parasitic infestation due to worms. These are sometimes found in other members of the family. A history of anogenital contact may provide relevant indications. Pruritus and a burning sensation associated with discharge are typical of humid eczema, a fistula, anusitis with hypersecretion of the anal glands, or ulcerative colitis. Pruritus, a burning sensation, and secretions combined with pain and the sensation of a foreign body are typical of a strangulated prolapse.

When evaluating a patient presenting with anal pruritus, any possible allergies should be identified. The physician should look into the use of suppositories or the application of local preparations: steroids affect the long-term natural resistance of the skin to fungal infections; antibiotics and anesthetics increase skin sensitivity. The most serious perianal dermatitis can result from abuse of such preparations.

4.4 Pain

Abdominal pain tends to be nonspecific unless the parietal peritoneum is involved. The clinician needs to know its site, if and which relieving or favoring factor exists (e. g., meals, postural relief or aggravation, defecation or medication), its character (constant or colicky), its intensity, its duration, and whether associated symptoms are present. Right-colon-related pain tends to arise in the right lower quadrant. Pain from the sigmoid is localized in the left lower quadrant, and rectal pain can occur in the hypogastrium. Crampy abdominal pain can occur with a partial bowel obstruction or from a colonic volvulus. Crampy pain also results from muscle spasm caused by the irritable bowel syndrome or diverticulosis. Pain originating from other organs in the abdominal cavity may mimic colonic pain, making symptom-based diagnosis difficult.

Perineal pain is a complaint often encountered in proctologic practice and can be most disabling to the patient. It is an expression of a lesion of the anus, rectum, or a pelvic structure. Its precise localization, whether superficial or deep, sometimes presents difficult problems of evaluation, which may lead to errors of diagnosis and treatment. Functional anorectal disorders can also produce pain with resultant difficulty to differentiate it from somatic etiology [3].

The patient often has difficulty in differentiating the location and character of perineal pain with precision. An in-depth examination alone permits the exact site of its origin to be determined. The term "pain" is necessarily subjective and has a very wide range of meanings for different individuals; it is therefore important to distinguish discomfort from pain and to attempt to define the pain as mild or severe. A detailed description of the pain, in particular of factors such as its periodicity, intensity, possible aggravating or alleviating circumstances, its duration, and all relationships to defecation and sexual intercourse should be obtained.

The most common causes of anorectal pain are:

1. Perianal region:
   a. Thrombosed varix
   b. Hematoma
   c. Fissure
   d. Condylomata acuminata
   e. Tumor
   f. Herpes
   g. Postactinic damage
2. Anus:
   a. Cryptitis
   b. Acute/chronic abscess
   c. Thrombosed and prolapsed hemorrhoids
   d. Crohn's disease
   e. Tumor
3. Rectum:
   a. Solitary ulcer
   b. Tumor
   c. Intussusception
4. Functional anorectal pain [3]:
   a. Chronic proctalgia: levator ani syndrome or unspecified functional anorectal pain
   b. Proctalgia fugax
5. Nonproctologic origin:
   a. Gynecologic
   b. Urologic
   c. Musculoskeletal
   d. Neurologic

Severe pain, generally aggravated by defecation, is most commonly due to an acute fissure, an anorectal abscess possibly complicated by a fistula, a perianal hematoma, a thrombosed perianal varix, or thrombosed and prolapsed internal hemorrhoids. The pain caused by a hematoma is very acute. If it becomes progressively worse, it indicates an abscess. A fissure is classically characterized by rhythmic pain in three phases during the passage of stools: absence of pain prior to evacuation, painful defecation, progressive resolution of the pain after the motion. Less common causes of pain are condylomata acuminata, herpes, Crohn's disease, or a tumor. In all of these situations, an ulcerated lesion, inflammation, infection, or invasion of

nervous tissues may give rise to severe pain. Solitary ulcers of the rectum may also be the origin of deep-seated perineal pain not easily linked to a specific part of the system. If related to the coccyx and exacerbated by moving from a sitting to a standing position, it is coccygodynia. Finally, certain patients suffer from functional anorectal pain. It remains a diagnosis by exclusion and may result from genetic predispositions influenced by psychological, environmental, and social factors. They are classified according to the Rome III Classification System of functional gastrointestinal disorders [3]. Perineal pain can sometimes last for many years and be accompanied by major personality disorders or symptoms compatible with irritable bowel syndrome.

Very violent cramp-like spastic pain originating from deep within the rectum, which may occur at any time but mainly at night, is typical of proctalgia fugax.

A burning pain is characteristic of an inflammatory process such as dermatosis or anusitis. Constant or intermittent pain associated with a stinging sensation is encountered in infections of the anal canal, such as cryptitis, abscess, carcinoma, or thrombosis of internal hemorrhoids, and these lesions may produce a feeling of harboring a painful foreign body. Cryptitis is characterized by dull pain in the anal canal that is aggravated by defecation. A tension pain associated with a swelling in the anus indicates hemorrhoidal thrombosis or para-anal abscess. Painful defecation with tenesmus is typical of sphincter spasm.

In the absence of any apparent pathology, it is important to obtain information about the patient's medical history relating to a possible trauma, pelvic operation, or prior treatment of an anal lesion.

4.5 Discharge

Discharge or a sensation of wetness in the perianal region is associated with a local cutaneous or mucosal inflammation. The most common cause is an organic disorder, but inadequate anal hygiene is often at the root of the problem in many individuals. The unpleasant smell due to discharge frequently represents the main reason for consultation.

The precise nature of the discharge must be determined, as well as its site of origin and the presence of any associated symptoms such as pruritus, rectal bleeding, pain, incontinence or prolapse. Discharge may be aqueous, mucoid, purulent, or fecal. It may originate from the anal verge, the anal canal, or the rectum.

Direct examination, a complete anorectal inspection possibly including the colon, and microbiologic or serologic examination generally reveal the origin of the discharge. In certain cases, however, this may be difficult to find or may remain obscure. Fecal soiling of underclothes, for example, the most banal discharge possible, may have no apparent origin.

Various causes of discharge are:

1. Perianal:
   a. Perspiration
   b. Inadequate anal hygiene
   c. Cutaneous excoriation
   d. Eczema
   e. Fissure
   f. Condylomata acuminata
   g. Tumor
   h. Abscess
   i. Fistula
   j. Furuncle
2. Anal:
   a. Condylomata acuminata
   b. Hemorrhoids
   c. Mucosal prolapse
   d. Fistula
   e. Abscess
   f. Incontinence
3. Colorectal:
   a. Rectal prolapse
   b. Inflammatory disease
   c. Solitary ulcer
   d. Adenoma
   e. Irritable bowel

These causes may be medical (cutaneous lesion, fistula, inflammatory disease of the rectum, infectious anoproctitis, hemorrhoidal prolapse, rectal prolapse) or surgical (complication arising from interventions in the rectum and anus).

An aqueous discharge indicates an irritation of the anal glands associated with anusitis or a villous adenoma. A clear, viscous discharge from the rectal epithelium occurs when a prolapse or a solitary ulcer is present. A brownish discharge mixed with stools is found mainly in cases of sphincter incontinence. A purulent discharge originates from a fistula. A partially bloody, mucopurulent discharge indicates colitis. A discharge tinged with blood is found in the presence of prolapsed hemorrhoids, a mucous or intestinal prolapse, and in ulcerative colitis. Oozing from a bleeding wound is frequently seen after the Whitehead operation with protrusion of the rectal mucosa, as well as after a hem-

orrhoidectomy performed using the Milligan–Morgan method. After this type of intervention, cicatrization may take a long time. A bloody discharge associated with pruritis, a burning feeling associated with the sensation of a foreign body, and pain indicate a strangulated prolapse.

Less common organic causes include small abscesses of the posterior end of the anal canal with no perceptible track toward the anal verge or excessive secretion by the subpectineal anal glands. Both phenomena are difficult to determine. The secretion of these glands may explain why a patient complains of minor oozing producing a sensation of constant wetness. In parting the folds of the anal verge, a minuscule orifice may be found in the subpectineal mucous zone within the anal canal. Distal pressure applied with the finger at this point produces a drop of pus, or more frequently a clear liquid like a drop of dew. The secretion is minimal and usually does not occur again during the same examination. Another rare cause of discharge is represented by voluminous internal, nonprolapsing hemorrhoids. Finally, fecal oozing often occurs in the absence of any organic cause. It is a functional problem indicating a mini-incontinence. Systemic disease (e.g., diabetes mellitus) may be a factor. Clinical or electromanometric examination will often show a minor sphincter deficiency in patients whose anal verge is slightly soiled, often without their knowledge.

4.6 Fecal Incontinence

Fecal incontinence may be defined as the "involuntary loss of stool or soiling at a socially inappropriate time or place" [6]. Its origin is either organic or functional. In the latter situation, definition should be based on the Rome III criteria as the "uncontrolled passage of fecal material recurring for ≥3 months in an individual with a developmental age of ≥4 years" [1].

Information on anal incontinence must be requested, as it rarely volunteered. It is a very debilitating symptom to which sufferers do not readily admit, as it could lead to rejection by the family and society in general. Studies report prevalence ranging from 1.5% in children to more than 50% among nursing home residences [10, 13]. A distinction must be made between the patient being truly unaware of passing stool and urgency, corresponding to the incapacity to differ an imperious need to defecate for more than 15 min. Similarly, it is essential to distinguish soiling from true incontinence. By questioning the patient, a precise determination can be made of the severity of this problem, its frequency, and the relationship between it and stool consistency or lifestyle, the presence of any associated diarrhea, and the patient's previous surgical history, in particular operations for anal fistulas or obstetric interventions. An obstetric history should include the number of vaginal deliveries and the severity of any perineal lacerations. A urologic assessment should also be conducted to ascertain any associated symptoms, above all urinary incontinence, which is classically associated with fecal incontinence [9]. Any medication taken, radiotherapy, and indications of spinal or perineal trauma are also investigated. This information may permit the physician to differentiate between discharge and fecal incontinence, patients frequently confusing the two symptoms. The severity of the phenomenon can be evaluated from the frequency of incontinence and the consistency of the feces, which may range from simple oozing, emission of gas or occasional soiling of underclothes to the involuntary emission of a fecal bolus several times per day. The consistency of the stools – liquid, semisolid, or firm – is of importance. The frequency and urgency of defecation may also be due to certain types of diarrhea. Finally, the physician should investigate the possibility of voluntary defecation and the circumstances under which uncontrolled evacuation may occur.

The severity and frequency of incontinence together with its impact on quality of life needs to be recorded. Continence grading scales have been described and are useful in establishing scores of incontinence [12]. A symptom diary can also play an important role to assess the severity of the troubles. To identify the consistency of the feces, the Bristol Stool Form Scale is a very useful tool [11].

Diarrhea represents the most frequent cause of incontinence. This problem may even be found in a patient with intact sphincter function when the urgent need to defecate results in passage of a liquid motion. Incontinence may thus complicate any condition associated with diarrhea.

The most frequent causes of anal incontinence are:

1. Diarrhea:
   a. Inflammatory disease
   b. Infectious disease
   c. Solitary rectal ulcer
   d. Tumor
2. Neurologic disorder:
   a. Psychiatric disorder
   b. Senility

   c. Generalized neuropathy
   d. Localized neuropathy (pelvic floor)
   e. Descending perineum
   f. Spinal trauma
3. Functional gastrointestinal disorders: functional fecal incontinence
4. Fecal retention
5. Anatomical lesion:
   a. Rectal prolapse
   b. Rectovaginal fistula
   c. Anorectal fistula
   d. Scleroderma
   e. Trauma: injury or surgical or obstetric sequelae

Sphincteric feebleness may be due to muscular weakness, such as the dystrophy observed in association with a generalized neurologic disorder. Progressive dystrophy of the anal sphincter represents a normal consequence of aging and speeds up after the age of 70 years. A similar type of diffuse dystrophy may also be observed among younger patients suffering from low motor neuropathy affecting the muscles of the pelvic floor (e.g., in diabetics). Anal incontinence may also complicate fecal retention with impaction when the distension of the rectum produces a reflex relaxation of the internal sphincter (the rectoanal inhibitory reflex).

The sphincter mechanism may be damaged during trauma or surgical intervention. Surgery for anal fistula represents the most frequent cause of traumatic incontinence after childbirth. Incontinence is also observed when the anal sphincter is bypassed by a fistula from the rectum opening to the outside above the anorectal junction. Rectovaginal or extrarectal fistulas in contact with the perineum maybe congenital or acquired, in the latter case resulting from a trauma, specific disorder, or radiotherapy for carcinoma of the uterine cervix. Anal incontinence is also observed after medullary trauma with lesion of the cauda equina.

When no gross anatomic lesion is found, functional fecal incontinence has to be considered. It remains an exclusion diagnosis, but its spectrum has broadened with the introduction of the new Rome III criteria in 2006 [1]. Minor sphincter defects are accepted in this definition since the extent of lesion is often not correlated with the symptoms; denervation/reinnervation changes that are not included in generalized disease process (e.g., diabetes with peripheral neuropathy or multiple sclerosis) can also be considered for the same reason.

4.7 Diarrhea

Many patients present with diarrhea. History-taking, focusing on duration and pattern, quantifies this symptom and may help to establish its cause. The number of bowel movements per day and night, and their consistency should be recorded. The presence of blood or mucus in the stool, a modification of the general state of health, or pain should be sought. The use of medications, above all laxatives or antibiotics, should also be recorded.

In general, the various types of diarrhea are due to an infectious or functional disorder of the gastrointestinal tract; however, they may also accompany a specific colorectal disease. Symptoms of this kind may stem from an inflammatory disorder or an obstruction. Excessive production of mucus by a tumor or a solitary ulcer of the rectum may also produce diarrhea.

The term "diarrhea" is often used incorrectly or overused by patients who give it various meanings: increased frequency of defecation, reduction of the consistency of the stools, an urgent need to defecate, or incontinence. A distinction must be made between acute diarrhea, with decreased fecal consistency, lasting for < 14 days, and chronic diarrhea, persisting for more than 30 days [4, 5]. Each of the associated symptoms must consequently be distinguished and precisely defined. Frequent passage of urine or stools may be due to diarrhea, but could equally be caused by the elimination of an excessive quantity of mucus or pus. An urgent need to defecate often cannot be controlled and may be accompanied by incontinence. Finally, it is important to remember that fecal impaction represents a classical association between diarrhea and an episode of constipation.

The most common causes of diarrhea are:

1. Fecal impaction
2. Inflammatory (infectious, noninfectious)
3. Excessive production of mucus
4. Obstructive lesion
5. Digestive insufficiency
6. Malabsorption
7. Metabolic/electrolytic disorders
8. Functional diarrhea
9. Medications
10. Psychological

The patient's medical history allows the character of the diarrhea, any triggering factor or contamination, and the previous medical or surgical history to be precisely

defined. Travel history is also important. Certain operative procedures involve an increased incidence of long-standing diarrhea, especially vagotomy, cholecystectomy, or small-bowel bypass or resection. Pancreatic abnormalities lead to malabsorption, with resultant diarrhea [2, 15].

4.8 Constipation

The term "constipation" is understood somewhat differently by each individual. It is usually defined as the passage of fewer than three stools per week, although an occasional patient may have fewer movements without significant impairment [8]. Constipation must be further divided into the infrequent passage of hard, narrow, or small stools, or of stools that are difficult to pass. In some patients, feces fail to reach the rectum (slow-transit constipation), whereas others have difficulty evacuating the stool, requiring long efforts at defecation or even manual disimpaction (terminal constipation). Furthermore, sometimes the two forms may coexist, defining a mixed clinical situation. Incomplete evacuation may be the only symptom of an internal rectal prolapse [14]. Patients sometimes suffer from headaches; flatulence and anorexia are occasionally ascribed to constipation.

The impression of the patient that her/his bowel habits have changed may have great significance. It is one of the symptoms suggestive of colonic neoplasm. Changes may be as obvious as diarrhea when the patient has had a long history of constipation, or as subtle as the development of normal bowel movements in a patient after many years of a difficult or irregular pattern. Consistency of the stools should be assessed by using the Bristol Stool Form Scale [11].

Constipation is generally due to a localized lesion producing an obstruction or a functional anomaly of the bowel slowing the passage of fecal matter. The proctologic origins most often relate to anal obstruction or lesion. Functional constipation is defined as a "persistent, difficult, infrequent, or seemingly incomplete defecation, which does not meet the irritable bowel syndrome criteria" [7]. More rarely, patients may have normal bowel passage but a functional disorder of rectal evacuation. Over time, some constipated patients develop a perineal descent syndrome and a solitary ulcer of the rectum.

Difficulty in defecation with a prolonged need to strain is frequently due to megarectum. A history of this kind will often have its origin in childhood and is associated with frequent episodes of fecal impaction and soiling. Many patients suffering from defecation problems show an absence of rectal or colonic distension coupled with an excessive need to strain when passing motions. Several attempts to defecate generally end in incomplete evacuation. The number of daily sessions on the toilet and their duration should be precisely determined.

Patients suffering from constipation due to obstruction generally have a short history, whereas those with a problem of functional origin often give a very long history. Consideration should also be given to any changes in lifestyle or dietary habits, pregnancy, general or psychiatric complaints, and ingestion of certain medication.

The most common causes of constipation are:

1. Local lesion:
   a. Tumor
   b. Diverticulitis
   c. Inflammatory bowel diseases (Crohn's disease > ulcerative colitis)
   d. Stenosis
   e. Intussusception
   f. Rectocele
   g. Rectal prolapse
2. Functional disorder:
   a. Functional constipation
   b. Irritable bowel syndrome
3. Others:
   a. Psychological disorder.
   b. Pregnancy
   c. Medication
   d. Dietary
   e. Systemic disorder
   f. Immobilization
   g. Dyschezia

4.9 False Need to Defecate

The false need to defecate is a symptom that produces pathologic evacuation instead of true defecation. It therefore indicates a need that is not totally false, but is both urgent and repeated. The patient often feels the need to evacuate gas. He or she may additionally produce a mucus or mucus/bloody evacuation, or even pass pure blood.

Defined in this way, the false need to defecate represents a specific organic symptom. It may be due to a lo-

cal or diffuse lesion of the rectum or the rectosigmoid, classically a rectal tumor. A rectal prolapse, a solitary ulcer of the rectum, or even a rectocele sometimes give rise to episodes of a false need to defecate. Postactinic proctitis may also provoke this symptom.

4.10 Conclusion

Depending on their presence or absence, the characteristic signs and symptoms of diseases of the colon, rectum, and anus allow the examining physician to determine one or more specific sites of origin. These symptoms are listed together in Table 4.1 as a function of four relevant localizations: anal verge, anal canal, rectum, and colon.

Coexisting medical therapy, especially anticoagulants, diabetic therapy, anticonvulsants, antihypertensives, anti-inflammatory drugs, and immunosuppressants, among others, should be recorded. Social circumstances should also be assessed.

This chapter has addressed the evaluation of the symptoms frequently associated with colorectal and anal disorders. The general principles of history-taking have been discussed, but the reader is advised to consult the specific chapters for further evaluation of a particular entity.

Table 4.1 Most common locations of colorectal and anal symptoms

Symptom	Anal verge	Anal canal	Rectum	Colon
Bleeding	+	+	+	+
Discharge	+	+		
Wetting	+			
Incontinence		+		
Pruritus ani	+			
Pain	+	+	+	+
Diarrhea			+	+
Constipation			+	+
False need to defecate			+	
Burning	+			
Spasm (tenesmus)		+	+	
Incomplete evacuation			+	
Sensation of a foreign body	+	+		

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Self-Assessment Quiz

Question 1

Massive hemorrhage of the distal gastrointestinal tract:

a. Is common
b. Is seen mainly in elderly patients
c. Is due to a usually easy-to-discover etiology
d. Is never related to angiodysplasia
e. Always ceases spontaneously

Question 2

Pain related to anal fissure is:

a. Only seen in elderly patients
b. Difficult to localize
c. More painful during the night
d. At its greatest during defecation
e. Never accompanied by bleeding

Question 3

Fecal incontinence is:

a. Not a very debilitating situation
b. Only diagnosed on the basis of subjective symptoms
c. Often associated with previous surgical history
d. Similar to discharge
e. Most often diagnosed in young people

Question 4

The false need to defecate is:

a. Related to age
b. Classically associated with psychiatric disorders
c. Both urgent and repeated
d. Usually accompanied by pus
e. Usually due to an unknown cause

Question 5

Constipation is:

a. Generally characterized by a very long medical history when due to obstruction
b. Never accompanied by headaches, flatulence, anorexia
c. A symptom that is poorly defined
d. Not due to difficulty in evacuating stools
e. Usually corresponds to the passage of less than three stools per week

1. Answer: b
Comments: Massive colorectal bleeding is seen mainly in elderly patients. The etiology and location of hemorrhage are usually difficult to establish. Bleeding may cease spontaneously and the site of origin remain unknown. The phenomenon is most frequently due to angiodysplasia, diverticular disorder, inflammatory conditions, ischemia, tumors or hematologic disorders.
2. Answer: d
Comments: Acute fissures generate severe pain that is generally aggravated be defecation. Anorectal abscess or perianal hematoma also generate pain, but not specifically related to defecation. A fissure is classically characterized by rhythmic pain in three phases during the passage of stools: absence of pain prior to defecation, painful evacuation and progressive resolution of pain after the motion.
3. Answer: c
Comments: Surgery for anal fistula represents the most frequent cause of traumatic incontinence after childbirth. Injury and other proctological operations (hemorrhoids) are further classical but less frequent causes.
4. Answer: c
Comments: The false need to defecate is both urgent and repeated. It indicates a need that is not totally false. The cause relates to pathologic evacuation instead of true defecation. The patient often feels the need to evacuate gas. It represents a specific organic symptom that is due to a local or diffuse lesion of the rectum/rectosigmoid, classically a rectal tumor.
5. Answer: e
Comments: The term "constipation" is understood somewhat differently by each individual, but is usually defined as the passage of fewer than three stools per week. It must be further divided into the infrequent passage of hard, narrow, or small stools, or of stools that are difficult to pass.

5 Proctological Examination

Jean-Claude R. Givel

CONTENTS

5.1 Introduction

"More is missed by not looking than by not knowing." This statement by Thomas McCrae (1870–1935) underlines the paramount importance of clinical examination in proctological diagnosis. Numerous anorectal problems can be diagnosed simply by careful inspection of the perianal area.

Although a proctological consultation may well represent a routine professional activity for the doctor, it has to be remembered that it is quite a different matter for the patient. He or she often finds a procedure of this kind difficult to cope with, particularly if it is the first time. There are various personal, psychological, and social reasons why a fairly long interval of time may elapse between the appearance of the first symptoms and the proctological consultation. Likewise, it is not uncommon, even at the present time, for patients to be subjected to a prolonged treatment for a proctological complaint without any prior local examination being made. Thus, advanced lesions may sometimes be discovered at the specialist's initial consultation.

A proctological consultation is much like any other medical workup comprising a record of the patient's medical history, a general and local examination, and various supplementary examinations. Numerous proctological diagnoses may be made on the basis of the medical history and local findings without the need for any complex or time-consuming procedures.

5.2 Medical History

The first step is to have the patient describe the exact profile of the complaint, in particular the circumstances in which it occurred and the nature of the symptoms that have led him or her to seek treatment. It is important to question the patient about any loss of blood, discharge, incontinence, anal irritation, perineal pain, diarrhea, constipation, or a false urge to defecate. Personal habits or unusual sexual practices may be relevant in some cases. Information on the patient's personal history together with any earlier proctological or general conditions with possible effects in the anorectal region complete the record. Medication and obstetrical histories are often also relevant. Finally, a note should be made of the family medical history with the aim of determining the presence of any hereditary conditions (see Chap. 4).

5.3 General Examination

All proctological examinations start with a quick inspection aimed at determining any changes in the patient's general state of health or any associated symptoms. Particular attention is given to the digestive system, the skin, the mucosa, and the urogenital system. Examination of the nervous system may be indicated, for instance, in patients with continence problems.

5.4 Local Examination

It is absolutely essential to explain to the patient beforehand all the aspects of the proctological examination. This comprises the following phases:

1. Positioning
2. Inspection and palpation
3. Digital examination

5.4.1 Positioning

Several positions may be used for an effective proctological examination. The choice of position depends on the equipment available, the age of the patient, and his or her state of health, as well as the doctor's preferences. The position adopted should be comfortable for both the patient and the examining doctor, allowing the latter to carry out an effective inspection and to perform certain diagnostic and possibly also therapeutic activities.

In a nonspecialist's consulting room, in the absence of suitable equipment, the examination is carried out with the patient in the left lateral or genucubital position. The left lateral (Sim's) position is comfortable for the patient; since it avoids undue embarrassment, it is also the position of choice for older patients. Lying on the left side, the patient is positioned so that the trunk crosses the top of the couch obliquely at an angle of 45°. The buttocks project slightly beyond the edge of the table, and the thighs are flexed so as to form an angle of about 90° with the trunk. This position allows the perianal and sacral regions to be comfortably examined, whereas the anterior perineum is masked from view. It allows an excellent proctological examination as well as certain endoscopic and therapeutic interventions (Fig. 5.1).

The genucubital position allows an excellent inspection of the perineal, sacral, and posterior perineal regions without any specialized aids. The patient kneels with the trunk leaning forward supported by the forearms (Fig. 5.2). This is a convenient position for the examining doctor, who parts the buttocks in a manner allowing complete observation of the anus and perianal region. This position is equally convenient for performing a rigid sigmoidoscopy, in which case the rectosigmoid junction is approached via the anteroinferior ptosis of the sigmoid flexure. This position is easily tolerated by young patients, but is not recommended for older patients or those suffering from cardiac or respiratory failure.

If the doctor has an adequate examination couch available, as in a specialized surgery or in a hospital, the lithotomy or genupectoral positions may be considered. The lithotomy or gynecological position requires the use of a table with supports for the lower limbs. The patient lies on his or her back with the buttocks projecting beyond the end of the table and the lower limbs raised above the trunk (Fig. 5.3). This position, which is generally easily tolerated by the patient, allows a convenient examination of the perineum and the perianal region. The proctological investigation is performed under excellent conditions, with most diagnostic and therapeutic interventions being feasible. This is the position used for most surgical interventions in proctology, in particular with an anesthetized patient. Less convenient for an ingress via the rectosigmoid junction than an anterior position, it nevertheless allows sigmoidoscopy with a rigid tube.

The genupectoral position requires a special examination table. The patient lies on his or her chest (face down), with the legs supported, and there is a mechanism to ensure a 90° angle between the trunk and

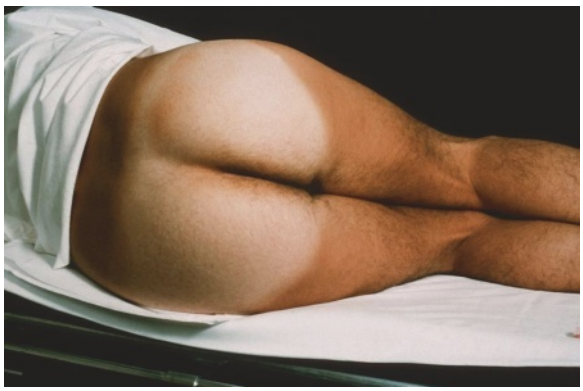

Fig. 5.1 Left lateral position

Fig. 5.2 Genucubital position

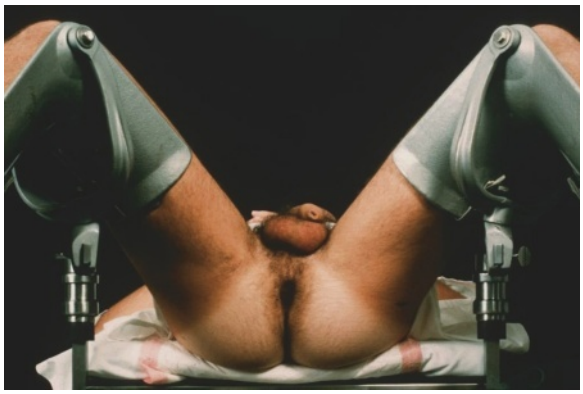

Fig. 5.3 Lithotomy or gynecological position

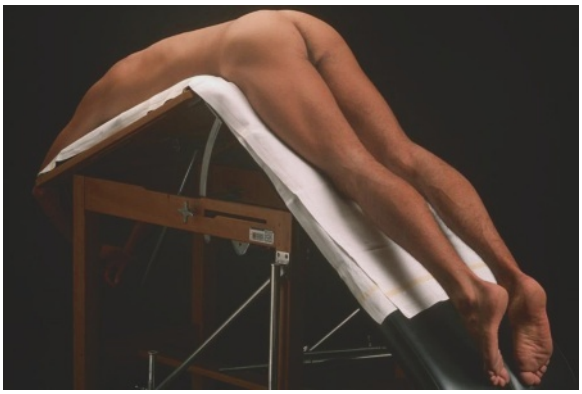

Fig. 5.4 Genupectoral position

thighs. The perianal region is thus easy to observe, and examinations and treatments may be performed in conditions similar to those permitted by the genucubital position. This position is also indicated for anorectal surgery requiring a posterior approach (Fig. 5.4).

5.4.2 Inspection and Palpation

A proctological lesion is conventionally localized by reference to a "clock-face" surrounding the perineum, with the patient in the lithotomy position. Twelve o'clock is the anterior direction, 6 o'clock posterior, while 3 and 9 o'clock are situated to the patient's left and right, respectively (Fig. 5.5).

The proctological examination starts with a complete inspection of the anus, the perianal region, and the adjacent perineum. Several conditions can be diagnosed entirely on inspection. All anomalies are noted, in particular the presence of moisture, pus, mucus, blood and fecal soiling, as well as scar tissue, any abnormal orifices, ulcerations, cutaneous lesions, swellings, or prolapses. The position of the perineum at rest will also be noted, as well as the movement of this structure in relation to the ischial tuberosities during pelvic floor contraction and straining. During the latter, a rectocele, hemorrhoids, anal polyps, intra-anal warts, or a rectal prolapse may become evident. Parting of the buttocks may reveal an anal fissure.

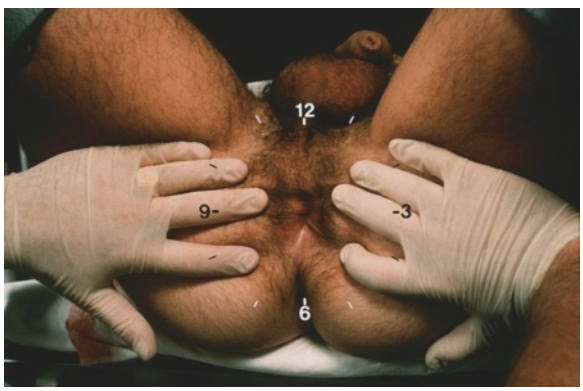

Fig. 5.5 Localization of a proctological lesion

A scar generally indicates a previous operation or trauma. Often fibrous, this sequela causes a retraction of the adjacent tissues with a consequent modification or disappearance of the radial folds of the anal margin. The entire anus may thus be drawn sideways toward the scar, in a paramedian position. A scar should alert the physician to obtain a more precise proctological history and should lead to a careful search for the nature of the pathological condition that caused it.

A para-anal orifice, solitary or multiple, generally represents the cutaneous end of a fistulous tract. It is thus the external opening of a tract whose internal component can extend proximally as far as the pectinate line. Such a fistula, which may be simple or complex, represents the natural evolution of a trivial para-anal abscess. A lesion of this type, especially if present at several locations in the perianal region, should prompt a search for an inflammatory condition, particularly Crohn's disease, of which it may sometimes be the first or sole apparent manifestation.

An ulceration is a break in the anal mucosa. Such a lesion, which may be shallow or deep, is often not initially apparent, being concealed under the radiating mucous folds. It can be clearly seen only by drawing back the skin of the perianal region. The most common type of ulceration is a fissure. Generally of a small di-

mension, solitary or multiple, a fissure may be acute or chronic. If acute, it is generally shallow and shaped like a segment of an orange, with a normal mucous lining. A history of acute pain that is exacerbated by defecation is usually diagnostic. A chronic lesion is deeper, showing the sphincterial muscle fibers at the base of a crater lined by a slightly fibrotic cicatricial mucosa. Sentinel piles or a skin tag frequently covers fissures of this kind.

Various dermatologic lesions can be observed in the mucosa and the skin of the perianal region. Ranging from simple erythema to pseudotumoral growths, these may represent lesions specific to this region or, more frequently, a perianal localization of a systemic dermatologic condition. Numerous proctological complaints are accompanied by cutaneous lesions, generally due to irritation. In practice, the underlying complaint often prevents correct perianal hygiene or gives rise to slight incontinence involving the discharge of irritating substances. Lesions due to scratching then invariably occur, adding to the basic problem.

A para-anal swelling is frequently encountered. It is the classic sign of a collection of fluid or a growth, and is easy to recognize. If accompanied by inflammation, it indicates the presence of an abscess or a para-anal phlegmon, both of which are common and painful lesions. Benign or malignant tumors can be found at the anal margin or in the adjacent skin and may cause swelling.

A prolapse can occur when the patient is at rest or exerting an effort, such as straining during defecation or coughing. It may be a superficial and exclusively mucosal phenomenon due to excessively abundant tissue. A prolapse may also occur due to growths such as internal hemorrhoids or neoplastic lesions of the rectum that have slipped through the anus. A complete, musculomucosal parietal prolapse may also be present, for example, in association with a rectal procidentia. It is not uncommon to observe an edematous component in conjunction with these lesions, especially when certain purplish zones represent thrombotic regions.

In contrast to inspection, palpation of the anal margin and of the anterior and posterior poles does not involve drawing back the radiating folds. The induration of a sensitive fistulous track, which may be suspected by its exterior orifice or may even be totally blind, may thus be determined solely by feeling with the examining finger. The induration can generally be assumed to lie above the lesion, at least in part. At the posterior pole, a small infiltration may represent a prolongation of an infected fissure to the skin. In the anterior region, care must be taken not to confuse a fistulous track with the linear induration of the median raphe of the base of the scrotum.

5.4.3 Digital Examination

Digital examination of the anal canal is a simple procedure requiring no more than a glove and a lubricant gel. Finger cots should not be used, especially with the prevalence of acquired immunodeficiency syndrome (AIDS) and other sexually transmitted diseases. Lubricant jelly should be warmed, if possible, to afford more comfort for the patient. Xylocaine (lidocaine) jelly is useful in the examination of a patient with anal fissure.

Digital examination should always be performed when investigating a proctological problem. It provides information of the first order regarding both the morphology and content of the anus or rectum and the condition of the adjacent organs. It also permits the function of the neuromuscular structures involved in the mechanism of continence to be examined. Its only contraindications are, in some cases, certain acutely painful lesions of the anus.

After warning the patient, the covered and lubricated index finger is inserted gently into the anus following the anatomical direction of the anal canal, advancing cranially along an axis toward the umbilicus in the lithotomy position. Using mild pressure usually allows the anal sphincter complex to relax. Asking the patient to strain may facilitate performance of the digital examination, especially in an anxious subject.

The anal canal and rectum and their surroundings structures should then be investigated in an organized manner. The resting tone of the sphincters, the presence of induration, scars, local pain, and discharge will be assessed first. Six locations might then be distinguished during digital examination (Fig. 5.6):

1. Intestinal lumen (anal and rectal): possible presence of feces, blood, or a foreign body
2. Wall (mucosa and entire wall): palpable lesions, such as a polyp, a tumor, a diffuse inflammation of the mucosa, an ulceration, or an indurated zone, which may represent the thrombosis or sclerosis of old hemorrhoids. If a tumor is discovered, its position, size, characteristics (polypoidal, sessile, ulcerated), depth of bowel-wall involvement, mobility (mobile, tethered, fixed), and relationship to the local anatomy must be recorded.

3. Behind the rectum: through the rectal wall, it is possible to feel the sacral concavity and coccyx and thus to discover bone anomalies, adenopathies located in the perirectal fat, or occasionally tumors.
4. Pelvic floor: anal incontinence depends on the proper function of a dual mechanism – the puborectal sling, which maintains an adequate anorectal angulation, and the sphincter apparatus. The latter comprises two distinct muscles: a smooth internal muscle representing the caudal thickening of the intrinsic circular layer of the rectal muscles, and a striated external muscle capable of voluntary contraction. The morphology and function of these two structures can be checked during rectal examination. The puborectal sling can be palpated by a bidigital examination, with the index finger pushing the puborectal muscle while the thumb is brought to meet it by an external route. Voluntary contraction may be tested by asking the patient to tense the anal muscles. The transition between internal and external sphincter muscles may also be palpated with the index finger when withdrawing it after having completed the rectal examination. This examination therefore permits the doctor to note the tonus at rest, the presence or absence of voluntary contractions, and the coughing reflex. The function of these muscles may be tested by asking the patient to contract them. In this way it is sometimes possible to reveal indurations or swellings that are generally due to abscesses.
5. In front of the rectum (the region of the uterine cervix in females and the prostate in males): the presence, consistency, and morphology of any suspected tumoral abscesses or lesions of these two organs can be inspected through the rectal wall. The rectovaginal septum must be carefully palpated from both sides.
6. Above the rectum: palpation of the pouch of Douglas allows direct contact with the peritoneum and its contents, which are painful in certain circumstances, as well as with internal genital organs in females. An intestinal segment (e. g., a colonic swelling associated with diverticulitis or Crohn's disease) may also be palpated.

5.5 Endoscopy

The proctological examination should, in most cases, be completed by an endoscopic investigation, usually in an unprepared patient, provided there is no painful anal lesion. This may include three procedures: anoscopy, proctosigmoidoscopy, and flexible sigmoidoscopy.

5.5.1 Anoscopy

This allows the anal canal and the distal rectum to be examined. It is probably the best means of evaluating hemorrhoids, fissures, and other anal canal lesions. It does not require specialist knowledge and is within the capability of every general practitioner. Various anoscope models exist, made of either metal or disposable plastic, and of various calibers and lengths. Light is provided by a cold lamp or by distal illumination located outside or inside the scope (Fig. 5.7).

The anoscope and its obturator are smeared with lubricant and introduced into the canal along an axis run-

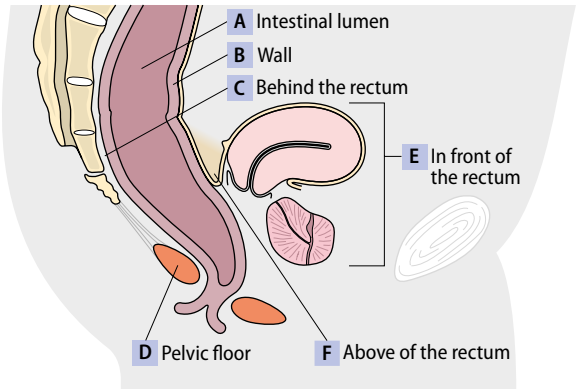

Fig. 5.6 Sites to be investigated during rectal examination

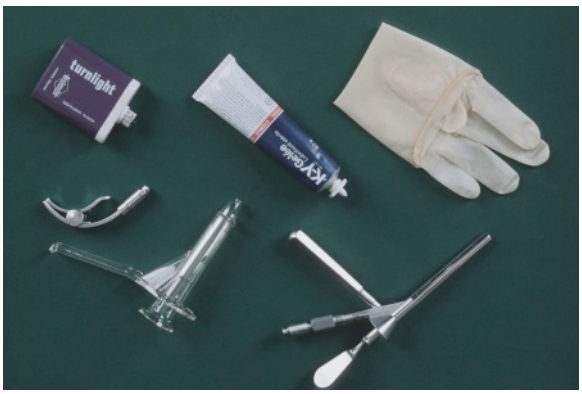

Fig. 5.7 Anoscopy equipment

ning from the anal margin to the umbilicus. This manipulation should not normally cause any pain and can be performed easily except when there is a strong reflex contraction of the sphincter due to a painful lesion of the anal canal (e. g., a fissure). When the anoscope has reached the distal end of the rectum, its obturator is withdrawn and the light source adjusted. The last 8 cm of the digestive system are examined during the progressive withdrawal of this instrument. By twisting it in various directions, the walls and the anorectal lumen can be examined in detail. The rectum is characterized by fleshly mucous folds and a lumen that remains distended after the endoscope has been withdrawn. The pronounced parietal tonicity of the anal canal tends to expel the anoscope. The presence of the three venous plexuses corresponding to the sites of formation of internal hemorrhoids is observed at this point (at 3, 7, and 11 o' clock). The pectinate line, the site of possible hypertrophied anal papillae, marks the transition between the rectal and anal mucosae.

5.5.2 Proctosigmoidoscopy

This permits examination of the rectum and often of the distal part of the sigmoid. Metal or plastic (disposable) rigid rectoscopes usually have a diameter of 20 mm and a length of 20–25 cm. In some cases, the rectosigmoid junction and certain constrictions can be traversed only by using a tube of smaller diameter. Illumination is provided by a cold light source and a lens is attached to the external orifice of the rectoscope. Bellows connected to this orifice allow air to be insufflated so that the rectum can be distended to facilitate the passage of the instrument or to reveal certain regions that are not easily visible. A suction tube allows any endoluminal residues to be sucked out (Fig. 5.8).

The preparation for this examination varies accordingly to individual preference. Some regard it as being contraindicated as it may mask important signs such as blood or mucus originating from a level higher than the one observed. It may also modify the nature of feces or any biopsy samples to be taken for bacteriological examination. For some investigators, the routine preparation consists of a small enema of a hypertonic solution (e. g., 120 ml sodium phosphate) administered a few moments before the investigation. If the patient has had a bowel movement that morning, an enema is usually unnecessary.

The tube and its obturator are lubricated and gently inserted 5–8 cm through the sphincter of the anal canal, in the same direction as for anoscopy. When the instrument strikes a wall, the obturator is withdrawn, and the light and lens are installed. The tube is then advanced while examining the lumen and walls with small side-to-side movements, sometimes after insufflation of air. As little air as possible should be insufflated, and the insertion must always be carefully controlled, never forcing against resistance as there is a risk of perforating the rectal wall. Similarly, the advance must be interrupted if the patient complains of increasing pain. Houston's valves can be traversed by successively pressing them down. It may be necessary to retrace the path taken and to examine the crescent formed by the free edge of the valve to determine the direction in which to insert the tube. At about 15 cm from the anal margin, the flexure of the rectosigmoid junction stops the advance of the rectoscope. One then looks for the small passage masked by a valve, which is crossed under visual control. This is often a difficult moment and can cause extreme pain to the patient as a result of the air insufflation and of stretching the mesentery of the rectosigmoid colon when the instrument is pushed against the rectal wall. In numerous subjects, this passage cannot be made with a rigid instrument. The walls of the rectal ampulla are sufficiently wide to form a cavity and contrast with those of the deeper-lying sigmoid, which is a portion of the colon folded back upon itself and not easy to illuminate.

The insertion into the sigmoid must not be forced; if necessary, a fiberoptic sigmoidoscope may be used to explore this organ more extensively. The mean depth investigated during a proctosigmoidoscopy is approximately 20 cm. In half of men examined, the instrument can be passed to 21–25 cm, and in women it can be passed that distance in one-third of cases [1]. The prin-

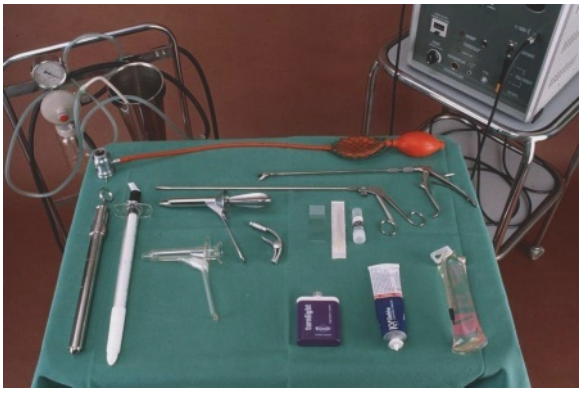

Fig. 5.8 Proctosigmoidoscopy equipment

cipal examination takes place during the withdrawal of the tube: an efficient retrograde helicoidal exploration will leave no mucosal surface unexamined. When examining a lesion during this procedure, with the aim of performing a surgical excision, for example, it should be remembered that its size is naturally increased by the bowel distension caused by the endoscope.

The examining doctor must have biopsy forceps available, allowing him or her to take mucosal and submucosal samples. The tips of the forceps should not be too sharp so as to avoid the risk of perforation. Several biopsy samples are taken during the investigation of a diffuse lesion. Problems of hemostasis and vascular lesions are contraindications to biopsy. After any biopsy, the bowel wall must be allowed to heal before performing a barium enema. This usually takes approximately 10 days. Benign tumors, and sometimes small, localized, malignant ones, can be either excised or destroyed by endoscopic resection or electrocoagulation. Polyps in particular are usually treated in this manner.

Injury with the rigid sigmoidoscope is quite rare [2]. The two classic complications of biopsy are hemorrhage and perforation.

5.5.3 Flexible Sigmoidoscopy

Using the flexible sigmoidoscope, a short type of colonoscope (60 cm), the entire sigmoid colon can be reached in 45–85% of cases, and in a few individuals, the splenic flexure can also be visualized [3]. Sigmoidoscopes provide powerful suction and are designed to perform both washout and air insufflation, as well as allowing the use of biopsy forceps. These instruments are easy to handle and light. Preoperative preparation is identical to that for rectoscopy. Sigmoidoscopy therefore allows routine examinations to be made on an outpatient basis (Fig. 5.9).

Four times more neoplasms are discovered by sigmoidoscopy with a flexible tube than with a rigid one [4], but the role of flexible sigmoidoscopy is not easy to define. It cannot be considered adequate when a complete colonic examination is indicated, since the proximal sigmoid is seen in only 65–75% of cases [5,6]. The indications for this technique of investigation are nevertheless very broad, particularly for patients over 40 years of age being investigated for a colorectal problem for the first time.

Although the flexible sigmoidoscope is easier to handle and to learn to use than the fiberoptic colonoscope, proper training is necessary. The technique of introducing the instrument and the examination are described in detail in Chap. 6 and in specialized literature on colonoscopy.

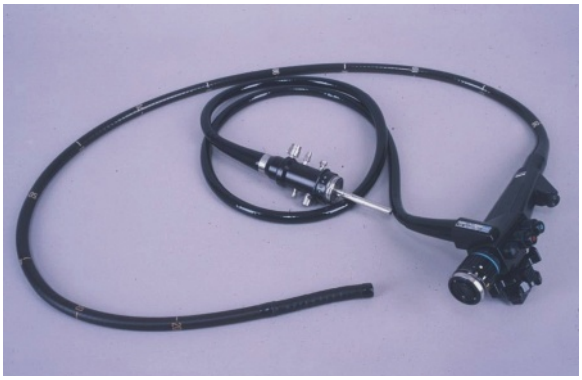

Fig. 5.9 Sigmoidoscope

5.6 Complementary Examinations

Subsequent to clinical examination, various complementary examinations may be ordered. These are described in detail in Chaps. 6–11.

5.7 Specific Conditions

5.7.1 Bleeding

A perineal examination, rectal palpation, and a proctosigmoidoscopy should always be performed in the case of any rectal bleeding. A rigid rectoscope is used for initial assessment, followed by a flexible sigmoidoscopy where a left colonic lesion, in particular a neoplastic one, is suspected. Colonoscopy also allows diagnosis of small or superficial lesions, such as an inflammatory condition or angiodysplasia. Computed tomography (CT) colography, or now less commonly barium enema, is used as an alternative to colonoscopy for inflammatory and neoplastic conditions. In the case of massive hemorrhage when colonoscopy proves negative, angiography or CT angiography should be considered. These examinations, in addition to scintigraphy with labeled red cells, allow the origin of a severe hemorrhage to be localized in most cases. After exclusion of an upper digestive tract origin, the most probable diagnosis is angiodysplasia or possibly some other vascular malformations.

5.7.2 Pruritus Ani

The general examination will rule out dermatosis or systemic disorders. During an anal inspection, the physician will look particularly for cutaneous irritation, wetting, eruption, discharge, soiling, maceration, excoriation or eruption, excrescence, prolapse, or pain suggesting a fissure or fistula. Fecal soiling may be brought to light by wiping the region with a white tampon. The presence of worms is determined by microscopic examination of a biopsy sample taken from the perianal skin, which will reveal any eggs. Rectal palpation and endoscopic examination may show sphincteric insufficiency, fistula, and hemorrhoids, as well as rectal lesions producing mucus. Biopsy specimens should be taken after examination for bacteria and fungus, and serological tests should be carried out if a sexually transmitted disease is suspected. A microbiologic examination of the stools should be performed if there is diarrhea; a biopsy sample is taken from a rectal lesion and the anorectal physiology examined in patients with sphincter disorder (see Chap. 25).

5.7.3 Pain

Apart from a local examination and endoscopy, investigation of perineal pain will include examination of the adjacent nonanorectal structures.

5.7.4 Incontinence

In incontinent patients, an examination will include inspection of any perianal soiling, any orifice, deformation, prolapse, or perineal scar. Absence of the radiating folds in a quadrant of the anal circumference is of great interest. Voluntary contraction of the perineum allows the strength of the skeletal muscles to be evaluated. By asking the patient to strain, an abnormal perineal descent or even a prolapse may be observed. A digital examination begins by palpation of the pelvic muscles. The tonus of the sphincters and the anal levator is determined and the response to voluntary contraction and to the coughing reflex is also tested. Finally, any persistent gaping of the anus after removal of the finger is noted. An investigation of incontinence will inevitably include an examination of the anorectal physiology, in particular by manometry and electromyography.

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Self-Assessment Quiz

Question 1

Which among these positions is not suitable for a proctological examination?

a. Left lateral (Sim's)
b. Genucubital
c. Trendelenburg
d. Lithotomy
e. Genupectoral

Question 2

What should NOT be used to perform an anorectal examination?

a. A pair of gloves
b. A lubricant gel
c. Lidocaine gel
d. Finger cots
e. An anoscope

Question 3

Which of the following should NOT be used to evaluate a rectal bleeding?

a. Scintigraphy with red-labeled cells
b. Rectal examination
c. Endoscopy
d. Perineal examination
e. Hemoglobin

Question 4

By using a flexible sigmoidoscope, the entire sigmoid colon can be reached in:

a. 20% of cases
b. 90% of cases
c. 30–60% of cases
d. 45–85% of cases
e. 100% of cases

Question 5

Anoscopy is probably the best method to evaluate:

a. Hemorrhoids
b. Low rectal tumor
c. Perianal abscess
d. Acute fissure
e. Defecatory problems

1. Answer: c
2. Answer: d
3. Answer: a
4. Answer: d
5. Answer: a

6 Lower Gastrointestinal Endoscopy: Diagnosis and Treatment

Philippa L. Youd and Brian P. Saunders

CONTENTS

6.1 Introduction

Video colonoscopy is an evolving procedure that is rapidly developing to meet modern diagnostic and therapeutic demands. Over the past 35 years colonoscopy has evolved from fibreoptic to video and has become the optimal technique for diagnosing, and in many cases treating, mucosal disease. The margins between endoscopy and surgery are becoming increasingly blurred. Endoscopic mucosal resection (EMR) and endoscopic submucosal dissection (ESD) now play a major role in the management of neoplasia, where surgery was once the gold standard. Colonic stenting is influencing surgical options in obstructing cancer, whilst endoscopic dilatation has become the first-line option for short, benign strictures. Standardising and optimising the colonoscopy technique remains of paramount importance for all diagnostic and therapeutic procedures. Accreditation for bowel cancer screening-derived colonoscopies has now been introduced in the UK and there is an increasing focus on demonstration of quality in colonoscopic practice [47]. To this end, the requirement for both basic and advanced colonoscopy training is being supported by renewed commitment and fresh concepts [59]. The following pages provide an insight into how colonoscopy is influencing the world of colorectal surgery.

6.2 When to Perform a Colonoscopy

Colonoscopy has emerged as the primary method of large-bowel investigation for the diagnosis and treatment of mucosal disease. Current established indications for colonoscopy are summarised below [1].

6.2.1 Diagnostic

1. Abnormal barium enema or other imaging study (e.g. virtual colonoscopy)
2. Unexplained gastrointestinal bleeding:
   a. Haematochezia
   b. Melaena after an upper gastrointestinal source has been excluded
   c. Presence of faecal occult blood
3. Unexplained iron deficiency anaemia
4. Assessment of the severity and extent of inflammatory bowel disease
5. Diarrhoea of unexplained origin
6. Intraoperative identification of a lesion not apparent at surgery (e.g. polypectomy site, location of a bleeding site)
7. Assessment of altered bowel habit
8. Investigation of abdominal mass
9. Marking a neoplasm for localisation

6.2.2 Therapeutic

1. Treatment of lower gastrointestinal bleeding
2. Polypectomy
3. Dilatation of stenotic lesions
4. Palliation of stenotic or bleeding cancers
5. Removal of a foreign body
6. Colonic decompression (pseudo-obstruction, volvulus)

6.2.3 Surveillance

In addition, guidelines exist for the colonoscopic surveillance of individuals in the following high-risk groups:

1. Longstanding, extensive ulcerative colitis [21]
2. Following colonic adenoma removal [4]
3. Post cancer resection [51]
4. Acromegalics [44]
5. Those with a family history of bowel cancer [13]

In the USA and some other countries, colonoscopy every 10 years is also employed after the age of fifty as the recommended modality for average-risk colorectal cancer screening.

6.3 The Fundamentals of Diagnosis

Accuracy of diagnosis, whilst maintaining safety and comfort, are the initial key aims of the colonoscopist. The following routine steps should be taken prior to and during every procedure to ensure that these aims are achieved.

Good bowel preparation is critical, determining quality, difficulty, speed and completeness of colonoscopy [27]. Adenoma detection rates increase with an improved quality of bowel preparation, although no single cleansing regime is appropriate and superior for use in all patients [9]. Sodium phosphate preparations have the advantage of being lower in volume than PEG (polyethylene glycol)-electrolyte solutions and are therefore better tolerated by some, but must be used with caution in the elderly and those with cardiac and renal disease. A cheaper, well-tolerated and effective alternative is the osmotic laxative magnesium citrate used in combination with Senna. Some degree of dietary restriction is necessary with all bowel preparations.

There is some evidence to suggest that the administration of an antispasmodic prior to colonoscopy improves the ease and success of caecal intubation [49], whilst enabling a clear view during the withdrawal phase. In our department we routinely premedicate with Buscopan (hyoscine *N*-butylbromide; Boehringer Ingelheim, Germany) 20 mg intravenously or glucagon 500 μg – 1 mg if Buscopan is contraindicated.

In the absence of faecal impaction or stricturing, competent colonoscopists should be achieving a caecal intubation rate of at least 90% [2]. A single-handed insertion technique is widely accepted as the optimal method of performing colonoscopy [18]. This depends on the right hand manipulating the shaft of the scope (torque steering) while the left hand alone employs the controls on the head of the colonoscope (Fig. 6.1). Changing the position of the patient during colonoscopy is a simple technique that has been shown to improve both insertion of the colonoscope and polyp detection by increasing luminal distension and visualisation [23]. Initial data suggest that for optimal lesion detection the patient should be in the left lateral position for examination of the hepatic flexure, supine for examination of the transverse colon, and in the right lateral position for examination from the splenic flexure to the sigmoid-descending junction. The process of changing a patient's position is assisted by the avoidance of heavy sedation.

Meticulous mucosal examination during scope withdrawal depends on both patience and hand skills. Competent scope handling and a straight scope are of paramount importance for an accurate mucosal assessment and a high adenoma detection rate. A satisfactory withdrawal examination should take at least 6 min [5] Attention must be paid to interrogating the proximal

Fig. 6.1 Correct positioning of the left hand on the head of a colonoscope

sides of folds and flexures, re-scanning "missed" areas, thorough irrigation, suction and adequate distension [47]. Examining the rectal vault with the scope in retroflexion has also been shown to result in a greater diagnostic yield [31, 60].

6.4 Characterising the Lesion

Determining whether a lesion is benign or malignant is usually based on its visual appearance. Ulceration, induration and friability suggest malignancy [10], as does wall deformity and hardness of the lesion on gentle palpation with the biopsy forceps (Fig. 6.2). Suspicion of malignancy is also raised when a polyp fails to lift with a submucosal injection of saline, the "non-lifting" sign [36]. Lesions that fail to lift should be biopsied, tattooed and referred for surgical resection. If, however, the lesion lifts on submucosal injection, excision is safe, and for some early submucosally invasive cancers, endoscopic excision may be a definitive treatment.

Recognising the mucosal pit pattern of a colonic lesion using magnifying colonoscopes can further contribute to in-vivo characterisation [35]. A disrupted (type V) pit pattern suggests malignancy. High-frequency, mini-probe endoscopic ultrasound (EUS) can also be used in the further assessment of malignant lesions when endoscopic therapy is being considered [56]. However, high-magnification scopes and EUS are not available in many centres and in clinical practice they have little additional advantage over assessment using the non-lifting sign.

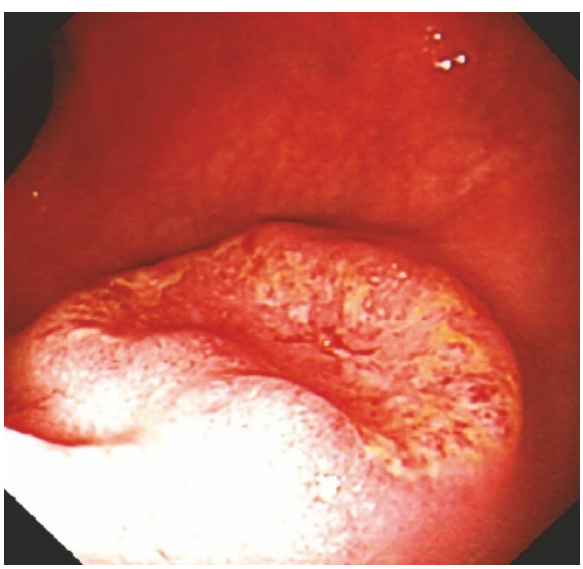

Fig. 6.2 Early cancer showing irregularity, friability, and induration

It is advisable to tattoo the colonic mucosa around a large neoplastic lesion with India Ink to leave a permanent mark for future identification of the lesion [42]. A useful method for accurately placing a submucosal tattoo is to first define the submucosal space with a saline injection prior to injecting the ink into the same space.

6.5 Newer Optical Techniques for the Improvement of Adenoma Detection

6.5.1 Chromoendoscopy

Chromoendoscopy describes the application of dye to the colonic mucosa. The surface dye indigocarmine (0.1–0.5%) is commonly used, either injected directly down the biopsy channel or via a diffusion catheter. The latter technique allows long segments of the bowel to be covered with the dye. Chromoendoscopy improves the identification of flat and depressed lesions, helps delineate neoplastic tissue from the normal surrounding tissue and can be helpful during polypectomy by delineating the margins of flat or sessile lesions [33]. Significantly more dysplastic lesions are detected in colitics on colonoscopic surveillance when a pan-colonic dye spray technique with targeted biopsies is employed rather than the traditional approach of multiple random biopsies without dye. Pancolonic dye spray and targeting of suspicious lesions may be a more time-efficient and successful surveillance strategy in high-risk groups [11, 37, 48].

6.5.2 High Magnification and High Resolution

High-magnification colonoscopes magnify the endoscopic image up to 100 times, whereas high-resolution scopes have increased pixel density and improve detail discrimination. In combination with chromoendoscopy, these technologies can allow pit pattern discrimination of neoplastic from non-neoplastic lesions and effectively in-vivo histology (Fig. 6.3d). However, magnification endoscopy with or without dye spray is time consuming and technically challenging, being perceived by many to complicate the procedure with little additional gain.

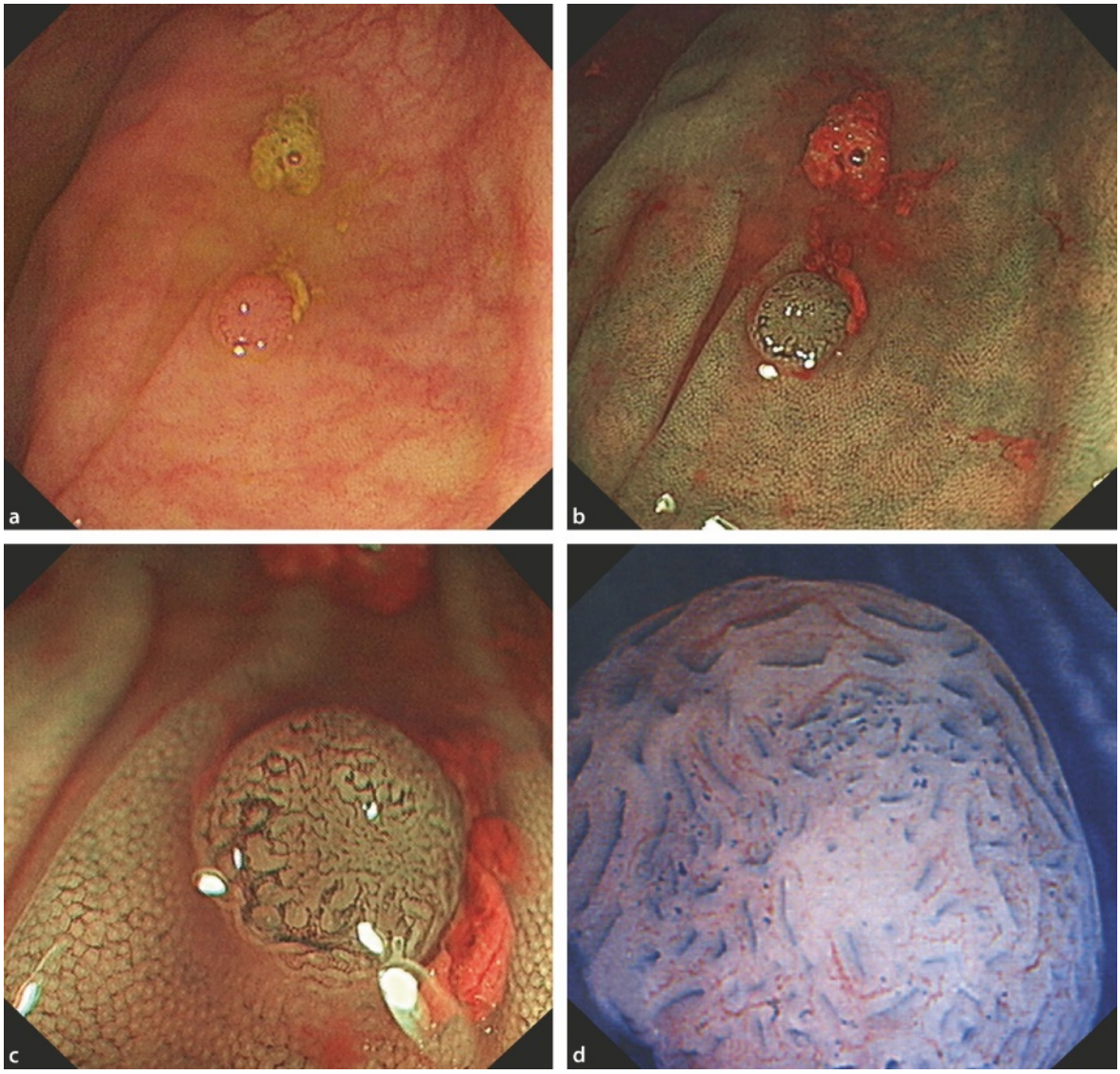

Fig. 6.3a–d An adenoma seen with white light (**a**), narrow band imaging (NBI; **b**), NBI with magnification (**c**), and chromoendoscopy with magnification (**d**)

6.5.3 Narrow-Band Imaging

Narrow-band imaging (NBI) is an easy-to-use, high-resolution endoscopic technique that enhances the fine structure of the mucosal surface (capillaries) without the use of dyes. It has been termed electronic dye-spray and is activated at the push of a button. NBI is based on the relationship between the wavelength of light and its depth of penetration. Blue light has a short wavelength and penetrates tissue only superficially, whilst red light has a longer wavelength and penetrates deeply. When NBI is activated, optical filters are placed in front of the light source to increase the relative concentration of blue light resulting in clearer surface detail, particularly the microvasculature [28]. With NBI, neoplastic lesions appear darker brown due to their increased vascularity, and flat or small adenomas become more apparent, seen by the colonoscopists as a colour change on the mucosal surface. Figure 6.3 shows the same adenomatous lesion seen with white light, magnification, NBI and chromoendoscopy, specifically demonstrating the greater surface detail and pit-pattern discrimination seen using NBI in combination with magnification. Randomised controlled trials assessing the value of NBI in colonoscopy for increased adenoma detection appear promising [24]. NBI with magnification may also be the optimal current technique for obtaining optical biopsy in-vivo.

6.6 Colonoscopic Management

6.6.1 Polyps and Endoscopic Mucosal Resection

Cancer prevention depends on the detection, safe removal and post-procedure surveillance of colonic adenomas [16]. The majority of polyps can be removed endoscopically depending on their size, characteristics and accessibility. Those probably not removable endoscopically are those with submucosal invasion, large sessile polyps extending beyond 50% of the bowel wall circumference, large rectal polyps abutting the dentate line, lesions encircling the appendix and those with generally poor endoscopic access [61]. The accessibility of a polyp can sometimes be improved by changing the patient's position, aiming to orientate the lesion at 5 o' clock, opposite the working channel of the colonoscope.

Small polyps less than 0.5 cm in size can be removed by hot biopsy, cold snare or hot snare. A good hot-biopsy technique is essential and involves tenting of the mucosa to concentrate a short burst of current through a pseudostalk, thereby heating directly below the polyp, but not across the bowel wall [63]. Alternatively, removing small polyps with the mini-snare is usually straightforward, although up to 30% remain unretrieved following this technique [41].

Larger stalked polyps are best removed using a conventional large or mini-snare. The stalk should be transected approximately half way between the polyp and the bowel wall. This ensures a clear resection margin whilst leaving sufficient stalk in situ to facilitate endoscopic treatment should post-polypectomy bleeding occur. Slow transection of the stalk is recommended with a low power coagulating current (15 W) to allow adequate haemostasis of the blood vessels within the polyp stalk [26].

EMR refers to the removal of a polyp following a submucosal fluid injection and can often be used to successfully remove sessile lesions >1 cm in diameter [3]. The submucosal injection will lift a non-invasive mucosal lesion away from the muscular layer, enabling a snare to pass over the lesion more easily and reducing the risk of thermal injury to the bowel wall (Fig. 6.4) [62]. It is the authors' experience that the addition of adrenaline to the saline injection, to a concentration of 1 in 200,000, improves haemostasis. In addition, a few drops of methylene blue added to the solution will help differentiate the normal submucosa, which appears blue, from the adenoma, which remains pink. Single lesions up to 2 cm in diameter can be removed in one piece, whilst larger polyps require piecemeal resection. For polyps removed piecemeal, treatment at their margins with argon plasma coagulation (APC) reduces the risk of recurrence or residual neoplasia [12] and a follow-up endoscopy is recommended at 2–3 months to ensure a clear polypectomy site. Figure 6.5b shows a semi-circumferential scar following an uncomplicated polypectomy.

Multiple hyperplastic polyps within the rectosigmoid are a common finding. Cold biopsies of representative lesions are sufficient in such cases to confirm the histological diagnosis. Hyperplastic-appearing lesions proximal to the rectosigmoid but less then 0.5 cm in diameter should be removed at the discretion of the endoscopist. However, all polyps greater than 0.5 cm in diameter should be removed and sent for histological assessment wherever possible, as a percentage will prove to contain dysplasia.

Various methods of polyp retrieval can be employed. Polyps less than 1 cm in diameter can be sucked through the scope into a polyp trap or onto a

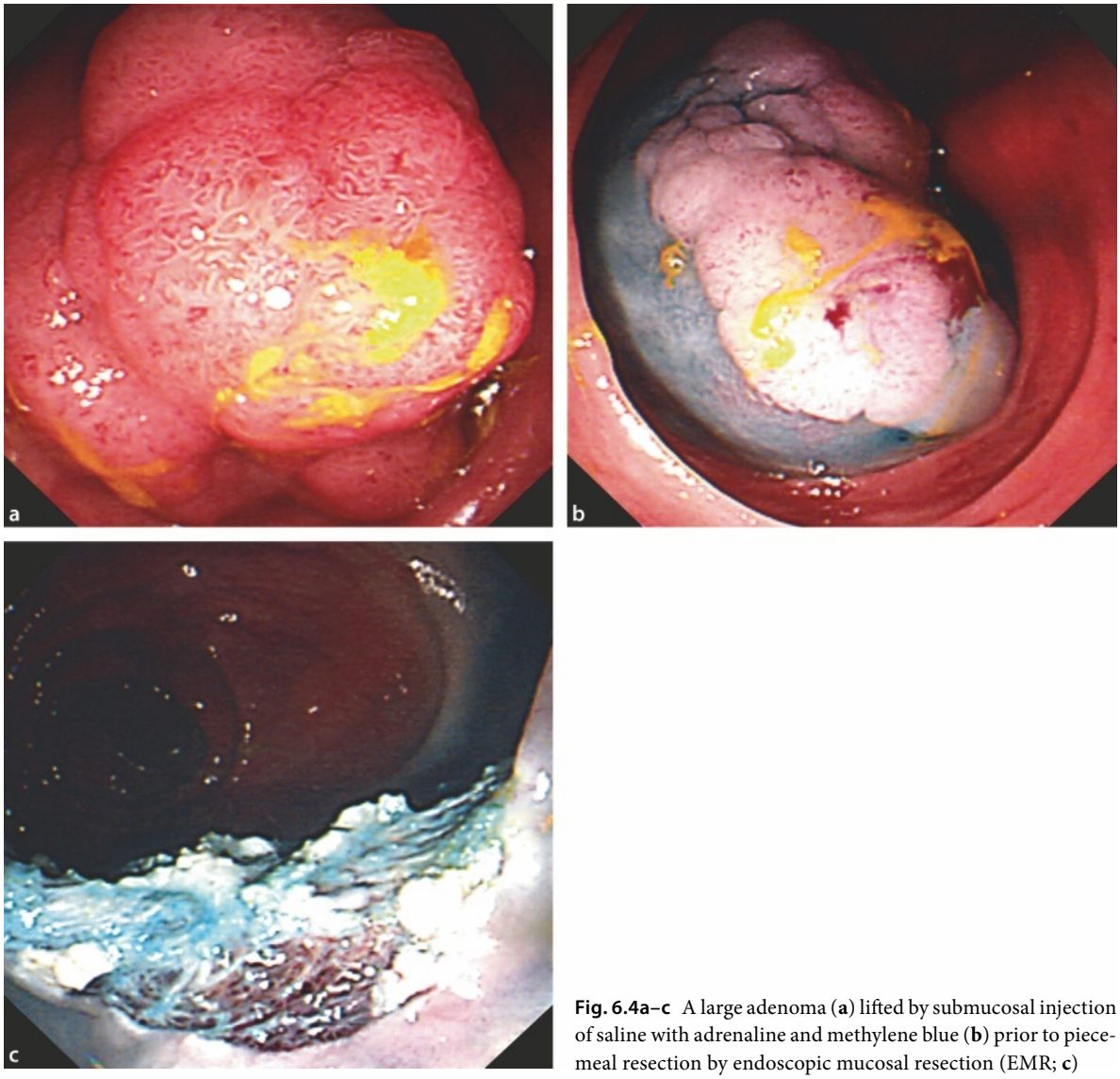

Fig. 6.4a–c A large adenoma (**a**) lifted by submucosal injection of saline with adrenaline and methylene blue (**b**) prior to piecemeal resection by endoscopic mucosal resection (EMR; **c**)

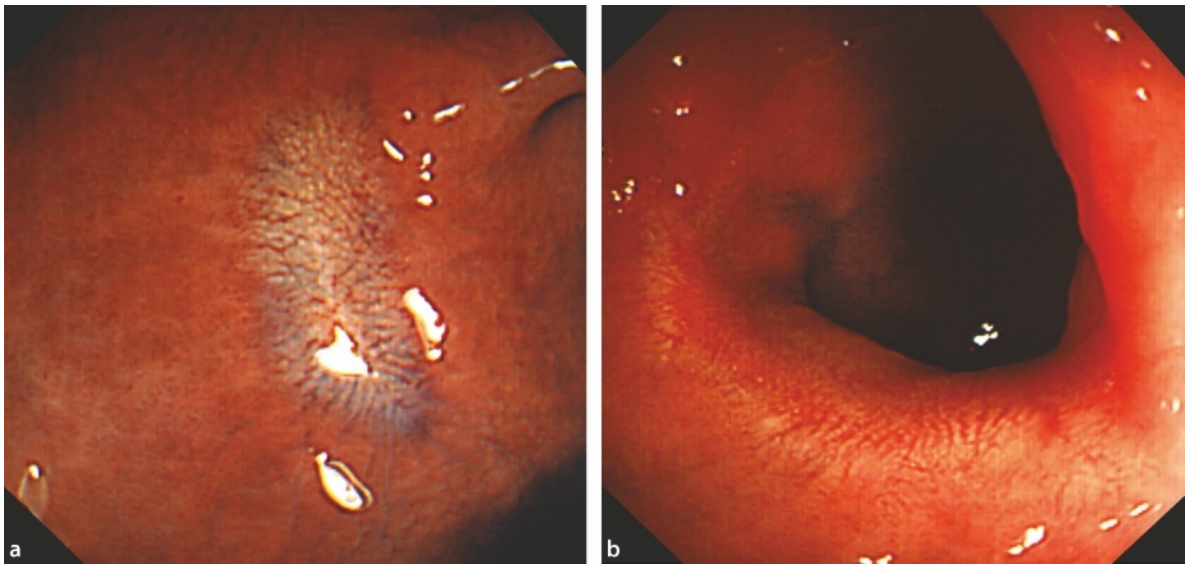

Fig. 6.5a,b Uncomplicated post-polypectomy scars with no evidence of recurrent neoplasia

Roth nets are particularly useful for retrieving more than one piece of tissue at a time, for example following a piecemeal resection.

The complications of polypectomy include bleeding (0.2–3%), perforation (0.5%) and post-polypectomy syndrome (0.5–1%). The latter refers to peritoneal inflammation due to thermal injury of the deep serosal layers of the colon in the absence of perforation, and usually responds to conservative treatment [15]. Perforation is more likely in the thinner-walled right colon where diathermy should be kept to a minimum and submucosal injection is recommended to reduce the risk of perforation [17]. Marking the snare handle to avoid entrapping large volumes of tissue within the closed snare is important for maintaining patient safety, as is responding to patient discomfort (a sign of serosal irritation). In the event of immediate (intraprocedural) or delayed (up to 30 days) post-polypectomy bleeding, endoloops (Fig. 6.7), endoclips (Fig. 6.8), 1:10,000 adrenaline injection or APC can be employed, depending on the situation. Applying an endoloop around the base of a large stalk prior to polypectomy can also be helpful to prevent bleeding (Fig. 6.7).

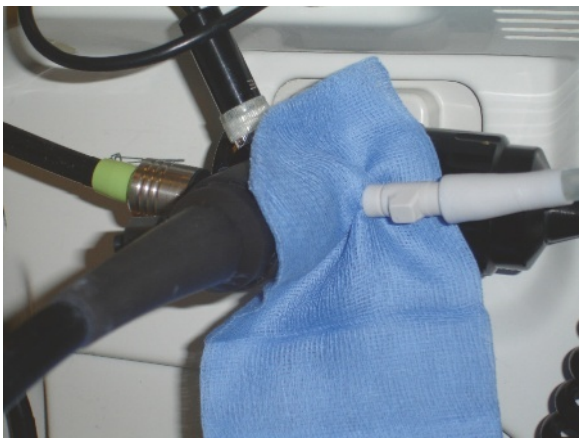

Fig. 6.6 Gauze interrupting the suction channel for retrieval of small polyps

6.6.2 Endoscopic Surgical Dissection

ESD has recently been developed for the treatment of large benign and T1 gastrointestinal tumours [64]. Figure 6.9 shows a clean and uncomplicated resection site following ESD. A deep, submucosal lift is created using a viscous solution such as sodium hyaluronate or 10% glycerine. Mucosal and submucosal incisions are made using a modified needle knife, a transparent hood being attached to the endoscope tip to help retract tissue and maintain the submucosal field of view. Several endoscopic knives, such as the FlexKnife (Olympus, Tokyo, Japan), have been developed (Fig. 6.10). Successful ESD depends on good control of bleeding during the procedure, which can be managed using APC

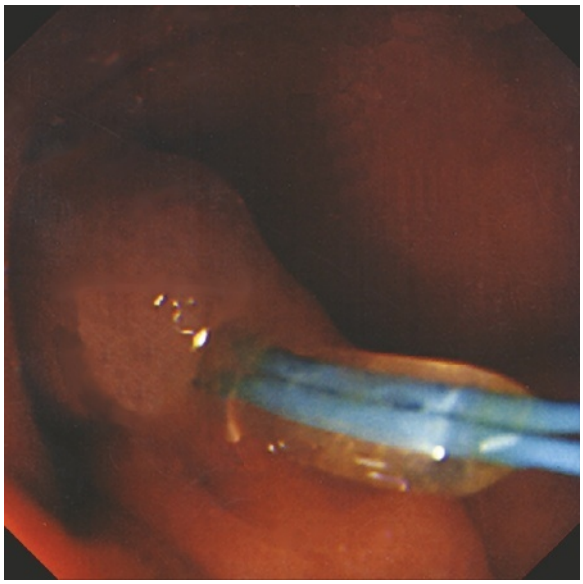

Fig. 6.7 Endoloop tightened around a polyp stalk prior to polypectomy

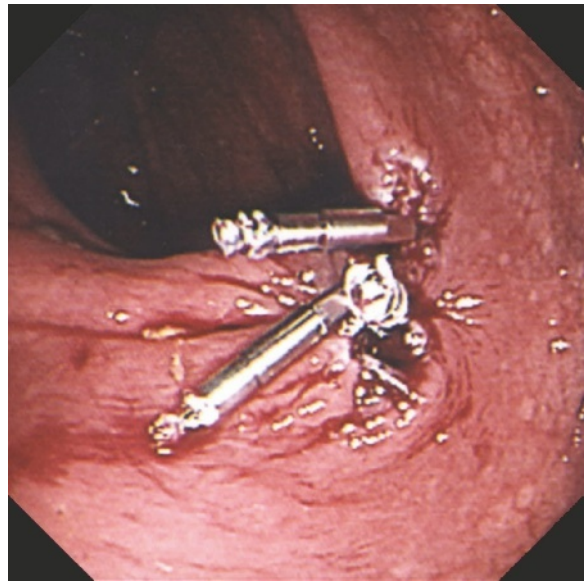

Fig. 6.8 Two clips placed at the EMR site for treatment of post-procedural bleeding

or haemostatic forceps. Whilst ESD has the advantage of producing an "oncologically correct" specimen for histological analysis and appears to abolish recurrence rates at the resection site, it carries a perforation risk in the colon of up to 5%. For this reason it has not yet been widely adopted.

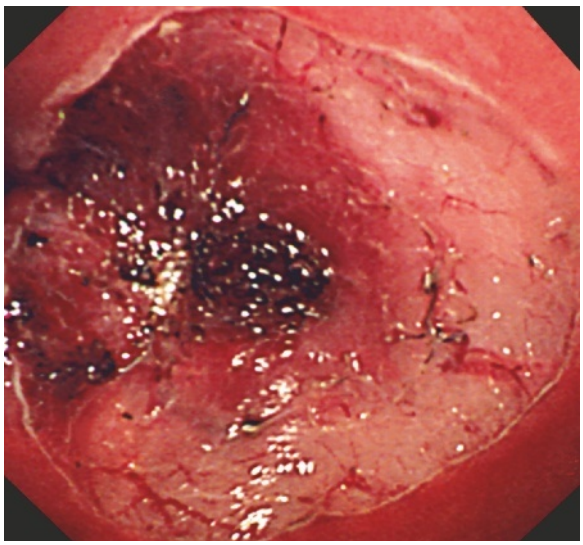

Fig. 6.9 Uncomplicated resection site of a lesion removed by endoscopic surgical dissection (ESD)

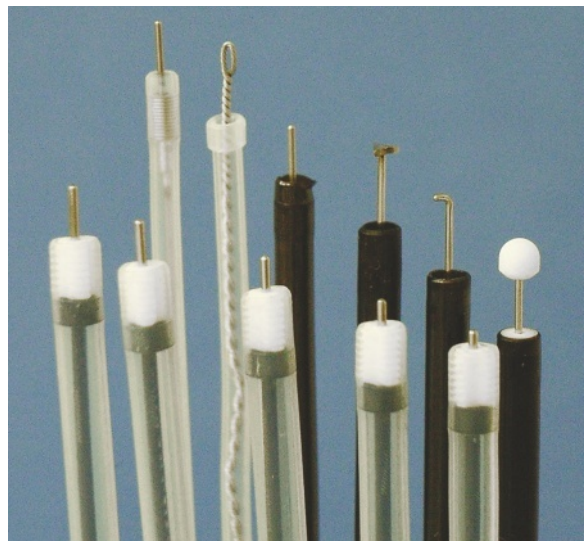

Fig. 6.10 Examples of modified knives designed for ESD

6.6.3 Strictures

The dilatation of colonic strictures is generally reserved for benign disease (Fig. 6.11), whereas the use of self-expandable metal stents (SEMS) is usually indicated for malignant disease. The visual appearance of a stricture helps the endoscopist decide on its appropriate management, the decision being supported by laboratory-based investigations such as brushings, biopsies, polymerase chain reaction and tuberculosis cultures. Through-the-scope (TTS) balloon dilators have been shown to have a 50% success rate in the management of strictures associated with inflammatory bowel disease, although multiple attempts are sometimes required [50]. Case reports also describe the successful dilatation of non-steroidal anti-inflammatory-drug-induced colonic strictures and diverticular strictures, although more data regarding the safety and efficacy of balloon dilatation is required as its complications, namely perforation and bleeding, carry a risk of 4–11%. New data confirm that corticosteroid injection is not beneficial post-dilatation [22].

SEMS can be placed endoscopically or radiologically under fluoroscopic guidance and expand within the colon to restore luminal patency (Fig. 6.12). Endoscopically, a stent is usually passed through the working channel of the colonoscope and can be deployed as far as the proximal ascending colon. Since non-TTS stents are only practical when used in the rectum and distal sigmoid, the choice of stent partly depends on the anatomical location of the lesion. Other influencing factors are stricture length and final desired lumen diameter, a contrast enema often providing valuable pre-procedural information [7].

Preoperative stenting has paved the way for one-stage surgical procedures in patients with colorectal cancer, allowing en bloc resection of both the stent and tumour in theatre in a fully resuscitated and stable patient [6]. No adverse effect on tumour recurrence rates or survival has been shown [14] and a favourable patient outcome and cost has been shown for patients receiving endoscopic SEMS placement followed by elective surgery (one-stage procedures) compared with those receiving surgical intervention alone [39]. The overall success rate of preoperative stent placement is 88.6% [52].

Although uncovered stents are preferred to covered ones in the colon due to their lower migration risk, covered stents have been successfully employed to prevent tumour in-growth [54] and in the treatment of colovaginal fistulae [38]. SEMS also have an important role in the palliation of malignant strictures, having been shown to last up to 1 year [55].

Despite high migration rates, stenting can also be considered as a potential therapy for selected benign strictures [57]. SEMS insertion for anastomotic stric-

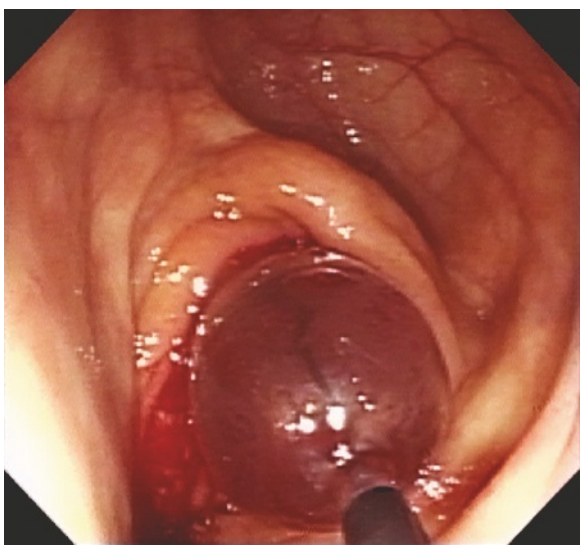

Fig. 6.11 Dilated balloon within a benign colonic stricture

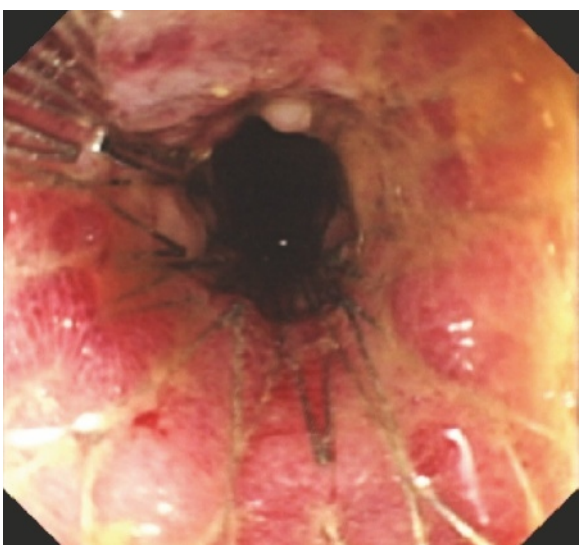

Fig. 6.12 Deployed stent restoring bowel patency within a malignant colonic stricture

tures tends to be temporary, but can be attempted in cases unresponsive to dilatation [30, 58]. Experience of stenting is also reported with some success in the management of Crohn's disease [40], diverticular disease [8, 19] and radiation-induced strictures [65].

The limitations and complications of colonic stenting include the inability to pass the guidewire through the stricture and anatomical difficulties such as a fixed sigmoid. "Failed" stents can be attributed to malpositioning, migration, proximal obstruction, perforation and reobstruction, the causes of stent obstruction including tumour in-growth, stool impaction, mucosal prolapse and peritoneal seeding. In addition, bowel function following SEMS placement is not always acceptable to the patient, varying from frequency of loose stool to constipation [20], and patients need to be advised of this prior to the procedure. The more serious complications of bleeding and perforation can occur as either intraprocedural or late complications of colonic stenting, perforation being limited by minimal air insufflation and the avoidance of aggressive pre- or post-stent dilatation [7, 52].

6.6.4 Acute Lower Gastrointestinal Bleeding

The lower gastrointestinal tract accounts for one-quarter to one-third of all hospitalised cases of gastrointestinal bleeding [45]. Diverticular disease is by far the most common cause of lower gastrointestinal bleeding, with colitis, cancer, polyps and angiodysplasia accounting for the majority of the rest [25]. Anorectal lesions account for approximately 10% of cases.

In patients whose bleeding stops spontaneously, an elective colonoscopy with routine bowel preparation is appropriate. In cases of continued bleeding, prompt diagnosis is required and endoscopic therapy is the treatment of choice. An urgent therapeutic colonoscopy after rapid purge can be highly effective, decreasing both the recurrence of bleeding and the need for surgical intervention [34]. An actively bleeding vessel can be injected with 1 in 10,000 adrenaline followed by thermal therapy, whilst thermal therapy alone is often sufficient for the treatment of non-bleeding vessels. Endoclips applied to bleeding points, either as a single therapy or in combination with adrenaline injection or APC, play an important role in the management of lower gastrointestinal tract bleeding. They have also been described as successfully controlling diverticular bleeding by closing the mouth of the diverticulum [32]. Urgent colonoscopy appears to have a low complication rate [66] and is currently considered safer, with a greater diagnostic yield, than urgent angiography and embolisation. Surgery is reserved for cases of recurrent, uncontrolled or massive bleeding.

6.6.5 Colonic Decompression

Sigmoid volvulus is the third most common cause of bowel obstruction after cancer and diverticular disease. Flexible sigmoidoscopy with placement of a decompression tube, preferably proximal to the peak of the volvulus, is the initial treatment of choice. However, despite its initial success rate of 78% [43], colonoscopic decompression of a sigmoid volvulus is only a temporising measure and recurrence is common. Elective surgery is therefore still considered the definitive treatment of choice. Emergency surgery is reserved for a volvulus unresponsive to endoscopic therapy or for patients with bowel ischaemia or peritonitis.

Ogilvie's syndrome is defined as an acute pseudo-obstruction of the colon characterised by the signs, symptoms and radiological pattern of a large-bowel obstruction, but without a detectable organic cause. The aetiology is unclear and is likely to be multifactorial. Ogilvie's syndrome can be self-limiting, responsive to colonic decompression and sometimes recurrent [29]. In stable patients an initial conservative approach can be taken. If a trial of conservative management fails, however, colonoscopic decompression is generally accepted as the first invasive therapeutic manoeuvre [46]. Placement of a decompression tube during colonoscopy is advised, as in the management of sigmoid volvulus, to reduce the risk of recurrence. Colonoscopic decompression is said to fail in 31% of patients or to be followed by recurrence in 40% of those in whom initial decompression is successful. Emergency surgery is again only indicated in resistant or complicated cases, such as those with perforation or ischaemia.

6.7 Colonoscopy Training – in Brief

Despite new developments in colonoscopy training in recent years, the emphasis on hand-skills, cognition, core knowledge and an ethical approach remain [59]. The traditional apprenticeship model of colonoscopy training is now being complemented, in line with modern educational theory, with the introduction of intensive, hands-on courses for individuals and small

groups. The importance of "training the trainers" has been recognised in the development of focused courses for motivated colonoscopy trainers. Televised workshops for larger groups of endoscopists expose attendees to expert technical skills and newer concepts. Computer simulation has been shown to be of value, at least in the early phase of colonoscopy training, whilst simulation with animal models is of value in the practice of therapeutic procedures such as haemostasis or polypectomy.

The ScopeGuide (Olympus, Tokyo, Japan) is an electromagnetic endoscopic imaging device that was developed to demonstrate looping and colonoscope tip location during real-time colonoscopy and is beneficial to both new and experienced colonoscopists, increasing understanding of the large variations in colonic anatomy [53].

Underpinning all these advances in colonoscopy training is the introduction in the UK of competency assessments, formal accreditation to perform screening-derived colonoscopies and the development of national colonoscopy training centres.

6.8 Conclusion

This chapter has provided an overview of colonoscopy, a technique that now plays a central role in the diagnosis, treatment and prevention of colorectal disease. Various optical techniques have emerged for improving in-vivo diagnosis, the most promising of these being NBI.

Therapeutic colonoscopy, with techniques such as EMR, ESD, dilatation and stenting is becoming widely adopted and will impact on the need for traditional open or laparoscopic surgery. At the forefront of all technological advances in colonoscopy is the importance of sound clinical practice, and to this end there is an ongoing and increased focus on training, the demonstration of quality and the acceptance of accreditation.

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Self-Assessment Quiz

Question 1

Regarding colonoscopic surveillance for colorectal cancer, which of the following statements is true?

a. Patients with primary sclerosing cholangitis are at no higher risk of bowel cancer than patients with ulcerative colitis (UC) alone.
b. Patients who have five or more adenomas removed at baseline colonoscopy require a repeat colonoscopy at 3 years.
c. Patients with left-sided UC have a lower risk of malignancy than patients with pancolitis.
d. After endoscopic mucosal resection (EMR) of a 4-cm rectal polyp, endoscopic follow-up at 1 year is indicated.
e. The risk of malignancy in colitis does not increase with the duration of disease.

Question 2

With respect to patient position during colonoscopy, which of the following positions are thought to be *optimal* for mucosal visualisation?

a. Left lateral at the splenic flexure
b. Supine at the hepatic flexure
c. Right lateral in the descending colon
d. Right lateral at the splenic flexure
e. Prone in the sigmoid colon

Question 3

Which of the following has not been shown to be useful in the management or prevention of post-polypectomy bleeding?

a. Endoloops
b. Argon plasma coagulation
c. Narrow-band imaging
d. Endoscopic clips
e. 1:10,000 adrenaline injection

Question 4

Regarding the management of colonic strictures, which of the following statements are true?

a. Dilatation is the initial treatment of choice for malignant lesions.
b. Previous stent insertion is a contraindication to surgical resection of the lesion.
c. Covered stents have an increased risk of migration.
d. A contrast study is useful in evaluating the stricture prior to stent insertion.
e. The risk of a major complication at balloon dilatation of an ileocolonic anastomotic stricture in Crohn's disease is between 4 and 10%.

Question 5

Regarding malignant polyps, which of the following statements is true?

a. Ulceration is uncharacteristic.
b. They should be removed in a piecemeal fashion where possible.
c. Lifting with submucosal injection of saline is a poor prognostic sign.
d. They usually have a type I pit pattern.
e. Endoscopic ultrasound can be useful for assessing invasion.

1. Answer: c
Comments: Regarding UC surveillance, patients with concurrent primary sclerosing cholangitis require more frequent colonoscopies than those with UC alone due to their increased risk of malignancy. The recommended frequency of UC surveillance increases with the duration of disease, with pancolitis carrying a higher risk of colorectal cancer than left-sided disease. Patients with five or more adenomas at baseline colonoscopy should be followed up at 1 year and a large rectal polyp should be reviewed early, for example at 3 months, following EMR to ensure complete excision.
2. Answer: d
Comments: Evidence suggests that lesion detection is improved with the patient in the left lateral position for examination of the hepatic flexure, supine for examination of the transverse colon, and in the right lateral position for examination from the splenic flexure to the sigmoid-descending junction [23].

3. Answer: c
Comments: An endoloop can be applied over the stalk of a polyp, either before or after polypectomy, to reduce the risk of post-polypectomy bleeding. This is more common in stalks of larger diameter. Endoscopic clips can be applied to a post-polypectomy bleeding site. Argon plasma coagulation and adrenaline injection are also used in the management of post-polypectomy bleeding.

4. Answer: a
Comments: The dilatation of colonic strictures is mostly reserved for benign disease. Failures are usually associated with recurrent neoplasia, adjuvant radiation therapy or large dehiscence.
A stent can be inserted preoperatively to allow a one-stage surgical procedure with en bloc resection of the stent and lesion. Uncovered stents become embedded in the colonic tissue by pressure necrosis, thereby reducing their chance of migration.

5. Answer: e
Comments: Compared with benign lesions, malignant tissue is more likely to be indurated, ulcerated, friable and vascular. Pit pattern type I is the normal mucosal pattern of colonic mucosa [35], a disrupted type V pattern being more typical of malignancy. Lesions that have invaded into the submucosal tissues tend not to lift with submucosal injection and can be further evaluated by endoscopic ultrasound, if it is available.

7 Pathology of Anorectal and Colonic Specimens

Daniel J. Royston and Bryan F. Warren

CONTENTS

7.1 Introduction

This chapter outlines a practical approach to anorectal and colonic pathology. In particular, there is emphasis on pathological assessment, which is relevant to patient management. The chapter is broadly divided into three main sections: the interpretation of mucosal biopsies from the large bowel, the examination of resected specimens for benign disease and the examination of resected specimens for malignancy.

Familiarity with the histology of the normal large bowel wall and the normal mucosal appearances in different parts of the large-bowel mucosa is important for the understanding of large-bowel pathology. This is particularly true for the diagnosis and staging of adenocarcinoma. The layers of the normal bowel wall are demonstrated in Fig. 7.1. Two important regions in the large-bowel mucosa have to be understood in order to avoid misinterpreting normal as abnormal. These are the right side of the colon and the columnar cuff of the anal canal. The fact that the normal caecal mucosa contains more chronic inflammatory cells than the rest of the large-bowel mucosa [1] is important in order to avoid over-interpreting the normal microanatomy as a skip lesion in inflammatory bowel disease and to avoid over-assessing the extent of ulcerative colitis. The normal columnar cuff biopsy from the upper part of the anal canal may have crypt architectural distortion, muscularisation, and basal lymphoid aggregates [1, 2]. It is easy to appreciate that this region (which in truth is rarely deserving of biopsy outside ileoanal pouch surgery) may be over interpreted as mucosal prolapse [3], follicular proctitis [4] or ulcerative proctitis.

Communication and context are the two most important concepts in effective and clinically useful colorectal pathology. It is worth sending an endoscopy report and a picture or video of the findings, as pathologists are often quite good at "macroscopic" pathology. Endoscopic biopsy specimens have to be put into a container and it is advantageous to place them in a histopathology-processing cassette in the endoscopy room. This means they can be dropped into a pot of formalin, sent to the laboratory and be put straight into the histopathology processing machine. The alternative is for the pathologist to spend time fishing the biopsy specimens out of a pot of formalin and placing them in a cassette. This also adds a potential contamination step with one biopsy specimen being carried over to the next by forceps, for example [5].

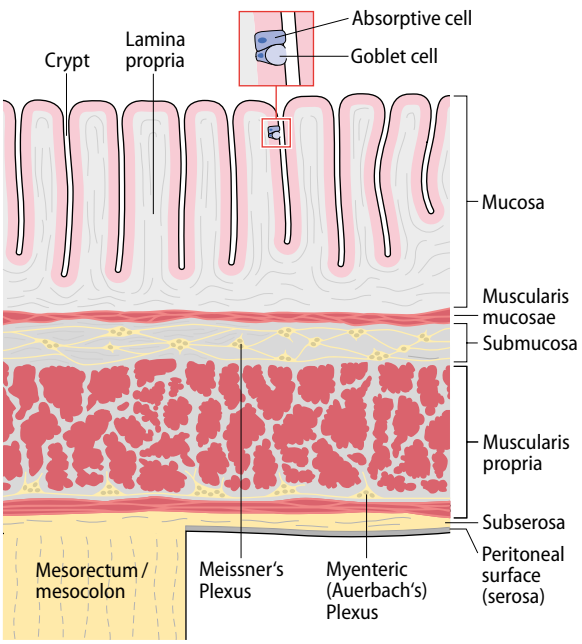

Fig. 7.1 Normal large bowel. Simplified diagram showing the layers of the normal large bowel wall and its innervation

7.2 Practical Interpretation of Large-Bowel Mucosal Biopsies

7.2.1 Introduction to Mucosal Biopsies

Biopsy diagnosis in large-bowel disease relies on pathological interpretation in the context of clinical and endoscopic information. This is particularly true for colitis, when the colonoscopic findings may be as useful as the pathology report in achieving a diagnosis. The distribution of colitis is all-important to the diagnosis. The absence of pathological features from biopsied "skip lesions" in Crohn's disease or the diffuse nature of the inflammatory changes in distal biopsy samples from ulcerative colitis can only be interpreted correctly if the biopsy and colonoscopic findings concur. Proper labelling of biopsy sites and a colonoscopy report are essential if the pathologist is to provide a useful report.

The pathology report should provide a description and diagnosis of the basic disease processes present, in terms that can be easily understood by others using recognised terminology. In cases of neoplasia, the biopsy report should be unambiguous.

This section discusses some of the more common and important lesions that may be biopsied from the

anus, rectum and colon. Emphasis is placed on the practical issues of biopsy interpretation and on areas of potential diagnostic confusion.

7.2.2 Biopsy Material from Inflammatory Colorectal Disorders

The correct histological diagnosis of colitides is important for patient management. This is exemplified by the potentially serious complications of treating a case of infective colitis with immunosuppressive therapy following a mistaken diagnosis of either ulcerative colitis or Crohn's disease.

7.2.2.1 Acute Self-Limiting (Infective) Colitis

There are numerous bacterial, viral, protozoal and parasitic causes of colitis. Their relative incidence will depend upon the country, travel history and immune status of the patient. Many of these infective agents are culture negative and their diagnosis in cases of acute colitis is important. Only some of the more common infectious entities likely to result in recognisable tissue pathology will be considered here. Of particular importance are the infections that may be mistakenly diagnosed as chronic idiopathic inflammatory bowel disease (CIIBD). These are the so-called inflammatory/invasive group of bacteria, which include *Salmonella, Shigella*, *Campylobacter*, *Escherichia coli* and *Clostridium difficile*. The most important protozoal infection that is likely to enter the differential diagnosis of CIIBD is *Entamoeba histolytica*.

A common problem facing the pathologist is the biopsy diagnosis of patients presenting with an acute episode of culture-negative diarrhoea when there is clinical and/or colonoscopic evidence of proctocolitis. The differential diagnosis from CIIBD may present difficulty if infections persist and begin to develop more chronic histological features after about 10 days. It takes up to 6 weeks for the characteristic crypt architectural changes to appear in ulcerative colitis [6, 7]. In the presence of diffuse crypt architecture distortion and/or a villiform epithelial surface, the diagnosis of infective colitis should be seriously questioned. However, care should still be taken as these features have been described in some cases of infective colitis, particularly those caused by shigellosis or amoebiasis [8]. The regular crypt pattern of an acute self-limiting infective colitis is often accompanied by striking degenerative and reactive changes that are largely confined to the superficial portions of the crypts. Many of these crypts may appear superficially dilated with mucin depletion and epithelial cell flattening. These crypt outline abnormalities, sometimes referred to as "crypt withering", are seen in infective colitis, pseudomembranous colitis and ischaemia.

Unlike the rather diffuse pattern of inflammation often seen within the lamina propria of CIIBD biopsies, focal superficial clusters of neutrophil polymorphs are often seen with infections. Pseudomembranous colitis and Crohn's disease may also show a focal pattern of inflammation, although usually with fewer polymorphs [9]. The relative proportions of the various inflammatory cell types may differ in infective and non-infective cases of proctocolitis. Infections tend to contain a relative abundance of polymorphs over plasma cells, in contrast to CIIBD, and frequently occupy more superficial parts of the biopsy [6]. Unfortunately, these features may be subtle or impossible to discern, particularly if there is evidence of marked oedema of the lamina propria. In extreme circumstances, this oedema may also result in some artefactual distortion of the crypt architecture. It is a myth that crypt abscesses are diagnostic of ulcerative colitis and that polymorphs confined to the crypt epithelium (cryptitis) are more suggestive of infective colitis.

The finding of basal lymphoid aggregates within the lamina propria indicates chronicity and is more suggestive of CIIBD, although the inflammatory features of chronic *Campylobacter jejuni* and amoebic colitis are markedly similar [7]. However, if the biopsy specimens are ulcerated and partially lined by a haematoxyphilic slough, a search for amoebae should be made. Amoebae with characteristic prominent nuclear karyosomes and intracytoplasmic red blood cells may be present within the necrotic ulcer material, but they may only be seen at certain times in the disease history when they are released in a shower from ulcers [10]. The other important feature of amoebiasis is the presence of eosinophilia in the mucosa rather than neutrophilia.

Sometimes, however, even in the presence of positive cultures, biopsy of infective colitis does not always reveal characteristic features. Indeed, some biopsy specimens may appear entirely normal or display only mild degrees of oedema within the lamina propria. Where doubt remains, the pathologist should request a repeat biopsy after 1–2 months, since most cases of acute self-limiting infective colitis resolve within this time period.

7.2.2.2 Pseudomembranous Colitis

The diagnosis of pseudomembranous colitis requires a combination of colonoscopic and microscopic features. Macroscopically, there should be discrete raised and indurated creamy plaques or a coalescent necrotic membrane attached to the underlying mucosa of the large bowel. The microscopic features of pseudomembranous colitis have been split into types I, II and III [11].

Type I lesions are tiny, superficial erosions or "summit lesions" that arise when the intercryptal epithelium has been destroyed and replaced by fibrin and acute inflammatory cells. It is important to examine the adjacent mucosa when these features are identified, as other pathologies such as the solitary rectal ulcer, polyps with superficial trauma or inflammatory cap polyps may have similar appearances [12].

In type II lesions, small foci of disrupted crypts are seen. The base of each crypt is typically intact, with the superficial part being dilated and filled with cellular and inflammatory debris. The ghost outline of crypts typically seen below the inflammatory infiltrate may be used to distinguish this stage of pseudomembranous colitis from purely ischaemic colitis. Furthermore, ischaemia tends to result in haemorrhage into the adjacent mucosa, often accompanied by other ischaemic features. By contrast, the mucosa adjacent to type II lesions in pseudomembranous colitis often appears only mildly acutely inflamed or oedematous.

In type III lesions, the crypt destruction is more complete and a layer of inflammatory slough replaces the mucosa. These histological features cannot be distinguished from those seen in severe mucosal ischaemia and are not diagnostic of pseudomembranous colitis.

7.2.2.3 Antibiotic-Associated Colitis

Antibiotic-associated colitis seldom warrants surgical intervention and is therefore nearly always a biopsy-based diagnosis. By definition, no necrotic mucosal membrane is seen and the inflammatory pattern may closely mimic infectious proctocolitis [13]. Stool cultures and *Clostridium difficile* toxin estimation are indicated if the clinical context is appropriate.

7.2.2.4 Chronic Idiopathic Inflammatory Bowel Disease

The clinical and colonoscopic context of mucosal biopsies in inflammatory bowel disease is critically important. The timing of the biopsy in relation to clinical exacerbation or resolution and in relation to medical or surgical intervention may have considerable influence on the histological appearances [14].

In selecting sites for biopsy, the endoscopist should thoroughly sample areas of apparently normal mucosa in addition to any clearly abnormal ulcerated or polypoid lesions. The interpretation of such lesions in the patient presenting with CIIBD requires knowledge of the background inflammatory processes occurring throughout the whole colorectum. Familiarity with the spectrum of normal and pathological changes seen within post-surgical biopsy specimens from ileostomy sites, segments of defunctioned bowel and ileal pouches/pouch reservoirs is also important. This is particularly true when patients present with symptoms and/or a clinical course that is inconsistent with a previous diagnosis of CIIBD.

Two regions of the normal large bowel may be misdiagnosed as CIIBD. The increased density of chronic inflammatory cells seen in the lamina propria of the caecum and proximal ascending colon needs to be recognised as normal. Up to one in seven crypts in the normal colorectal biopsy sample are branched, but in the columnar cuff of the anal canal crypt branching is more frequent and is accompanied by prominent lymphoid follicles and muscularisation of the lamina propria. These features may be misinterpreted as mucosal prolapse [3], follicular proctitis or CIIBD.

Biopsies Performed Early in the Course of CIIBD

The characteristic crypt architectural abnormalities of CIIBD are absent in the first 6 weeks. In these cases, the finding of basal lymphoid aggregates and large numbers of plasma cells within the basal portion of the mucosal biopsy specimen favour a diagnosis of CIIBD [6]. However, infections such as *Campylobacter* may produce similar inflammatory changes that are indistinguishable from those of early CIIBD [7].

Distinguishing Ulcerative Colitis and Crohn's Disease in the Mucosal Biopsy

Some well-characterised histological features have been shown to have associations with either ulcerative colitis or Crohn's disease, but no single definitive microscopic feature distinguishes these entities. Again, the history and colonoscopic features must be considered if the histological findings are to be interpreted correctly.

However, it must be accepted that on some occasions it may be impossible to distinguish between these entities histologically. In these circumstances the term "inflammatory bowel disease, type unclassified" should be used in biopsy reports [15]. "Indeterminate colitis" is a term reserved for the appearances of a colectomy specimen.

In typical ulcerative colitis biopsy samples, a diffuse mucosal infiltrate of neutrophils and chronic inflammatory cells is associated with a characteristic diffuse pattern of epithelial damage in the form of cryptitis, crypt abscess formation, surface erosions/ulcerations and mucin depletion. By contrast, Crohn's biopsy samples characteristically display a patchy pattern of inflammatory changes with focal erosions, focal architectural changes and relatively little mucin depletion.

Biopsy Appearances after Treatment

The biopsy pathology in ulcerative colitis often varies over time and later stages of ulcerative colitis may be confused with Crohn's disease, particularly in biopsy specimens taken from previously treated ulcerative colitis patients [16]. Such cases may show microscopic areas of patchy inflammation and evidence of focal epithelial damage. However, erosions with severe acute inflammation would be unusual in healed or healing phases of ulcerative colitis. This feature may sometimes distinguish Crohn's disease from the patchy and focal chronic colitis of healed or healing ulcerative colitis. Another important area of potential diagnostic confusion is the finding of mucosal granulomas in biopsy specimens. In ulcerative colitis, mucosal granulomas may directly cause crypt damage (cryptolytic granulomas) or be a response to the spillage of damaged crypt contents into the lamina propria [17]. Neither is specific for Crohn's disease.

Biopsy of Focal Lesions in CIIBD

Several visible and discrete mucosal lesions in the colorectum of a CIIBD patient may be biopsied. As already mentioned, these lesions can only be interpreted correctly in the context of the findings from the remainder of the bowel.

Ulcers may simply represent part of the spectrum of CIIBD changes. However, they may also represent a secondary pathology such as viral (e. g. cytomegalovirus) or protozoal (e. g. amoebae) infection or solitary ulcer/prolapse syndrome. In such cases, care should be taken to assess the diagnosis of CIIBD by examining biopsy samples from both the ulcer margin and distant mucosa. Most importantly of all, when confronted by an ulcerating lesion in the context of CIIBD, the endoscopist should be ever vigilant for evidence of an ulcerating carcinoma.

Several colorectal polypoid lesions may be identified in the bowel of CIIBD patients. In addition to inflammatory polyps, polypoid lesions may arise in infections such as cytomegalovirus and amoeba. Importantly, it must not be forgotten that older patients with CIIBD may also develop typical adenomas, with the same diagnostic features and management implications as those identified in normal individuals.

The differentiation of sporadic adenoma and dysplasia-associated lesion or mass (DALM) in patients with ulcerative colitis is controversial. Although sometimes fraught with difficulty, distinguishing these lesions can be relatively simple if the clinical context, adjacent mucosa and distant mucosal appearances are considered [18]. For example, a biopsy specimen taken from a dysplastic polypoid lesion in the proximal large bowel of a patient with colonoscopic evidence of limited distal ulcerative colitis is most likely to be an adenoma. This is particularly true if the patient is relatively old. By contrast, a dysplastic lesion occurring in a young patient in a region of the bowel affected by ulcerative colitis is likely to be a DALM. However, there are clearly some situations in which definitive diagnosis becomes very difficult, as with older patients presenting with flat or sessile lesions in areas of colitis [19]. Although the initial microscopic features of such lesions may not allow confident diagnosis, multiple biopsies of both the lesion and the adjacent mucosa may help. If the adjacent flat mucosa shows evidence of dysplasia, the lesion is far more likely to be a DALM.

Although management strategies have differed for sporadic adenomas and DALMs, there is evidence that chromoendoscopy can detect most dysplastic lesions in ulcerative colitis, whether flat or otherwise [20]. There is also evidence that in patients with dysplastic lesions identified by chromoendoscopy, endoscopic local excision has the same prognosis as radical surgery provided the colonic mucosa can be accurately surveyed at the time and on follow up by chromoendoscopy [20–22]. The differentiation between DALMs and sporadic adenomas may become less important in the future.

7.2.2.5 Ileal Pouch Biopsies

The correct interpretation of ileal pouch biopsies in ulcerative colitis requires an awareness of the usual

histological changes that commonly occur in pelvic ileal reservoirs. In ulcerative colitis, pouches display some architectural abnormalities of the villi in addition to varying degrees of chronic inflammation [23]. These changes are thought to be particularly prevalent in those portions of the pouch that are in contact with static faecal material. In some cases the mucosa may acquire a so-called colonic phenotype, particularly if there is evidence of severe mucosal chronic inflammation. This is regarded as "adaptive change" in the pouch mucosa and does not warrant a specific diagnosis.

Pouchitis is a joint clinical, colonoscopic and histological diagnosis that requires characteristic generalised endoscopic inflammation within the pouch mucosa and a spectrum of clinical symptoms including diarrhoea, pain, discharge, urgency and systemic upset [24]. Microscopy of the pouch biopsy sample should show severe acute mucosal inflammation and focal erosion/ulceration on a background of chronic inflammation and villous atrophy. However, it is important to remember that similar acute inflammatory changes may be seen in other pouch pathologies such as ischaemia, Crohn's disease, mucosal prolapse and infectious enteritis [24]. Furthermore, identical features to those described herein may also be seen in localised, secondary pouchitis resulting from pathology external to the pouch. The mass effects of neoplasms and inflammatory lesions such as abscesses have been particularly implicated as causes of secondary pouchitis. Importantly, although it appears that some patients with classical ulcerative colitis who undergo ileal-pouch anal anastomosis (IPAA) may later develop genuine Crohn's disease, a diagnosis of Crohn's should not be made on the pouch biopsy findings alone [25, 26].

Although dysplasia arising in pouch mucosa has been reported, particularly in areas of colonic phenotypic change, the risk of malignancy appears to be low [27]. Nonetheless, surveillance programs involving biopsy specimens from multiple sites are recommended, particularly in patients with evidence of severe inflammation or dysplasia in the colon or rectum. Patients with significant amounts of anal transitional zone mucosa and/or "cuffitis" following ileal-pouch anal anastomosis are also considered to be at greater risk of neoplasia and should be kept under particularly close surveillance [28].

7.2.2.6 Microscopic Colitis

Colorectal biopsy specimens are often taken from patients suffering from chronic, watery, bloodless diarrhoea with or without abdominal pain. In these circumstances the diagnosis of microscopic colitis should be considered. Despite some historical confusion regarding the definition of microscopic colitis, this group of entities is now commonly regarded as being defined by joint clinical, endoscopic and pathological features. In addition to the clinical symptoms described above, the diagnosis requires a normal or near-normal colonoscopy, although colonic mucosal splits and tears have been recorded [29]. The pathological component of the diagnosis requires the recognition of distinct microscopic features of the different colitides encompassed within the term "microscopic colitis".

In lymphocytic colitis there is an increase in the number of mononuclear cells within the lamina propria in addition to an increase in the number of intraepithelial lymphocytes (IELs). The presence of a diffuse increase in the number of IELs (>20 per 100 epithelial cells) is diagnostic of lymphocytic colitis although post-treatment biopsy samples may exhibit less inflammation [30]. If large numbers of eosinophils are seen, the possibility of a drug-related cause (e.g. non-steroidal anti-inflammatory drugs, NSAIDs) should be considered, although fewer mononuclear cells are typically seen in these cases. Focal and diffuse epithelial cell changes have also been described in lymphocytic colitis; these include epithelial cell flattening, detachment, mucin depletion and cytoplasmic vacuolisation.

Collagenous colitis has the characteristic feature of a significantly thickened subepithelial collagen layer (SCL) measuring greater than 10 μm, although this is often patchy [31]. SCL thickening is most readily appreciated in biopsy specimens from the transverse and proximal colon [32, 33]. A diffuse infiltrate of lymphocytes within the lamina propria is seen with scattered eosinophils. Occasionally, neutrophils may also be noted. There is often an increase in the number of IELs with associated epithelial changes that may appear similar to lymphocytic colitis. Rectal sparing may be seen in 30% of collagenous colitis cases [33]. A normal rectal biopsy does not therefore exclude the diagnosis.

In addition to lymphocytic and collagenous colitis, other types of microscopic colitis have been described. They include microscopic colitis with giant cells [34], granulomatous-type microscopic colitis [35] and pseudomembranous-type microscopic colitis, although whether these actually represent discrete entities is unclear. The term "microscopic colitis, not otherwise specified" has also been recognised as a subtype of microscopic colitis. It has been used for patients with typical clinical features of microscopic colitis, normal colonoscopy and non-specific chronic

inflammation in the absence of increased IELs or SCL thickening [32].

Drugs are an important cause of microscopic colitis [33]. Of particular importance are the NSAIDs, protein pump inhibitors (PPI) and the antiplatelet drug ticlopidine. These may cause any of the histological features of microscopic colitis, including chronic inflammation with prominent eosinophils, increased IELs, apoptosis, melanosis coli and SCL thickening.

7.2.2.7 Diverticular Colitis

The assessment of mucosal biopsies from the sigmoid colon with evidence of colitis requires caution and context. Both Crohn's disease and ulcerative colitis may be superimposed upon diverticular disease, with the final diagnosis often resting upon the careful examination of a sigmoid colectomy specimen. However, a limited sigmoid colitis occurring in the presence of diverticula and with no evidence of concomitant ulcerative colitis or Crohn's disease is much more common [36].

Mucosal biopsy samples from these cases of so-called diverticular colitis may display a variety of often confounding appearances, ranging from normal to focal or diffuse inflammation and features of mucosal prolapse. Examining a rectal biopsy specimen significantly helps to distinguish diverticular colitis from ulcerative colitis; a normal rectal biopsy making the diagnosis of ulcerative colitis less likely. Conversely, inflammatory changes in the rectum effectively rule out a diagnosis of diverticular colitis since diverticula are not seen in the rectum. Distinguishing diverticular colitis from Crohn's disease on the basis of mucosal biopsies is rather more difficult, as the key distinguishing transmural inflammatory features will not be present in the biopsy specimen. In these cases, a diagnosis of Crohn's disease will require detailed clinical, radiological and colonoscopic correlation. In light of these considerations, it should be recognised that a diagnosis of either ulcerative colitis or Crohn's disease limited to the sigmoid colon in the presence of diverticula is frequently incorrect [36, 37].

7.2.2.8 Drug-Induced Proctocolitis

A wide range of drugs may cause colorectal inflammatory changes either by directly causing inflammation in the normal bowel or by reactivating quiescent pre-existing inflammatory bowel disease. The patterns of inflammation, apart from microscopic colitis, may resemble those of CIIBD, acute self-limiting (infective) colitis and ischaemia.

NSAIDs are capable of reactivating CIIBD and may also precipitate the onset of new disease, in particular ulcerative colitis. The symptoms are often identical to those of ulcerative colitis in which there has been no history of NSAID use [38]. However, in cases where the biopsy inflammatory changes are non-specific, a conspicuous increase in the number of apoptotic bodies within the crypt epithelium or lamina propria may suggest the diagnosis. This increased apoptotic activity in epithelial cells or lymphocytes can result in the accumulation of mucosal lipofuscin pigment [39]. Consequently, in cases of colitis in which the histological features do not fit a well-defined histological pattern, particularly when numerous apoptotic bodies are seen, the possibility of NSAID-induced colitis should be considered and discussed with the clinician [40]. When used as suppositories, NSAIDs may also cause a localised proctitis or ulceration that may resemble solitary rectal ulcer [41, 42].

Chemotherapeutic regimens can affect the mitotically active mucosal surface of the colorectum within several days of treatment. The biopsy features may include increased apoptosis, degeneration of the surface epithelium, superficial necrosis and atypical nuclear features. Healing may result in persistent architectural and nuclear abnormalities that should not be confused with neoplasia. A documented history of chemotherapy should prevent such misdiagnosis.

Heavy metals such as gold, mercury, silver and arsenic may result in a picture of colitis with diffuse mucosal inflammation that is rich in eosinophils, associated with normal crypt architecture. Again, clinicopathological correlation including a history of heavy metal ion treatment or exposure, and the characteristic colonoscopic findings of multiple petechial haemorrhages and focal ulceration, is required for diagnosis.

Finally, various drugs may result in a pattern of ischaemic colitis (see below). These include oestrogen- and progesterone-containing oral contraceptives, the antimigraine drug ergotamine and various anti-inflammatory drugs such as alpha-interferon and interleukin-2 [43, 44].

7.2.2.9 Focal Active Colitis

The histological diagnosis of focal active colitis (FAC) is characterised by the finding of focal crypt infiltration by neutrophils in the absence of other abnormal microscopic findings. It is typically seen in mucosal biopsy

samples taken from the right side of the colon and in adults may be a result of bowel preparation artefact or post-infective changes. Although similar findings may be seen in Crohn's disease, FAC does not predict the development of Crohn's disease in the adult population and should not be misdiagnosed as such [45]. By contrast, FAC in children predicts a higher likelihood of Crohn's disease [46]. Consequently, the recognition of FAC is of importance and requires careful clinicopathological correlation.

7.2.2.10 Irradiation Proctitis

Several acute and chronic radiation-induced changes are recognised in colorectal biopsy samples taken from patients treated for gastrointestinal or other abdominal/pelvic tumours. The microscopic appearances may reflect the time course of the therapy, and their correct interpretation requires context and an adequate history.

Acute radiation-induced changes are often seen in the rectal mucosa of patients who have undergone preoperative short- and long-course radiotherapy for rectal cancer. Biopsy specimens can have a somewhat alarming appearance due to the combination of marked epithelial cell atypia and crypt architecture distortion. These features may be mistaken for diffuse dysplasia or even viral cytopathic effects. However, the diffuse nature of the mucosal changes along with a reduced mitotic cell count and eosinophil crypt abscesses should alert the pathologist to the correct diagnosis [47].

Patients with chronic radiation-induced changes typically present with symptoms of proctocolitis within a few months to several years of receiving therapy. However, presentation can be many years later, when a history of previous radiotherapy may be overlooked or forgotten. Unlike the acute changes, the chronic radiation-induced features primarily affect the submucosal and intramural connective tissues. The biopsied submucosa may appear oedematous or homogenously eosinophilic and may contain bizarre fibroblasts. Small vessels, particularly arterial, may be lined by prominent atypical endothelial cells associated with intimal fibrosis [48]. The vessels may even show evidence of fibrinoid necrosis and contain fibrin microthrombi. Permanent damage to the mucosa may be recognised at low power in the form of crypt architectural distortion. Of note, the vascular changes may be seen in adjacent areas of the bowel that appear otherwise normal.

7.2.2.11 Diversion Proctocolitis

Biopsy specimens from segments of defunctioned (diverted) large bowel require correct interpretation. Biopsy specimens from a diverted, previously normal bowel show a relative lack of crypt architecture distortion, lymphoid hyperplasia, diffuse mucosal chronic inflammation within the lamina propria, acute inflammation and surface ulceration [49]. The lack of crypt architectural distortion is important to discriminate diversion proctocolitis from CIIBD.

In cases where diseased bowel has been diverted, the biopsy appearance can be quite different from that described above. In Crohn's disease the inflammatory changes may be become less pronounced following diversion of the faecal stream; the mucosa may appear fibrosed with little inflammation, and any granulomas may become degenerate and hyalinised [50]. The findings may resemble those of ulcerative colitis. By contrast, the diverted rectum in the three-stage ileal pouch procedure for ulcerative colitis may demonstrate an exacerbation of the inflammatory features [23]. Importantly, the worsening biopsy features, which may include fissuring ulceration, granulomas and granulomatous vasculitis, may mimic those of Crohn's disease [51]. It must be emphasised that a diagnosis of ulcerative colitis or indeterminate colitis should not be changed to one of Crohn's disease on the basis of an examination of the diverted rectum alone. Instead, the previous colectomy and the whole patient should be reassessed.

7.2.2.12 Ischaemic Colitis

Ischaemic injury to the large bowel may reflect either arterial or venous insufficiency. The two most important causative factors are vascular occlusion and hypotension, each of which can be subdivided into numerous individual aetiologies. The spectrum of changes seen in the ischaemic colon and rectum is determined both by the timescale of the ischaemia and its underlying cause. Ischaemic lesions are generally more common on the left side of the bowel than the right. Ischaemia of the rectum is uncommon (7% of cases) [52].

Although biopsies are seldom performed in cases of severe acute ischaemia, they typically reveal mucosal and submucosal haemorrhage with varying degrees of oedema and necrosis. The crypts are often described as having a "bursting" appearance and may be covered with necrotic material. A moderate lymphocytic infil-

trate may accompany these changes, as may fibrin microthrombi within mucosal and submucosal vessels. In cases of massive bowel infarction, only an outline of the normal tissue histology may be seen. If there has been less severe ischaemic injury, the damage may be confined largely to the superficial portions of the mucosa. The epithelial cells may show non-specific degenerative features such as flattening, and occasional crypts may be entirely lost. The degree of crypt loss broadly corresponds to the degree of ischaemia. The lamina propria may contain abundant eosinophilic collagen, but unlike cases of CIIBD, typically relatively few lymphocytes are seen. Finally, during the recovery phase of ischaemia, there is distortion of the regenerative and hyperplastic crypts. The lamina propria appears fibrotic and characteristically contains haemosiderin-laden macrophages.

The differential diagnosis of an acute ischaemic biopsy includes pseudomembranous colitis, infection and collagenous colitis. The superficial crypt damage characteristic of ischaemia and early pseudomembranous colitis can be confused, although in ischaemia the superficial crypts tend to show more degenerative features, and mucinous debris is more typical of pseudomembranous colitis. The degenerative epithelial appearances of ischaemia may resemble the crypt "withering" of infective colitis. The sparse inflammation characteristic of ischaemia contrasts with the superficial neutrophil clusters of infection. Neutrophils in the lamina propria that extend into the crypt epithelium form cryptitis. Where the prominent fibrosis of ischaemia resembles the thickened subepithelial collagen layer of collagenous colitis, a collagen stain may be required. Amyloid may also cause confusion at this site unless special stains are used.

In cases of chronic ischaemic damage, the crypt architecture abnormalities may raise the differential diagnosis of CIIBD, particularly ulcerative colitis. In these cases, careful clinicopathological correlation and assessment of the disease distribution should greatly aid the diagnosis. Finally, it should be remembered that chronic ischaemia-induced changes in the mucosa may be part of the pathogenesis of mucosal prolapse, where small vessels become compressed and occluded.

7.2.2.13 Mucosal Prolapse and Solitary Ulcer Syndrome

The terms polypoid mucosal prolapse, inflammatory cap polyp and inflammatory cloacogenic polyp are now considered to represent a spectrum of changes that are encompassed by the unifying concept of mucosal prolapse [53]. Mucosal prolapse may be found at colostomy margins, adjacent to polyps and in diverticular segments. The commonest site is the anterior or anterolateral wall of the rectum, the so-called solitary ulcer syndrome [54]; "solitary ulcer" is not always solitary and not always ulcerated [55].

Biopsy samples from sites of early mucosal prolapse often show replacement of the normal lamina propria by smooth muscle fibres extending superficially from the muscularis mucosae [54, 56]. This is important since the presence of smooth muscle fibres surrounding crypts may be mistaken for evidence of malignancy, particularly if adenomatous lesions are sectioned tangentially. The mucosa overlying areas of a prolapse may become ulcerated and lined by granulation tissue. Associated mucus-filled glands at the edge of the ulcerated area can become misplaced into the submucosa and again be mistaken for adenocarcinoma [55]. These appearances have been referred to as "localised colitis/proctitis cystica profunda" [57]. Biopsies from areas of mucosal prolapse therefore require careful inspection. A lack of epithelial dysplasia and the presence of the typical microscopic features of mucosal prolapse in the remainder of the lesion should prevent a mistaken diagnosis of malignancy.

7.2.3 Biopsy Material from "Non-inflammatory" Colorectal Disorders

7.2.3.1 Vascular Disorders of the Colorectum

In addition to ischaemia-related changes, several other vascular disorders are recognised in the large bowel. Amongst the primary disorders, angiodysplasia is one of the commonest causes of bleeding in elderly patients [58]. It typically arises in the right side of the colon, although any part of the bowel may be affected. Angiodysplasia is widely regarded as a degenerative lesion, best defined as an ectasia of colonic submucosal veins with or without ectatic vessels in the overlying mucosa [58]. Histological diagnosis on superficial biopsy specimens can be very difficult. Even if adequate submucosal tissue is included in the biopsy, crush and other artefactual changes can prevent a diagnosis. For these reasons, approximately 50% of cases cannot be diagnosed on biopsy alone [59, 60] and the diagnosis may require a combination of angiography, endoscopy and histology.

Vasculitis may present in the large bowel, although in most cases gastrointestinal involvement is part of a systemic illness. Polyarteritis nodosa, Wegener's granulomatosis, systemic lupus erythematosus, rheumatoid arthritis and Behçet's disease have all been described in the large bowel [61]. If biopsy material includes submucosa, it may show the typical features of vasculitis. Secondary changes such as focal mucosal ischaemic ulceration or non-specific inflammation may be all that is present in the mucosal biopsy sample. It may be useful to examine multiple levels in order to identify the focal lesions of vasculitis. Importantly, the vascular inflammation and thrombosis sometimes seen in the vessels lining areas of ulceration should not be mistaken for primary vasculitis.

7.2.3.2 Amyloid

Amyloid deposition in the colorectum is most commonly associated with systemic type AA (reactive) amyloidosis, but may be seen in any of the other disorders resulting in amyloid protein deposition [62, 63]. In biopsies, the protein is commonly deposited in the lamina propria and walls of mucosal vessels. However, it may be limited to the muscularis propria or vessels of the submucosa and therefore missed on biopsy. On occasion, the vascular deposition of amyloid may result in severe mucosal haemorrhage or areas of discrete ulceration [33].

The differential diagnosis of colorectal amyloid includes collagenous colitis, where the eosinophilic subepithelial band of collagen may resemble amyloid in a conventional haematoxylin and eosin stain (H&E). Arteriosclerotic changes within submucosal vessels in deep biopsy samples may also be mistaken for vascular amyloid deposition on staining with H&E. In both situations, a Congo Red stain and/or immunohistochemistry for serum amyloid P component should identify the amyloid protein and secure the diagnosis.

7.2.3.3 Pigment Deposition

Biopsy samples taken from the large bowel sometimes show evidence of abundant granular pigment within the mucosa. In melanosis coli, the accumulation of granular lipofuscin pigment within the histiocytes of the lamina propria is thought to reflect increased epithelial cell apoptosis [39, 64]. It is seen predominantly in the right side of the colon and appendix and may be highlighted with a periodic acid-Schiff stain. Although associated with anthraquinone laxative use, it may also be caused by other drugs such as NSAIDs. The key differential diagnosis is the mucosal haemosiderosis of bowel-wall ischaemia/ischaemic colitis. A Perls' stain can confirm the presence of haemosiderin in ischaemic cases.

7.2.4 Biopsy Material from Neoplastic Colorectal Lesions

The majority of neoplastic biopsy specimens taken from the colorectum are from adenomas or adenocarcinomas. The single most important function of the pathologist when assessing these neoplastic lesions is the identification of malignancy. In the UK, the diagnosis of malignancy is made in properly orientated and adequately sized biopsy samples, when dysplastic crypts are seen to invade through the muscularis mucosae. In contrast to Japan and the United States, the terms carcinoma-in-situ and intramucosal carcinoma are not used in the UK.

Some colonoscopic biopsies are superficial and poorly orientated, with varying degrees of artefactual distortion or disruption. In these cases the assessment of malignancy requires careful assessment of the glandular epithelium and its degree of dysplasia, the location of the glandular elements relative to the muscularis mucosae, and the appearances of the periglandular stromal tissue.

7.2.4.1 Biopsy Diagnosis of Colorectal Adenocarcinoma

The biopsy diagnosis of colorectal adenocarcinoma depends upon the identification of unequivocal evidence of invasion by a tumour through the muscularis mucosae. In cases where this is difficult to assess, the presence of a desmoplastic stromal reaction in the form of fibroblast, myofibroblast and endothelial cell proliferation can be strongly suggestive, but not diagnostic of an invasive tumour.

There are occasions when despite clinical, colonoscopic and radiological evidence of an invasive tumour, the biopsy is composed of superficial fragments of necrotic tissue or dysplastic epithelium with no relation to the stroma or muscularis mucosae. In such cases the

specimen is inadequate and the pathologist is unable to independently verify the diagnosis of malignancy.

7.2.4.2 Avoiding the Biopsy Misdiagnosis of Colorectal Adenocarcinoma

Biopsies from suspicious lesions may show severe dysplasia and architectural complexity in the form of glandular crowding, cribriforming and budding. These may raise concern over the possibility of malignancy, particularly if the specimen has been subjected to crush artefact. However, regardless of the severity of the cytological and architectural features, a diagnosis of malignancy cannot be made on the epithelial appearance alone; similar findings may be observed in superficial biopsy samples taken from severely dysplastic adenomas. If possible, it is far better to remove a polyp in its entirety endoscopically than to biopsy it.

Another important feature that may lead to a mistaken diagnosis of malignancy is the presence of crypts within or beneath the muscularis mucosae of an otherwise benign polypoid lesion. These misplaced crypts and their lamina propria usually appear identical to the overlying mucosa and represent previous torsion. In cases where misplaced dysplastic crypts are seen in the stalk of an adenomatous lesion, these findings have been referred to as pseudocarcinomatous invasion or pseudo-invasion [65, 66]. It should be distinguished from true malignant invasion by the lack of a desmoplastic stroma tightly surrounding the dysplastic epithelium. The presence of associated haemosiderin-containing macrophages or frank haemorrhage favours previous torsion. Occasionally, reparative changes within a polyp may result in hypertrophy of the muscularis mucosae with extension of smooth muscle bands between the glands of an adenoma. Again, careful assessment of the surrounding stromal tissue should prevent the misdiagnosis of malignancy.

Biopsies with evidence of mucosal ulceration, such as may be seen in ischaemia and CIIBD, can contain granulation tissue with large, highly atypical cells bearing pleomorphic nuclei. Careful assessment of the adjacent non-ulcerated epithelium, underlying tissue and other associated features should prevent these cells, known as bizarre stromal cells, from being misinterpreted as malignant [67].

Small biopsy specimens may fail to provide enough tissue to assess the true tumour grade, while areas of ulceration and associated inflammation from superficial parts of the tumour may lead to the mistaken interpretation of a poorly differentiated tumour.

7.2.4.3 Other Primary Tumours of the Colorectum

Several tumours other than adenocarcinoma may be biopsied from the colon, rectum and anus. These are less common than adenocarcinoma and are considered herein only briefly.

Endocrine tumours of the large intestine are uncommon (less than 1% of all colorectal tumours) and usually arise in the rectum or the right side of the colon. The majority of colonic tumours are of the enterochromaffin cell type with appearances similar to those seen in the ileum or appendix, with solid clumps or islands of uniform cells with eosinophilic granular cytoplasm. By contrast, endocrine tumours in the rectum are mostly of the L-cell type (non-argentaffin tumours synthesising enteroglucagon and peptide YY) with cells commonly arranged in ribbons around vascular cores [68]. Various histochemical and immunohistochemical stains may be required for the diagnosis and classification of these tumours, the details of which are beyond the scope of this chapter. It is important to appreciate, however, that endocrine tumours may resemble adenocarcinomas displaying a "carcinoid pattern" of growth with small cell carcinoma probably representing the most malignant type of endocrine tumour. Endocrine tumours cannot be classified as benign or malignant on the basis of the biopsy findings alone. The prognosis and management will depend upon the tumour size, mitotic activity, invasion and presence of metastasis.

Primary squamous cell carcinomas of the colon and rectum are exceptionally rare and care must be taken to exclude secondary tumour deposits [69]. Rectal squamous cell carcinoma has been described in cases of ulcerative colitis, although the possibility of an anal tumour invading proximally into the bowel poses a potentially difficult differential diagnosis. Careful clinicopathological correlation is essential.

Primary malignant lymphomas represent less than 1% of colorectal tumours and are more commonly found in biopsy material taken from the caecum and rectum. The majority of these tumours are B-cell mucosa-associated lymphoid tissue (MALT) lymphoma or mantle cell lymphomas (malignant lymphomatous polyposis, MLP). Distinguishing these tumours from benign lymphoid polyps/polyposis in biopsy speci-

mens is critically important. The colonoscopic appearances may be useful, with large ulcerating lesions typically being malignant. Both MALT and MLP can have a similar histological appearance and the differential diagnosis rests upon the clinical and colonoscopic features as well as on immunohistochemical studies. Rarely, Burkitt-type lymphoma can involve the right-sided colon of children, and high-grade diffuse large B-cell lymphomas may complicate acquired immunodeficiency syndrome [70]. Isolated cases of T-cell lymphomas have also been identified in the large bowel.

Very occasionally, colonoscopic biopsies may reveal tumour cells with a spindle-shaped morphology. Increasingly, these tumours are recognised as c-kit-positive gastrointestinal stromal tumours (GISTs) unless clearly identifying features indicating an origin from a specific connective tissue cell type are recognised [33]. GISTs are rare in the colorectum and tend to be intramural masses, making their presence in mucosal biopsy material uncommon. The diagnosis requires an awareness of the protean histological features that may be seen in GISTs, and the value of immunohistochemical and molecular studies. Importantly, some GISTs are negative for c-kit and CD34, and these markers should not be considered as simple diagnostic tests for these tumours. A panel of immunohistochemical markers including stains for muscle differentiation (desmin, smooth muscle actin, heavy caldesmon), S100 and vimentin should also be used. Predictions about the clinical behaviour of these tumours depend largely on the size, necrosis and mitotic counting of several areas of excised tissue. The amount of prognostic information obtained from a biopsy specimen is usually limited [33].

7.2.4.4 Biopsy Diagnosis of Metastatic Tumours

Several common tumours may spread to the colon and rectum and present either as solitary or multiple tumour deposits. The more common tumours known to metastasize to the colorectum include carcinomas of the stomach, breast, ovary, kidney, cervix and lung. Prostatic carcinomas may involve the rectum by direct spread, although these patients usually have urological symptoms. The primary tumour may remain occult, despite the presence of gastrointestinal symptoms from secondary deposits, and the clinical and colonoscopic findings may suggest a typical primary colorectal adenocarcinoma. Consequently, the pathologist must always be alert for tumours with unusual cytological and/or architectural features. A panel of confirmatory immunohistochemical markers may be helpful and, in concert with clinical and radiological findings, may identify the primary tumour.

7.2.5 Biopsy Material from Inflammatory Disorders of the Anus

Biopsy samples may be taken from discrete lesions in the anus or as part of the surgical exploration and treatment of anal lesions such as abscesses and anal fistulae. The purpose of these biopsies is to exclude malignancy or unusual infection. Other inflammatory conditions may also become apparent.

7.2.5.1 Anal Fissures

Most primary fissures are of unknown aetiology and biopsy reveals non-specific inflammatory features within the squamous mucous membrane of the lower anal canal. The edges of the fissure may be oedematous and thickened with a heavy infiltrate of lymphocytes and plasma cells. Small polypoid "sentinel tag" lesions may also be seen at the edge of a fissure. Important causes of secondary fissures include Crohn's disease, leukaemia, infections and squamous carcinoma.

7.2.5.2 Anal Fistulae and Abscesses

Representative fragments of tissue are often taken for histology during the surgical exploration and treatment of anal fistulae. These fragments usually show non-specific acute inflammatory changes that are in keeping with the assumption that most fistulae develop from infections of the anal glands [71]. On occasion, the inflammatory infiltrate may contain features suggestive of another specific aetiology. Granulomas with or without giant cells may represent a simple foreign-body-type reaction to faecal material, although the diagnosis of Crohn's disease, tuberculosis, hidradenitis suppurativa and pilonidal sinus need to be excluded. This is particularly important if there are abnormal clinical and/or endoscopic findings. In Crohn's disease affecting the anus, the most important histological feature is the presence of discrete epithelioid cell granulomas with Langhans-type giant cells. By contrast, the granulomas of tuberculosis are typically confluent and may contain caseous necrosis, although small necrotic foci may be seen in other granulomatous diseases. The

tissue diagnosis of tuberculosis requires a Ziehl-Neelson stain for acid-fast bacilli or molecular diagnostic methods such as polymerase chain reaction.

7.2.5.3 Crohn's Disease

The incidence of perianal Crohn's disease is unknown. This is partly because anal lesions may precede the onset of intestinal features and partly because some patients with confirmed intestinal Crohn's disease have perianal inflammation as a result of diarrhoea. In cases with no previous diagnosis, Crohn's disease may be suggested on the basis of the anal biopsy if the characteristic discrete granulomas are identified. However, the final diagnosis should only be made in light of the clinical and endoscopic features since other pathologies such as tuberculosis, sarcoidosis and foreign-body reactions may also cause a granulomatous pattern of inflammation. Other anal lesions that may be seen in Crohn's disease include ulcers, skin tags, fissures, abscesses and strictures. As with other sites affected by CIIBD, evidence of dysplasia or malignancy should be excluded.

7.2.5.4 Infections of the Anal Region

Several infections may present in the anus, frequently as a complication of anal intercourse. Primary syphilis may be confused with other ulcerating anal pathologies such as tuberculosis, fissures, Crohn's disease and carcinoma. Although the spirochaetes may be detected in biopsy material using immunofluorescence, the diagnosis of syphilis requires the appropriate serological tests. Granuloma inguinale, a primarily tropical disease caused by *Calymmatobacterium granulomatis*, may also result in ulceration with a dense mixed inflammatory cell infiltrate. Occasionally, diagnostic Donovan bodies may be demonstrated within macrophages using a Giemsa or Warthin-Starry stain. The role of human papillomavirus (HPV) in anal disease is considered later.

7.2.6 Biopsy Material from Tumours and Tumour-Like Lesions of the Anus

Tumour biopsy material taken from the anus is relatively uncommon and its appearance reflects the various epithelial types present in the normal anal canal.

7.2.6.1 Benign Lesions

Fibroepithelial polyps (skin tags) are amongst the more commonly biopsied lesions in the anal canal. Histologically, they appear as polypoid lesions composed of a myxoid or collagenous stroma lined by squamous epithelium. The stromal cells may display atypical nuclear features, but fibroepithelial polyps should not be regarded as posing any significant neoplastic potential [72].

Mucosal prolapse may present in the anal canal as an ulcerated polypoid mass mimicking an adenoma. As in other parts of the large bowel, microscopy reveals increased smooth muscle or fibrosis in the lamina propria with no evidence of epithelial dysplasia.

Bowenoid papulosis is an important condition since it is benign and often misdiagnosed. It presents as a papular eruption in the anogenital region of young and middle-aged adults. The histology resembles Bowen's disease (see below). There are scattered dyskeratotic cells in a background of near-normal epithelium with a salt-and-pepper distribution effect [33]. There is no propensity at all for malignant transformation [72]. The lesions may regress spontaneously and they have a characteristic clinical appearance of multiple lesions. Several HPV types have been implicated – HPV 16, 18, 31, 32, 34, 35, 39, 42, 48, 51, 52, 53 and 54 – and may recur.

7.2.6.2 Premalignant Lesions

Although not necessarily premalignant, viral warts (condylomata accuminata) caused by HPV have been seen in association with anal dysplasia and carcinoma [73]. These lesions have a characteristic sawtooth outline on microscopy, with epithelial hyperplasia, koilocytosis and occasional dyskeratotic cells. Giant condylomata of Buschke and Loewenstein are large penetrating lesions that may penetrate the tissue of the perianal and anorectal region, sometimes extending into the ischiorectal fossae, perirectal tissues and even the pelvic cavity [74]. They have similar features to simple viral warts and are also associated with HPV infection. It is not possible to distinguish these clinically distinct entities via biopsy. As with simple anal warts, giant condylomas have been shown to have both dysplastic and malignant potential [75].

Bowen's disease of the perianal skin is a form of carcinoma in situ [76]. As with similar lesions elsewhere in the skin, all layers of the thickened epithelium contain

dysplastic and mitotically active cells. Biopsy samples should be carefully examined to exclude evidence of malignancy, particularly if the lesions are ulcerated.

Anal intra-epithelial neoplasia (AIN) is more frequently seen in the transitional epithelium above the dentate line than in the squamous mucous membrane of the lower anal canal [77]. Although the malignant risk of low-grade dysplasia is uncertain, it is increasingly appreciated that high-grade disease may progress to carcinoma [78]. It is always difficult to achieve agreement amongst pathologists with regard to the correct grading of AIN as 1, 2 or 3. In general terms, AIN 1 has nuclear abnormality limited to the lower third of the squamous epithelium, AIN 2 to the lower two-thirds and AIN 3 to the full thickness of the squamous epithelium [33]. Where AIN is detected, the whole biopsy sample should be processed for histological examination and be cut to several levels to exclude any more severe grade of AIN or invasive squamous cell carcinoma.

7.2.6.3 Squamous Cell Carcinoma of the Anal Canal

The majority of anal squamous cell carcinomas arise above the dentate line within the transitional zone mucosa [79]. Tumours at this site commonly extend proximally and may present as low rectal cancers. Interpretation of anal squamous cell carcinoma requires familiarity with the various histological appearances that may be seen. Tumours may comprise small basaloid cells showing no evidence of keratinisation, often with areas of necrosis [80]. These tumours have been referred to as "non-keratinising small cell squamous carcinoma" and tend to involve the upper anal canal. Other tumours have the more familiar appearances of squamous cell carcinoma with larger cells showing some evidence of keratinisation. Due to the relative subjectivity involved in discriminating these histological subtypes, all biopsy material from such tumours should be reported using the generic term squamous cell carcinoma. The biopsy report should also attempt to grade these lesions, although it must be appreciated that small superficial biopsies may not be representative of the whole tumour.

The differential diagnosis includes basal cell carcinoma of the anal margin, endocrine tumours, melanoma and local extension from other regional primary tumours including those of the female genital tract. The differential of basaloid squamous cell carcinoma and a locally infiltrating perianal basal cell carcinoma is of particular importance as the latter can be excised locally. Consideration of the clinical and radiological findings is invaluable in distinguishing these lesions. A panel of immunohistochemical stains may also be required, particularly in cases of melanoma or tumours spreading directly from elsewhere in the pelvic cavity.

7.2.6.4 Adenocarcinomas of the Anal Canal

As most anal canal malignancies invade the lower rectum, distinguishing between low rectal and anal canal adenocarcinomas is not always possible. However, two specific types of anal canal adenocarcinoma are recognised: adenocarcinoma of the anal ducts and glands, and mucinous adenocarcinoma in anorectal fistulae.

Adenocarcinoma of the anal ducts and glands is a rare submucosal tumour that may widely infiltrate the anal canal [81]. The diagnosis rests upon the specific microscopic demonstration of a transition from normal anal canal duct epithelium to carcinoma through an in situ stage. Without this, other tumours such as rectal adenocarcinoma and squamous cell carcinoma cannot be excluded from the differential diagnosis. Often, mucosal biopsies contain only mucous material.

Patients with mucinous adenocarcinoma in anorectal fistulae present with recurrent anal abscesses rather than discrete mucosal lesions. The tumours are well differentiated and contain pools of mucin that infiltrate the perianal stromal tissue. The diagnosis is important to consider in fistulae that are seen clinically to contain mucin. Biopsy specimens may contain mucin alone or fragments of mucinous tumour that are so well differentiated that the diagnosis is missed. The differential diagnosis includes normal anal fistulae in which the lining rectal mucosa is misplaced into the stromal tissue. Misplaced epithelium mimicking a well-differentiated mucinous carcinoma may also be seen in cases of mucosal prolapse (solitary rectal ulcer syndrome). In both situations the clinical context should help prevent misdiagnosis.

7.2.6.5 Extramammary (Perianal) Paget's Disease

Paget's disease is a rare but important diagnosis to make in biopsy specimens of the perianal skin. The epidermis is typically thickened and contains numer-

ous atypical large cells with vacuolated cytoplasm. The origin of these cells is uncertain, but they are thought to arise either from the glandular skin appendages or pluripotent intraepidermal cells [82, 83]. Unlike Paget's disease of the nipple, most cases of perianal Paget's disease are not associated with underlying malignancy, although a diagnosis of downward pagetoid spread by anorectal adenocarcinoma needs to be excluded [84]. The important differential diagnoses of Bowen's disease and melanoma can usually be distinguished with the help of immunohistochemical studies.

7.3 Non-neoplastic Colorectal Diseases

7.3.1 Polypoid Lesions

7.3.1.1 Serrated Polyps

Two types of polyp and mixtures thereof have a serrated architecture. They are hyperplastic/metaplastic polyps and serrated adenomas. Metaplastic polyps have no dysplasia and are benign. They were once thought to have no association with neoplasia apart from in the very rare non-inherited metaplastic polyposis syndrome [85]. They are now viewed as part of a spectrum of serrated polyps from benign (metaplastic polyps) to serrated adenomas that are dysplastic and undergo malignant change just like other adenomas. In some cases they may be part of an inherited serrated pathway syndrome [86].

7.3.1.2 Non-adenomatous Polyposis

Polyposes may be non-adenomatous or adenomatous. The non-adenomatous polyposes may be divided into familial and non-familial non-adenomatous polyposis syndromes. One uncommon polyposis syndrome that does not fit easily into these groupings is the hereditary mixed polyposis syndrome. This section will outline the classification of polyposes and the important differential diagnostic features.

Familial Non-adenomatous Polyposes

Peutz-Jeghers polyposis has three cardinal components: gastrointestinal polyposis, oral pigmentation and an autosomal dominant pattern of inheritance [33]. There is a germ-line mutation of the serine/threonine kinase 11 gene on the short arm of chromosome 19 [87]. All components are present in 55% of patients. Other forms exist without perioral pigmentation or without polyps. In some patients the pigment may be present for a considerable period of time before the polyps. Polyps develop anywhere in the gut, often in crops. The gender incidence is equal. The polyps occur most frequently in the jejunum, ileum and duodenum [33]. The polyps present with haemorrhage, anaemia and recurrent intussusception usually after meals. Many such intussusceptions will reduce spontaneously and may therefore be managed conservatively.

Macroscopically, a Peutz-Jeghers polyp is a coarsely lobulated polyp like an adenoma but with larger lobules, and totally unlike a juvenile polyp, which is absolutely smooth [33]. The polyps may be tiny or up to several centimetres in diameter. They may be sessile or pedunculated; when pedunculated they have a broad stalk.

Microscopically, the core of the polyp comprises arborising smooth muscle fibres covered by normal or mildly hyperplastic epithelium and lamina propria [33]. There is no excess of lamina propria. Misplaced glands and lamina propria are seen to represent pseudo-invasion. Dysplasia may occur in the epithelium of Peutz-Jeghers polyps [88] both on the surface and in the areas of misplaced epithelium, which can cause considerable anxiety.

Malignancy in Peutz-Jeghers patients is rare in the polyps [33]. However, they do have a risk of developing colorectal cancer that is 13 times that of the general population. The risk of malignancy extends to non-gastrointestinal sites. The other tumours seen in Peutz-Jeghers patients include bilateral breast cancer [89, 90], ovarian sex cord stromal tumours with annular tubules [91], and Sertoli cell tumours of the testis [92, 93]. Endometrial hyperplasia and adenoma malignum of the cervix may also occur.

Juvenile polyps may be seen singly or as part of a polyposis syndrome [94]. They may present with diarrhoea, bleeding, malnutrition or intussusception. The polyps have a smooth surface. They are comprised of dilated crypts set in an expanded lamina propria. There are no smooth muscle fibres in the lamina propria [95]. Ulcerated polyps, when biopsied, may yield only granulation tissue. It is important to be able to examine polypectomy specimens histologically to make the diagnosis. Juvenile polyposis is diagnosed by the St Mark's criteria, when one of the three following condi-

tions is met: (1) more than five polyps in the colorectum, (2) polyps at more than one site in the gastrointestinal tract or (3) any number of polyps with a family history [96].

The Ruvalcabra-Myhre-Smith syndrome is rare. It includes juvenile polyps, macrocephaly and pigmented penile macules [97]. Familial juvenile gastric polyposis is also rare and so far has been described only in Japan.

Cowden's syndrome is a familial syndrome of multiple hamartomas in the gastrointestinal tract, mouth and skin [98]. In the gastrointestinal tract, inflammatory polyps and adenomatous polyps are also seen [99]. There is a low risk of colorectal cancer, but there is a significant increase in the incidence of breast and thyroid malignancy [97].

Neurofibromatosis and ganglioneuromatosis are self-evident, uncommon causes of gastrointestinal polyps.

Other rare familial non-adenomatous polyposes include the blue rubber bleb naevus syndrome, comprising haemangiomas in the skin and gastrointestinal tract, and the Devon family syndrome, comprising benign inflammatory fibroid polyps.

Non-familial Non-adenomatous Polyposis Syndromes

Cronkhite-Canada syndrome has polyps that look just like juvenile polyps, but in this condition the intervening non-polypoid mucosa shows similar histological changes [33]. Dysplasia may occur rarely. There are striking clinical features of alopecia, white nails and protein-losing enteropathy [100].

Hyperplastic polyposis has large numbers of ordinary or slightly large hyperplastic polyps [85]. It is non-inherited but has a significant cancer risk [33].

Inflammatory cap polyposis is a rare manifestation of mucosal prolapse [33]. It presents with diarrhoea and hypoalbuminaemia. It is a close mimic of pseudomembranous colitis and of other polyposis.

Other rare non-familial non-adenomatous polyposis include lymphoid polyposis, malakoplakia, lipomatous polyposis and pneumatosis coli [33].

Hereditary Mixed Polyposis Syndrome

This condition is uncommon and is autosomal dominant. The polyps seen include adenomas, hyperplastic polyps and atypical juvenile polyps [101].

Familial Adenomatous Polyposis Syndromes

Familial adenomatous polyposis is composed of multiple tubular adenomas. It is diagnosed when greater than 100 polyps are identified or when microadenomas or unicryptal adenomas are seen in flat colorectal mucosa [102]. Many eponymous names exist for familial adenomatous polyposis syndromes according to the other organ systems that are abnormal.

7.3.2 Diverticular Disease

Colonic diverticular disease is most common in the sigmoid colon, but may occur at other sites. This is not a disease of the rectum. The pathology of diverticular disease involves thickening and shortening of the muscularis propria and the muscularis mucosae. Diverticula form between the taenia coli (hence they are not seen in the rectum) usually at points of mesocolic vascular entry. The thickening and shortening of the muscularis propria may result in mucosal redundancy with formation of polyps and folds of normal mucosa [103]. Diverticulitis and diverticular abscess formation may occur. Diverticular colitis is described in the biopsy section.

The treatment of diverticulitis and diverticular abscesses is rather different from that of ulcerative colitis, so the diagnosis of diverticular-associated colitis needs to be correct to avoid attempts at treating the underlying sepsis with overlying secondary diverticular colitis with steroids or immunosuppression. The inflammation around an inflamed diverticulum often develops a pattern of lymphoid follicles and aggregates that radiate out and around from the diverticulum. This may resemble the "Crohn's rosary" [9]. The distinction from Crohn's disease is aided by close study of the pattern of radiation of lymphoid follicles around the diverticulum. In Crohn's disease, the lymphoid follicles are transmural and not focussed on a single area such as a diverticulum [33]. Some patients with ulcerative colitis will become old enough to develop sigmoid diverticular disease. This does not create a particular diagnostic problem until it is encountered at laparotomy for pan proctocolectomy and ileoanal reservoir construction. The finding of a thickened narrow sigmoid colon may then raise concerns about whether the patient does indeed have ulcerative colitis or Crohn's disease. The diagnosis of Crohn's disease in a segment of sigmoid diverticular disease in the presence of what is otherwise clearly ulcerative colitis needs a good deal of consideration and is usually incorrect.

Occult, diffuse "linitis plastica" like adenocarcinoma is another not infrequent problem in diverticular resections. The thickened muscle coat may hide a diffuse cancer, and mucus pools from obstructed diverticula may mimic adenocarcinoma macroscopically. It is foolhardy to deny the presence of diffuse adenocarcinoma in a diverticular segment based on macroscopic examination alone. On this basis, we tend to treat all sigmoid diverticular disease resections as if they are going to contain an occult adenocarcinoma. That is to say, after adequate fixation we sample a "high tie" node at the end of resection margins. We then slice the specimen transversely at approximately 3-mm intervals, lay out the slices and inspect for any mucin pools or other features of concern for the presence of adenocarcinoma. Several random slices including areas of wall thickening and diverticula are processed for histological examination. All of the lymph nodes found in the mesocolon are then submitted for histological examination.

7.3.3 Colitis

The macroscopic appearance of colitis is too often neglected. They are all-important in the differential diagnosis of ulcerative colitis, Crohn's disease and other more unusual forms of colitis.

7.3.3.1 Classic Pathology of Ulcerative Colitis and Crohn's Colitis

The distinction between ulcerative colitis and Crohn's colitis has become crucially important since the introduction of pouch surgery [24, 26].

Ulcerative Colitis

The pathology of ulcerative colitis may be difficult when it is fulminant [33], after treatment or when rare varieties fail to be recognised. Colectomies in ulcerative colitis are performed for three reasons: severe fulminant disease (toxic megacolon), failure to respond to medical treatment and for the presence of dysplasia, a precancerous change. Usually the diagnosis will have been established clinically, radiologically, endoscopically and histologically from biopsy material. At the time of a severe attack, further biopsies will have been performed to exclude a superimposed infection, such as cytomegalovirus.

In severe acute disease the colon is dilated, while in long-standing disease the colon will be shrunken and "hose-pipe"-like. There is no fat wrapping and the serosa has a shiny surface. Full-thickness involvement of the colonic wall occurs in fulminant disease following ulceration of the mucosa and inflammation of the deeper layers. The inflammation remains diffuse in pattern and causes diffuse destruction of the underlying muscularis propria by myocytolysis. Lymph nodes are frequently enlarged but do not usually contain granulomas. The disease is continuous, classically involves the rectum, and is sharply demarcated from the adjacent normal bowel. Inflammatory pseudopolyps may be seen in very long-standing disease and may be villiform, resembling a polyposis syndrome. The ileum may be involved by "backwash ileitis", which is a diffuse change over a short distance of ileum. Two skip lesions have been described in ulcerative colitis: the appendiceal skip lesion [104] and the caecal patch lesion [104, 105]. These are the only two acceptable skip lesions in ulcerative colitis.

The histological appearance of ulcerative colitis is quite classical. The mucosa tends to have an irregular surface with widespread crypt architectural distortion. There is mucin depletion at times of activity and Paneth cell metaplasia in long-standing disease. With long-standing disease the muscularis mucosae may also become a dual layer. Ganglion cells may be seen within the muscularis mucosae and within the base of the mucosa after previous ulceration and healing. During the active phase there is acute inflammation leading to considerable numbers of crypt abscesses forming in a diffuse pattern, with associated crypt destruction, erosion and ulceration. Crypts tend to rupture downwards, and after healing there is crypt architectural distortion. In a small number of patients these changes may disappear completely. In the early stages of disease a biopsy investigation may be at its most difficult to interpret (i. e. before 6 weeks, when there has been insufficient time for crypt architectural distortion to occur). In such cases, the presence of basal plasma cells in lymphoid aggregates may allow differentiation from an infective condition. Another common difficulty in biopsies performed early in the disease is the presence of superficial oedema. This may be seen in both ulcerative colitis and infective disease. Biopsy pathology may be useful following treatment, as residual small clusters of neutrophils in the lamina propria predict relapse. Granulomas may be seen in ulcerative colitis, but these are related to ruptured crypts. This association with ruptured crypts may be identified by the presence of

epithelial cells, neutrophils, mucin or a combination of all three.

The pathology of ulcerative colitis in the resected specimen is at its most difficult in fulminant colitis, which is a sort of end-stage disease process for the colon, whatever the underlying cause. In disease failing to respond to medical therapy, the classical features are of diffuse crypt architectural distortion, diffuse acute and chronic inflammation in the mucosa, and crypt abscess formation. Where there is ulceration, the acute and chronic inflammation will spread downwards in a diffuse pattern into the muscularis propria, causing myocytolysis in a totally different pattern to that seen in Crohn's disease; there is typically transmural inflammation in the form of lymphoid aggregates in Crohn's disease. The other classical pathological feature of ulcerative colitis that may be seen is a DALM [106].

Crohn's Colitis

The pathological appearance of colorectal Crohn's disease is fundamentally the same as that in the small intestine. Crohn's colitis was described by Lockhart-Mummery and Morson in 1960 when they distinguished its features from those of ulcerative colitis [107]. The presentation of Crohn's colitis is usually with diarrhoea, rectal bleeding or perianal disease, or a combination of the three. It may also be accompanied by recurrent abdominal pain and intestinal obstruction. These latter features are much less conspicuous than in small-bowel Crohn's if the disease is confined to the colon. Perianal pathology including skin tags, deep ulcers, fissures, fistulae, abscesses and strictures of the anal canal occur in up to 75% of cases of large-bowel Crohn's disease at some point during the patient's life. Perianal manifestations are usually seen when the colonic disease is severely active, although this is not always the case. Perianal pathology in Crohn's disease may also be associated with a higher incidence of extra-intestinal manifestations of Crohn's disease.

Large-bowel Crohn's disease may be found in isolation or may coexist with Crohn's disease at other sites in the gastrointestinal tract. It is probably limited to the large bowel in about 20% of cases. There are three basic patterns of involvement of isolated large-bowel Crohn's disease: (1) Crohn's disease isolated to the rectum, (2) stricturing large-bowel Crohn's disease and (3) a diffuse Crohn's colitis. The latter may cause most diagnostic difficulty since it may closely mimic ulcerative colitis. On gross examination the serosa of the bowel is often dusky blue. There is vascular congestion, which may be accompanied by an inflammatory exudate. There may be fat-wrapping, which appears unique to Crohn's disease [108, 109]. It is much easier to assess in the small bowel than in the large bowel because of the normal anatomical features of mesorectal fat and mesocolic fat in the sigmoid colon.

Crohn's colitis is easy to identify if it presents as a discontinuous patchy or focal distribution of disease. The ulcers seen in Crohn's disease may vary from small superficial aphthoid ulcers to large deep-fissuring ulcers. The aphthoid ulcers have a classical appearance of ulceration over lymphoid follicles or aggregates. The larger ulcers are quite discrete, but with overhanging oedematous mucosal edges unlike the normal adjacent mucosa of aphthoid ulcers. As ulcers heal in Crohn's disease, which they may since the pattern of disease is of relapse and remission, they leave ulcer scars that are depressed. These scars are similar to those seen in affected small intestine. There is oedema in the intervening mucosa, which gives rise to the classic cobblestone appearance. This may be difficult to identify in the large bowel, and other forms of colitis may mimic the appearances of pronounced submucosal oedema.

Fistulae from colonic Crohn's disease occur in up to two-thirds of patients. However, free perforation of colonic Crohn's disease is exceptional. This may suggest that the inflammatory process penetrates the tissues slowly and causes loops of inflamed bowel and omentum to prevent the perforation of any abscesses. Any perforations or abscesses that do occur arise from the base of fissuring ulcers, where the inflammatory process extends into the deeper tissues. Colonic strictures in Crohn's disease occur at sites of transmural inflammation with fibrosis and fibromuscular proliferation. As in the small bowel, the focal sites of fibromuscular proliferation in the muscularis mucosae seem to be clearly linked to ulcer edges. However, these areas are less commonly associated with the "ulcer-associated cell lineage" observed in the small intestine. Indeed, the precise healing mechanism for ulcers in Crohn's colitis, or indeed other forms of ulcers in the large bowel, remains uncertain. Differentiating Crohn's strictures from other forms of post-infective or drug-induced strictures may be difficult. Diverticular strictures may cause particular confusion [110] if diverticular disease coexists with ulcerative colitis. The presence of strictures will sometimes be most helpful in distinguishing a difficult case of Crohn's colitis from ulcerative colitis.

The diffuse colitis form of Crohn's disease is the most difficult form to diagnose. One may be helped by rec-

tal sparing, and adequate sampling from the colon may reveal enough evidence of transmural inflammation in the form of lymphoid aggregates, transmural granulomas or perineural chronic inflammation. If the bowel wall is thin and the disease is predominantly mucosal this may require a large number of tissue blocks. Most of the difficulty in this condition in referral practice results from inadequate macroscopic description, lack of photography and an inadequate number of blocks taken for histology. Unfortunately, such cases often remain insoluble.

The diagnosis of Crohn's disease in patients who do not require colectomy may be even more difficult. In such cases the diagnosis requires a combination of clinical, endoscopic, radiological and biopsy findings. The histological feature on which most pathologists will agree for the diagnosis of Crohn's disease is a patchy distribution of acute and chronic inflammation. In a biopsy sample there may be extension of the inflammation into the submucosa. There may be granulomas and focal active chronic colitis. This needs care, as there are many causes of FAC, most of which do not turn out to be Crohn's disease. Focal cryptitis may be helpful, as may individual crypt pick-outs (i. e. an involved inflamed ruptured crypt surrounded by normal crypts). "Proper" Crohn's granulomas are helpful (i. e. epithelial cell granulomas away from sites of crypt rupture). Multiple microgranulomas may be equally helpful, but care is needed since they may be seen in many other forms of colitis including diverticular disease, infection and other systemic granulomatous disease. Granulomas in relation to crypt rupture may be seen in any inflammatory bowel disease. Cryptolytic granulomas, where small granulomas appear to be destroying a focal part of a crypt, were thought originally to be quite specific for Crohn's disease. However, extensive study has revealed them to be present in all manner and forms of colitis, and this represents an important medicolegal issue when one is considering whether or not patients should have had restorative proctocolectomy. In longstanding disease one may find Paneth cells or ulcer-associated cell lineage. As mentioned earlier, ulcer-associated cell lineage is rare in the colon for reasons that remain uncertain. Any erosions and ulcers in Crohn's disease tend to be fissuring and lined by ulcer slough and granulation tissue. The adjacent mucosa within a few millimetres appears quite normal. Aphthoid ulcers may be identified in biopsy material, but perineural and transmural chronic inflammation will not be seen. Occasional intralymphatic granulomas may be seen on biopsy, and these are quite helpful. We have never identified granulomatous vasculitis in a biopsy specimen, although this remains helpful in resection specimens [111].

The resection specimens are considerably easier, in that one may appreciate fully the connective tissue changes throughout all layers of the bowel wall. These include the focal thickening and disruption of the muscularis mucosae with proliferation of smooth muscle fibres adjacent to sites of ulceration. Thickening of the muscularis propria and enlargement of nerves, usually with perineural chronic inflammation, may also be seen in the submucosal and myenteric plexus. Transmural inflammation is always seen in the form of lymphoid aggregates, and focality will be appreciated in the mucosa. Granulomas are best sought adjacent to blood vessels, and occasionally one may identify granulomatous vasculitis [111]. However, this is not absolutely specific, since it has been described in diverticular disease [110] and diverted ulcerative colitis [112].

In very difficult cases of Crohn's colitis one may be helped by knowledge of the perianal disease, previous biopsy series and the current state of the rest of the patient's gut. Occasionally, one may be helped by gastroduodenal biopsy material from apparently normal upper-gastrointestinal endoscopic examination. Focal active gastritis and focal active duodenitis have a poor predictive value for Crohn's disease when found in isolation, but when found with a colitis they may help the pathologist to identify the type of the colitis [113].

Pseudomembranous Colitis

Pseudomembranous colitis has a distinctive appearance of discrete yellow/grey plaques on the mucosal surface [11].

Motility Disorders

The histopathology of motility disorders is usually unrewarding. The purpose of histological examination in these cases is to exclude rare abnormalities of the muscularis propria or of innervation. Congenital visceral myopathies are rare, but usually easy to identify in a resected specimen. Abnormalities of nerves may be more difficult, but one often overlooked condition is plexitis. Plexitis is a perineural lymphocytic infiltrate in the myenteric (Auerbach's) plexus. It is seen in association with diabetes mellitus, in association with malignancy or in isolation [33].

Ischaemia

Causes of ischaemic colitis include those of ischaemia at other body sites. The histological examination of ischaemic colitis specimens is often unrewarding, but occasionally dramatic. It is important to exclude the vasculitides, amyloid, systemic sclerosis, and emboli of unusual types such as cholesterol after coronary artery bypass surgery.

Obstructive Colitis Mimicking Inflammatory Bowel Disease

Obstructive colitis (and/or ileitis) may mimic Crohn's disease [114]. The context and macroscopic appearances are essential to enable the correct diagnosis; there is always a gap of normal mucosa between the site of obstruction and the area of colitis. The colitis may vary from mildly active localised colitis, to an area of geographic ulceration with oedematous mucosal edges, mimicking Crohn's disease. The histological findings often closely mimic Crohn's disease, with fissuring ulceration and transmural inflammation. Perineural chronic inflammation and deep granulomas would, however, be unusual. The distinction from Crohn's disease is easy if one can see a single patch of colitis in relation to the area of obstruction. Slides referred for expert opinion from cases of obstructive colitis may lead to an erroneous (out of context) diagnosis if there is no macroscopic photograph or adequate macroscopic description.

7.4 Neoplastic Colorectal Diseases

7.4.1 Local Excision of Adenomas

Adenomas need to be examined histologically in their entirety, whatever their size, in order to exclude invasive adenocarcinoma. They are classified into pedunculated, sessile and flat lesions. Microadenomas and unicryptal adenomas are found in familial adenomatous polyposis. Histologically, adenomas are further divided into tubular, tubulovillous, villous and serrated types. The severity of epithelial dysplasia is also classified. Unlike Barrett's oesophagus and ulcerative colitis, in which dysplasia is classified as low grade or high grade, the Muto and Morson classification into mild, moderate and severe dysplasia is still used for adenomas [115]. There is often confusion about the presence of dysplasia in adenomas. All adenomas are dysplastic by definition.

Finding adenomas in the left colon is useful in screening programmes for colorectal cancer, as they may be predictive of right-sided colonic neoplasia. The presence of more than three adenomas, adenomas of greater than 10 mm in diameter, or an adenoma with severe dysplasia is predictive of neoplasia elsewhere in the large bowel.

7.4.2 Local Excision of Early Rectal Cancer

Tumours that are confined to the rectal mucosa have little or no potential to metastasise to the lymph nodes due to the paucity of lymphatic vessels within the large-bowel mucosa [33]. Lesions that are confined to the mucosa may be defined as dysplasia or adenoma in the UK, while in the American or Japanese literature the term intramucosal carcinoma is used [33].

It is only when tumours have invaded the submucosa that the possibility of lymph node metastases arises, and hence may be called adenocarcinoma. Early rectal cancer (ERC) in the UK describes adenocarcinomas that are invading but not beyond the submucosa [33]. ERC may present as a polypoid carcinoma, as a focus of malignancy within a large pedunculated or sessile adenoma, or as a small ulcerating adenocarcinoma [33].

7.4.2.1 Specimen Receipt, Preparation and Cut Up

Endoscopically excised polyps should be fixed in five times their own volume of formalin. Local excision specimens are best delivered to the pathologist fresh. Polyps less than 10 mm in diameter are fixed and processed whole; they are embedded in paraffin wax and orientated to show the correct anatomical relationship between the polyp and the underlying tissues [116]. If the polyp is greater than 10 mm in diameter it is sliced vertically to trisect the polyp and leave a central section containing the intact stalk [117]. The polyp will have been placed under traction at the time of removal and it is possible to create an elongated "false" stalk. Occasionally, the precise orientation of the polyp and its base or stalk cannot be identified and histological sectioning at several levels may be required for accurate assessment.

Parks' per anal excision and transanal endoscopic microsurgery (TEM) specimens are pinned to a cork-

board with dressmaker's pins and fixed for 24 hours in formalin. The underside is then painted with gelatine containing Indian ink. The specimen is sectioned transversely at 3-mm intervals and embedded in agar before being processed in sequentially labelled cassettes.

Macroscopic classification of ERC by Kudo resembles that for gastric cancer [118]. Adenomas are pedunculated or sessile, with approximately 42–85% of early colorectal cancers pedunculated and 15–58% sessile [119, 120]. Adenocarcinoma in a pedunculated polyp is less likely to have invaded the deep part of the submucosa [119]. The risk factors for development of adenocarcinoma within an adenoma are size, shape and severity of dysplasia. Size is the most important factor in determining the risk of malignant transformation. In over 5000 adenomas of less than 5 mm in size, none was found to include malignancy [121]. For adenomas over 42 mm in size, 78.9% contained adenocarcinoma [121]. Villous adenomas have the highest malignant potential (29.8%) and tubular adenomas have the lowest (3.9%) [121]. Rectal adenomas have the highest risk of malignancy (23%) when compared to the right side of the colon (6.4%) and the left side of the colon (8%) [121].

Dukes' staging cannot be used for local excision specimens, since no lymph nodes are available for examination. TNM [122], Kikuchi [123] and Haggitt [124] staging systems are used for local excision specimens. ERC necessarily are stage T_1 (a tumour that is invading the submucosa). It is the problem of predicting the N stage that necessitates refinement, subdivision and further study of T1 tumours. Haggitt staging is used to subdivide submucosal invasion within a polyp (Fig. 7.2) [124]. This classification is widely used for describing the invasion of ERC in a polyp, although levels 1, 2 and 3 apply to pedunculated lesions only. An invasive carcinoma in a sessile polyp can only be a level 4 Haggitt lesion. Haggitt staging is therefore not helpful in refining the assessment and potential nodal involvement of sessile T1 adenocarcinomas. Kikuchi staging describes the depth of invasion into the submucosa and is used for refining the staging of sessile T1 adenocarcinomas (Fig. 7.3) [119]. The Kikuchi classification divides the submucosa roughly into thirds.

Accurate subdivision of T1 adenocarcinomas in locally excised tumours is very important for further patient management. Local excisions in our opinion are best regarded as "big biopsies", the examination of which will guide the treatment plan. Polypectomy alone is usually considered as adequate management for low-risk ERC. The treatment of ERC by polypectomy alone

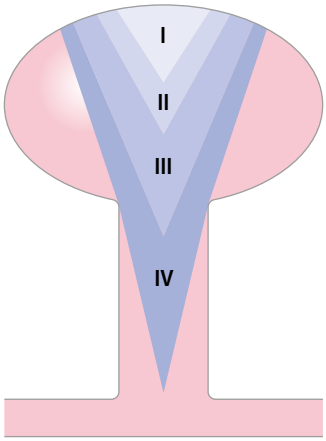

Fig. 7.2 Haggitt staging of early colorectal cancer. According to the classification of early colorectal cancer in polyps by Haggitt et al. [124], level I cancers invade the submucosa but are limited to the head of the polyp, level II cancers invade the neck of the polyp, level III cancers invade any part of the polyp stalk, and level IV cancers invade beyond the stalk but remain above the muscularis propria

requires consideration of the chances of subsequent development of residual cancer at the polypectomy site or the presence of involved lymph nodes. If the endoscopist is confident that the polyp has been completely excised, the chance of recurrence and/or metastasis has to be determined via histopathological assessment. For an adenoma complicated by a low-risk adenocarcinoma (completely excised, well or moderately differentiated with no evidence of lymphatic or vascular invasion), polypectomy is adequate treatment in most cases [125].

The situation for high-risk ERC developing within an adenomatous polyp is rather different. High-risk ERC is defined as one that shows features of poor differentiation, extension of the tumour to the resection margin, or the presence of lymphatic or vascular invasion and deep submucosal invasion (Table 7.1) [116, 124–130]. These factors have been further investigated to determine the relative risk of metastasis (Table 7.2) [131]. Patients with fewer than four out of five of these risk factors did not have nodal disease, whereas patients with four or five risk factors had nodal metastases in one-third and two-thirds of cases, respectively. Locally excised high-risk lesions have resulted in treatment failure (recurrence and/or nodal metastasis) in 20% and 33% of cases [128, 129]. The incidence of lymph node metastasis increases with Kikuchi stage: 1–3% risk with sm1, 8% with sm2 and 23% with sm3 [132].

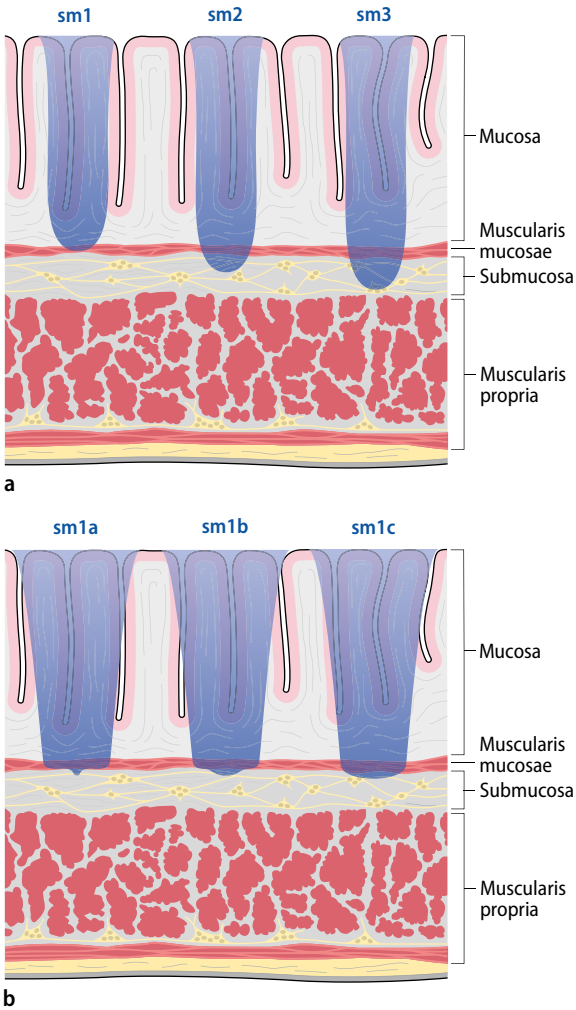

Fig. 7.3a,b Kikuchi staging of early colorectal cancer. **a** Kikuchi staging divides early sessile adenocarcinomas of the bowel wall into sm1, sm2 and sm3. Sm1 represents infiltration by the tumour into the upper third of the submucosa to a depth of 200–300 μm. Sm2 cancers invade the middle third of the submucosa. Sm3 cancers infiltrate the lower third of the submucosa, close to the inner surface of the muscularis propria. **b** Kikuchi further divides sm1 sessile adenocarcinomas into sm1a, sm1b and sm1c. Sm1a corresponds to horizontal invasion of the submucosa limited to less than one-quarter of the width of the tumoural component of the mucosa. Sm1b tumours show horizontal invasion of the submucosa limited to one-quarter to one-half of the width of the tumoural component in the mucosa. Sm1c tumours show horizontal invasion of the submucosa greater than one-half of the width of the tumoural component in the mucosa

The size of the ERC may or may not be important for nodal metastases [119, 120, 133]. Other newer features may indicate a high metastatic potential for ERC. These include tumour budding, represented by tiny clusters of undifferentiated cells found ahead of the invasive deep tumour edge [134], the shape of the submucosal invasive front, tumour differentiation at the leading edge of the lesion, being sessile, and lymphatic and blood vessel invasion [116, 134, 135]. Location of the early cancer within the rectum is also important [119]. The Japanese Research Society for Cancer of the Colon and Rectum subdivides lymphatic (ly) and vascular (v) invasion. Invasion may be absent (ly0, v0), slight (ly1, v1), moderate (ly2, v2) or massive (ly3, v3) [136].

The histological assessment of Parks' per anal excision and TEM after previous partial local excision may present several interesting difficulties. Previous partial local excision may produce scarring of the lamina propria that can mimic the stromal sclerosis of a malignancy. It may also misplace epithelium and lamina propria into the deeper layers of the rectal wall, resulting in pseudo-invasion in sessile polyps. This may be difficult to interpret and distinguish from true invasion. Sometimes such post-surgical pseudo-invasion may extend into the mesorectal fat. The appearance may be of epithelial misplacement alone, but 100 sections later in one case we demonstrated the coexistence of lamina propria with this epithelium and no true tumour stromal sclerosis. This case therefore represented an example of pseudo-invasion. Following TEM, the patient has had no evidence of invasive adenocarcinoma, recurrent tumour or metastases after more than 8 years. Disruption and scarring of the muscularis mucosae may also occur at a previous partial local excision site.

The pathologist can play a role in the audit and assessment of good surgical practice in TEM, just as they can in total mesorectal excision specimens. It is well known that the quality and "intactness" of the mesorectal margin correlates well with the histological assessment of the mesorectal margin. Tumour involvement of the mesorectal fascia or a defect in the mesorectal fascia is also correlated with local recurrence [137]. In TEM, the assessment of the quality of surgery is important and is remarkably similar to the assessment of total mesorectal excision specimens. It is important for the pathologist to examine the specimen for holes and defects. The underside may consist of muscularis propria or a thin layer of mesorectal fat. The underside, whatever the level in the muscularis propria, should be smooth. Since most TEM specimens are based around a tumour, with its invasive component in the centre, the surgeon will produce a thicker piece of muscularis propria in the centre of the lesion, tapering out to the edges of the lesion. This is perfectly acceptable and is normal practice. The mucosal resection margin around

Table 7.1 Histopathological features and risk of lymph node metastasis in early rectal cancer

Low risk	High risk
Adenocarcinoma and mucinous adenocarcinoma that is well- or moderately differentiated	Poorly differentiated adenocarcinoma or mucinous adenocarcinoma
	Signet ring cell carcinoma
	Undifferentiated carcinoma
	Well- or moderately differentiated adenocarcinoma with a focus of any of the above
	Lymphatic or vascular invasion
	Carcinoma at the resection margin

Table 7.2 Histopathological risk factors for lymph node metastases

Tumour budding
Poor demarcation of cancer at the invasive front
Moderately and poorly differentiated tumour in the submucosal invasive front
Increasing depth of submucosal invasion
Lymphatic invasion

the local excision specimen should be of normal large-bowel mucosa. Soon after resection, the muscularis propria and the muscularis mucosae begin to contract. The muscle layers of the normal bowel wall contract more than those in the area of the neoplasm. The surgeon's excellent margin of normal mucosa will start to contract within minutes of removal. It is important, therefore, to pin-out this rim of normal mucosa properly soon after excision. The pins have to be close or the normal tissue will contract beneath the neoplastic tissue and the cut sections will give the pathologist a full-face section of the block before the edges of normal tissue have been visualised. This produces difficulty in communication between the surgeon, who has seen a normal margin through his magnifying endoscope during the TEM procedure, and the pathologist, who is unable to report a clear resection margin.

Since a local excision specimen of rectal cancer is regarded as a "big biopsy", further surgery may be deemed appropriate after discussion between the members of the multidisciplinary team involved in patient management. This may take the form of a TEM of an endoscopic polypectomy base, a Parks' per anal excision of a polypectomy base, a formal anterior resection or an abdominoperineal excision. It may be difficult for the colonoscopist or surgeon to identify the site of the previously excised tumour. For this reason, the site should be tattooed with ink at the time of polypectomy. Fibrous scarring will always be found histologically, but multiple histological sections may be needed for its demonstration. The macroscopically scarred area must be carefully inspected, sliced and all embedded for histological examination. All the available lymph nodes must also be blocked. The operating surgeon should be aware that the purpose of the operation is to remove and histologically assess two things: the site of the previous local excision for assessment of residual tumour and lymph nodes for the presence of metastases. Pathologists have to understand the surgical techniques of local excision and the potential for artefacts and pseudo-invasion if they are to provide proper reports for correct patient management.

7.4.3 Malignant Tumours of the Large Bowel

The commonest malignant tumour in the large bowel is adenocarcinoma. Other tissues in the large bowel wall may be the origin of malignant tumours. The current World Health Organisation/Union Internationale Contre Le Cancer (UICC, International Union Against Cancer) Classification [138] of large-bowel malignancy is listed below;

1. Adenocarcinoma not otherwise specified.
2. Mucinous adenocarcinoma (>50% mucinous; i.e. should comprise epithelium that is differentiated towards mucin production, as evidenced by the presence of mucin on H&E sections that is intracellular and/or luminal and/or interstitial).
3. Signet ring cell adenocarcinoma (>50% signet ring cells).
4. Squamous cell carcinoma.
5. Adenosquamous carcinoma.

6. Small cell undifferentiated carcinoma.
7. Medullary carcinoma (tumours with a solid growth pattern, but usually with some cribriform or acinar component that will confirm its identity as an adenocarcinoma; may be associated with DNA microsatellite instability and hereditary nonpolyposis colorectal cancer, as may signet ring and mucinous tumours).
8. Undifferentiated carcinoma.
9. Carcinoid not otherwise specified.
10. Other (specify type).

The differentiation of adenocarcinomas is classified as poor, moderate or well, according to how closely the tumour resembles the normal large bowel mucosa. Mucinous tumours were thought previously to have a poor prognosis. As with non-mucinous tumours, the degree of differentiation appears to be important, as does the site. Mucinous tumours on the right side of the colon have a much better prognosis than those on the left side. Signet ring cell adenocarcinomas have a poor prognosis, with early spread to lymph nodes, and should always be graded as poorly differentiated (grade III). Grading of colorectal cancer should be made on the worst area even if it does not predominate [139].

7.4.3.1 Anatomy of the Surgically Resected Colorectal Cancer Specimen and its Clinical Relevance

Rectum

Anterior resection and abdominoperineal resection specimens need careful pathological assessment to provide a useful report on which to base patient management and to provide audit of surgical technique, radiological assessment and pathological assessment [140, 141].

The assessment of the quality of the mesorectal excision and of the dissection below the mesorectum in an abdominoperineal resection specimen may be carried out by the pathologist, who can assess the smoothness of the plane of excision. Any defects that are small and do not reach the muscularis propria are less significant than those that do reach the muscularis propria or defects in the muscularis propria. In some studies these have been graded as 1, 2 or 3 [140]. We prefer to give a descriptive report and to photograph the surfaces of the specimen. Ideally, the specimens should be received fresh in the pathology department and opened anteriorly from the proximal end down as far as just above the tumour or just above the peritoneal reflection, whichever is reached first. The specimen should then be washed in cold water and fixed in 10% formalin for 2–3 days. After fixation, the mesorectum is marked using ink in gelatine. The specimen is then sliced at 3 mm intervals and the slices laid out in order to be photographed. This slice photography is very important as it forms a permanent record of any surgical breaches of the mesorectal margin. It also allows a direct comparison with radiological slices seen in magnetic resonance imaging or computed tomography. This allows accurate comparison with the preoperative radiological T staging and helps to audit the accuracy of preoperative radiological staging. It is extremely important to have good communication between the operating surgeon and dissecting pathologist, especially when extra resection margins have to be considered, such as adherent areas of adjacent organs or abdominal wall.

There is good evidence that a positive mesorectal margin (tumour at the margin or within 1 mm of it) correlates with local recurrence and survival [142]. The margin positivity may be used as a marker of surgical quality without having to wait 5 years to assess 5-year survival and local recurrence figures. In the UK, this has been used to highlight problems such that if a surgeon has a margin positivity rate in the mesorectum of 10% or above, preoperative chemoradiotherapy downsizing should be considered.

Peritoneal surface involvement by adenocarcinoma has a poor prognosis [143, 144]. Unfortunately, there is still considerable misunderstanding amongst pathologists about its interpretation [145]. It is a surface, not a "margin". Measurement of the distance between the tumour and the peritoneal surface is of no prognostic value. It is important to assess the quality of tissue between the tumour and the peritoneal surface. If the tumour is clearly visible on the surface or separated from it by loose "ulcerated" granulation tissue, the tumour is T4 and has a poor prognosis. Shepherd classified peritoneal surface involvement into four categories and correlated the histological findings with outcome [143]. These four categories are: (1) no tumour near the peritoneal surface, (2) tumour separated by dense fibrous tissue, (3) tumour separated by loose "ulcerated" granulation tissue and (4) tumour clearly on the surface. To identify peritoneal surface involvement in practice needs a little care. One has to look for the macroscopic peritoneal changes of a whitened area with neovascu-

larisation. It is also important to block areas where the peritonealised part of the muscularis propria meets the peritonealised part of the mesorectal fat, since it is in this groove that one commonly finds peritoneal invasion by tumour. Two to four standard-sized blocks are taken (less if big blocks are used). If the tumour is seen to be very close to the peritoneal surface but not invading it, three levels are cut from each block to rule out peritoneal surface involvement.

Lymph node sampling needs to be thorough and complete [146], with some workers advocating fat-clearance methods [147]. We have found that we can equal the number of fat-clearance lymph nodes using adequate time and commitment, a sharp knife and a good light. Our preferred method also allows proper examination of the mesorectal and mesocolic margin for histological sampling.

Vascular invasion is a very important prognostic variable in colorectal cancer [148]. We identify it by careful histological inspection and do not use vascular stains routinely.

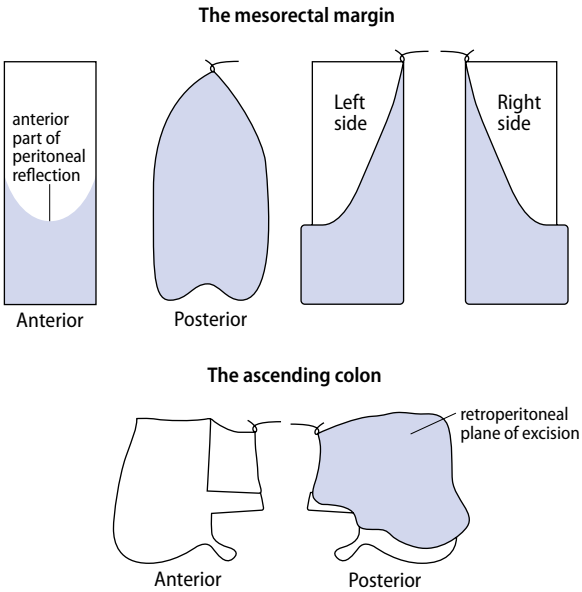

Fig. 7.4 Margins in rectal and ascending colon cancer resection specimens

Ascending Colon

The rectum has received a huge amount of attention in the surgical, oncological and pathological literature. The colon also has a retroperitoneal resection margin that has traditionally been ignored by pathologists [149]. This is most obvious in the ascending colon, where it is very easy to identify a broad and hopefully smooth and intact retroperitoneal plane of excision (Fig. 7.4). The presence of a tumour at or within 1 mm of this margin has the same implications as mesorectal margin positivity.

Staging of Colorectal Cancer

Two staging systems are used concurrently in the UK. These are the 5th edition of the UICC TNM staging system and Dukes' staging. Difficulties in lymph node definition in the UICC TNM 6th edition have led to a decision not to adopt it for colorectal cancer staging in the UK. The difference between the 5th and 6th editions is the recognition of mesorectal or mesocolic tumour deposits that represent entire replacement of a lymph node by tumour (i.e. no normal lymph node structure remains visible). In the 5th edition, a mesorectal or mesocolic tumour deposit that was greater than 3 mm was regarded as a replaced lymph node for purposes of N staging. In the 6th edition, a mesorectal or mesocolic tumour deposit that was round in shape was regarded as being a replaced lymph node (a vein would also be a round structure that might contain a tumour). The practicality of the 5th- and 6th-edition criteria for identification of a lymph node entirely replaced by tumour was tested in an interobserver study in Wales [150]. The result was that the interobserver variation in measurement was considerably better than that experienced in the identification of "roundness". A decision was therefore made to retain the 5th edition in the UK. TNM staging is summarised in Fig. 7.5. R staging is a very important addition to signify completeness of resection (R0) or residual microscopic tumour (R1) or residual macroscopic tumour (R2). Dukes' staging is also retained for familiarity and because it separates involvement of the high-tie lymph node, which TNM does not. Dukes' staging is summarised in Fig. 7.6. It is reproduced in some textbooks incorrectly, which accounts for some of the problems in its interpretation [151]. The major confusion with Dukes' staging is that there have been several modifications of Dukes' system and that other staging systems use the letters A, B and C but with different prognostic significance. These include the Astler-Coller staging system, which is popular in the USA, and the Concorde Hospital staging system, which is little used outside of Australia.

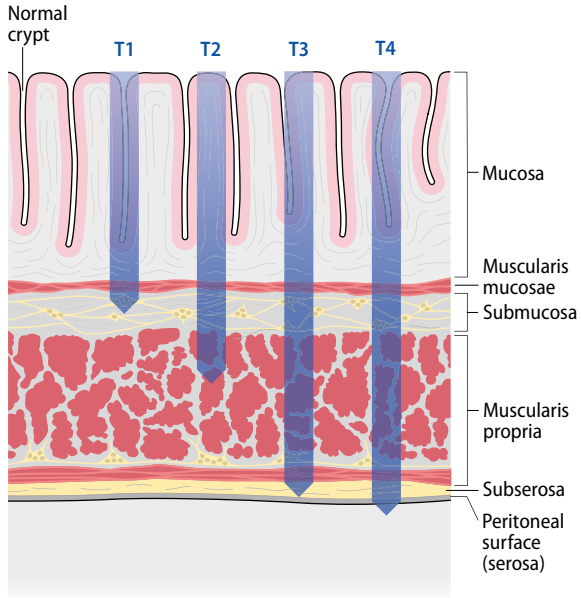

Fig. 7.5 Tumour staging of colorectal cancer using the TNM system. T1 tumours invade the submucosa. T2 tumours invade the muscularis propria. T3 tumours invade through the muscularis propria into the subserosa or into the non-peritonealised pericolic or perirectal tissues. T4 tumours directly invade other organs or structures and/or perforate the visceral peritoneum

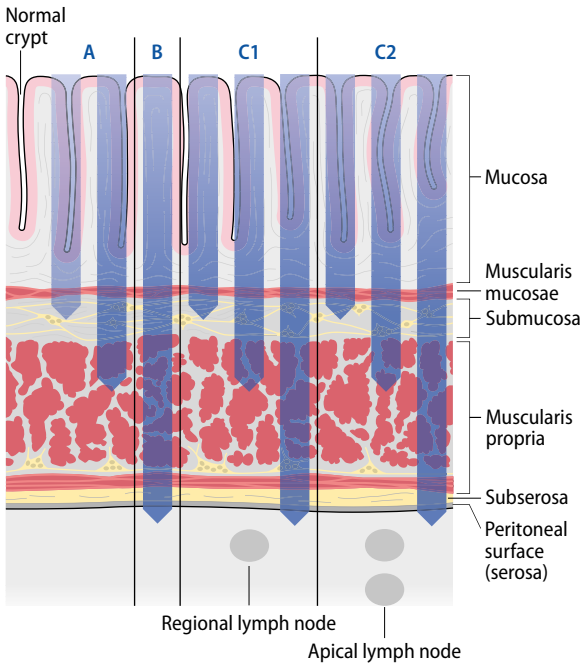

Fig. 7.6 Dukes staging of colorectal cancer. Dukes A tumours are confined to the bowel wall and show no lymph node spread. Dukes B tumours invade beyond the muscularis propria but show no lymph node spread; they may involve the free peritonealised surface of the bowel wall or other adjacent organs. Dukes C1 tumours spread to regional lymph nodes but show no involvement of the apical node. Dukes C2 tumours spread to the apical node

Downsized Tumours

The recent recognition of the benefits of adjuvant chemoradiotherapy has led to a need for new methods of histological assessment. It has been important to find a reproducible method of assessing the amount of "downsizing" which has occurred and to relate it to prognosis [152]. The Mandard system classified the amount of tumour regression into five subtypes. We found this difficult to reproduce and devised a simpler three category system [152]. Complete or almost complete regression of tumour correlates with a good prognosis. It has been important to recognise the effects of radiotherapy on the non tumour mucosa. These effects have previously been misinterpreted as ulcerative colitis, eosinophilic colitis, cytomegalovirus colitis, or even unicryptal adenomas of familial adenomatous polyposis. This exemplifies the need for histological awareness of rigid diagnostic criteria for these conditions and for interpretation of histological material within context.

7.5 Anal Pathology

7.5.1 Normal Anal Microanatomy

The lining of the anal canal is often misunderstood. There are three types of mucosa encountered within the bounds of the internal anal sphincter, which defines the anal canal. There is columnar cuff mucosa, which resembles rectal mucosa but has increased frequency of crypt branching and crypt dilatation. It also exhibits muscularisation of the lamina propria and numerous lymphoid follicles in the base of the mucosa. This causes considerable problems with misinterpretation, with some pathology textbooks referring to it as "the normal low rectal biopsy", which is clearly anatomically quite wrong. It may be misdiagnosed as follicular proctitis, chronic inflammatory bowel disease and/or mucosal prolapse. The mucosa encountered in the anal transitional zone has a pseudostratified columnar squamous epithelial lining and can resemble urothelial mucosa. After that, one encounters squamous

epithelium. The border between these three zones of columnar cuff, transitional mucosa and squamous epithelium is represented in most textbooks as an orderly line. After inflammation and disease, particularly in ulcerative colitis, the orderliness of these borders is broken down and one encounters squamous islands in glandular mucosa and glandular islands in squamous mucosa [28].

7.5.2 Inflammatory Disorders of the Anal Canal

Inflammatory disorders of the anal canal are considered in Sect. 7.2.5 in the context of mucosal biopsy interpretation.

7.5.3 Tumours and Tumour-Like Conditions of the Anus

Some of these entities have previously been considered in Sect. 7.2.6. A few are worthy of further consideration.

7.5.3.1 Viral Warts

These are warty outgrowths typically related to HPV6 and HPV11, though HPV16 and HPV18 are associated with squamous cell carcinoma of the anal canal [78].

7.5.3.2 Giant Condyloma of Buschke and Loewenstein

This is a rare, large, cauliflower-like lesion. Local invasive malignancy may develop [75] but it is uncommon and multiple biopsies may not reveal if it is a well-differentiated verrucous form of invasive carcinoma. Keratoacanthoma and pilar tumours may also be seen in the anal canal.

7.5.3.3 Malignant Tumours of the Anal Canal

The commonest malignant lesion is a squamous cell carcinoma. It may be very well differentiated or verrucous and difficult to diagnose on a biopsy. There is an increased risk of squamous cell carcinoma in chronic anal sepsis, fistulae and Crohn's disease. It may spread to the inguinal lymph nodes. Basaloid and small-cell undifferentiated tumours may occur [80].

Malignant Melanoma

This invariably presents quite late due to its site and has usually spread. It is very difficult to treat.

Adenocarcinoma

Columnar epithelium of the transitional zone and glandular mucosa from anal glands or anal gland ducts may produce mucinous adenocarcinoma associated with fistulae. Anal duct mucinous adenocarcinoma may be very difficult to diagnose since multiple biopsies may reveal only normal mucosa and mucus [33].

7.5.3.4 Epithelial Tumours of the Anal Margins

Both squamous cell carcinoma and basal cell carcinoma can be seen at the anal margin and it is important to state clearly where the biopsy has been taken from. A basal cell carcinoma can sometimes be confused with a basaloid cancer of the anal canal and this is a very important distinction since basal cell carcinoma responds very well to simple local excision. Basal cell carcinoma has little nuclear pleomorphism and prominent nuclear palisading. There is a characteristic stroma and clefting between epithelial islands and surrounding stromal tissue.

7.5.3.5 Presacral Tumours

These are rare and varied in type. There may be congenital abnormalities, bone tumours, neurogenic tumours, metastatic tumours and connective tissue tumours [33]. The congenital abnormalities include dermoid cysts, teratomas, meningoceles and pelvic kidneys.

7.5.3.6 Retrorectal Cyst Hamartoma

This is a rare condition with multilocular cysts lined by squamous, transitional and columnar epithelium. It must be differentiated from a simple anal gland cyst, teratoma, dermoid cyst, duplication cyst of the rectum and well-differentiated adenocarcinoma of anal glands

[33]. Complete surgical removal is important for assessment.

7.5.3.7 Haemorrhoids

Most haemorrhoids that are removed have changes of mucosal prolapse in the columnar cuff that covers them. Squamous epithelial coverings should be assessed for the presence of wart virus infection and AIN.

7.5.3.8 Oleogranulomas

These may be seen after injection of haemorrhoids with lipid-related substances and may present as a submucosal "tumour" just inside the anal canal. Histologically, there are foreign-body giant cells and granulomas containing lipid.

7.6 Summary

The importance of context and clinicopathological correlation in the diagnosis, staging and planning of treatment in colorectal disease cannot be overemphasised. This is aided considerably by regular consultations in the endoscopy room, operating theatre and specimen dissection room, and by means of regular clinicopathological meetings. Pathology will then contribute properly to patient management in benign and malignant diseases of the anus, rectum and colon.

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Self-Assessment Quiz

Question 1

Which statement referring to colonoscopic biopsy material from normal caecal mucosa is correct?

a. Contains more branched crypts, fewer neutrophils, more Paneth cells and more plasma cells than biopsies from normal mucosa elsewhere in the colon.
b. Contains fewer branched crypts, fewer neutrophils, more Paneth cells and fewer plasma cells than biopsies from normal mucosa elsewhere in the colon.
c. Contains more branched crypts, fewer neutrophils, fewer Paneth cells and more plasma cells than biopsies from normal mucosa elsewhere in the colon.
d. Contains more branched crypts, no neutrophils, more Paneth cells and more plasma cells than biopsies from normal mucosa elsewhere in the colon.
e. Contains occasional branched crypts, no neutrophils, more Paneth cells and more plasma cells than biopsies from normal mucosa elsewhere in the colon.

Question 2

Which statement referring to the colonoscopic biopsy diagnosis of microscopic colitis is correct?

a. Depends on the findings of diarrhoea with blood, normal colonoscopy, normal crypt architecture and a diffuse increase in chronic inflammatory cells in the mucosa.
b. Depends on the findings of diarrhoea without blood, normal colonoscopy, normal crypt architecture and a diffuse increase in chronic inflammatory cells in the mucosa.
c. Depends on the findings of diarrhoea with blood, abnormal colonoscopy, distorted crypt architecture and a diffuse increase in chronic inflammatory cells in the mucosa.
d. Depends on the findings of diarrhoea without blood, normal colonoscopy, abnormal crypt architecture and a diffuse increase in chronic inflammatory cells in the mucosa.
e. Depends on the findings of diarrhoea with blood, normal colonoscopy, normal crypt architecture and a patchy increase in chronic inflammatory cells in the mucosa.

Question 3

Which statement referring to recommendation for the diagnosis of indeterminate colitis (IC) is correct?

a. Is diagnosed on colonoscopic biopsies with caecal sparing and histological features that overlap between those of Crohn's disease and ulcerative colitis.
b. Is diagnosed on colectomy specimens with caecal sparing and histological features that overlap between those of Crohn's disease and ulcerative colitis.
c. Is diagnosed on colonoscopic biopsies with caecal sparing and histological features that overlap with those of Crohn's disease.
d. Is diagnosed on colonoscopic biopsies with rectal sparing and histological features that overlap between those of Crohn's disease and ulcerative colitis.
e. Is diagnosed on colectomy specimens with rectal sparing and histological features that overlap between those of Crohn's disease and ulcerative colitis.

Question 4

Which statement is correct?

a. Serrated adenomas are dysplastic lesions that develop from hyperplastic polyps, occur as part of the serrated pathway syndrome, and do not occur in other polyposes.
b. Serrated adenomas are non-dysplastic lesions that develop from hyperplastic polyps, occur as part of the serrated pathway syndrome, and may occur in other polyposes.
c. Serrated adenomas are dysplastic lesions that develop from hyperplastic polyps, occur as part of the serrated pathway syndrome, and may occur in other polyposes.

d. Serrated adenomas are non-dysplastic lesions that develop from hyperplastic polyps, occur as part of the serrated pathway syndrome, and do not occur in other polyposes.
e. Serrated adenomas are dysplastic lesions that are not related to hyperplastic polyps, occur as part of the serrated pathway syndrome, and may occur in other polyposes.

Question 5

Which tumour stage is correct, referring to an anterior resection specimen containing an adenocarcinoma that has invaded through the muscularis propria by 10 mm and is within 1 mm of the mesorectal margin posteriorly; the tumour has invaded 4/32 lymph nodes and the high tie node is not invaded by tumour?

a. Dukes B, pT3c, N2, Mx, R1.
b. Dukes C2, pT3b, N2, Mx, R0.
c. Dukes C1, pT3c, N2, Mx, R1.
d. Dukes C1, pT3a, N1, Mx, R1.
e. Dukes C1, pT3c, N1, Mx, R0.

1. Answer: e
It is well recognised that the caecal mucosa in normal individuals is histologically distinct from the remainder of the colon. Failure to recognise this may lead to the mistaken diagnosis of a skip lesion in inflammatory bowel disease or an overestimate of the extent of ulcerative colitis. Occasional branched crypts are seen throughout the normal colon and are more common in the rectum. The lamina propria of the caecum usually contains a greater number of chronic inflammatory cells, such as lymphocytes and plasma cells, although increased numbers of eosinophils may also be noted [153]. Neutrophils are not normally seen in the caecum and should be regarded as abnormal if present. Paneth cells are normally found in the caecum and right side of the colon, but are an abnormal finding in the distal bowel.

2. Answer: b
A diagnosis of microscopic colitis requires a combination of clinical, endoscopic and pathological features. Patients with microscopic colitis suffer from chronic, watery and bloodless diarrhoea and may experience abdominal pain. Colonoscopy is always normal or near normal. Histologically, the correct diagnosis requires that there be no significant crypt architectural distortion. In lymphocytic colitis there is a diffuse increase in the number of mononuclear cells within the lamina propria in addition to an increase in the number of intraepithelial lymphocytes. Collagenous colitis has a significantly thickened subepithelial collagen layer as well as increased numbers of lymphocytes within the lamina propria.

3. Answer: e
The term IC is only appropriate following assessment of a colectomy specimen in which the macroscopic and microscopic features do not conform to those typically seen in Crohn's disease or ulcerative colitis [154]. IC is often applied to cases of fulminant colitis in which features classically associated with ulcerative colitis are obscured by severe ulceration, transmural lymphoid aggregates, and relative rectal sparing, features normally associated with Crohn's disease. Achieving a correct diagnosis in cases of IC requires a detailed assessment of all the previous rectal and colonic biopsies and careful monitoring of the subsequent disease process.

4. Answer: c
Both serrated adenomas and hyperplastic/metaplastic polyps have a serrated architecture and are now considered to represent part of a spectrum of entities with malignant potential. Hyperplastic polyps display no dysplasia and are benign. Serrated adenomas are dysplastic and may undergo malignant change like any other adenoma. Serrated adenomas and hyperplastic polyps may be part of an inherited serrated pathway syndrome and may occur in other inherited and non-inherited polyposes [155].

5. Answer: c
The tumour has spread beyond the outermost border of the muscularis propria and is therefore stage pT3. This tumour stage can be subdivided into pT3a (<1 mm beyond the border of the muscularis propria), pT3b (1–5 mm beyond the border of the muscularis propria), pT3c (>5–15 mm beyond the border of the muscularis propria) and pT3d (>15 mm beyond the border of the muscularis propria). The minimum distance between the tumour and circumferential margin in this case is ≤ 1 mm so the surgical margin is regarded as being involved. This can be annotated as R1, which is defined as tumour left behind microscopically at a resection margin (R0 would denote no tumour left at the resection margins; R2 would denote macroscopic tumour left at the surgical margins). Since four or more nodes are involved by tumour the nodal status is annotated as N2. The high tie node remains uninvolved, making the tumour Dukes C1 regardless of the extent of local tumour spread. Finally, as no tissue has been submitted by the surgeon to establish distant metastasis, the annotation Mx is used.

8 Anorectal, Pelvic and Colonic Imaging

Simon A. Jackson and Bruce M. Fox

CONTENTS

8.1 Introduction

Since the discovery of the X-ray by William Conrad Roentgen in November 1895, radiology of the lower gastrointestinal tract has been at the forefront of advances in medical imaging. For many years examinations were confined to the twin imaging modalities of the plain film and contrast study. Whilst these techniques still play a role in the assessment of patients with anorectal and colonic diseases, the advent of the cross-sectional imaging modalities, including computed tomography (CT), magnetic resonance (MR) imaging (MRI) and ultrasound (US) have revolutionised the role of radiology. In addition, the relentless increase in computer power with a doubling time of approximately 18 months (Moore's law) continues to result in further technical innovations, which include the expanding role of functional imaging techniques such as positron emission tomography (PET)/CT. These developments continue to provide exciting advances for the imaging of patients in the 21st century.

This chapter provides a succinct overview of current imaging modalities, with particular reference to their role in patients with anorectal, pelvic and colonic diseases. The role of anal and rectal sonography is covered in Chap. 9.

8.2 Plain Radiographs

The plain radiograph has traditionally been the first radiological investigation chosen for the assessment of abdominal pathology. Whilst many of the historical indications for a plain abdominal film have been superseded by other imaging modalities, this technique continues to provide invaluable information in a variety of pathologies.

8.2.1 Indications

Several evidence-based publications including "Making the Best Use of a Department of Clinical Radiology", published by the Royal College of Radiologists [1], support the use of plain films in the initial assessment of patients presenting with acute abdominal pathology.

8.2.1.1 Perforation

The combination of an erect chest X-ray (CXR) and a supine abdominal X-ray (AXR) allows the detection of small volumes of free gas (as little as 2 ml). The presence of free gas within the peritoneal cavity can be diagnosed by several radiological signs including the lu-

cent liver sign, the depiction of both sides of the bowel wall (Rigler's sign) and demonstration of the peritoneal reflections and ligaments outlined by the free gas [2].

8.2.1.2 Bowel Obstruction

The diagnosis of small-bowel obstruction by dilated jejunal and ileal loops measuring greater than 2.5 cm and 3.5 cm in diameter, respectively, is non-specific. Thus the differentiation of mechanical obstruction from paralytic ileus can be problematic based on plain film appearances, and radiological appearances must be interpreted in combination with the clinical history and physical examination. The relative proportions of gas- and fluid-filled small-bowel loops may, however, increase the sensitivity of the plain film, with acute small-bowel obstruction demonstrating a relative paucity of gas-filled small-bowel loops due to retrograde peristalsis resulting in passage of gas from the small bowel back into the stomach.

Large-bowel obstruction from various pathologies results in dilatation of the colonic lumen, with characteristic appearances observed particularly when this results from the presence of a volvulus. A volvulus, as with all closed-loop obstructions, demonstrates the radiographic appearance of a C-shaped volvulus pointing towards an apex at the position of the twisted segment. Thus, a sigmoid volvulus will extend from the right upper quadrant towards an apex in the region of the left sacroiliac joint, with a caecal volvulus pointing from the left upper quadrant to an apex in the right iliac fossa. The sensitivity of the AXR for the differentiation of large-bowel obstruction from pseudo-obstruction is limited, and in many cases the use of correlative imaging such as CT or a water-soluble contrast study is required (Fig. 8.1).

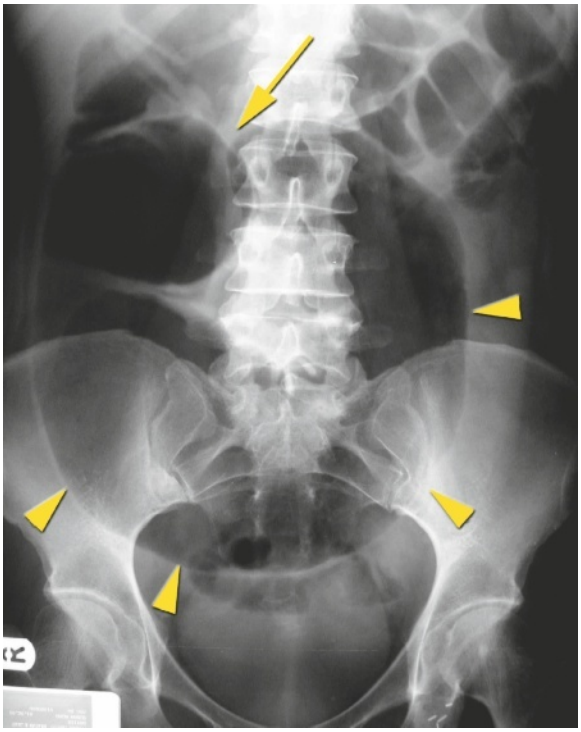

Fig. 8.1 Plain abdominal radiograph showing a grossly dilated caecum (*arrowheads*) twisted about an abnormally placed mesentery (*long arrow*)

8.2.1.3 Inflammation

The role of the plain abdominal film is to evaluate complications and exacerbations of colonic inflammation, not to diagnose early mucosal changes, which should be assessed by endoscopy. Mucosal inflammation results in an absence of faecal contents within the affected segment and, as disease severity progresses, bowel wall thickening and mucosal oedema, with mucosal islands becoming visible. This can be observed radiologically as "thumb printing", especially in the transverse colon. The presence of mucosal islands significantly increases the likelihood that the patient will require subsequent surgery. The presence of dilatation, and in particular transverse colonic dilatation with a cross-sectional diameter of greater than 6 cm, is indicative of a toxic megacolon with the associated increased risk of complications including perforation (Fig. 8.2).

8.3 Contrast Imaging

Contrast examinations of the gastrointestinal tract were first performed in 1896. These early single-contrast studies provide limited diagnostic information and were undertaken primarily to observe alterations in normal peristalsis. The modern double-contrast barium examination was introduced during the 1920s following improvements in both equipment and barium preparations. This examination became the mainstay of colonic imaging for most of the 20th century. Whilst other imaging modalities, including colonoscopy, have

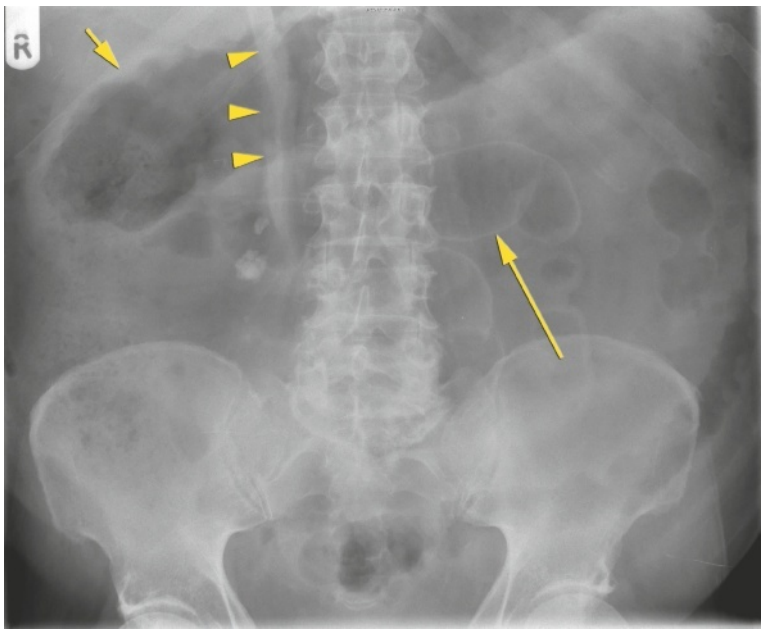

Fig. 8.2 Plain abdominal radiograph showing a perforated toxic megacolon, the falciform ligament (*arrowheads*), Rigler's sign (*long arrow*) and a grossly thickened transverse colon (*short arrow*)

superceded the barium enema, a significant number of patients require a complete colonic mucosal evaluation, which cannot be provided by endoscopy. Contrast imaging techniques thus play a limited but vital role in the diagnosis of colonic pathology.

8.3.1 Contrast Enema

The standard barium enema examination requires full bowel preparation, preferably using a dry purgative preparation and with the addition of intravenous smooth muscle relaxant in order to obtain optimal mucosal coating and colonic distension. Patients who are unable to undergo optimal preparation should be considered for alternative imaging, including CT. The quality of the examination also is dependent upon the expertise of the radiologist, with optimal studies demonstrating high sensitivities for the diagnosis of colorectal neoplasia and polyps (Fig. 8.3) [3, 4].

The examination can also demonstrate mucosal inflammation and be used to assess the severity of diverticular disease and its complications (fistula formation or pericolic abscess). Severe diverticular disease, however, limits the sensitivity of mucosal examination.

Although the incidence of fatal sclerosing peritonitis has decreased significantly since the improvement

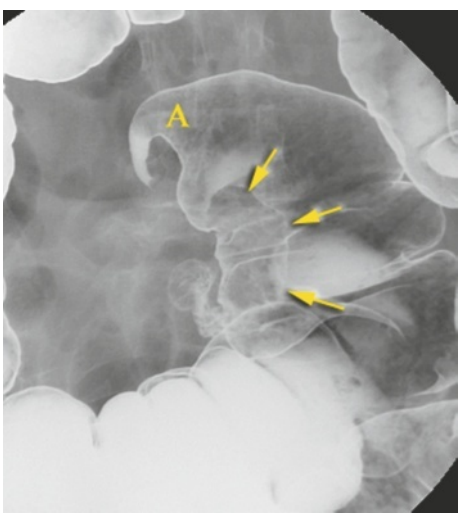

Fig. 8.3 Double-contrast barium enema image showing an ileocaecal cancer (*short arrows*) adjacent to the appendix orifice (*A*)

in barium preparations, the presence of a suspected perforation remains a contraindication to examination of the colon by barium enema. Studies should therefore be performed using water-soluble contrast agents. The most common contrast agent used is Gastrografin, which is a hyperosmolar solution that contains a com-

bination of sodium amidotrizoate and meglumine amidotrizoate. Gastrografin may therefore also be used as a therapeutic enema for intractable constipation. The unprepared water-soluble enema is used routinely for the assessment of colonic anastomotic integrity (Fig. 8.4).

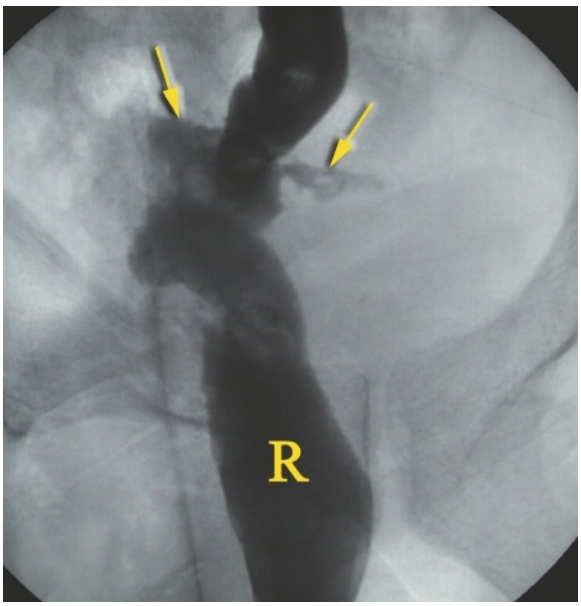

Fig. 8.4 A water-soluble contrast enema in a patient following an anterior resection, showing an anastomotic leak (*arrows*). *R* Rectum

8.3.2 Colonic Transit Studies

The assessment of colonic transit time is important for the investigation of patients with chronic constipation. Where a reliable history can be obtained, the plain abdominal film has little or no role in the diagnosis of constipation. Exceptions include the paediatric and geriatric patient groups, where the AXR can be used as a guide to colonic transit according to the distribution of solid stool throughout the colon. The presence or absence of stool, however, does not correlate accurately with colonic transit time. More accurate radiological techniques include the ingestion of radio-opaque markers (colonic transit study) or the use of scintigraphy.

Colonic transit studies require the patient to refrain from laxatives, enemas or other medications known to alter bowel motility. At day 1 the patient ingests a known number of radio-opaque markers, with either a limited series of abdominal films or a single AXR obtained on day 6. The number and distribution of retained markers provide information on overall whole gut transit (Fig. 8.5) [5].

Gut scintigraphy requires the oral administration of a radioactive isotope, with progression of the isotope through the gut monitored using a gamma camera [6]. The test can be modified to investigate gastric, small-bowel and colonic transit during a single examination.

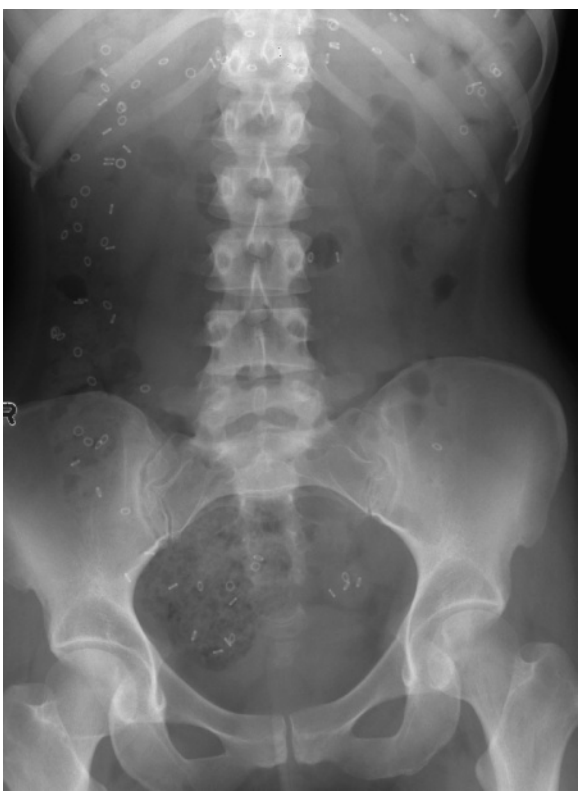

Fig. 8.5 An abdominal radiograph on day 6 of a colonic-transit study showing multiple retained shapes, evenly distributed throughout the colon, consistent with general colonic inertia

8.3.3 Contrast Evacuation Proctography

The reported incidence of functional pelvic floor disorders continues to rise as awareness of both the underlying conditions and the therapeutic options available to the patient increases. Assessment of pathology, which is associated with weakness or dysfunction of the pelvic floor musculature, relies on a combination of clinical history, physical examination and imaging techniques. These include both dynamic contrast examination of evacuation (evacuation proctography) and static examination of the sphincter complex, most commonly by transrectal US (see Chap. 9). Evacuation proctography is indicated in particular for patients with symptoms of obstructive evacuation. The examination allows both

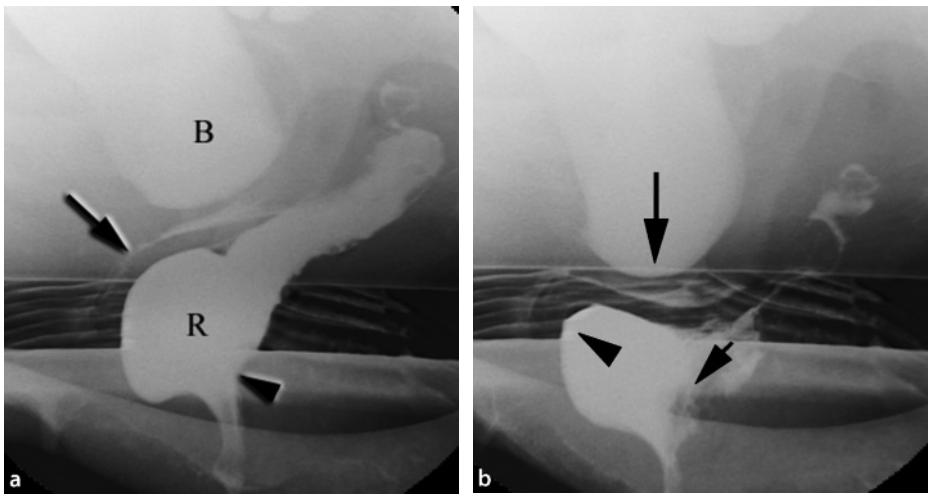

Fig. 8.6 **a** A single image of an evacuating proctogram, showing the rectum (*R*), bladder (*B*), vagina (*long arrow*) and puborectalis impression (*arrowhead*). **b** The same patient towards the end of evacuation, demonstrating a cystocoele (*long arrow*), rectocoele (*arrowhead*) and rectal descent (*short arrow*).

Video Images from the evacuation phase of a proctogram in a patient with symptoms of obstructed evacuation. The video demonstrates descent of an occult enterocoele to the level of the pelvic floor. There is also a transient posterior mucosal prolapse and anterior rectocoele

the assessment of evacuation and evaluation of the dynamics of the surrounding organs.

Evacuation proctography is undertaken in the X-ray department using standard fluoroscopy equipment and a modified commode. Patient preparation requires the opacification of the rectum, usually with a thickened barium-based preparation. In addition, the small bowel is also opacified with contrast ingested approximately 1 h prior to the procedure. This enables visualisation of small-bowel loops in the pelvis and their position in relation to the pelvic floor during evacuation. The middle compartment can also be opacified using vaginal paste.

The standard investigation assesses the appearance of the rectum and adjacent anatomy in three stages, namely: pre-evacuation, during evacuation and post-evacuation. The examination thus provides recorded information on structural rectal changes during evacuation and a functional assessment of the degree and rate of rectal emptying (Fig. 8.6) [7].

8.4 Cross-Sectional Imaging

8.4.1 Computed Tomography

The combination of rapid technological developments in CT and its availability has resulted in the widespread use of the technique for imaging patients with abdominopelvic pathology. Multidetector row CT (MDCT), which was initially introduced in 1998, has facilitated shorter scanning times and improved spatial resolution, and now allows multiphasic contrast enhanced studies to be performed [8, 9]. In addition, concurrent advances in post-acquisition data-processing techniques also provide rapid 2D and 3D multiplanar reconstruction projections, increasing the yield of information from examinations [10]. Despite these advances, CT remains a high-radiation-intensive modality, with an average abdominal or pelvic examination providing the equivalent radiation dose of approximately 500 CXRs [1].

8.4.1.1 Standard Technique

The standard abdominopelvic CT examination requires the correct administration of both oral and intravenous contrast media. Oral contrast solutions include both water-soluble and barium-based compounds, which in the majority of circumstances are administered both 12–24 h and 1 h prior to the procedure. Ingestion results in the positive (increased density) opacification of both small- and large-bowel loops. In specific circumstances, contrast can also be administered per rectum for increased distension of the distal colon and rectum.

Alternatively, negative (reduced density) contrast media such as water and gas may be used in specific circumstances.

Non-ionic intravenous contrast is routinely injected during a standard abdominopelvic study. The rate and volume of contrast injection provide two fundamental and related variables that can be used to improve the demonstration and characterisation of a pathology. In particular, MDCT allows image acquisition during either arterial or venous phases, or during a combination of both vascular phases. Scanner software packages allow accurate multiphasic timing in patients with cardiac disease or other pathologies affecting circulation times.

The standard abdominopelvic CT examination plays a central role in the diagnosis and management of patients with a variety of pathologies, including the assessment of complex intra-abdominal pathology and the diagnosis of post-operative complications. In addition, the technique is used routinely in both the diagnosis and staging of patients with suspected or known colorectal malignancy. Whilst technical limitations in soft-tissue resolution reduce the accuracy of CT for tumour (T staging) and metastatic lymph node infiltration (N staging), CT plays a primary role in the assessment of disseminated malignancy (M staging) as well as determining the management of patients with recurrent malignancy (Fig. 8.7).

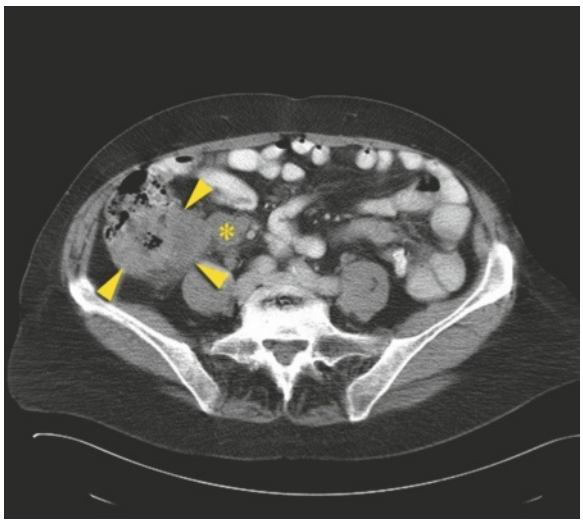

Fig. 8.7 A single computed tomography (CT) image of the lower abdomen showing a mass in the right iliac fossa representing an ascending colon cancer (*arrowheads*). There is an adjacent nodal mass (*asterisk*)

8.4.1.2 CT Colonography

CT colonography (CTC) or virtual colonoscopy has rapidly developed as a sensitive, minimally invasive technique for the detection of colonic pathology and can be performed in an outpatient setting without the need for intravenous sedation. The accuracy of examination depends on optimal patient preparation. In particular, the colon should be cleansed in the same manner as for a barium enema using dry preparation "purgatives" (sodium phosphate or magnesium citrate) in order to avoid residual colonic fluid, which may mask mucosal pathology. Recent technological advances, however, include the increasingly widespread use of faecal tagging agents as an adjunct to bowel preparation. These tagging agents, which include barium sulphate or water-soluble contrast media, are used to increase the density of residual stool and fluid, respectively, which can then be subtracted electronically (electronic cleansing), thus facilitating data interpretation [11, 12]. Early publications also suggest that laxative-free or "prepless" CTC with associated increased patient compliance may become a standard examination technique in the future [13].

The CTC examination is performed following colonic insufflation via a small rectal catheter using either carbon dioxide or room air. Automated pump insufflators are commercially available to facilitate colonic distension. The quality of examination is improved by the routine use of intravenous antispasmodics including hyoscine butylbromide (20 mg). These reduce colonic spasm and ease the incidence of abdominal cramping. Examinations are performed in both the supine and prone position, requiring a degree of patient mobility. Intravenous contrast can be administered to facilitate a full staging examination in patients with colorectal malignancy. CTC is a safe technique with few significant adverse events. Studies have concluded that an examination has an overall complication rate of 0.02–0.08% and a perforation rate of 0.005–0.03% [14, 15].

A routine examination generates in excess of 1,000 images and yields a total effective dose of 5–10 mSv [16]. This dose can, however, be reduced using low-dose modulation algorithms, resulting in a reduction of the total effective dose to approximately 2 mSv [17]. Dedicated software algorithms provide post-processed 2D and 3D reconstructions. The 3D techniques provide virtual colonoscopy or fly-through series. Reporting remains time consuming, although advances in computer-aided detection software, which is now commer-

cially available, promise to improve both reporting accuracy and speed [18].

CTC provides several advantages for the assessment of colonic pathology in patients in whom colonoscopy or barium enema are contraindicated. The technique is minimally invasive, safe, quick, less expensive than colonoscopy and is well tolerated by patients [19, 20]. In addition, significant extracolonic pathology is diagnosed in approximately 15% of patients. Multiple publications including several meta-analyses have confirmed the accuracy of the technique for the diagnosis for colonic pathology [21–23], and the technique is now widely accepted for several clinical indications including:

1. Completion whole-colonic examination following an incomplete optical colonoscopy (Fig. 8.8).
2. Evaluation of the colon in patients with severe diverticular disease or significant colonic stricture.
3. The diagnosis and assessment of colonic polyps or malignancy where conventional optical colonoscopy is contraindicated or declined by the patient.

In addition, there is widespread interest with regard to the role of CTC as an alternative, minimally invasive colorectal cancer screening examination. Whilst the use of CTC in this context is currently not endorsed throughout Europe, the American Cancer Society released joint guidelines with the American College of Radiology in March 2008 supporting its use. In addition, a recent publication by the American College of Radiology Imaging Network has confirmed that the overall sensitivity of CTC for significant polyp diagnosis in average-risk, asymptomatic patients is 90%, the results adding strength to existing published data [24].

8.4.2 Magnetic Resonance Imaging

The first human MRI examination was performed on 3rd July 1977, requiring approximately 5 h to generate a single image. The technique was thus initially of limited use when compared to CT due to the extended examination times. However, recent technological developments have resulted in a marked reduction in examination times, with modern MRI scanners allowing the acquisition of various sequences during a single breath hold. The modality has significant advantages when compared to CT, requiring no ionising radiation

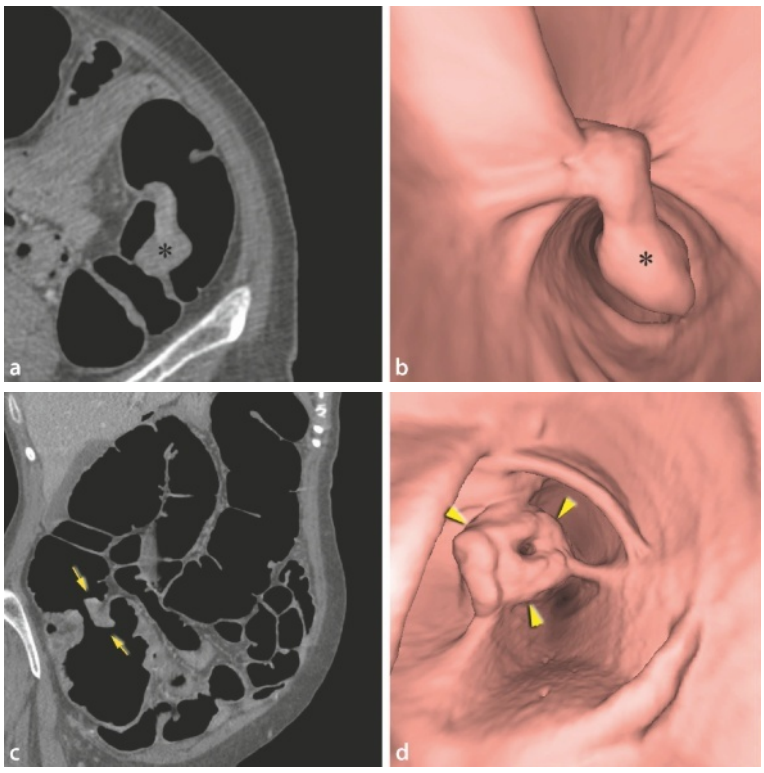

Fig. 8.8a–d CT colonography (CTC) image showing both 2D (**a**) and 3D (**b**; virtual colonoscopy) views of a pedunculated polyp (*asterisk*). **c,d** CTC image showing both 2D (**c**) and 3D (**d**; virtual colonoscopy) views showing an annular caecal carcinoma (*arrowheads*)

and providing extremely high soft-tissue contrast resolution. This allows increased accuracy for both the diagnosis and characterisation of pathology [25].

The basic MRI technique requires positioning of the patient within an extremely strong magnetic field generated by either a whole body or surface multicoil magnet. The patient is then exposed to an intermittent radiofrequency pulse, which results in an increase in stored energy at an atomic level. The energy, which is released when the pulse is stopped, is then emitted as a signal. This signal is analysed and used to reconstruct the final images. The use of various intravenous contrast media provides increased accuracy for the detection and characterisation of pathology. A more detailed description of sequence acquisition is beyond the scope of this chapter.

Whilst MRI is extremely safe, the use of a strong magnetic field (for example 1–1.5 Tesla) requires the preprocedure screening of patients for contraindications to the examination. These include the presence of metallic implants or foreign bodies such as cardiac pacemakers, intracranial aneurysm clips, intraocular foreign bodies and cochlear implants. The presence of orthopaedic implants, such as hip prostheses, however, is not normally regarded as a contraindication to MRI.

Current indications for MRI in patients with anorectal, pelvic and colonic diseases can be divided into the broad categories of rectal cancer staging, the assessment of perianal fistulae and anal sphincter trauma, the rapidly emerging technique of MR colonography (MRC) and the use of MRI to assess pelvic floor pathology.

8.4.2.1 Rectal Cancer

Rectal cancer remains a common malignancy worldwide and despite advances in treatment algorithms, outcome following surgical resection, and in particular the incidence of locally recurrent disease, remains variable. Preoperative MRI plays two important roles in the multidisciplinary management of patients. Firstly, optimal imaging provides an accurate preoperative road map of the primary tumour and its relationship to adjacent anatomical structures. Secondly, MRI predicts prognostic patient subgroups and thus becomes fundamental in the determination of the various therapeutic algorithms currently available to minimise the risk of subsequent locally recurrent disease.

MRI remains complimentary to both CT and US for the assessment of rectal malignancy. The relatively limited soft-tissue resolution of CT reduces the accuracy of the technique for local T staging [26] and thus the modality is primarily used for preoperative M staging. Transrectal US has been used routinely for local rectal staging for many years [27] and remains an accurate technique for the assessment of tumours confined to within the mucosa and submucosa of the bowel wall (T1/T2; see Chap. 9).

The widely accepted MRI examination is performed on patients without the need for bowel preparation, rectal distension or the injection of intravenous contrast media. The majority of examinations are performed using a high-resolution phased-array surface coil, the use of endoluminal coils being limited due to availability issues. Multiplanar T2-weighted high-resolution sequences are performed in the three orthogonal planes with particular emphasis on thin-section axial imaging; slices are obtained perpendicular to the long axis of the tumour. A standard examination lasts approximately 30 min.

Early results assessing the accuracy of the high-resolution, thin-section technique suggest a high sensitivity for T-stage prediction [28]. Subsequent papers, however, have questioned the accuracy of preoperative T staging. Beets-Tan et al. reported only moderate results with considerable interobserver variation [29]. More recent publications, however, clearly demonstrate the high accuracy of the technique for the demonstration of the mesorectal fascia and the relationship of rectal tumour extension to the circumferential resection margin (CRM) [30]. Recently published results from the Mercury study group report a specificity for the prediction of a clear resection margin by high-resolution MRI of 92% [31]. In addition, MRI provides detailed prognostic information regarding the presence of extramural venous spread, local peritoneal infiltration and nodal status [32].

High-resolution imaging plays a central role in the preoperative staging of rectal cancer, and in particular predicts which patients will benefit from local curative surgery alone and those patients at risk of a positive CRM in whom neoadjuvant therapy can improve surgical outcome and reduce the incidence of recurrent disease (Figs. 8.9 and 8.10).

8.4.2.2 Perianal Fistulae

The majority of perianal fistulae diagnosed by clinical history and physical examination can be easily assessed, and subsequent treatment by surgery results in a good

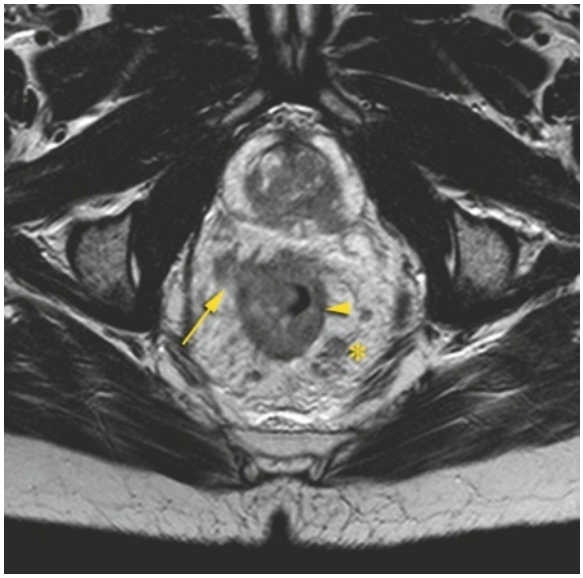

Fig. 8.9 An axial T2-weighted, high-resolution magnetic resonance imaging (MRI) image of the low rectum showing a rectal cancer that has breached the muscularis propria (*arrowhead*) infiltrating the mesorectal compartment (*arrow*). There is also mesorectal lymphadenopathy (*asterisk*)

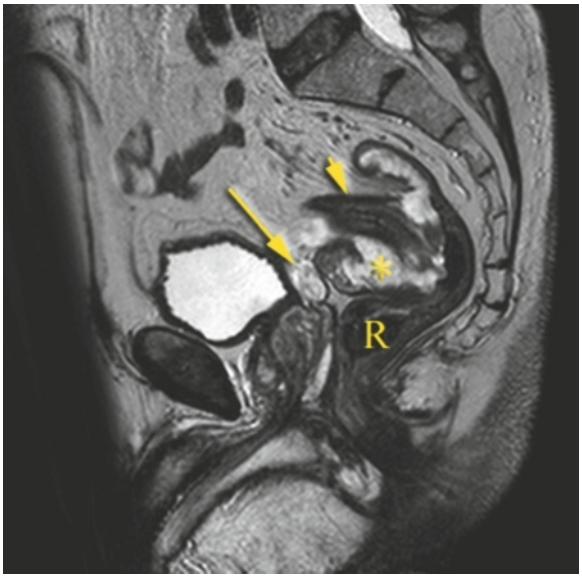

Fig. 8.10 A sagittal T2-weighted MRI image showing a mucinous (high signal, *asterisk*) sigmoid cancer that has intussuscepted into the rectum (*R*); the mesenteric pedicle is clearly seen (*short arrow*). There is also a mucinous peritoneal deposit (proven at surgery) invading the peritoneum above the seminal vesicles (*long arrow*)

post-operative outcome [33]. However approximately 5–15% of fistula tracts are complex with fistulous primary communications involving the ischiorectal fossae and supra levator compartment, as well as containing occult secondary extensions. This group of complex fistulae is difficult to assess clinically and is associated with a higher rate of recurrence following surgical intervention. A variety of diagnostic techniques has been used for the preoperative assessment of complex fistulae, with simple contrast fistulography and CT offering only a limited sensitivity for the depiction of complex fistula anatomy. Transanal US can provide high-resolution assessment of fistulae and their relationship to anal sphincter anatomy, although the limited field of view reduces the sensitivity of the examination [34]. High-resolution MRI is now firmly established as an accurate technique and can add valuable additional information with regard to pelvic pathology, particularly in patients with Crohn`s disease. Current MRI techniques involve the use of either endoluminal or body phased-array surface coils, and whilst the resolution of endoanal MRI is high, the field of view is limited and the availability of the coils is largely limited to specialist European centres. The standard surface-coil MRI technique uses a combination of multiplanar T1- and T2-weighted fat-saturated sequences with or without intravenous contrast enhancement.

Initial reports on the accuracy of MRI for the depiction, detection and classification of perianal fistulae suggested an accuracy of 86–88% between MRI and surgical findings. More recent studies have reported an increased sensitivity for the detection of fistulous tracts and abscesses, with accuracy approaching 100%. Important additional information, particularly in patients with recurrent and complex perianal disease, is demonstrated in approximately 20% of patients [35]. Studies also suggest that surgery based on MRI findings can reduce recurrent fistula formation by approximately 75% (Fig. 8.11) [36].

8.4.2.3 MR Colonography

Technical advances in MRI scanner components and reconstruction software have facilitated the introduction of MRC as a viable alternative to CT colonography. Studies are performed using either traditional bowel-cleansing methods or a faecal tagging approach. Bowel distension is optimised with the aid of a fluid enema and the intravenous administration of antispasmolytic

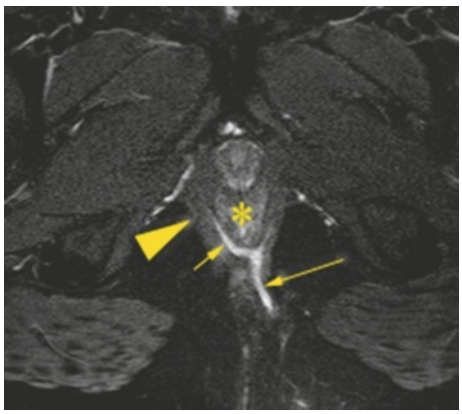

Fig. 8.11 An axial short T1 inversion recovery MRI image of the perianal region showing an intersphincteric fistula (*short arrow*) that has crossed the external sphincter (*large arrowhead*) posteriorly on the left (*long arrow*). The upper anal canal is marked (*asterisk*)

agents. The choice of intraluminal enema contrast media determines the method of image production, with the colonic lumen depicted as either "bright" or "dark". In particular, a "bright" lumen or positive MRC shows mucosal pathology as filling defects on a "bright" luminal background. In contrast, the instillation of a water enema and dynamic intravenous contrast enhancement produce a negative or "dark"-lumen MRC, demonstrating enhancing mucosal pathology such as polyps on a "dark" luminal background. Recent results demonstrate high patient satisfaction with a recent trial comparing "dark"-lumen MRC versus conventional optical colonoscopy demonstrating an overall sensitivity of MRC for the detection of colorectal masses of 90% and specificity 96%. Polyp detection sensitivities were 100% for polyps larger than 10 mm and 84% for polyps between 6 and 9 mm in diameter [37]. Similar results have been reported; Ajaj et al. [38] reported an overall sensitivity and specificity of 93% and 100%, respectively, for the detection of polyps greater than 5 mm in diameter.

8.4.2.4 MR Evacuation Proctography

The use of MRI to evaluate the anatomy of the pelvic floor is standard practice in many radiology departments, with studies capable of demonstrating structural changes including rectocoeles, excessive pelvic floor descent and intussusceptions [39]. However, the use of dynamic MR examinations to assess evacuation has been limited due to the design of conventional MR scanners, which requires the patient to lie in the horizontal plane. The availability of open-configuration MR systems, however, allows dynamic MR evacuation proctography with the patient in the sitting position. The technique provides an accurate assessment of anorectal function and morphology without exposing the patient to ionising radiation [40, 41]. Examinations are, however, limited due to the availability of open-scanner technology.

8.5 Positron Emission Tomography/CT

PET is a physiological or functional imaging technique that is based on the display of the in-vivo distribution of molecules labelled with positron-emitting radioisotopes. Positrons result from the decay of specific radiopharmaceuticals, the most widely used of which is currently fluorine (^{18}F) combined within a glucose molecule as fluorodeoxyglucose (^{18}FDG). This is taken up into metabolically active cells where it becomes phosphorylated to a molecule that cannot easily pass through the cell membrane. This process takes approximately 1 h. After this period, a dedicated scanner is used to detect the radioactive breakdown products of the FDG, which appear as "hot spots" on imaging. Combining PET with CT allows the precise localisation of pathology within the body.

The principle indication for the use of PET/CT is for the detection and staging of malignancy. Whilst PET/CT currently offers a limited role in the diagnosis and initial staging of primary colorectal tumours, the technique is useful for the re-staging of suspected recurrent disease, and in particular the diagnosis of occult metastases [42–44]. A significant proportion of patients with recurrent but resectable disease will have their disease upstaged following a PET examination. In a large prospective study, PET altered the clinical management in 59% of patients [45]. In addition, the modality can be used as a problem-solving tool to distinguish post-operative changes from locally recurrent disease, for example following anterior resection. PET/CT is also being used increasingly for the staging and further management of anal cancer, as this tumour is also FDG avid [46].

PET scanning can be used for the diagnosis of inflammatory conditions, including the assessment of activity in Crohn's disease [47]. However, as the tech-

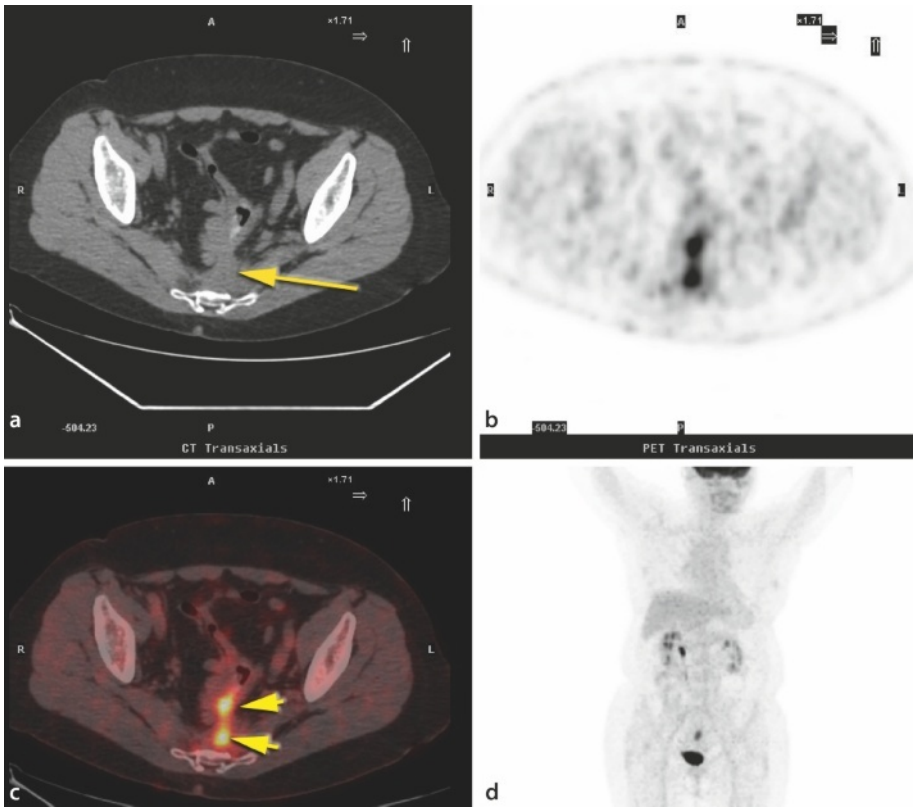

Fig. 8.12a,b Positron emission tomography (PET)/CT image showing soft-tissue thickening around an anterior resection anastomosis (*long arrow*). **c,d** PET/CT fusion images confirm increased metabolic activity, consistent with biopsy-proven recurrence (*arrowheads* in **c**)

nique requires ionising radiation, its routine use is relatively contraindicated (Fig. 8.12).

8.6 Conclusion

The result of rapid technological advances and the widespread availability of imaging modalities now provide the modern clinician with a complex array of techniques that can be combined with the standard clinical history and physical examination to accurately assess pathology. The role of radiology for the depiction of anorectal, pelvic and colonic diseases remains fundamental to the multidisciplinary management of patients. In addition, the emerging fields of molecular and functional imaging promise to ensure that the central role of imaging in patient care continues during the 21st century.

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Self-Assessment Quiz

Question 1

Which of the following statements regarding abdominal radiographs is true?

a. At least 10 ml must be present for the detection of free gas.
b. Normal jejunal diameter can be up to 4 cm.
c. A caecal volvulus classically points towards the right upper quadrant.
d. The presence of mucosal islands in acute colonic inflammation is associated with an increased requirement for surgery.
e. A transverse colonic diameter of up to 8 cm is normal.

Question 2

Which of the following statements regarding contrast imaging is true?

a. The barium enema is the investigation of choice for post-operative anastomotic assessment.
b. The incidence of fatal sclerosing peritonitis is increasing secondary to barium extravasation.
c. A water-soluble contrast enema is contraindicated in patients with an iodine allergy.
d. Evacuation proctography is carried out in the supine position.
e. The small bowel cannot be assessed during an evacuating proctogram.

Question 3

Which the following statements about computed tomography (CT) is true?

a. The X-ray dose of a standard abdominal/pelvic CT is equivalent to approximately 200 chest X-rays.
b. Colonic pathology can only be effectively demonstrated with the use of negative oral contrast agents.
c. The use of intravenous contrast agents increases spatial resolution.
d. CT colonography can only be performed effectively with complete bowel cleansing and the administration of gas.
e. A partially obstructing tumour is not a contraindication for CT colonography.

Question 4

Which are the following statements regarding magnetic resonance imaging (MRI) is true?

a. Magnetic field strength is measured in Teslas.
b. Suspected sphincter trauma is a contraindication to a standard MRI examination.
c. The role of high-resolution MRI for the evaluation of rectal cancer is principally to identify T1 and T2 tumours.
d. The use of MRI in rectal cancer provides little information about peritoneal involvement.
e. Malignant nodal infiltration on an MRI examination relies on size criteria only.

Question 5

With respect to positron emission tomography (PET)/CT imaging, which of the following is correct?

a. PET scanning does not rely on ionising radiation.
b. The most commonly incorporated substrate for PET scanning is heavy water.
c. Preparation for a PET scan requires the patient to refrain from physical activity for 1 h prior to the examination.
d. The main role for PET/CT is currently T staging.
e. Optimal tumour demonstration requires the rapid injection of tracer and a rapid acquisition of images.

1. Answer: d
The abdominal X-ray is sensitive in detecting free gas, having the ability to identify as little as 2 ml. The normal jejunal diameter should be less than 2.5 cm, and 4 cm would be considered to be pathological. Similarly, a transverse colonic diameter of up to 6 cm is considered the norm, and 8 cm pathological. A caecal volvulus classically points to the left upper quadrant, with the apex of mesentery fixed in the right iliac fossa.
2. Answer: c
Water-soluble contrast contains iodine and thus should be avoided in patients with iodine allergy. Barium should be avoided in the assessment of post-operative anastomoses due to the risk of leakage into the peritoneum. The incidence of sclerosing peritonitis following barium leakage is decreasing because of improved barium preparations and technique. Evacuation proctography should be carried out in the sitting position to mimic the natural physiological position, with small-bowel opacification standard during the procedure to allow identification of enterocoeles.
3. Answer: e
The X-ray dose of a standard abdominopelvic CT is equivalent to approximately 500 chest X-rays. Both positive and negative oral contrast can be used to outline the gut wall; however, the use of intravenous contrast agents increases only the contrast resolution of images. CT colonography, whilst performed with full bowel preparation, can be modified with the use of stool tagging agents to opacify bowel contents.
4. Answer: a
Suspected sphincter trauma is a relative contraindication to the use of endoanal MRI but is an indication for standard techniques. MRI plays a primary role in the identification of T3 and T4 malignancy, with the assessment of early tumours better demonstrated by transrectal ultrasound. MRI can be used to identify infiltration through the mesorectal fascia into adjacent structures including the peritoneum. Whilst size is an indicator for nodal infiltration, signal heterogeneity and node outline are also important predictors.
5. Answer: c.
Excessive muscle activity during the incorporation phase of ^{18}fluorodeoxyglucose will promote increased uptake of the tracer into skeletal muscle rather than the target area, thus decreasing the sensitivity of the examination.

9 Endorectal and Anal Sonography

Bruno Roche, Joan Robert-Yap and Nicolas C. Buchs

CONTENTS

9.1 Introduction

In the past decade there has been a resurgence of interest in the use of endoluminal ultrasonography (EUS) for a variety of anorectal applications. The introduction of technology that allows real-time, 360° radial scanning of the anorectum and the surrounding structures began a new era in endoluminal imaging. The ability to accurately stage rectal cancer preoperatively was the first real benefit realised by the use of this new modality; many other useful applications in the field of colorectal surgery have since become apparent.

9.2 General Overview

It is necessary to understand the physics of ultrasound so that the maximum information can be collected at each examination, thus avoiding pitfalls and errors in diagnosis. Ultrasonography is an imaging technique, the principle of which is based upon the interaction between transmitted sound waves and the juxtaposed different tissue densities of the body.

9.2.1 What is Ultrasound?

Ultrasound is a sound emitted at a frequency above the limit of human audibility (i. e. above 20 kHz). Many animals, such as dolphins and dogs, are able to hear at certain ultrasound frequencies, a phenomenon that was studied by Sir Francis Galton, who in 1876 developed the Galton whistle (dog whistle or silent whistle), which can produced sounds at frequencies of 1.6–22 kHz, to test differential hearing ability. Other applications for ultrasound include industry, fishing, war and medicine.

Diagnostic ultrasound is based on the detection and display of acoustic energy reflected from interfaces within the body. This mechanical energy travels through matter as a wave, causing the particles therein to vibrate. Sound frequencies used for diagnostic application typically lie in the range 2–15 MHz. Ultrasound is characterised by:

1. Frequency (f): > 20 kHz
2. Wavelength (λ): the distance between two corresponding points on the curve

3. Propagation velocity (m/s): the velocity (c) of propagation depends on the tissue (Fig. 9.1). In medical diagnosis application the velocity is considered constant at 1540 m/s

The transmitter energises the transducer; the transducer converts the electric energy provided by the transmitter into mechanical energy, and vice versa. The transmitter comprises a ceramic crystal that has the ability to change shape and vibrate under the action of an electric field; this is called a piezoelectric effect.

The transducer emits pulsed sound waves of a specific frequency with defined depth of penetration through the tissue layers. The ultrasound pulses must be spaced by enough time to permit the sound to travel to the organ of interest and return to the transducer before the next pulse is sent. The time difference between sound transmission and reception is calculated, and the digital sequential processing of a multitude of sound waves generates images [19]. When ultrasound pulses are transmitted into the body they are propagated – as a result of the vibration of molecules, which transmits the energy step by step in a longitudinal wave – reflected or backscattered, refracted and absorbed – due to transformation within the tissue of the acoustic energy to heat (Fig. 9.2). The sound waves pass through tissue planes, and at each interface between different tissue densities and acoustic impedance, some of the sound waves are reflected back towards the transducer. These reflected echoes stimulate the transducer, which converts this signal into a voltage. This amplification builds the image on the screen. In diagnostic ultrasound, the different media crossed by the incident energy are characterised by their acoustic impedance ($Z = \rho c$).

When ultrasound passes from one tissue to another, the difference in their acoustic impedance is responsible for the reflection of variable amounts of the incident sound energy. If the difference in acoustic impedance is large (soft tissue/bone or air), the reflection of the incident energy is almost total and the structures behind this interface cannot be analysed (Fig. 9.3). A signal of greatest intensity appears white; absence of signal appears black and a signal of intermediate intensity appears as shades of grey. At least 256 shades of grey are possible for each pixel. Depending on their reflectivity, the analysed structures are characterised by their echogenicity as being hypo-, iso-, or hyperechoic. Their echo patterns may be homogeneous or inhomogeneous.

The appropriate probe is selected according to the region to be analysed. The ultrasound frequency achieved depends upon the thickness of the transmitting crystal. For an anorectal examination, we usually use a rotating endoprobe with a frequency range from 6 to 16 MHz, providing a full 360° transverse view. The rectum and anal canal are well suited for ultrasonographic evaluation because of the variety of tissue density interfaces present in this readily accessible region.

Ultrasonography is less expensive than other imaging modalities, such as magnetic resonance imaging (MRI) and computed tomography (CT), relatively quick and is well tolerated by the patient. Moreover, the patient is not exposed to radiation during the course of the examination. In addition, the examination can be performed as an intraoperative procedure, which may

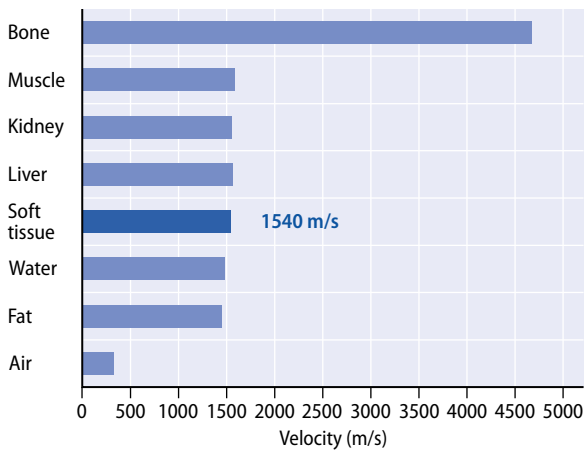


Fig. 9.1 The velocity of propagation of an ultrasound wave depends on the tissue

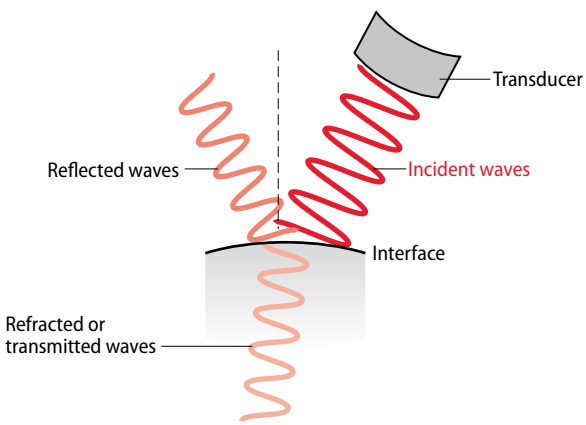


Fig. 9.2 Ultrasound waves transmitted into the body are reflected, refracted, transmitted or absorbed

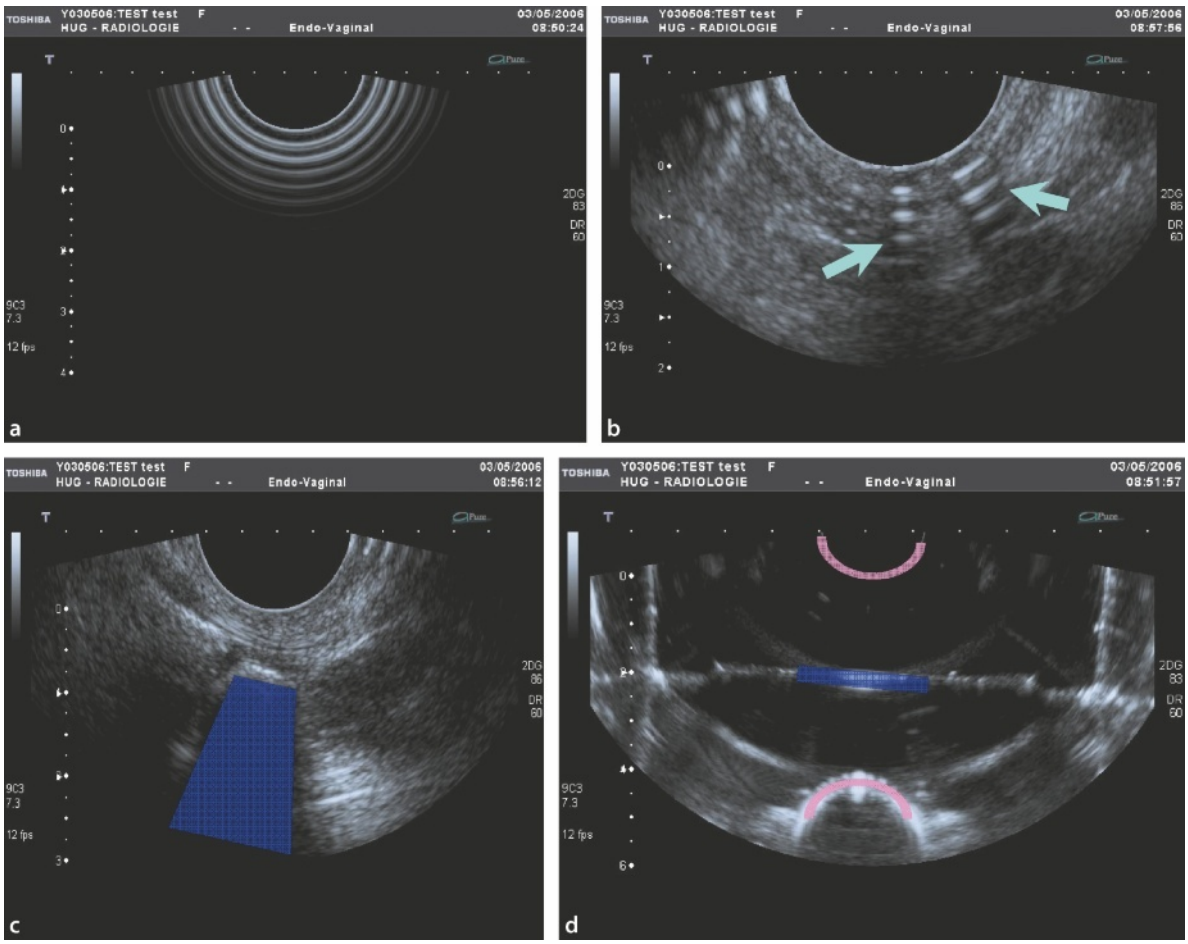


Fig. 9.3a–d Examples of ultrasound image artefact. **a** Air surrounding the probe. **b** Air or reverberation artefact. **c** Shadow. **d** Mirror artefacts

be helpful for detecting abscess cavities, fistula tracts or internal openings.

EUS has emerged as one of the newer diagnostic examinations that can complement the clinical examination and therefore provide relevant information with a direct impact on planned treatment. The new three-dimensional (3D) generation of rotating endoprobe provides new possibilities in the accuracy of diagnosis. This new technique is performed using reconstruction of a series of two-dimensional (2D) images. Reconstruction is based on a high number of parallel transaxial images. The usual setting is 0.2–0.3 mm between adjacent transaxial images. The data of a median of 175 parallel images is combined to create a 3D volume, which is displayed as a cube. This cube can be freely rotated, rendered, tilted and sliced to get the most information out of the data (Fig. 9.4).

9.3 Endorectal Ultrasonography Technique

There is no need for bowel cleansing or ingestion of contrast material prior to endorectal ultrasonography (ERUS). The patient is instructed to prepare with one or two Fleet enemas 1 h before the examination. These enemas can be administered in the examining room before the examination. There is no need for sedation, and therefore no need for specialised monitoring. The patient is placed in the gynaecologic position. A digital rectal examination serves the dual purpose of excluding significant anal stenosis and lubricating the anal canal.

We currently used the 1846 Brüel and Kjaer (Naerum, Denmark) scanner and a 7.0-MHz 8539 transducer with a focal length of 2–5 cm. A small finger cot/balloon is placed over the transducer and properly

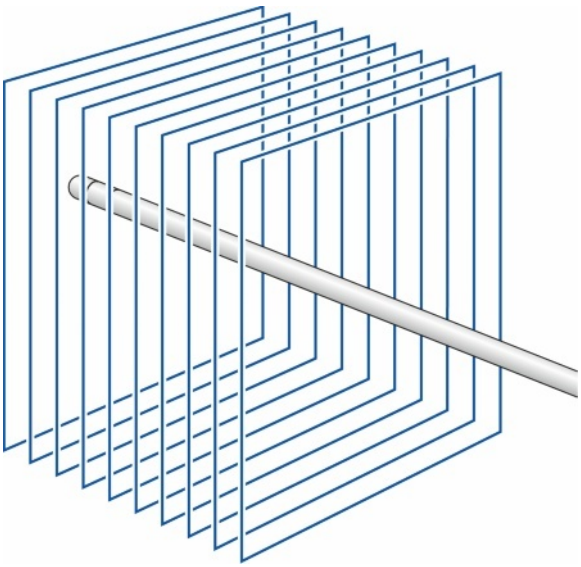


Fig. 9.4 Three-dimensional (3D) imaging technology acquisition: a 3D ultrasound image is constructed from a synthesis of a high number of parallel, transaxial two-dimensional (2D) images

secured in place. It is not necessary to use expensive degassed saline water as long as all bubbles have been evacuated from the water. Since 2006, we also use the Brüel and Kjaer medical scanner Hawk 2102 EXL with anorectal transducer type 2050, which allows 3D image reconstruction.

By convention, the ultrasound probe is held with the spigot in the upright position, and the probe is maintained in the centre of the lumen. Anatomically, the anterior view is the upper part of the image and the posterior view is represented below.

9.4 Endoanal Ultrasonography Technique

With the 1846 Brüel and Kjaer scanner and a 7.0-MHz 8539 transducer, a sonolucent, tapered plastic cap is placed over the transducer. This cap is then filled with water and all bubbles are removed. There is no need for water because of the 3D image reconstruction enabled by the Brüel and Kjaer medical scanner Hawk 2102 EXL with anorectal transducer type 2050. In both cases a condom containing ultrasound gel is placed over the probe, and this is lubricated with a water-soluble lubricant.

9.5 Image Interpretation

9.5.1 Endorectal Ultrasonography

9.5.1.1 Normal Image

Concentric circles of alternating hyperechoic and hypoechoic bands represent the normal rectal wall. The majority of investigators agree on a five-layer model of the rectal wall (Fig. 9.5), Hildebrandt and Feifel [22] believe that the three white lines represent interfaces, whereas the inner dark lines represent actual anatomic layers. In this model, the first white line is the interface between the balloon and the mucosa. The first dark line represents both the mucosa and the submucosa, which is followed by the middle white line, which investigators feel represents the interface between the submucosa and the muscularis propria. The outer dark line represents the muscularis propria followed by the interface with the perirectal fat, the outer white line (Table 9.1).

9.5.1.2 Preoperative Staging of Rectal Neoplasm with ERUS

The crucial layer is the middle white line, which, if broken, implies invasion through the muscularis mucosa into the submucosa (T1). If there is widening of the outer dark line, but no break in the outer white line, then the tumour is confined to the muscularis propria (T2), and if there is a break in the outer white line, the tumour has invaded the perirectal fat (T3; Table 9.2).

Ultrasonography allows for visualisation of the immediate perirectal tissue, and therefore a search for enlarged lymph nodes should be a routine step in the evaluation of a rectal tumour. One must be careful not to confuse blood vessels with enlarged lymph nodes.

The differentiation between inflammatory nodes versus metastatic nodes can at times be difficult. However, an enlarged lymph node located adjacent or superior to the level of the tumour, having a round appearance with irregular borders and of the same hypoechoic echogenicity as the primary tumour, should be considered a metastatic node [23].

The seminal vesicles are clearly observed and must be distinguished from lymph nodes. The prostate can be well discerned and any tumour invasion through Denonvilliers' fascia can be easily recognised (Fig. 9.6)

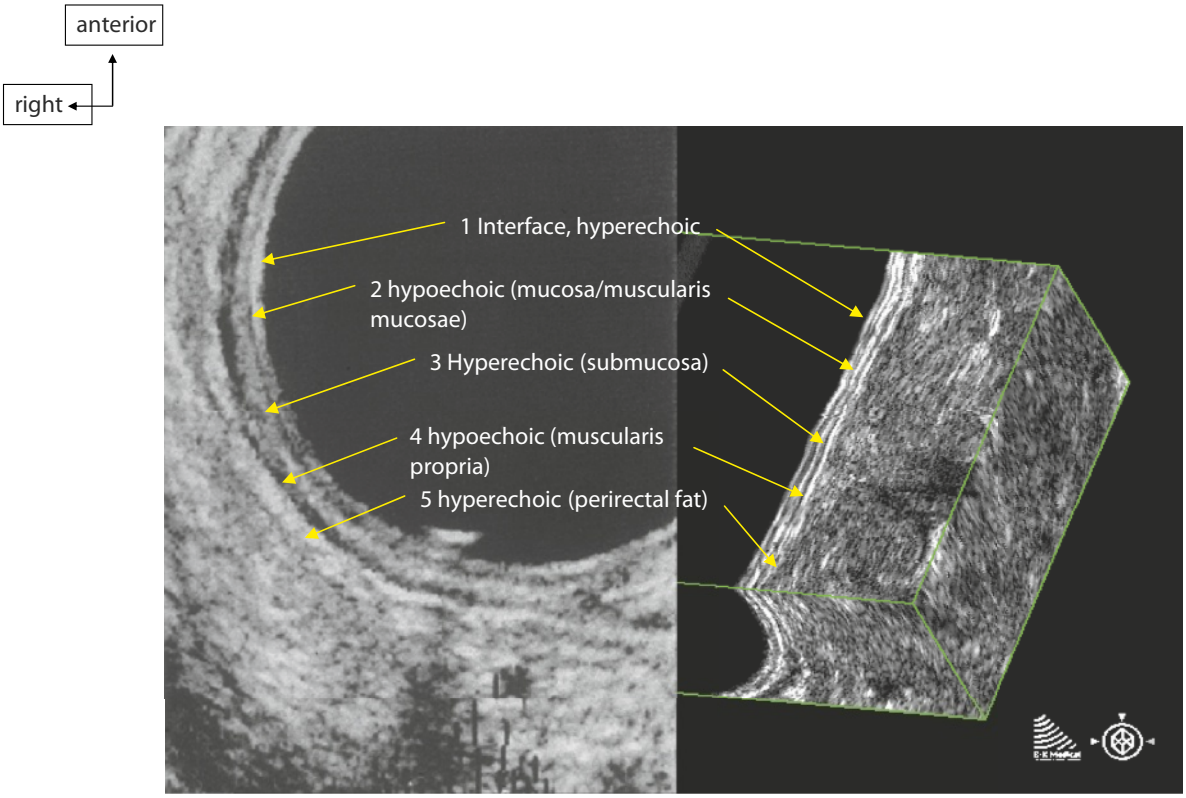


Fig. 9.5 The five-layer model of the rectal wall shown on 2D and 3D ultrasound

Table 9.1 Interpretation of the anatomic correlation of the five-layer rectal wall model

Series	Line 1 (White)	Line 2 (Dark)	Line 3 (White)	Line 4 (Dark)	Line 5 (White)
Hildebrandt and Feifel [22]	Interface (balloon/mucosa)	Mucosa/ submucosa	Interface (submucosa/ muscularis propria)	Muscularis propria	Interface (rectal wall/ perirectal fat)
Beynon et al. [4]	Interface (balloon/mucosa)	Mucosa/mus-cularis mucosa	Submucosa	Muscularis propria	Perirectal fat
Saitoh et al. [36]	Interface (balloon/mucosa)	Mucosa	Submucosa	Muscularis propria	Perirectal fat

Table 9.2 Comparison of depth of wall penetration using endorectal ultrasonography

Author	Year	Patients	Accuracy	Over-staged	Under-staged
Hildebrandt and Feifel [22]	1986	76	88%	11%	9%
Beynon et al. [4]	1987	49	90%	6%	4%
Holdsworth et al. [24]	1988	36	86%	11%	3%
Zainea et al. [46]	1989	30	90%	3%	7%
Katsura et al. [25]	1992	120	92%	4%	4%
Lindmark et al. [28]	1992	63	81%	8%	8%
Milsom and Graffner [29]	1993	67	85%	12%	3%
Herzog et al. [21]	1993	118	89%	10%	1%
Santoro et al. [37]	2001	61	89%	8%	3%

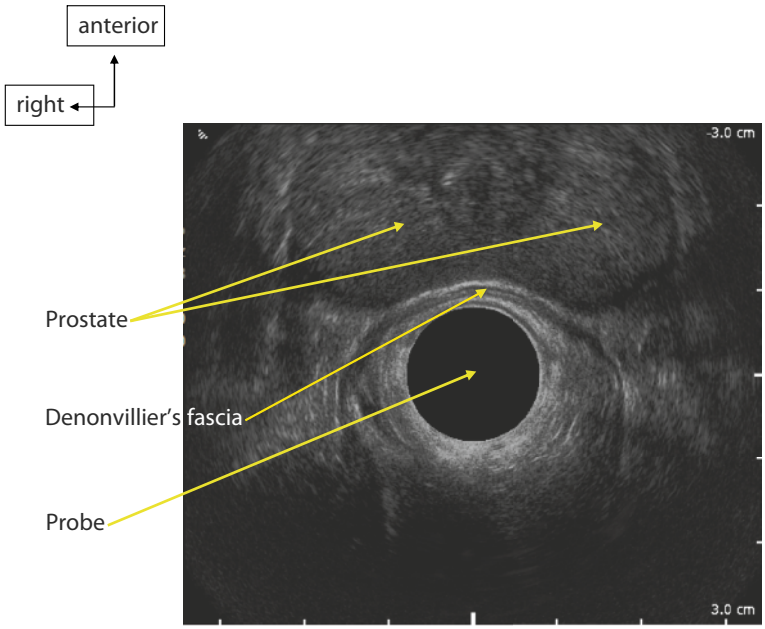


Fig. 9.6 2D ultrasound showing the relationship between the rectum and the prostate

The size of the lymph node is of little value in differentiating malignant from reactive lymphadenopathy [5]. To precisely locate metastatic lesions in lymph nodes, it is possible to perform a biopsy procedure under ultrasonographic control.

9.5.1.3 Assessment of Wall Invasion

The ultrasonic staging of rectal cancer, proposed by Hildebrandt and Feifel, corresponds to the TNM classification, as all anatomic layers of the rectum can be imaged [22].

- uT0: villous adenoma.
- uT1: tumour confined to the submucosa with an intact bright middle hyperechoic layer.
- uT2: tumour invading the muscularis propria with no disruption of the third hyperechoic layer.
- uT3: tumour penetrating through the muscularis propria to involve the perirectal fat. The tumour edge is usually irregular with disruption of the third hyperechoic layer.
- uT4: tumour invading an adjacent structure.
- uN0: absence of lymph-node metastases.
- uN1: presence of lymph-node metastases.

Benign Villous Lesion (uT0)

Using ERUS, a reliable preoperative assessment of malignant change in large villous lesions may be obtained, thus helping to plan definitive treatment. The middle white line (hyperechoic) seen on ultrasound is the key to diagnosing a benign lesion. This line corresponds to the submucosa and, if intact (Fig. 9.7), demonstrates that no invasive malignancy is present.

Lesion Confined to the Submucosa (uT1)

If the middle white line (submucosa) seen on ERUS is broken by a malignant lesion, this corresponds to submucosa invasion. The lesion is confined to the submucosa and is hence a UT1 tumour (Fig. 9.8). The reported incidence of lymph-node metastases in such a lesion varies from 6 to 11% (Fig. 9.8) [20–30].

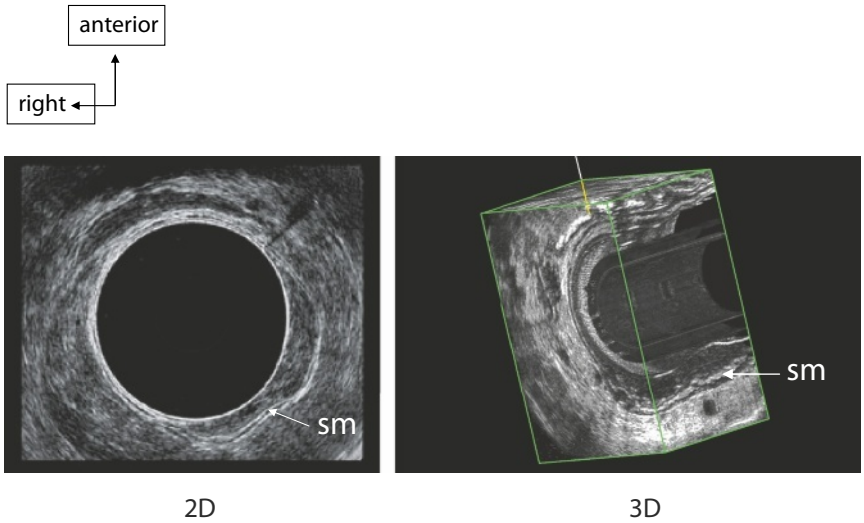


Fig. 9.7 A benign uT0 rectal tumour: a lesion that expands the inner hypoechoic line that represents the mucosa and is surrounded by a uniform middle hyperechoic submucosal layer (*sm*)

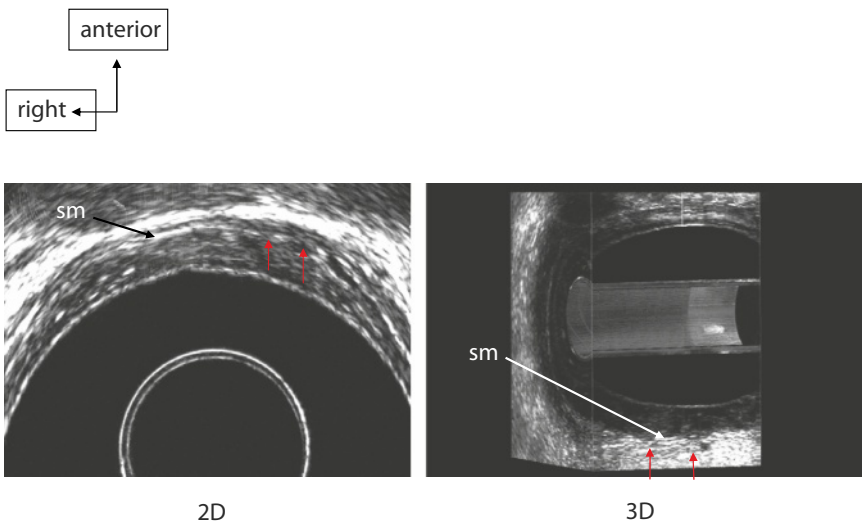


Fig. 9.8 An early rectal cancer (uT1): tumour invasion extended to the middle or lower third of the hyperechoic submucosal layer (*sm*; *red arrows*)

Lesion Involving the Muscularis Propria but Confined to the Bowel Wall (uT2)

Breach of the middle white line with expansion of the outer black line (muscularis propria) but preservation of the outer white line (perirectal fat) constitutes a T2 lesion (Fig. 9.9). The incidence of regional lymph node involvement is between 10 and 35% [34–39] when the muscularis propria is involved.

Lesion Invading the Perirectal Fat (uT3)

A UT3 lesion described on ERUS is when the outermost white line (perirectal fat) is broken, often by a hypoechoic irregular extension of tumour into the perirectal fat (Fig. 9.10).

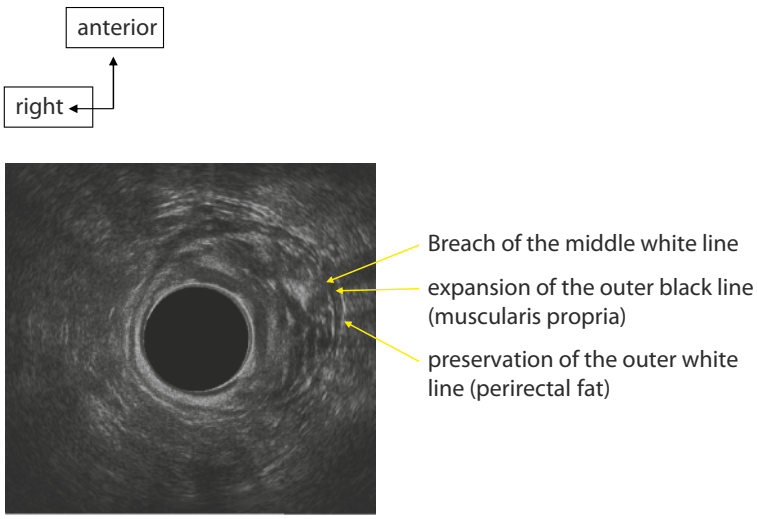


Fig. 9.9 A uT2 rectal cancer: tumour invading the muscularis propria with no disruption of the third hyperechoic layer

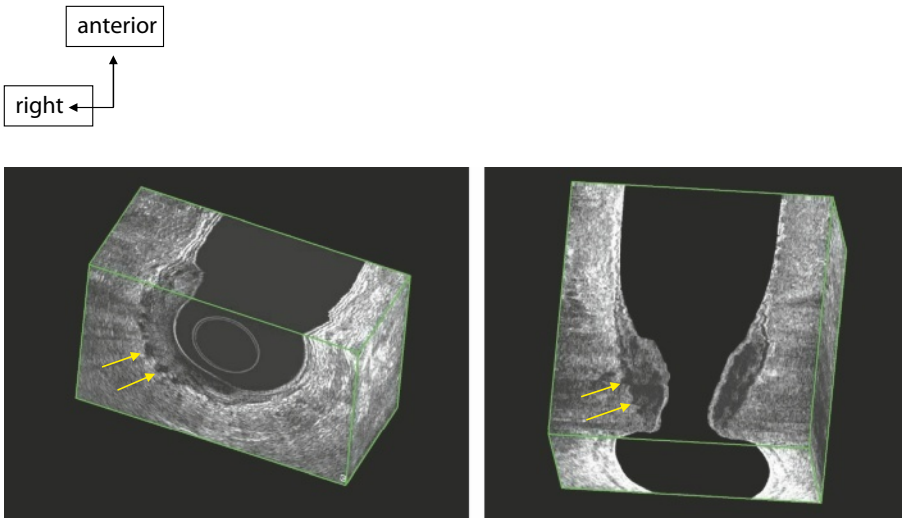


Fig. 9.10 A uT3 rectal tumour: perirectal fat invasion is diagnosed sonographically by the presence of irregularities of the outer hyperechoic layer (*arrows*)

Lesion Invading an Adjacent Organ (uT4)

Invasion of adjacent organs constitutes a T4 lesion. It is possible to visualise several structures in close proximity to the rectum by ultrasound. In women, the vagina, uterus and bladder may be visualised. In men, interruption of Denonvilliers' fascia (a white line between the rectum and the prostate gland and seminal vesicles) suggests tumour extension into these structures.

In most studies the accuracy rates of ERUS in the evaluation of rectal tumour invasion varies between 81 and 94%; overestimation occurred in 5% of the cases, and underestimation in 5%. A recent study demonstrates an overall accuracy of rectal wall invasion of 69%, with 18% of the tumours over-staged and 13% under-staged. The positive predictive value was 72%, and the negative predictive value 93% [15]. The interpretation of ultrasound data is highly operator-dependent, which may explain the differential results. Other causes of error can be summarised as follows:

1. Tumour dependent: difficulty differentiating between adenoma and a very early cancer
2. Involving the mucosa:
   a. Over-staging of tumours attributable to presence of inflammatory cell aggregation, and hypervascularity mimicking tumour invasion on ERUS
   b. Position of the tumour close to the anal canal
   c. Stenosing tumours
3. Device dependent:
   a. Limited focal length of the transducer
   b. Angulations between the probe and the tumour axis; only structures seen at 90° angles can be assessed correctly
   c. Shadowing or mirror image
   d. Over-pressure of the balloon

Many studies demonstrate a superior accuracy and reliability of ERUS compared with CT scan. ERUS is minimally invasive and less expensive than CT [16–33].

MRI and ERUS demonstrate equivalent efficacy in the preoperative staging of rectal tumours. Overall accuracy rates of 70–90% have been reported. One advantage of MRI is the ability to visualise the normal and pathological anatomy in multiple scan planes; however, taking into account the scan planes, 3D ERUS offers the same advantages as MRI. This technique can determine precisely the location and the local extent of the lesion (Fig. 9.11). In a prospective comparative study concerning the accuracy of 3D and conventional (2D) ERUS, Kim et al. [26] demonstrate no advantage of 3D ERUS. Lymph-node metastasis was accurately predicted by 3D ERUS in 84.8% of patients, whereas 2D (conventional) ERUS predicted the disorder in 66.7%. The difference was not statistically significant.

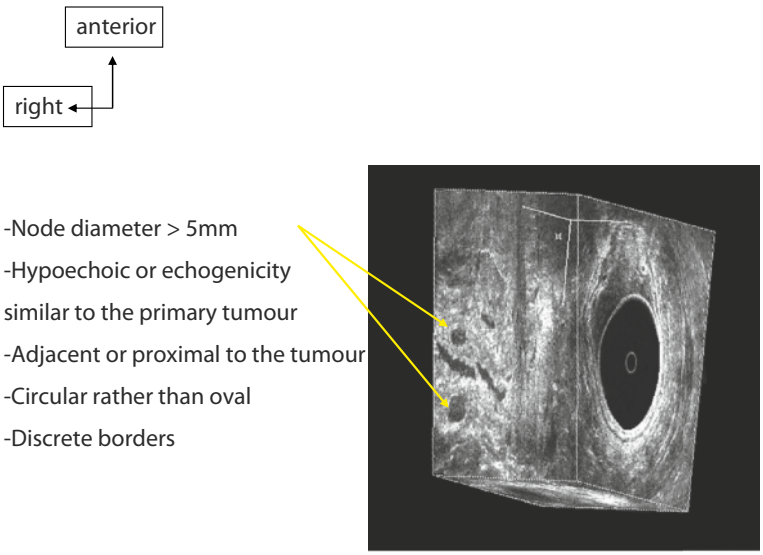


Fig. 9.11 An example of lymph-node metastases shown by 3D ultrasound

9.5.1.4 Lymph Nodes

The currently published data support the notion that ERUS is superior to other modalities in assessing perirectal lymph-node involvement. Assessment of lymph nodes requires from the operator much greater experience than the assessment of tumour-wall infiltration. The accuracy of ERUS in assessing lymph-node invasion varies from 58 to 86% (Table 9.3).

Undetectable or benign-appearing lymph nodes are classified as uN0. Malignant-appearing lymph nodes are classified as uN1 (Fig. 9.11). The criteria used to identify metastatic lymph nodes are:

1. Node diameter > 5 mm
2. Hypoechoic or echogenicity similar to the primary tumour
3. Adjacent or proximal to the tumour
4. Circular rather than oval
5. Discrete borders

9.5.1.5 Conclusion

ERUS enables us to distinguish between invasion of a neoplasm confined to the mucosa and those that invade the submucosa. Of the invasive tumours, those confined to the submucosa (T1) are ideally suited to local excision, whereas some lesions that involve the muscularis propria but do not penetrate this layer (T2) may also be suitable for local therapy. The technique is reliable in experienced hands and may change the management of patients with early cancer more than in patients with advanced cancer [38]. It is a better predictor of wall invasion and pararectal lymph-node involvement compared with CT scanning [46]. However, further studies are required to assess the accuracy of ultrasound in comparison with MRI. Thus, in 2007, ERUS remains the method of choice for the preoperative assessment of patients with rectal neoplasm.

9.5.2 Endoanal Ultrasonography

The imaging of pelvic floor structures is of great interest; in the last two decades, there have been many studies dedicated to the better understanding of pelvic floor anatomy in relation to physiology and pathophysiology. EUS and MRI have become an important part of the diagnostic workup in pelvic floor dysfunction [40, 41].

The advantages of EUS are that it is inexpensive, widely available and similar to other ultrasound methods. EUS is operator-dependent and it has been observed in the literature that even repeated measurements of the same anal structures did not provide homogeneous morphometric results [3–12]. We are persuaded that the most relevant factor regarding the accuracy of EUS findings is the operator's experience.

9.5.2.1 Normal Image

Tjandra et al. [44] have performed elegant post-mortem and clinical studies and have identified the anatomic layers that correspond to the anal ultrasound images. Bartram and his group confirm these studies [1]. The mucosa–submucosa complex typically appears as a hyperechoic band adjacent to the transducer and the cap.

The internal anal sphincter (IAS) is observed as a hypoechoic circle and has an average thickness of 2–4 mm, which seems to increase with advancing age [7]. There is no correlation between the sonographically determined anal sphincter thickness and the mean maximum resting pressure [14].

The external anal sphincter (EAS) is a striated muscle that appears sonographically as a mixed echogenic band outside the hypoechoic IAS. The outside borders of the EAS with the perirectal fat are not clearly defined [42].

It is easy to divide the anal canal into upper, middle and lower thirds based on anatomic landmarks. At the

Table 9.3 Comparison of lymph-node staging. *PPV* Positive predictive value, *NPV* negative predictive value

Author	Year	N	Accuracy	Sensitivity	Specificity	PPV	NPV
Holdsworth et al. [24]	1988	36	61%	59%	64%	50%	70%
Beynon et al. [5]	1989	95	83%	88%	79%	78%	89%
Milsom and Gaffner [29]	1993	61	77%	64%	87%	74%	81%
Herzog et al. [21]	1993	111	80%	89%	73%	71%	90%
Solomon et al. [38]	1993	517	58%	79%	80%	74%	84%
Santoro et al. [37]	2001	61	74%	70%	79%	72%	84%

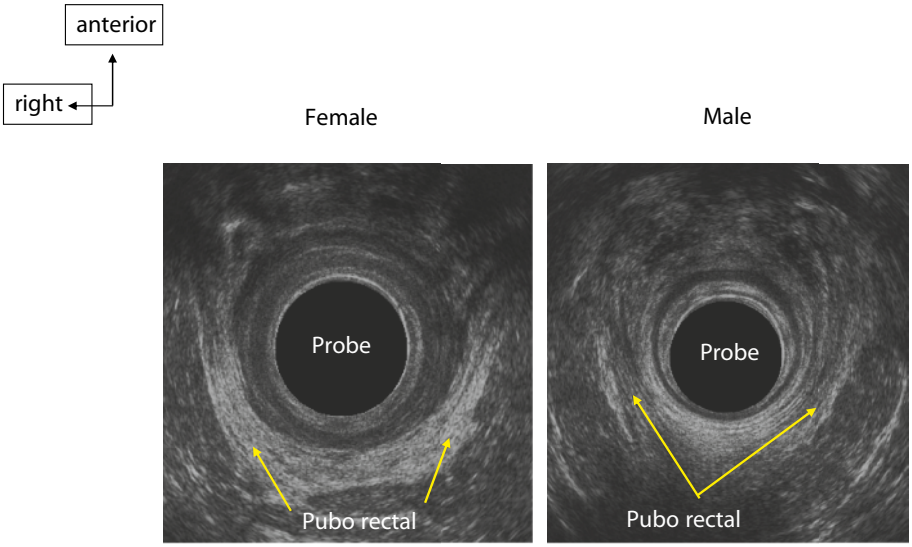


Fig. 9.12 Endoanal ultrasound at the level of the upper anal canal. The puborectal muscle sling curves posteriorly around the rectum. The relative lack of muscle fibres anteriorly is normal in female anatomy

level of the upper anal canal, the puborectal muscle sling is observed as a mixed echogenic U-shaped band, which encircles the rectum posterior (Fig. 9.12). Because of the sling anatomy of the puborectal muscle, there is a hypoechoic gap anteriorly, which can be easily confused with an anterior sphincteric defect. By filling a latex balloon with water or introducing the finger into the vagina it is possible to avoid this artefact and measure the thickness of the anterior wall.

In the middle canal, the hypoechoic IAS becomes more prominent, and the anterior quadrant is replaced with the circumferential mixed echogenic fibres of the EAS. The middle canal is where the IAS is at its maximum width (Fig. 9.13a,b). The majority of sphincter defects are discovered at this level. At the lower anal canal level, the majority of the musculature shows mixed echogenicity from the subcutaneous portion of the EAS (Fig. 9.14). The 3D endosonographic reconstruction demonstrates that the anterior anal sphincter is in general shorter in the female than in the male (Fig. 9.15).

9.5.2.2 Obstetrical Lesion

With regard to obstetrics, ultrasonography usually shows an anterior lesion between 10 and 2 o'clock, when the patient is in the gynaecologic position. The EAS is always involved, and the IAS can be damaged or exhibit scar tissue (Fig. 9.16).

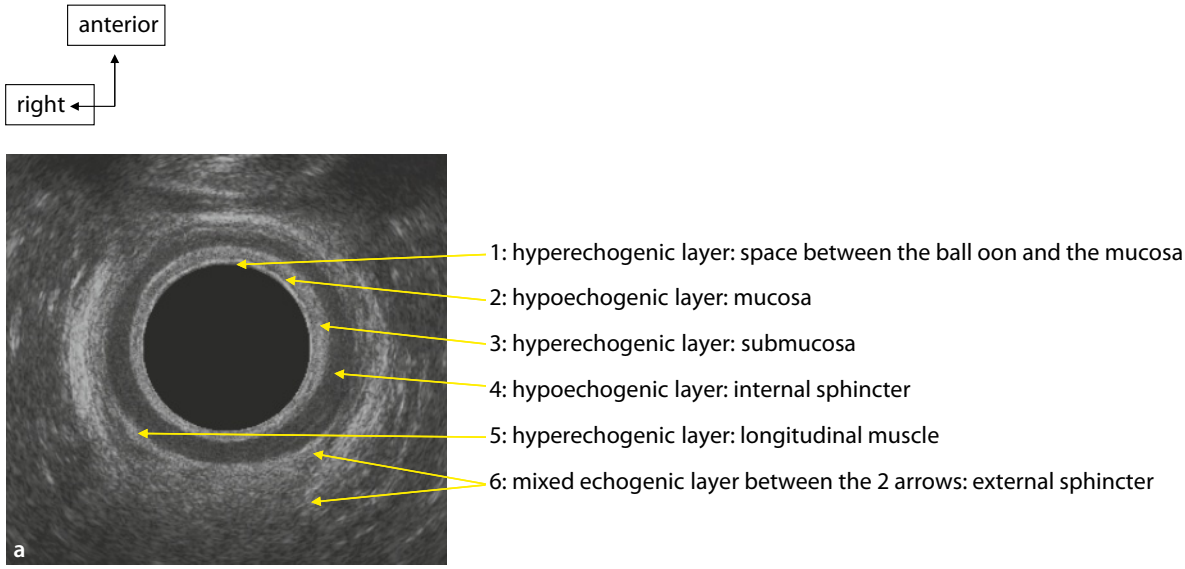
A dynamic examination confirms the site of the lesions and shows very precisely the gap between the muscles. Patients with incontinence undergo a surgical repair (see Chap. 26). In our experience we compared the clinical findings during the operation to the preoperative endoanal ultrasonography (EAUS) and found a 100% confirmation of our suspected diagnosis [34]. After sphincteroplasty, ultrasound may be useful to show the size of the overlap and confirm that the surgical therapy has been successful.

9.5.2.3 Post-Traumatic Incontinence

In these cases the lesions are usually plurifocal and often involve both the IAS and the EAS in their total length. The lesions are well delimited.

9.5.2.4 Post-Surgical Incontinence

Both, the IAS and EAS can be involved in this type of damage. The lesions are unifocal or multifocal and usually very well delimited. In the case of anal distension,



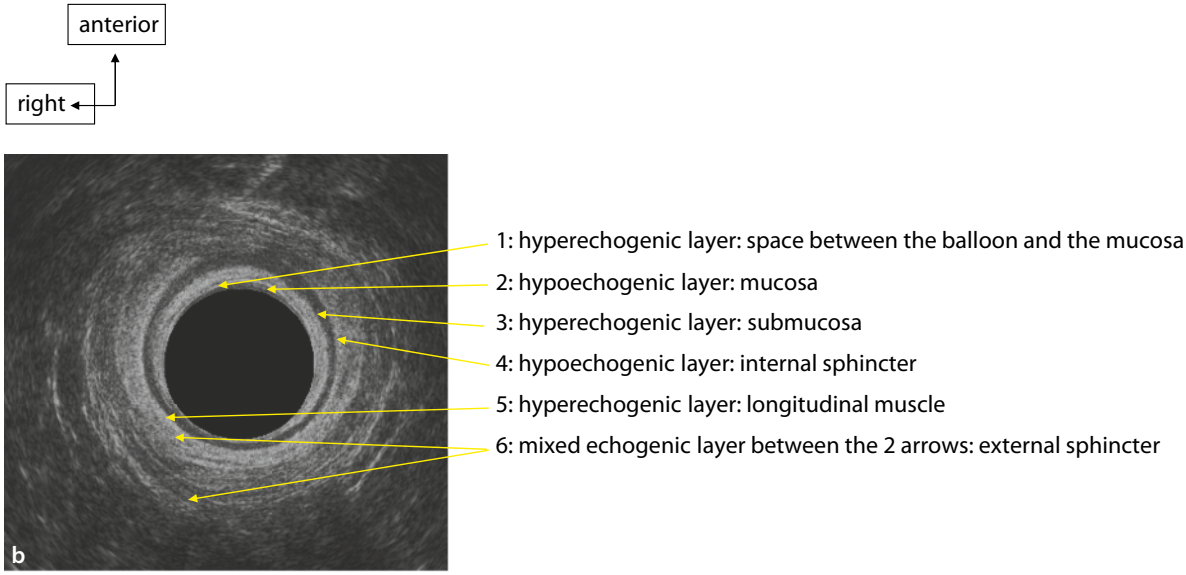


Fig. 9.13 **a** Normal endoanal ultrasonography of the medial part of anal canal in a female. **b** Normal endoanal ultrasonography of the medial part of anal canal in a male

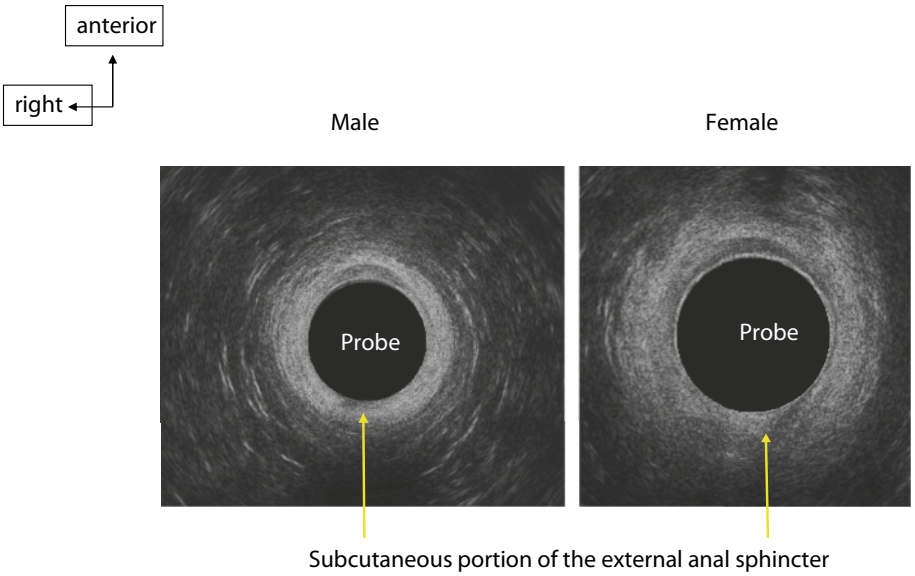


Fig. 9.14 Images of the lower anal canal in a male and a female

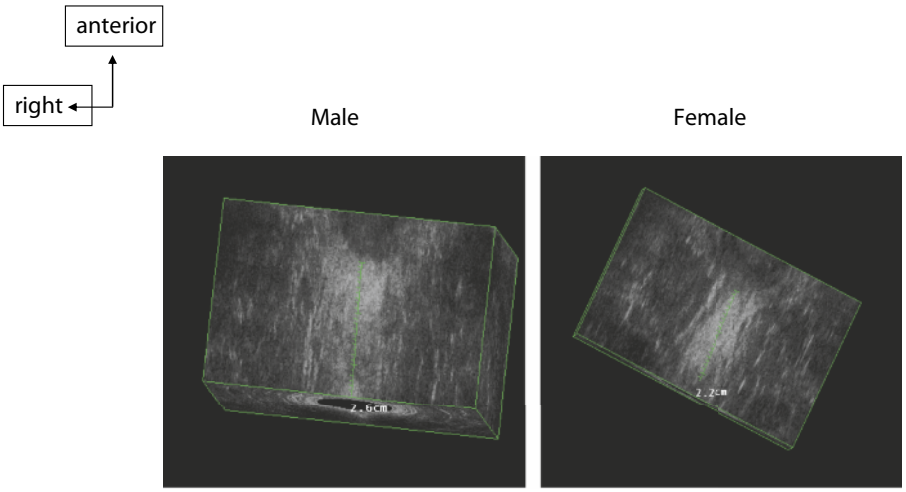


Fig. 9.15 This 3D endosonographic reconstruction demonstrates on a superior view that in general, the anterior anal sphincter is shorter in the female than the male

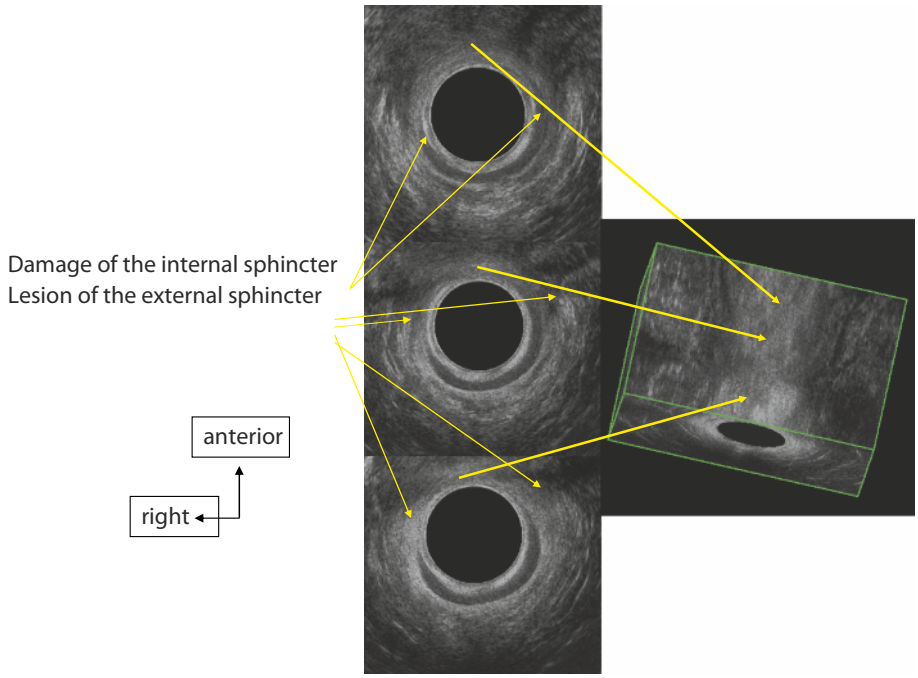


Fig. 9.16 2D and 3D images showing obstetric injuries to the internal and external sphincters

the IAS can appear fragmented (Fig. 9.17). Post-surgical damage of the IAS and EAS can easily be evaluated by EAUS (Fig. 9.18).

The accuracy of EAUS in the evaluation of incontinence has been compared with surgical findings. As a tool to assess anal defects, many authors report the sensitivity of EAUS to be between 90 and 100% [12–16, 18]. Diagnostic confidence in detecting damage to the sphincter complex in the longitudinal extent may be improved by 3D EAUS (Fig. 9.19) [9–18].

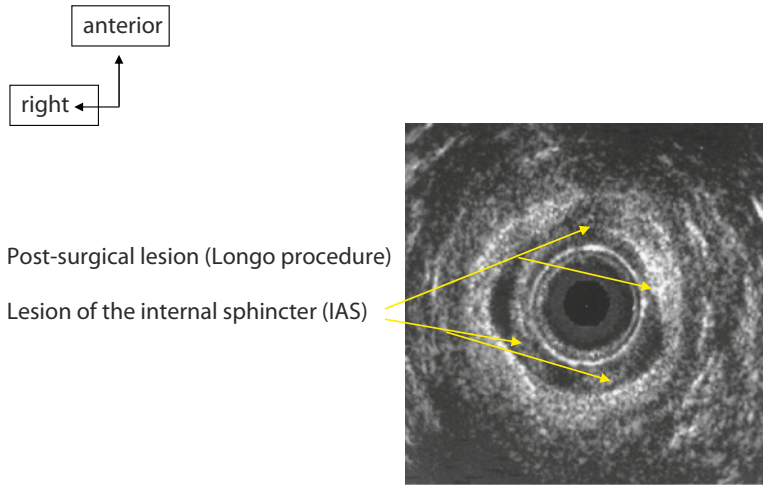


Fig. 9.17 An example of the ultrasound appearance of an internal anal sphincter (*IAS*) injury following anal surgery

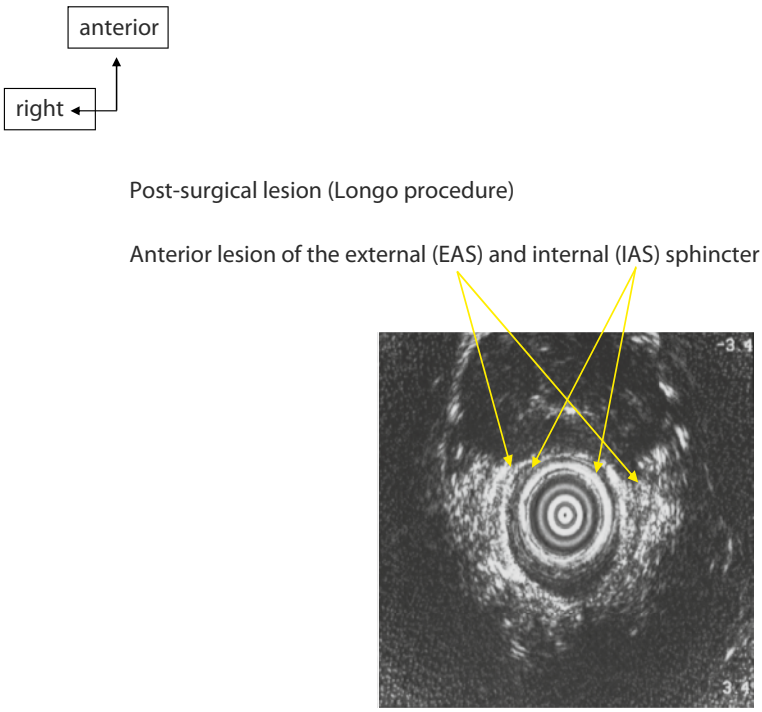


Fig. 9.18 Image showing injury to both the IAS and external anal sphincter (EAS) following anal surgery

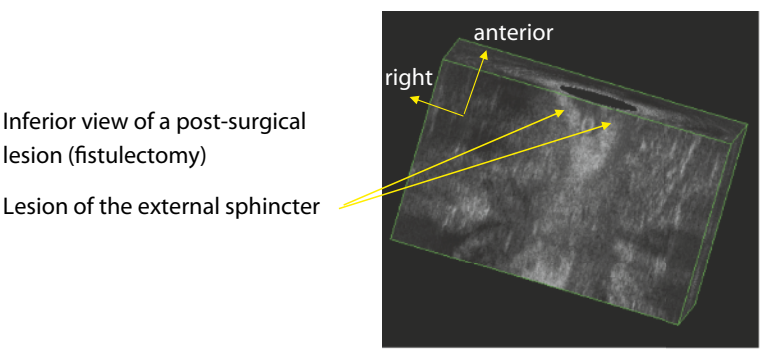


Fig. 9.19 3D image showing longitudinal damage after fistula surgery

9.5.3 Anal Ultrasonography in the Diagnosis and Management of Anorectal Abscess and Fistula

Most anal abscesses and anal fistulas have a similar cryptoglandular origin. Infection is thought to originate in the anal glands that lie in the intersphincteric space between the IAS and the EAS of the anal canal [31, 32]. Most cases of anorectal sepsis are easily cured by drainage of pus and laying open the superficial fistulas. In a few patients the diagnosis of anorectal sepsis is difficult because collections of pus are deep-seated and not obvious on clinical examination.

9.5.3.1 Methodology

EAUS should be no more painful than digital examination of the anus. Scanning is performed at different levels by gently moving the probe in and out of the anal canal. A general examination of the anal canal is performed, looking for any obvious gaps in the sphincter muscles. Defects in the sphincter muscles may result from damage caused by sepsis, or follow surgical division of the sphincter and division of the sphincter by a cutting seton. Tracts and collections of pus are identified. These may lie outside the anal sphincters (Fig. 9.20), pass through the external sphincter as a su-

pra or trans-sphincteric tract (Fig. 9.21) or lie in the intersphincteric space (Fig. 9.22).

It can be difficult to differentiate between a tract and a small collection at one level; both tend to be hypoechoic, but tracts often have hyperechoic shadows in the middle, which represent gas within the tract.

Injecting dilute hydrogen peroxide into the external opening accentuates the interface between the fistula tract and the surrounding tissues, resulting in a hyperechoic image on ultrasound scanning [6]. The technique is particularly suited to recurrent fistulas.

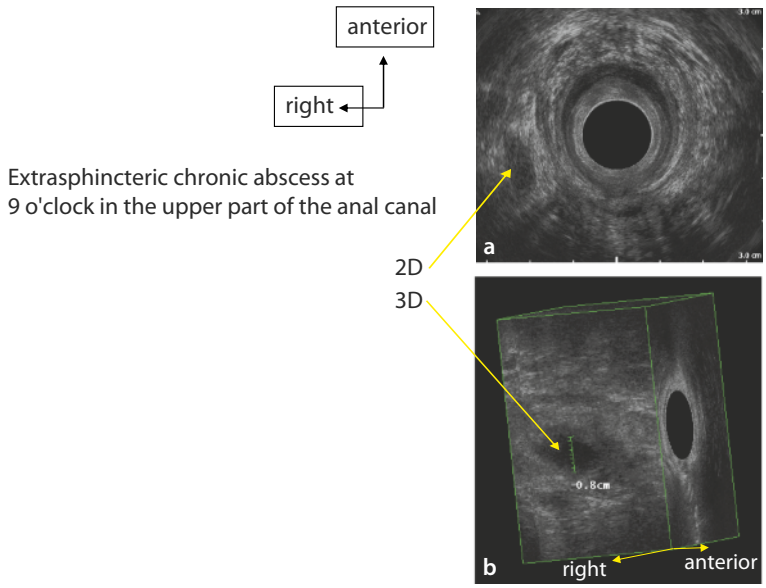


Fig. 9.20a,b 2D (**a**) and 3D (**b**) images of an extrasphincteric abscess in the upper anal canal

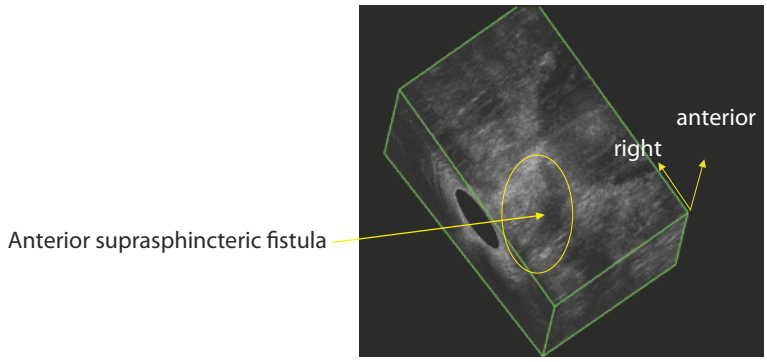


Fig. 9.21 3D image of a suprasphincteric fistula tract

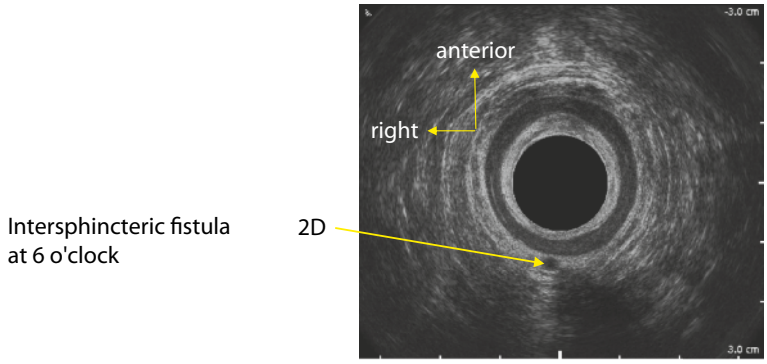


Fig. 9.22 2D image demonstrating an intersphincteric fistula

9.5.3.2 Results

EAUS using a rotating probe [43] or a linear sector probe [45] has been used for patients with Crohn's disease, abscesses and fistulas. Using this technique, these lesions can be identified around the anal canal and lower rectum when they are not clinically detectable.

Several studies have been performed to examine the usefulness of EAUS in cryptoglandular and anal sepsis [10–27]. Deen et al. [10] reported a consecutive series of 21 patients from Birmingham with complex anal fistulas. The ultrasound findings were compared with findings at surgery (Table 9.4). All fistula tracts and fluid collections were identified correctly. The internal opening was difficult to identify with confidence in most patients. A group from St Mark's Hospital reported similar results for the use of EAUS in assessing anal fistulas (Table 9.4) [27].

New criteria for identifying an internal opening include a hypoechoic breach of the subepithelial layer, a defect of the IAS and a hypoechoic lesion in the intersphincteric space. Using these criteria, the rate of accurately identifying the site of an internal opening now is more than 80%.

EAUS scanning is useful for excluding an anal origin for sepsis in the perianal region developing from hydradenitis suppurativa or a pilonidal sinus.

9.5.3.3 Conclusion

Accurate preoperative assessment of an anal fistula is fundamental for successful surgical treatment. EAUS provides much useful relevant information to the surgeon.

9.5.4 Ultrasonographic Classification of Anal Epidermoid Carcinoma

The majority of epidermoid carcinomas of the anus are treated with combined chemo-/radiation therapy. Ultrasound permits the staging and observation of these patients before, during and after the treatment.

To avoid confusion, one must understand that the TNM staging system for anal canal lesions differs from the ultrasonic staging system. The criteria, which are outlined in the following, compare the differences between the ultrasound (UT) and the clinical (T) classification staging system [2].

Stage	Ultrasound stage	Clinical stage
T1	Tumour confined to submucosa	Tumour 2 cm or less in greatest dimension
T2	Tumour invades muscle	Tumour larger than 2 cm but not more than 5 cm
T3	Tumour involves perirectal fat	Tumour larger than 5 cm in greatest dimension
T4	Tumour invades adjacent organ	Tumour invades adjacent organ

Table 9.4 Ultrasound (*US*) versus surgical assessment of anal fistulas. This table shows the results of two separate investigations into the accuracy of endoanal ultrasound scanning in assessing anal fistulas. The ultrasound findings were compared with the findings at operation

Series	Component	Surgery	US Right	US Wrong	Accuracy
Birmingham Series [10]	Internal opening	20	2	0	10%
	Horseshoe tract	11	10	1*	91%
	Fluid Collection	8	8	0	100%
	Fistula tracts	37	37	0	100%
St Mark's Series [27]	Internal opening	12	8	0	66%
	Horseshoe tract	5	5	0	100%
	Fluid Collection	16	12	3	75%
	Fistula tracts	12	11	0	92%

* A superficial horseshoe tract at the anal verge was missed by ultrasound

9.5.5 External Perineal Sonography

9.5.5.1 Technique

Sonography is performed with the patient in the dorsal gynaecologic position. Transverse images are obtained by placing the probe on the perineum, between the anus and the introitus. The probe is progressively inclined until the concentric muscular layers of the anal sphincter are visible. The entire anal canal can be scanned by changing the application pressure and the probe inclination. With the sphincter visible, the scanning plane is rotated through 90 to obtain a longitudinal section, which permits visualisation of the entire anal canal and the puborectal sling behind the rectum at the anorectal junction [35].

To determine movement of the puborectal sling, the first calliper is fixed on the anterior border of the puborectalis, with the patient in the resting position. Holding the probe in a constant position, the patient is then asked to either strain or squeeze. The image is then frozen and the second calliper placed on the anterior border of the puborectalis in its new position. The distance between the two callipers can then be measured.

9.5.5.2 Image

Transverse and longitudinal images of the puborectal sphincter, IAS and EAS are recorded with a 5-MHz linear probe and printed. In the longitudinal plane, the IAS is seen as the prolongation of the muscular layer of the rectal wall. The EAS is visible in both the transverse and longitudinal planes as an echogenic ring. Immediately exterior to the IAS, images of the transverse plane of the EAS at the three levels can be systematically investigated by endosonography (Fig. 9.23a–c). Mean EAS thickness is 4.7 mm (range 3.5–6.1 mm). In the upper part of the anal canal (Fig. 9.23a), the EAS is absent anteriorly, and posteriorly is in close contact, but not separate from the puborectal muscle sling, which runs posteriorly around the rectum at the anorectal junction. At the intermediate level (Fig. 9.23b), the EAS appears as a homogenous echogenic circular ring, the outer limits of which are not clearly defined. At the lower part of the anal canal, subcutaneously, only the EAS is visible and appears as an oval echogenic structure (Fig. 9.23c).

The puborectalis is identified in the transverse plane, and is seen in the upper anal canal as a u-shaped sling running posteriorly to the rectum at the anorectal junction (Fig. 9.23a). On longitudinal images, the muscular sling behind the rectum is easily visible at the anorectal junction as an echogenic, poorly demarcated area (Fig. 9.24). However, the movements of the sling in relation to the anal canal and distal rectum can be followed very precisely during squeezing and straining (Fig. 9.24a–c).

9.5.5.3 Results

In one study [13] we compared the displacement of the puborectalis sling in a group of normal volunteers and patients with pelvic floor disorder. During squeezing, the sling moves anteriorly by a mean (SEM) of

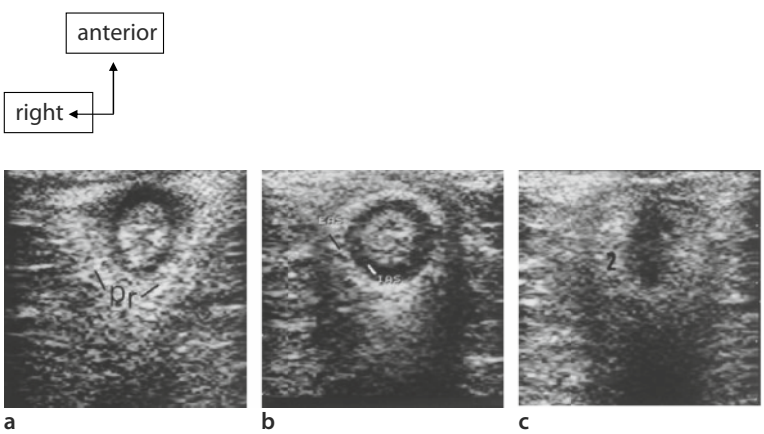


Fig. 9.23a–c Perineal sonograms of the anal sphincter. Transverse images (up is anterior). **a** Sonogram at the upper anal canal. **b** Sonogram at the intermediate anal canal. **c** Sonogram of the lower anal canal. The IAS forms a hypoechogenic ring, which can be seen in **b**. The mucosa and submucosa are indistinguishable from one another and are seen immediately internal to the IAS. The EAS is seen as a circular echogenic layer at the intermediate level (**b**) and as an ovoid echogenic layer at the lower level (**c**). The puborectal muscle (*PR*) is seen at the anorectal junction (**a**) as a V-shaped sling

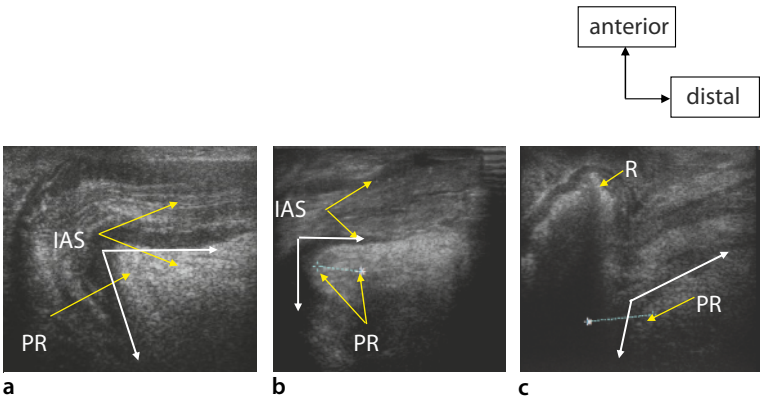


Fig. 9.24a–c Perineal anal sphincter sonograms. Longitudinal images. **a** Contraction of the PR and narrowing of the anorectal angle (*ARA*; *white arrows*) during squeezing. **b** Resting position with 90° ARA (*white arrows*). **c** Relaxation of the PR with posterior displacement during straining opening of the ARA (*white arrows*). *R* Rectocele

15.5 ± 2.2 mm; all normal volunteers had an anterior displacement of more than 7 mm. In the patients, anterior displacement was 7.4 ± 2.0 mm, significantly less than the normal volunteers ($p = 0.001$).

On straining, the mean (SEM) posterior displacement in normal volunteers is 16.5 ± 1.4 mm. Displacement is greater than 6 mm in all subjects. In the patients, mean displacement was 2.1 ± 1.6 mm. The difference between the volunteers and patients is significant ($p < 0.001$).

In a prospective study of 109 consecutive women with post-obstetrical anal incontinence, operated at a Swiss teaching hospital between 1999 and 2004 by overlapping anal sphincter reconstruction, we measured the preoperative, anterior shortening of the puborectal sling during voluntary contraction by perineal ultrasound. The post-operative outcome was assessed at 3 months using the Miller anal incontinence score.

The average (SD) Miller score was 13.3 (4.2) before surgery, and 2.6 (4.3) 3 months after surgical repair ($p < 0.001$). At follow-up, 60 (55.0%) patients were asymptomatic and 89 (81.7%) had a Miller score of ≤ 3 (asymptomatic or flatus incontinence). The proportion of patients with scores of ≤ 3 was 16.7% when the preoperative anterior shortening of the puborectal sling was ≤ 4 mm, 48.1% when it was 4.1–8 mm, and 98.7% when it was > 8 mm ($p < 0.001$). Using ≤ 8 mm to define an abnormal shortening, the sensitivity of the test was 0.95 (95% confidence interval 0.75–1.00), and the specificity 0.84 (95% confidence interval 0.75–0.91; Fig. 9.25). An anterior shortening of the puborectal sling exceeding 8 mm discriminates between patients with good and unsatisfactory functional outcome after surgical repair for post-obstetrical anal incontinence.

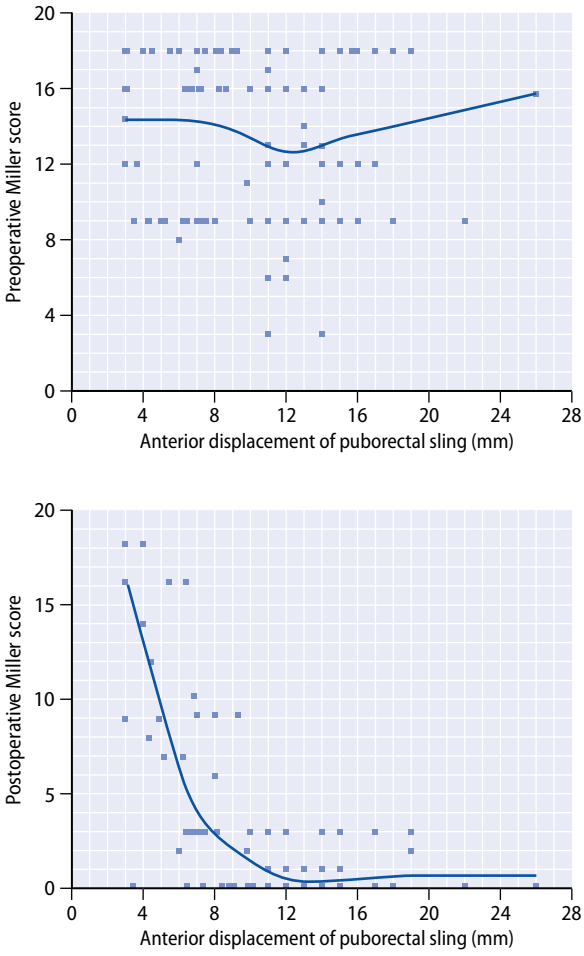


Fig. 9.25 Associations between the anterior shortening of the puborectal sling and the preoperative Miller score (*upper panel*) and the postoperative Miller score (*lower panel*), in 109 women who underwent surgical repair for anal incontinence. Non-parametric regression lines are superimposed

9.5.5.4 Conclusion

Perineal sonography is a technique that is easy to perform with standard ultrasound probes. It allows a dynamic evaluation of anterior and posterior movements of the puborectal muscle. The availability and excellent tolerance of method suggest a potential application as a screening test for defaecation disorder, and as a good predictor for functional outcome after surgical sphincter repair for post-obstetrical incontinence.

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Self-Assessment Quiz

Question 1

Endorectal ultrasonography is performed:

a. Under general anaesthesia
b. With antibiotic prophylaxy
c. In an operating room because of sterility
d. Only by a radiologist
e. With a rotating endoprobe

Question 2

For anorectal examination, a rotating endoprobe with a frequency range from 6–16 MHz, giving a full 360° transverse view, is usually used. In rectal wall staging, the most important layer is:

a. The first hyperechoic white line
b. The second hypoechoic line
c. The third middle hyperechoic white line
d. The fourth hypoechoic line
e. The fifth hyperechoic white line

Question 3

Three-dimensional endosonographic reconstruction (3DUS) demonstrates that the anterior anal sphincter is in general:

a. Shorter in the female than the male
b. Shorter in the male than the female
c. Similar in the male and female
d. Composed only of external sphincter fibres in the male
e. Composed only of external sphincter fibres in the female

Question 4

In obstetrical lesions, ultrasonography shows:

a. A posterior lesion
b. That the internal sphincter is always involved
c. That the external sphincter is always involved
d. That both the internal and external sphincters are always involved
e. Damage to the pudendal nerve

Question 5

Perineal ultrasonography has the following advantage:

a. Better visualisation of the internal sphincter
b. Better visualisation of the external sphincter
c. Better visualisation of sphincter damage
d. Dynamic evaluation of the puborectalis muscle
e. Measurement of endoanal tone

1. Answer: e
   Endorectal ultrasonography is a minimally invasive procedure that might be easily performed by a non-radiologist.
2. Answer: c
   The crucial layer is the middle white line, which, if broken, implies invasion through the muscularis mucosa into the submucosa.
3. Answer: a
   The 3DUS procedure demonstrates that the anterior anal sphincter is in general shorter in the female than the male, above all in multiparous women.
4. Answer: c
   Obstetrical lesions arise as a result of stretching of the anterior part of the sphincter due to the pressure of the baby during delivery on the external anal sphincter.
5. Answer: d
   Perineal ultrasonography is an easy technique to perform with standard ultrasound probes. It allows dynamic evaluation of the anterior and posterior movements of the puborectalis muscle. The availability and excellent tolerance of this method suggest a potential application as a screening test for defaecation disorder, and as a good predictor for functional outcome after surgical sphincter repair for post-obstetrical incontinence.

10 Anorectal Manometry

Graeme S. Duthie and Angela B. Gardiner

CONTENTS

10.1 Introduction

Anorectal pressure assessment with the aid of manometry has become important in the diagnosis and management of defaecatory disorders. Although it is quite widely used, there are several different manometry catheters and manometry systems in use, and there are really no industry standards. While manometry techniques are almost universal, the variety of systems and catheters in use means that each laboratory has to develop its own normal values, rendering interlaboratory comparison very difficult.

Manometry can be used to assess resting anal pressures, squeeze pressures, the length of the high-pressure zone, the presence or absence of an anorectal reflex, and rectal pressures and anal pressures as a response to rectal filling.

10.2 Manometry Techniques

Microballoon catheters, sleeve catheters, water-perfused catheters and microtransducer catheters have all been used [1]. The microballoon catheters are now not favoured. Sleeve catheters can be used, but produce a single pressure assessment over the whole length of the anal canal rather than producing the standard results generated by a station pull-through technique.

Water-perfused catheters are currently used in many centres, and have multiple ports on a single catheter, each port being perfused with water at a constant rate. This rate is sufficient to keep the port open and therefore the pressure recorded is actually resistance to the flow of fluid out of the port. Multiport catheters do tend to have a much larger bore than microtransducer catheters, which are probably the preferred method of assessment. The other potential problem with using perfused catheter systems is that the egress of water out of the ports may result in either rectal filling and potential activation of the rectoanal reflex, or leakage of fluid into the anal canal, resulting in anal sphincter contraction and falsely high recordings. These systems are, however, simple to use and relatively cheap, and as most manometry systems now use computerised multiport analysis, these catheters are the tool of choice when producing 3D pressure images of the anal canal. 3D pressure in the anal canal, or vector manometry, is a technique designed to show the radial pressures at eight points around the canal to produce a pressure diagram that is said to indicate any areas where the pressure is low, implying an underlying sphincter defect [2]. This technique has now been largely superceded by endoanal ultrasound.

Microtransducer pressure sensors avoid the pitfalls associated with the fluid leak and the bore of water-perfused systems. They are, however, unidirectional, expensive and damage quite easily. They are much easier to sterilize for reuse than multiport catheters, and sterilising and disinfection are becoming more important in health and safety. The unidirectional nature of these pressure transducers can be converted into an omnidirectional system by covering the transducer with an air-filled microballoon. This does, however, raise questions about sterilisation and disinfection, and negates the advantage of the small diameter of the microtransducer probe. Microtransducer probes are the only ones suitable for ambulatory manometric techniques.

10.3 Anal Canal Manometry

Manometry is used to determine the resting pressures and the squeeze pressures throughout the anal canal. The standard technique [3] is one of station pull-through, where the manometry recording device is pulled through the anal canal in 5-mm increments, recording the pressure at each position. After each pull-out, 30 s are allowed for normalisation of the pressure to avoid any false high or low readings due to stimulation of the anal canal. In general, the maximum of those readings is reported as the maximum resting pressure. After completion of the standard resting-pressure pull-through, the catheter can be reinserted and pulled back through in a similar manner, but asking patients to contract maximally their anal sphincter at each station. The maximum result is usually more distal in the anal canal and is reported as maximum squeeze or maximum contraction pressure. Many investigators now also report the increment between the resting and squeeze pressures as a reflection of the function of external sphincter contraction.

Physiological measurement in the human body is dynamic and the reproducibility of the recording technique is therefore important to establish. Rogers et al. [4] investigated the reproducibility of anorectal manometry by having patients investigated on two separate days and by two separate investigators. The mean difference between studies was 10 cmH_2O for resting pressure and 9 cmH_2O for squeeze pressure. Further investigations [5, 6] have revealed a closer correlation.

10.4 Use of Anal Manometry

Anal pressures provide information about internal and external anal sphincter function, and the technique of pull-through manometry can also be used to determine the length of the high-pressure zone in the anal canal.

The internal sphincter is a tonically active smooth muscle sphincter that is said to contribute up to 85% of resting pressures. Tonic activity in the external sphincter contributes the remainder, but there is also a small contribution made by the anal cushions. Anal pressure itself varies with age and gender, and resting pressure drops during sleep and is affected by posture: sitting and standing. It should be noted, however, that basal resting pressure is not a constant value. The anal canal exhibits a sinusoidal pressure variation, and in individuals with high pressure this can be overlaid by an ultraslow-wave pressure recording. This is common in the high-pressure anal diseases of anal fissure and haemorrhoids. Slow-wave activity varies but can be up to a frequency of 20 cycles/min, and the amplitude of anal pressure slow waves may be 10–20 cmH_2O. The ultraslow-wave frequency is ≤/min, but the amplitude change can be as much as 50–75 cmH_2O.

The maximum voluntary contraction assessment of the pressure increase due to voluntary contraction of the external sphincter, whether reported as the maximal voluntary contraction or as an incremental increase over resting pressure, is usually between 50 and 100% greater than resting pressure. When recording maximal voluntary pressure by squeeze it may also be advantageous to record cough pressures [1]. Squeeze pressures should reflect the maximal pressure of external sphincter contraction; the use of coughing to activate pelvic floor reflexes, and external sphincter contraction may result in a cough pressure considerably higher (Fig. 10.1) than the actual squeeze pressure achieved. In several situations, for example faecal incontinence, this may indicate that there is contraction capability that can be developed with techniques such as biofeedback. Low maximum contraction pressures are demonstrable in diseases related to incontinence and may be due to a physical defect in the sphincter apparatus or be due to damage of the pudendal nerve. Low pressures are also commonly seen in association with many of the more systemic diseases such as diabetes or multiple sclerosis, which affect the continence mechanism.

The assessment of anal canal length involves inserting the catheter into the rectum and withdrawing it into the anal canal. Once in the high-pressure zone (an increase in at least 10 cmH_2O) the catheter is withdrawn in a station pull-through manner from the rectum to the exterior. The length of the anal canal can then be calculated. A slow, continuous pull-through technique can also be used to generate this pressure profile. The anal canal length is generally considered to be between 2 and 4 cm, being longer in the male than the female (an average of 2.5 cm and 2 cm in a woman).

The assessment of anal canal pressure is also age dependent. Age-dependent normal values are readily found in various publications, but should be developed within any laboratory according to the equipment in use. Both resting and squeeze pressures drop with age, with men generally having higher pressures than women throughout life [7, 8].

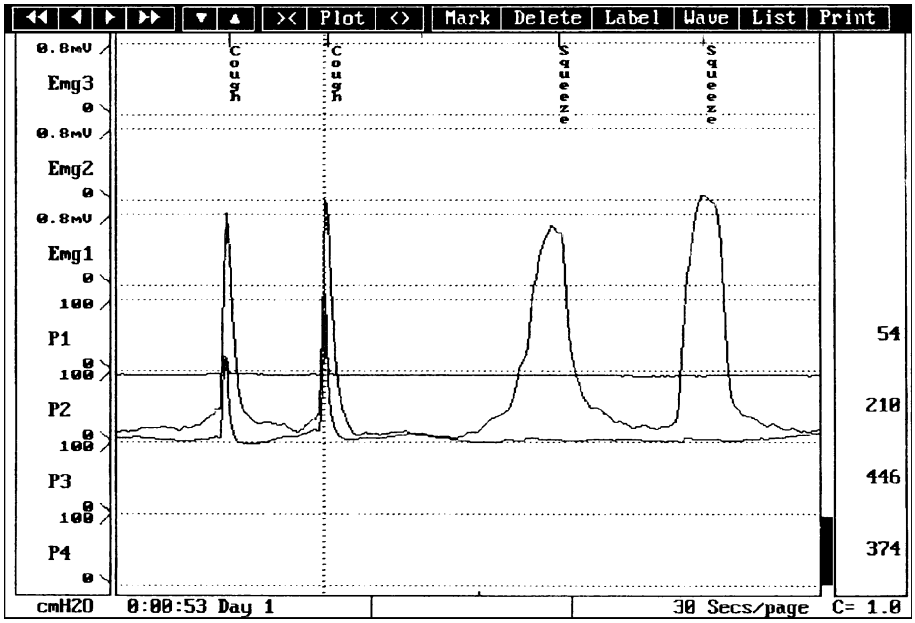

Fig. 10.1 This is an anal manometry trace made using a microtransducer system. The *bottom line* shows rectal pressure. During the first cough, an increase in rectal pressure of approximately 100 cmH_2O can be seen, and during the second cough it increases by 200 cmH_2O. There is no increase in intrarectal pressure with squeeze contraction in the third and fourth peaks. The *second line* shows the anal sphincter recording, which shows during the cough reflex an anal pressure of 300 cmH_2O for both the first and second cough. On the squeeze tracings, pressure is seen just below and above 300 cmH_2O

10.5 Assessment of Anorectal Reflex

The normal reflex function of the anus and rectum means that as the rectum is filled and pressure increases, the internal sphincter relaxes. This happens more frequently at larger rectal volumes. At submaximal rectal filling, the anal canal pressure usually recovers rapidly. There does, however, come a point where anal pressure recovery does not occur and this relaxation of the sphincter mechanism with a high rectal pressure results in defaecation, unless the external sphincter is contracted (Fig. 10.2) [9].

This reflex relaxation is absent in Hirschsprung's disease, and the presence of a reflex can thus be used diagnostically to exclude this disease. Post-operative patients who have had low rectal resection for cancer or neorectal replacement for inflammatory bowel disease, however, may also not demonstrate the reflex if the lower 1 cm of the rectum has been involved in the dissection, thus destroying the inhibitory connections into the anal sphincter. The loss of this mechanism demonstrates that this is a local intramural reflex.

The technique of choice for eliciting this reflex is to have the chosen manometry catheter situated within the canal recording anal pressure in a static position and then to incrementally fill a balloon catheter placed in the rectum. Traditionally, the threshold volume eliciting this reflex (a dip in 10 cmH_2O on the pressure trace) is the recorded measurement. Some laboratories also record the volume of distension that results in reflex relaxation for either 30 s or 1 min. A typical anorectal reflex is shown in Fig. 10.2.

10.6 Prolonged and Ambulatory Manometry

Computerised portable systems have been used in anorectal assessment. These should still be considered experimental, and interpretation of the results can be

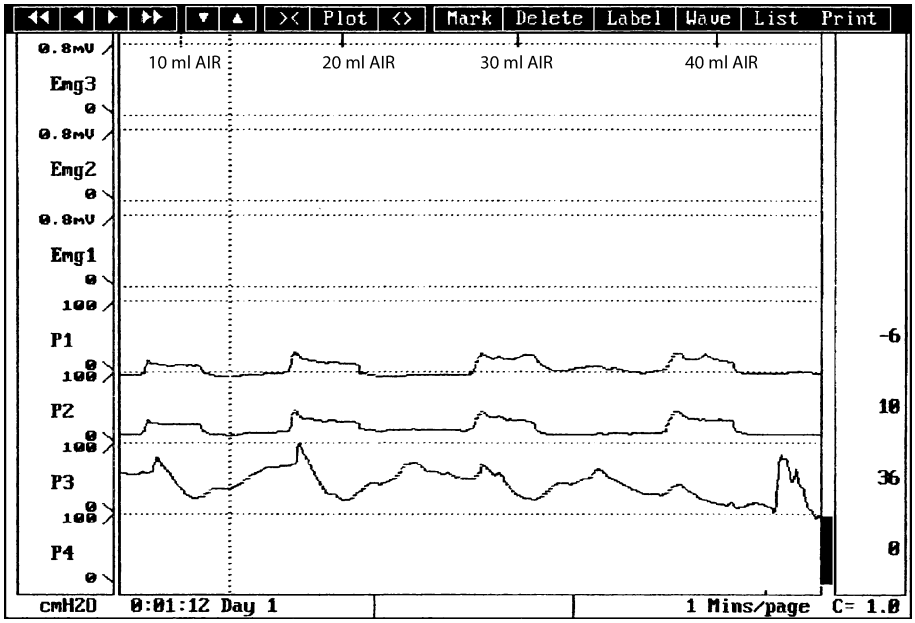

Fig. 10.2 A demonstration of the rectoanal inhibitory reflex. P3 is the anal canal response, and *P1* and *P2* are rectal pressure. Aliquots of air (10 ml) are introduced incrementally into the rectum at the points marked at the top of the graph. The P1 and P2 traces show the intrarectal pressure in relation to the infusion of air into the rectal balloon catheter. The P3 trace shows the change in anal canal pressure at the introduction of the aliquots. There is a significant drop in anal pressure in response to volumes of air being introduced into the rectum, and as the volume of air increases, recovery is progressively impaired until on the 40-ml increment, after which there is no recovery of resting pressure until the external sphincter squeeze noted at the end of the tracing

complex. Although useful information can be obtained with regard to function in patients with incontinence [10, 11], the use of both anal and rectal recording ports can also be used to look at the integrated function between anal canal tone and rectal motor activity [12].

10.7 Assessment of Rectal Function

The rectum is for storage of faecal material prior to defaecation. This rectal reservoir function exhibits receptive relaxation rather like the urinary bladder. Alterations in the compliance of the rectal wall to relaxation can be significant in certain diseases. The poorly compliant rectum seen in patients with colitis or after radiation therapy will be the underlying cause for the urgency and frequency these patients suffer. The more highly compliant rectum seen in patients with megarectum is also easily demonstrated by simply volume filling the rectum, with a pump flowing at a constant rate into a balloon (standard is 60 ml/min of air or water at 37 C). Note that when infusing air or water, compliance values are different due to the difference in compressibility of the medium used. Simple filling can generate volumetric results for: (1) the volume to first appreciation of rectal filling, (2) the volume at which the desire to defaecate is first appreciated and (3) the point of maximum filling – resulting in defaecatory urgency.

In addition to volumetric filling, the insertion of a pressure catheter allows rectal compliance to be assessed. The volume increase achieved using constant volume infusion, and the increase in rectal pressure is recorded (Fig. 10.3). The results of change in pressure against that known volume can be used to calculate compliance.

Normal rectal compliance varies widely, and compliance measured by manometric techniques is considered less useful than rectal dynamics assessed using barostatic techniques [13, 14]. Because of the variability of rectal compliance with age, gender and the degree of

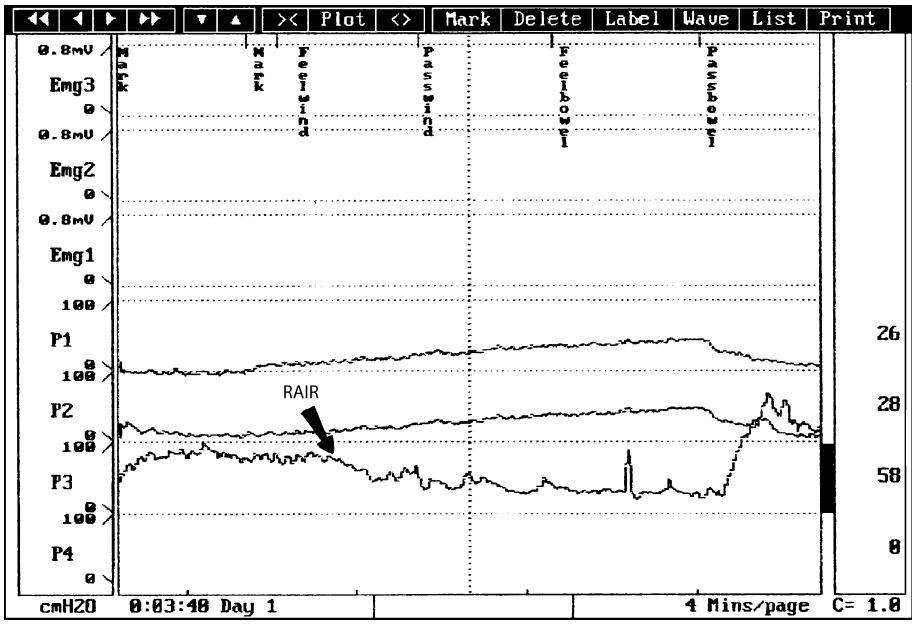

Fig. 10.3 Rectal physiology. In this trace, the rectum is distended by infusion of water at a regulated rate of 60 ml/min. The patients were asked to indicate when they felt the initial sensation as a feeling of wind, when they felt the sensation of the need to pass wind, when they first felt the urge to defaecate, and finally when they have to pass a bowel motion (i.e. the maximum tolerated volume). The upper two traces are rectal pressure, which can be seen gradually increasing as the volume of water is infused. The lower trace shows the anal canal pressure and the *arrow* marked "RAIR" is were the initial volume infused was sufficient to cause activation of the rectoanal reflex. This does not recover as the volume continues to be infused, and pressure continues to drop in the anal canal up until the point of maximum tolerated volume. These are the normal sensations recorded during rectal assessment, and compliance can be calculated from the rectal pressure graph because of the known constant volume infusion and the change in pressure

rectal filling at the time of the assessment [15], a more accurate reflection on rectal muscle tone in relation to distension can be calculated using a mathematical model, or based on the incremental elastic modulus [16]. These methods are not, however, useful in routine rectal assessment.

10.8 Summary

Anorectal manometry can be used to assess internal sphincter function, external sphincter function and the length of the high-pressure zones. It can be used to determine the presence or absence of the anorectal reflex and plays a role in the assessment of rectal dynamics. It is used in the investigation of patients with incontinence. It has also been used in constipated patients, especially those thought to have outlet obstruction. Manometry is not useful in the detection of spastic pelvic floor syndrome (or anismus), as it has been demonstrated [17] that static laboratory tests are unreliable in the diagnosis of this condition. Manometric assessment is also important in patients with a history of trauma to the anal canal and may help to determine whether or not there is internal sphincter dysfunction, external dysfunction or a combination of the two.

Manometry itself should only be considered as part of a more exhaustive anorectal assessment. The use of a barostatic assessment of rectal function and neurophysiological studies looking at both sensory and motor pathways and the use of radiological assessments such as proctography or transit studies should all be considered together with the patient's clinical history and the findings on examination.

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Self-Assessment Quiz

Question 1

Which of the following is true of anal manometry?

a. Microballoon catheters are widely used and have an important place in the anorectal physiology laboratory.
b. Water-perfused catheters are expensive.
c. Water-perfused catheters can cause problems by leakage of water into the rectum or onto the perianal skin.
d. Microtransducer pressure sensors are cheap and robust.
e. Both water perfused catheters and microtransducers can be used for ambulatory manometry.

Question 2

Which of the following is true of measuring anal canal manometry?

a. Station pull-through is the recording of anal canal pressures at 1-mm intervals.
b. After a pull-through, the anal canal is allowed to rest for 5 min.
c. The maximum resting pressure is the highest measured at the lower part of the anal canal.
d. Maximum squeeze pressure is the highest pressure maintained by squeezing the anal canal.
e. Manometric tests are highly reproducible.

Question 3

Which is true of anal canal pressure?

a. The internal anal sphincter contributes around 30% of resting pressure.
b. Anal canal resting pressure is constant within any individual.
c. Maximum voluntary contraction is usually 50–100% greater than resting pressure.
d. The anal canal in both males and females is around 2.5 cm in length.
e. Average anal canal pressures are similar in men and women throughout life.

Question 4

Which is true of the anorectal reflex?

a. As the rectum is filled, the anal pressure increases.
b. The reflex is present in Hirschsprung's disease.
c. The reflex is absent in patients with an ultra-low anterior resection, suggesting an intramural reflex.
d. The threshold volume is defined as the volume required to cause a dip in resting pressure of 20 cmH_2O or more.
e. It is not a manifestation of the sampling reflex.

Question 5

Which is true of rectal function?

a. The rectum is not a compliant reservoir with characteristics similar to the urinary bladder.
b. Rectal compliance can be reduced by diabetes.
c. Rectal compliance measurements are reliable.
d. Rectal dynamics assessed by barostat are more accurate.
e. In megarectum, rectal compliance is normal.

1. Answer: c
Egress of water into the rectum can stimulate a rectoanal inhibitory reflex and onto the perianal skin, stimulating anal contraction.
2. Answer: d
The maximum squeeze pressure is recorded as a squeeze or voluntary contraction pressure at each site in the anal canal during a pull-through procedure; it is independent of time. The highest recorded pressure is noted.
3. Answer: c
The maximum voluntary contraction assessment of the pressure increase due to voluntary contraction of the external sphincter is usually between 50 and 100% greater than resting pressure.
4. Answer: c
Many, but not all patients having a low anterior resection lose the rectoanal inhibitory reflex, which suggests that the reflex has a nerve pathway within the wall.
5. Answer: d
True – although the techniques are not useful in routine rectal assessment, as they are not widely available.

11 Microbiology of the Lower Digestive Tract

Guy Prod'hom and Jacques Bille

CONTENTS

11.1 Introduction

A great variety of microorganisms is potentially involved in infections of the anorectum and colon. For practical purposes, these microorganisms will be grouped into five main categories according to the type of infection they can cause, the anatomic localization of the infection, and according to some of the host characteristics. We will review the microorganisms involved in these five categories: (1) abscesses and fistulae, (2) perianal disease, (3) proctitis, (4) proctocolitis, and (5) infections in the immunocompromised host. Only selected pathogenic species of parasites will be reviewed; this selection is based on high prevalence data, the likelihood of occasionally encountering the pathogen in industrialized countries, and their propensity for infecting the terminal part of the intestine. Table 11.1 summarizes the relevant information regarding the practical aspects of diagnosing of these organisms.

Table 11.1 Relevant information concerning the practical aspects of diagnosis of the pathogenic microorganisms of the lower digestive tract. *STD* Sexually transmitted disease, *NAAT* nucleic-acid amplification test, *HSV* herpes simplex virus, *PCR* polymerase chain reaction, *LGV* lymphogranuloma venereum, *STEC/EHEC* Shiga-toxin-producing *E. coli*/enterohemorrhagic *E. coli*, *HIV* human immunodeficiency virus, *EIEC* enteroinvasive *E. coli*

	Anatomic site/ diagnosis/modifying circumstances	Frequency	Specimen	Laboratory diagnosis	Comments
	ABSCESS AND FISTULA				
	Acute infection				
1	Standard aerobic and anaerobic bacteria – "skin-derived bacteria" (coagulase-negative staphylococci, *Corynebacterium* spp., streptococci), – "gut-derived bacteria" (*Escherichia coli*, enterococci)	Common	Liquid aspirate with needle and syringe or surgical drainage (fistula: plus fragment of tissue of granulation)	Standard aerobic and anaerobic culture (direct examination and culture)	– Liquid samples or tissue are preferred to swab – For small samples, add several drops of sterile saline to keep moist
2	*Neisseria gonorrhoeae*	Rare	Syringe or surgical drainage (fistula: plus fragment of tissue of granulation)	Standard aerobic and anaerobic culture (direct examination and culture)	– Specific request
	Chronic infection				
3	*Actinomyces* spp	Rare	Syringe or surgical drainage (fistula: plus fragment of tissue of granulation)	Standard aerobic and anaerobic culture (direct examination and culture)	
4	*Mycobacterium tuberculosis* complex	Rare	Syringe or surgical drainage (fistula: plus fragment of tissue of granulation)	Standard mycobacterial culture (direct examination and culture)	– Specific request
	PERIANAL DISEASE				
5	*Herpes simplex virus* Vesicles, pustules, ulcers	Common	Swabbing of the base of the vesicle or ulcer to collect cellular material Use viral transport medium	Viral culture: "gold standard", NAAT: most sensitive test (cost?)	– Type-specific serologic tests: specific request (main indication: atypical symptoms with negative HSV culture)
6	*Treponema pallidum* Ulcers, mass lesions	Frequent (STD)	Active lesions: collect serous fluid (avoid contamination with blood or tissue debris) Serum	Direct fluorescent-antibody *T. pallidum* test Serological diagnosis: nontreponemal and treponemal tests	– Syphilis is subclinical for much of its course, serological testing is the procedure of choice for diagnosis

Table 11.1 (*continued*) Relevant information concerning the practical aspects of diagnosis of the pathogenic microorganisms of the lower digestive tract. *STD* Sexually transmitted disease, *NAAT* nucleic-acid amplification test, *HSV* herpes simplex virus, *PCR* polymerase chain reaction, *LGV* lymphogranuloma venereum, *STEC/EHEC* Shiga-toxin-producing *E. coli*/enterohemorrhagic *E. coli*, *HIV* human immunodeficiency virus, *EIEC* enteroinvasive *E. coli*

	Anatomic site/ diagnosis/modifying circumstances	Frequency	Specimen	Laboratory diagnosis	Comments
7	*Human papilloma virus* Condylomata acuminata	Common	Tissue or exfoliated epithelial specimen	Microscopic examination DNA hybridization with or without PCR	– Diagnosis recommended in atypical cases, plus immunosuppression – Annual screening for neoplasia
8	*Streptococcus pyogenes* Children	Occasional	Stool or swab from the anal canal	Aerobic culture	– Specific request
	PROCTITIS				
9	*N. gonorrhoeae* Tenesmus, discharge	Frequent (STD)	Specimen for culture: rectal swab (avoid fecal material). Bedside inoculation on specific media or immediate transport in Stuart's or Amies transport media. Specimen for NAAT: contact the laboratory since the collection system and transport medium may vary according to the diagnostic system used	Microscopic examination: poor sensitivity for rectal smears Culture: "gold standard" NAAT: most sensitive	– Specific request – Culture: mandatory for antimicrobial susceptibility (treatment failure)
10	*Chlamydia trachomatis* – including LGV serovars Tenesmus, discharge LGV late stage (rare): ulcers, strictures, fistulae	Frequent (STD)	Specimen for NAAT: contact the laboratory since the collection system and transport medium may vary according to diagnostic system used	NAAT: test of choice Isolation in cell culture: research laboratory	– LGV: definite diagnosis requires serovar-specific testing – (research laboratory) – Serology: acute infection, paired sera necessary to demonstrate fourfold increase in titer. Useful to distinguish LGV from non-LGV serovars (research laboratory)
11	*Herpes simplex virus* Tenesmus, discharge, ulcerative or vesicular anal lesions	Frequent (STD)	Swabbing of the base of the vesicle or ulcer to collect cellular material Use viral transport medium	Viral culture: "gold standard" NAAT: most sensitive test (cost?)	

Table 11.1 (*continued*) Relevant information concerning the practical aspects of diagnosis of the pathogenic microorganisms of the lower digestive tract. *STD* Sexually transmitted disease, *NAAT* nucleic-acid amplification test, *HSV* herpes simplex virus, *PCR* polymerase chain reaction, *LGV* lymphogranuloma venereum, *STEC/EHEC* Shiga-toxin-producing *E. coli*/enterohemorrhagic *E. coli*, *HIV* human immunodeficiency virus, *EIEC* enteroinvasive *E. coli*

	Anatomic site/diagnosis/modifying circumstances	Frequency	Specimen	Laboratory diagnosis	Comments
	PROCTOCOLITIS				
12	Nontyphoidal *Salmonella* spp. Diarrhea, fever, and abdominal cramps	Frequent	Specimen for culture: 1–2 g of stool Avoid use of swab	Culture: "gold standard"	– *S. enterica* subtyping in reference laboratory
13	*Shigella* spp. Fever, abdominal pain, tenesmus, mucosanguineous stool	Occasional	Specimen for culture: 1–2 g of stool Avoid use of swab	Culture: "gold standard"	– NAAT: not widely available
14	*Campylobacter* spp. (*C. jejuni* and *C. coli*) Fever, abdominal cramping, diarrhea	Frequent	Stool, eventually rectal swabbing Use transport medium if delay is anticipated	Microscopy: low sensitivity – typical microscopic morphology Culture: "gold standard"	
15	Colonic pathogenic *E. coli* STEC/EHEC Grossly bloody diarrhea, hemolytic-uremic syndrome, absence of fever (children)	Occasional (children)	Specimen for culture: 1–2 g of stool Avoid use of swab	Shiga-toxin immunoassay: from stool and *E. coli* isolated from stool culture Selective culture for O157 (STEC/EHEC)	– Specific request – NAAT: research laboratory
16	Colonic pathogenic *E. coli* EIEC Fever, abdominal pain, tenesmus, mucosanguineous stool	Occasional (travel)	Specimen for culture: 1–2 g of stool Avoid use of swab	NAAT: research laboratory	Culture: no test available (exclude other infectious causes)
17	*Clostridium difficile* Antibiotic-associated diarrhea, pseudomembranous colitis	Frequent	Specimen for culture: 1–2 g of stool Avoid use of swab	Antigen detection: cell culture assays for cytotoxin (toxin B): "gold standard" alternative immunoassay Culture: most sensitive, low specificity (carriage of nontoxigenic isolates)	
18	*Entamoeba histolytica* Mucosanguineous stool, colic pain, tenesmus	Frequent (travel, high endemic area)	Stool – repeat if negative – use conservative if examination not done within 30–60 min after voiding Material obtained from sigmoidoscopy and tissue biopsy (indicated when stool repeatedly negative) Serum	Microscopy: routinely applied Antigen detection: specific assay recommended. Serology Useful for invasive and extraintestinal amebiasis	Microscopy: low specificity since *E. histolytica* could not be distinguished from nonpathogenic *E. dispar* NAAT: most sensitive, research laboratory Serology; limited value in high endemic region

Table 11.1 (*continued*) Relevant information concerning the practical aspects of diagnosis of the pathogenic microorganisms of the lower digestive tract. *STD* Sexually transmitted disease, *NAAT* nucleic-acid amplification test, *HSV* herpes simplex virus, *PCR* polymerase chain reaction, *LGV* lymphogranuloma venereum, *STEC/EHEC* Shiga-toxin-producing *E. coli*/enterohemorrhagic *E. coli*, *HIV* human immunodeficiency virus, *EIEC* enteroinvasive *E. coli*

	Anatomic site/ diagnosis/modifying circumstances	Frequency	Specimen	Laboratory diagnosis	Comments
19	*Trichuris trichiura* Diarrhea, abdominal pain, anemia, rectal prolapse (children)	Frequent (endemic in tropical and subtropical areas)	Stool – repeat if negative	Microscopy: routinely applied	
20	*Schistosoma mansoni, S. japonicum* Abdominal pain, diarrhea	Frequent (endemic in Africa, eastern Mediterranean, South America, eastern Asian areas)	Stool – repeat if negative Serum	Microscopy: routinely applied Serology: useful for travelers or in previously unexposed patients	Eosinophilia
	PROCTOCOLITIS IN IMMUNOSUPPRESSED PATIENTS				
21	Cytomegalovirus Diarrhea, fever, abdominal pain	Frequent (HIV with CD4<100 mm^3); transplant patients)	Anticoagulated peripheral blood and/or Tissue biopsy Serum	NAAT: most sensitive Virus isolation (antigenemia, culture, shell vial assay): "gold standard" Biopsy histology: visualization of cytomegalic cells. Confirmation with immunohistology or hybridization) Enzyme immunoassay	Quantitative NAAT (formerly antigenemia) appropriate for follow-up of high-risk patients (transplant patients) Diagnosis of primary infection. Screening of blood, organ donors and recipient
22	Human herpes 8 (Kaposi's sarcoma-associated herpesvirus) Ordinary asymptomatic, rarely intestinal obstruction, bleeding	Occasional (HIV, transplant patients)	Tissue biopsy	Histopathology	Kaposi sarcoma is generally diagnosed on the basis of clinical and /or histopathology examination
23	*Mycobacterium avium* complex (*M. avium*, *M. intracellulare*) Fever, weight loss, night sweats, diarrhea, abdominal pain	Frequent (HIV with CD4<50 mm^3)	Blood Stool, tissue biopsy	Culture for mycobacteria	
23	*Strongyloides stercoralis* Immunocompetent patient: asymptomatic Immunosuppressed patients (glucocorticoid): abdominal pain, diarrhea, bleeding	Frequent (tropical areas)	Stool – multiple stool often necessary Duodenal aspirate Tissue biopsy	Microscopy: larvae examination Microscopy: adult worm, eggs examination	Eosinophilia often absent in severely immunosuppressed patients

11.2 Abscess and Fistula

Anorectal abscesses and anal fistulae represent the same disease process but viewed at different times; the abscess is the acute manifestation, whereas the fistula represents the chronic condition. An anorectal abscess may arise from local cutaneous infection following the colonization of obliterated apocrine glands or infection in an anal gland, leading to intersphincteric abscess, and then possibly extending to the perianal or ischiorectal space. An anal fistula is a connection between two epithelially lined spaces, one of which being the anus or the rectum. Anorectal fistulae are a frequent complication of Crohn's disease. In these patients, a fistula develops locally, either as a result of a deep penetrating ulcer in the anus or rectum, or secondary to an anal gland abscess.

Pain in the perineal area, fever, and inability to void form the classic triad of signs of perineal sepsis. The most common cause is advanced cryptoglandular infection resulting in a necrotizing perineal infection.

11.2.1 Specimen for Microbiological Examination

In this heavily contaminated area, material aspirated with a needle and syringe or surgical drainage material are the most appropriate specimen for microbiological examination of abscesses. In the case of fistula, the specimen should be obtained from the track of the fistula either as a liquid aspiration taken with a needle and syringe, or as a fragment of granulation tissue. Liquid or tissue are preferred to a swab, especially when transport of the specimen to the laboratory is possible within a few hours.

11.2.2 Microbiology

11.2.2.1 Acute Infections

Standard culture will allow the detection of both aerobic and anaerobic bacteria. Several studies have shown that so called "skin-derived bacteria" (coagulase-negative staphylococci, *Corynebacterium* spp., streptococci) predominate over "gut-derived bacteria" (*Escherichia coli*, enterococci) when specimens are obtained from an abscess. In addition, the presence of gut-derived bacteria indicates a possible communication with the anal canal, as observed in fistulae. Mixed cultures are obtained in the majority of cases of abscess and fistula [81]. The numbers of different aerobic organisms are significantly greater among patients with fistula than among patients without fistula. However, the relative proportion of skin-derived and gut-derived bacteria varies from study to study. Among anaerobic bacteria, *Peptostreptococcus* spp. predominate in abscesses and *Bacteroides* spp. predominate in fistula.

Gonococcal perianal abscesses, which were seen often in the preantibiotic era, are rarely seen in modern medical practice. If a gonococcal infection is suspected, the specimen must be rapidly transported to the laboratory with a specific request [23].

11.2.2.2 Chronic Infections

In chronic processes, slow-growing bacteria such as *Actinomycetes* or mycobacteria must be actively investigated. Primary anal actinomycosis of cryptoglandular origin is a rare cause of anal suppurative disease. In a recent series [7], this entity was observed in 6 out of 2,482 patients operated on for anal fistulae or abscesses. The etiological diagnosis is difficult since, (1) the classical "sulfur granules" corresponding to aggregates of microorganisms mixed with inflammatory debris could not always be found at the onset of the lesion (no patient presented macroscopic "sulfur granules" in the pus in one series [7]), (2) members of the *Actinomyces* species are commensal, and normal inhabitants of the gastrointestinal tract and their recovery from culture do not necessarily establish the presence of infection. Microscopic examination of the pus could show pleomorphic, beaded, branching, Gram-positive rods, suggesting *Actinomyces*. The most important pathogenic *Actinomyces* species isolated in humans is *A. israelii*, followed by *A. meyeri*.

Anoperineal tuberculosis represented 0.3% of the etiologies of anal fistulae and abscesses in a recent series from France [78]; this low incidence contrasts with that seen in developing countries, where in a major retrospective survey from India 9 of 122 fistulae (6%) were of tuberculous origin [72]. Anal contamination is usually caused by the swallowing of respiratory secretions that contain a large quantity of *Mycobacterium tuberculosis* bacilli; more rarely, it may originate from the blood or the lymphatic system. Anal fistula is the most frequent clinical presentation of anorectal tuberculosis (80–90% of cases). Positive diagnosis of anal tuberculosis depends on histologic and bacteriologic analysis. The typical histologic lesion is a granuloma with epi-

thelioid and multinucleated giant cells surrounding a caseous necrosis, but the pathognomonic presence of caseation is not constant and presents diagnostic problems, especially in the case of Crohn's disease with anoperineal localization. Diagnosis can also be established by looking for acid-fast bacilli in the anal lesions by direct examination (auramine, Ziehl-Neelsen stains) and culture. To overcome the delay associated with culture (3–4 weeks), new diagnostic techniques for tuberculosis have been proposed in complement it, in particular genomic amplification by polymerase chain reaction (PCR), which can detect the presence of the bacterial DNA within few hours with high sensitivity and specificity.

In rare cases of perianal abscesses, worms and eggs of *Enterobius vermicularis* (pinworms) can be observed by microscopy [17].

11.3 Perianal Disease

The squamous epithelium of the anal canal can be infected by herpes simplex viruses (HSVs), human papilloma virus (HPV), or by the agent of syphilis (*Treponema pallidum*).

11.3.1 Herpes Simplex Virus

HSVs are classified into types 1 (HSV-1) and 2(HSV-2). HSV-1 is widespread in the population and is the cause of herpes labialis; nevertheless, most infected individuals remain asymptomatic. HSV-2 is mostly acquired sexually. Genital herpes can result from infection with either viral type, and constitutes a chronic, lifelong viral infection. The majority of patients with symptomatic, first-episode genital HSV-2 infection subsequently experience recurrent episodes of genital lesions; recurrences are less frequent after initial genital HSV-1 infection. Intermittent asymptomatic shedding occurs in those with genital HSV-2 infection, even in those with longstanding or clinically silent infection.

At presentation, a primary infection may involve the perianal skin and anal canal and may extend to the rectum. Pain can be severe, occurring with rectal discharge, tenesmus, and constipation. S4–S5 dysesthesia, sacral paresthesia, urinary retention, and temporary impotence have been reported in up to 50% of primary anorectal HSV infections [31]. Perianal vesicles are typical, as are pustules and ulcers; these can cause severe skin lesions on the buttocks. HSV infection may present with systemic viral symptoms like fever, chills, and malaise.

11.3.1.1 Laboratory Diagnosis

The diagnosis of HSV infection can be confirmed by viral culture, PCR and type-specific serologic tests. Other methods, such as direct immunofluorescence and Tzanck smear cytology, lack accuracy [69, 75].

Viral Culture

If active genital lesions are present, the vesicle should be disrupted for sampling. The base of the lesion is then swabbed vigorously to recover infected epithelial cells. Specimens should be placed in viral transport medium and maintained at 4°C until inoculation. The overall sensitivity of viral culture of genital lesions is approximately 50% and declines rapidly as lesions begin to heal (95% for vesicular lesions, 70% for ulcerative lesions, 30% for crusted lesions) [48]. Viral isolation rates are also higher in primary compared to recurrent genital herpes.

Nucleic-Acid Amplification Tests

HSV nucleic-acid amplification tests (NAATs) have emerged as a more sensitive method of confirming HSV infection in clinical specimens obtained from genital ulcers, mucocutaneous sites, and cerebrospinal fluid. PCR is particularly useful for the detection of asymptomatic HSV shedding. The main limiting factor in adopting HSV NAATs as the primary diagnostic tool until now has been the cost of the assay. A dedicated specimen should be collected with a Dacron swab placed in viral transport medium. Specimens for NAATs can be maintained at 4°C for up to 72 h; if longer storage is required, the specimen should be kept at −20°C. HSV can be detected up to four times more frequently by NAATs than by culture [86].

Type-Specific Serologic Tests

HSV serologic assays may be useful in the following situations: (1) recurrent genital symptoms or atypical symptoms with negative HSV cultures; (2) a clinical diagnosis of genital herpes without laboratory confirma-

tion; (3) when specimen collection or transport is inadequate; (4) investigation of an asymptomatic patient (e. g., in the case of a partner with genital herpes).

Most epitopes are shared between HSV-1 and HSV-2. As a result, it is difficult to distinguish between antibodies to HSV-1 and those to HSV-2. Only glycoprotein G (gG) elicits predominantly type-specific responses. Both type-specific and non-type-specific antibodies to HSV develop and persist indefinitely. Accurate type-specific HSV serologic assays are based on the HSV-specific gG2 (HSV-2) and gG1 (HSV-1). Such assays first became commercially available in 1999. The serologic type-specific gG-based assays should be specifically requested when serology is performed. The sensitivities of these gG type-specific tests for the detection of HSV-2 antibody vary between 80 and 98%, and false-negative results might be obtained more frequently at early stages of infection. The specificity of these assays is >96% [5]. False-positive results can occur, especially in patients with a low likelihood of HSV infection. Confirmatory testing might be indicated in some settings, especially if recent acquisition of genital herpes is suspected [16].

Because nearly all HSV-2 infections are sexually acquired, the presence of type-specific HSV-2 antibodies implies anogenital infection, and education and counseling appropriate for persons with genital herpes should be provided.

If the presence of type-specific HSV-2 antibodies indicates anogenital infection (symptomatic or asymptomatic), the presence of HSV-1 can be consistent with either anogenital or orolabial infection. Since patients with genital herpes are also at risk for other sexually transmitted diseases (STDs) that can cause genitoanal ulcers, serology alone cannot confirm that HSV is the definitive etiologic agent responsible for the current infection.

11.3.2 *Treponema pallidum* (Syphilis)

Syphilis is a chronic infection caused by the bacterium *T. pallidum*. The manifestations of disease are notoriously protean, occurring in any one individual in different frequently overlapping stages over time [55].

Early syphilis is defined as the first stages of syphilis that typically occur within the 1st year after acquisition of the infection: (1) primary – ulcer or chancre at the infection site; (2) secondary manifestations include, but are not limited to, skin rash, mucocutaneous lesions, and lymphadenopathy; (3) early latent syphilis. Relapses of secondary syphilis may occasionally continue for periods beyond 1 year in untreated patients. Late or tertiary syphilis is defined as the stages of syphilis that occur after early (primary or secondary) or latent syphilis, and typically involves the central nervous and cardiovascular systems, and can also present as a chronic inflammatory condition (gumma), which usually involves the skin or bone but may occur in any organ. Late syphilis can arise as early as 1 year after the initial infection or up to 25–30 years later.

Syphilis can cause ulcers or mass lesions in the perianal and rectal areas. The chancre, the lesion of primary syphilis, can present as a perianal ulcer. These ulcers are typically painless and well demarcated, with indurated edges and a clean basis. They typically occur between 2 and 6 weeks after exposure. The lesions of secondary syphilis are usually painful and can present as an anorectal mass and condylomatous lesions. Condyloma latum refers to one or more large, raised, white or gray lesions found in warm, moist areas. Such lesions can also cause painful defecation that can mimic a fissure, fistula, or perirectal abscess.

11.3.2.1 *Laboratory Diagnosis*

T. pallidum cannot be cultured readily, thus the current tests for syphilis fall into three categories: (1) direct microscopic examination – used to detect *T. pallidum* in lesion exudates or tissue specimens; (2) non-treponemal serologic tests – used to detect anticardiolipin antibodies; (3) treponemal tests – used to detect antitreponemal antibodies.

Direct Examination

Active lesions prior to healing stages serve as the best source of the organism. The site should be cleansed and gently abraded with sterile gauze and saline until a serous exudate appears. The specimen should consist of serous fluid that is free of erythrocytes and tissue debris. A specimen for dark-field microscopy is collected onto a glass slide and covered with a coverslip. Exudates should be examined as soon as possible to ensure retention of motility, since *T. pallidum* is highly sensitive to exposure to oxygen, heat, and desiccation. For the direct fluorescent-antibody *T. pallidum* test (DFA-TP), the specimen is collected onto a slide and then air-dried. Samples from rectal lesions should be examined using specific anti-*T. pallidum* antibody (by

the DFA-TP test or immunohistochemistry), because non-*T. pallidum* intestinal treponema can colonize the gastrointestinal tract [52].

Serologic Tests

Antibody detection tests supplement the direct organism-detection methods and are the only useful methods of diagnosis during latent and late syphilis. Available serologic tests for syphilis are subdivided into: (1) nontreponemal assays – rapid plasma reagin (RPR), venereal disease research laboratory – (VDRL), and (2) treponemal assays – fluorescent treponemal antibody absorbed, *T. pallidum* particle agglutination (*T. pallidum* hemagglutination assay, TPHA).

Serum is the specimen of choice for both nontreponemal and treponemal tests. Plasma cannot be used in the VDRL test, since the sample must be heated before testing; in addition, plasma cannot be used in the treponemal tests for syphilis.

Nontreponemal tests detect the so-called reaginic antibodies that react with lipoidal particles containing the phospholipid cardiolipin. They are commonly used for screening and useful for determining the efficacy of treatment. Limitations include their lack of sensitivity in early primary syphilis cases (20% of those with primary syphilis have nonreactive, nontreponemal test results on the initial visit) and the possibilities of a prozone reaction or a false-positive result. The treponemal tests use the *T. pallidum* subspecies *pallidum* or its derivatives (e. g., recombinant proteins) as the antigen and detect anti-*T. pallidum* antibodies. The greatest value of the treponemal tests is in distinguishing true- from false-positive nontreponemal test results and in establishing the diagnosis of late latent or late syphilis.

Nontreponemal tests can be performed as quantitative tests by preparing a serial twofold dilution of the patient's serum to reach an end-point titer. Quantitative tests establish a baseline of reactivity from which change can be measured following treatment. Nontreponemal test results must be interpreted according to the stage of syphilis suspected and should be confirmed using a treponemal test.

New recommendations suggest that treponemal antigen-based enzyme immunoassays are an appropriate alternative to the combined VDRL/RPR and TPHA screen [22]. Enzyme immunoassay as a single screening test was shown to give similar results to the VDRL/RPR and TPHA combination some years ago [92].

11.3.3 Human Papilloma Virus

HPV causes warts, also known as condylomata acuminata. These are typically raised pale lesions that arise externally or internally in the anal canal as well as in the genital areas. Warts can be present singly, in small clusters, or even in large exophytic masses. Symptoms of external warts include friability, itching, and bleeding. Internal warts are usually asymptomatic.

In a sexually active population, the prevalence of DNA of the human papillomavirus is around 50% [53]. Clinically visible external genital warts are noted in ~1% of sexually active adults (aged 15–49 years) in the US population. Intra-anal warts are seen predominantly in patients who have had receptive anal intercourse.

HPVs are members of the *Papillomaviridae* family of DNA viruses. More than 100 types have been identified, 40 of which infect the anogenital region. The majority of HPV infections are self-limited, but malignant tumors develop in a subset of genital HPV infections. The anogenital HPV types are commonly referred to as high, intermediate, or low risk, depending on the frequency with which they are present in cancers. The most common high-risk types include HPVs 16, 18, 45, and 56, while HPVs 31, 33, and 35 are referred to as intermediate risk types; HPVs 6, 11, 42, 43, and 44 are considered to be low risk because they are almost never associated with malignancy.

Genotypes 6 and 11 are found in >90% of cases of condylomata acuminata, and the majority of these cases (>80%) clear spontaneously within 18 months. Patients with visible warts may be infected simultaneously with oncogenic "high-risk" HPVs, which mostly give rise to subclinical lesions. Condyloma acuminatum in the perianal and rectal areas are associated with dysplasia and epidermoid cancer, just as the HPV is associated with cervical dysplasia and cancer. The reported incidence of squamous cell carcinoma of the anus in patients with anal condyloma is 3–4% and is likely to increase with the increasing prevalence of HPV infection in immunosuppressed human immunodeficiency virus (HIV)-positive patients [65, 74]. The similarity between these lesions and cervical lesions has prompted some investigators to suggest an annual cytological screening of the anal region, notably for immunosuppressed patients [25].

11.3.3.1 Indication and Collection of Specimens

Biopsy is unnecessary for newly occurring, multiple, acuminate lesions, but is recommended in atypical

cases for differential diagnostic purposes or in any cases where the benign nature of a papular or macular lesion is unclear, such as conspicuous bowenoid papulosis, Bowen's disease, and giant condylomas. For the screening for anal intraepithelial neoplasia, the sampling of smears using a Dacron swab is a well-validated investigation with comparable sensitivity and specificity to cervical cytology. The smears are processed exactly as cervical smears, either with Papanicolau staining or using liquid-based cytology. Blind sampling of smears can be proposed for screening for anal neoplasia by cytology [82].

11.3.3.2 Laboratory Diagnosis

Since HPV cannot be grown in cell culture, a variety of other methods has been used to detect infection.

Microscopic Examination

Squamous cells infected with HPV frequently show a variety of changes, with some morphologic features being associated with infection with specific types of HPV. In genital tract infections, the most characteristic HPV-related change is perinuclear clearing, with an increase in the density of the surrounding rim of cytoplasm. Cells exhibiting such changes are referred to as koilocytes and can be seen in both exfoliated cell samples and tissue biopsy specimens. Other subtle changes include changes in the shape and size of the cytoplasm and nucleus, abnormal nuclear chromatin, and abnormal keratinization.

DNA Hybridization and NAATs

Detection of HPV DNA sequences by different in-situ hybridization technologies are the gold standard for the diagnosis of HPV. NAATs combine the amplification of the target with its specificity, obtained by hybridization with type-specific probes [60].

11.3.4 Perianal Streptococcal Dermatitis in Children

Perianal disease caused by group A β-hemolytic streptococci (GAS); *Streptococcus pyogenes* has been reported in the pediatric literature since 1966 [3]. Signs and symptoms include perianal dermatitis (90%), perianal itching (78%), rectal pain (52%), and blood-streaked stools (35%). Some patients with streptococcal perianal diseases or proctitis have simultaneously contracted streptococcal pharyngitis. In a normal host, colonization of the intestinal tract with GAS is infrequent, but up to 6% of patients with acute streptococcal pharyngitis have a positive anal culture for GAS.

The use of rapid antigen testing in anal swab for GAS perianal cellulitis has been described in several case reports. In a series of 27 symptomatic patients from whom perianal swab samples were obtained, antigen testing was positive in 24 (sensitivity: 89%) [51].

Stool or swab culture from the anal canal may also demonstrate the presence of GAS, but a specific request for GAS culture is mandatory, since the culture media used to identify usual enteropathogenic bacteria are not suitable for GAS detection.

11.4 Proctitis

Proctitis is an inflammation limited to the rectum (i. e., the distal 10–12 cm). Symptoms vary depending on the type of infection or pathologic process, but typically include rectal discomfort, tenesmus, rectal discharge, and constipation. Symptoms can also include anorectal mucoid, mucopurulent, or bloody discharge. On endoscopy, erythema and friable mucosa are typically observed.

Neisseria gonorrhoeae, *Chlamydia trachomatis* (including lymphogranuloma venereum – LGV – serovars), *T. pallidum*, and HSV are the most common pathogens involved.

11.4.1 *Neisseria gonorrhoeae*

N. gonorrhoeae is an exclusively human pathogen. Clinical manifestations vary according to the primary site of infection: symptomatic carriers exist in both genders and represent the major source of transmission. Infection in women is often asymptomatic compared to men, who are asymptomatic only 10% of the time.

Urethritis is the most common presentation in men, whereas women suffer from either urethritis, endocervicitis, or both. Oropharyngeal infections are either symptomatic with inflammation and exudate, or most often asymptomatic. Disseminated gonococcal infection is characterized by typical skin lesions, tenosynovitis, and arthritis. Endocarditis or meningitis are rare

and linked to bacteremia. Women may also infect their newborn infants with *N. gonorrhoeae* during birth, causing neonatal ophthalmia.

Gonorrhea infections in the rectal area are most common in women and in men who have sex with men (MSM). Perianal contamination from a cervical infection or a direct infection from anal intercourse can cause anorectal infections in women. In MSM, the infection is caused by direct exposure through anal intercourse.

In one study, approximately 85% of rectal gonococcal infections were asymptomatic [47]. If present, symptoms can include anal pruritus and mucopurulent discharge, usually with a bowel movement. Rectal pain, tenesmus, and bleeding are more common in MSM. Severe gonococcal rectal infections may be difficult to differentiate from inflammatory bowel disease.

Anorectal gonorrhea must be distinguished from other causes of proctitis (e.g., *C. trachomatis*, HSV, syphilis). The frequency of these etiologies was evaluated in a review of 101 episodes of proctitis among MSM in San Francisco; anoscopy was performed and specimens obtained that were tested for the aforementioned organisms [49]. The following frequency of causes was noted in 55% of the patients with an etiologic agent identified: gonorrhea 30%, chlamydia 19%, HSV 16%, and syphilis 2%. Of the infected patients, 45 (82%) had only 1 infectious agent, 9 had 2 infectious agents, and 1 patient had all 4 agents.

11.4.1.1 Specimen Collection

The laboratory should be contacted for specific instructions regarding the preferred methods of transport of the specimen to ensure an optimal recovery of pathogen(s). Specimens should be collected with Dacron, rayon swabs or transport medium containing charcoal to inactivate toxic materials. Calcium alginate and some brands of cotton swabs may be inhibitory for gonococci, but their use is acceptable if the specimens are inoculated directly onto growth media. Instruments used to aid in the collection of specimen should be lubricated with water or saline because various water- and oil-based lubricants may also inhibit organism growth.

Stuart's or Amies buffered semisolid transport media are used to transport swab specimens for *N. gonorrhoeae* culture, which should be kept at ambient temperature, not at 4°C as recommended for other organisms. To prevent loss of organism viability, swab specimens should be inoculated onto growth medium within 6 h of collection.

Transport of specimens already inoculated onto commercial selective culture media at the bedside has been proposed to maximize the recovery of gonococci. Media are inoculated with the specimen from a swab and placed into an impermeable plastic bag with a bicarbonate–citric acid pellet. Contact of the pellet with moisture via evaporation from the medium during incubation or by crushing an ampoule of water adjacent to the pellet generates a CO_2-enriched environment within the bag.

The collection of appropriate specimens for diagnosis of gonococcal infection is dependent on the gender and sexual practices of the patients and on the clinical presentation. Rectal specimens may be obtained blindly or via an anoscope; the latter is preferred for symptomatic patients. For blind swabbing, insert 2–3 cm into the anal canal; press laterally to avoid fecal material and to obtain columnar epithelial cells. If there is visible fecal contamination, discard the swab and obtain another specimen.

11.4.1.2 Laboratory Diagnosis

N. gonorrhoeae can be identified using several diagnostic modalities.

Microscopic Examination

Neisseria are coccal Gram-negative organisms that frequently occur in pairs. Diplococci have adjacent sides that are flattened, giving them a "coffee bean" appearance. Microscopic reading of Gram-stained material on a slide is useful, especially from symptomatic male urethral smears (sensitivity: ~90–95%), but not so for asymptomatic males and females (sensitivity: ~50–70%). Gram staining of rectal smears for *N. gonorrhoeae* has a low sensitivity (35%) but a high specificity when performed by experienced personnel [33]. However, in an evaluation of men with symptomatic rectal gonorrhea, the sensitivity of Gram staining was 79% when rectal samples were obtained via anoscopy, compared to 53% when they were obtained via an inserted swab [90]. Nongonoccocal species account for less than 1% of Gram-negative diplococci isolated from genital sites in heterosexuals.

Culture

Bacterial culture is generally regarded as sensitive and specific for the detection of gonorrhea, and to date, it remains the gold standard for definitive diagnosis. Cultures obtained less than 48 h after exposure may be negative. Culture is the recommended method, because it allows for antimicrobial susceptibility testing. Antimicrobial susceptibility testing for all isolates is suggested and is required for all isolates from positive (test of cure) follow-up cultures and treatment failures.

N. gonorrhoeae isolates have an obligate requirement for CO_2 for initial isolation and are nutritionally demanding. Various selective media allow recovery of *N. gonorrhoeae* from body sites harboring an endogenous bacterial flora. These media contain antimicrobial agents that inhibit other microorganisms and allow the selective recovery of pathogenic *Neisseria*.

Bacterial culture may be an insensitive tool for detecting (pharyngeal and) rectal gonorrhea in MSM. The lower sensitivity of bacterial culture in the extragenital sites may be attributed to the heavy colonization of these sites by a broad range of other organisms, including other *Neisseria* species, which may interfere with *N. gonorrhoeae* isolation.

Nucleic-Acid Amplification Tests

Nucleic-acid tests first became available for routine use in the early 1990s. They include both nucleic-acid hybridization assays and NAATs. NAATs include PCR, ligase chain reaction, transcription-mediated assay, and strand-displacement amplification. Nonculture tests are ideal methods when transport and storage conditions are not optimal for the viability of *N gonorrhoeae*. In addition to the commercial assays, numerous in-house *N. gonorrhoeae* NAATs have also been described. These have primarily used PCR and have targeted various *N. gonorrhoeae* genes.

There are promising data that require confirmation on the use of rectal swabs for *N. gonorrhoeae* and *C. trachomatis* in NAATs, but at the time of writing nonculture tests are not FDA cleared for use in the rectum [42].

N. gonorrhoeae NAATs offer improved sensitivity compared with bacterial culture. When compared with *N. gonorrhoeae* NAATs, gonoccocal culture ranges in sensitivity from 85 to 95% for acute infections and may fall as low as 50% for females with chronic infection. The increased sensitivity of NAATs makes them particularly suitable for screening, enabling accurate diagnosis of both symptomatic and asymptomatic gonococcal infections, which is critical to the control of the disease. Specimens collected for NAATs do not require the organism to be viable for detection and so require less stringent transport conditions compared with those collected for bacterial culture. NAATs can also be used effectively on noninvasive specimens such as urine and self-collected specimens. *N. gonorrhoeae* NAATs do have some limitations. These include the typical problems associated with the use of NAAT protocols, such as high cost, carryover contamination, inhibition of the reaction, high quality control requirements, and the absence of antibiotic resistance data. More importantly, there are sequence-related limitations that are unique to *N. gonorrhoeae* NAATs, including the generation of both false-negative and false-positive results. This is because target sequences may be either absent in some *N. gonorrhoeae* subtypes or otherwise present in some commensal *Neisseria* strains.

Given these problems, it has been suggested that any *N. gonorrhoeae* NAAT-positive result from an extragenital specimen should be confirmed using an NAAT assay targeting a different genetic sequence.

The current recommendation from the Centers for Disease Control is that bacterial cultures should be used to test for (pharyngeal or) rectal gonorrhea for diagnosis and antimicrobial susceptibility testing. This recognizes both the specificity problems of *N. gonorrhoeae* NAATs and the high incidence of commensal *Neisseria* species at these sites [89].

11.4.2 *Chlamydia trachomatis* (Including LGV Serovars)

C. trachomatis, a small Gram-negative bacterium, is the most common cause of bacterial STD in both men and women. As many as 85–90% of *C. trachomatis* infections in men and women are asymptomatic, thus providing an ongoing reservoir for infection.

C. trachomatis comprises 15 serovars, which are labeled according to major outer membrane protein antigenicity (A, B, Ba, C–K, and L1–L3). Genome studies have provided evidence that, the different *C. trachomatis* serovars share >99.6% genetic identity. Despite small genomic differences, *C. trachomatis* biovars exhibit diverse disease manifestations. *C. trachomatis* are grouped into the trachoma biovar (serovars A–K) and the LGV biovar (serovars L1–L3). The trachoma biovar is further divided into endemic trachoma strains (serovars A–C) and oculogenital strains (serovars D–K).

Oculogenital strains (*C. trachomatis* serovars D–K) are responsible for mild conjunctivitis and are the lead-

ing cause of bacterial STD. Clinical manifestations of *C. trachomatis* infections in women include acute urethral syndrome, urethritis, bartholinitis, cervicitis, upper genital tract infection, perihepatitis (Fitz-Hugh–Curtis syndrome), and reactive arthritis. In men, the most common clinical manifestation of *C. trachomatis* infection is nongonococcal urethritis.

Chlamydial proctitis is relatively uncommon. Symptoms include anorectal pain, discharge, tenesmus, and constipation. Regardless of symptoms, chlamydial rectal infections are usually associated with friable rectal mucosa and mucopurulent discharge, as seen on anoscopy. Sigmoidoscopy can yield normal findings or reveal mild inflammatory changes with small erosions or follicles in the lower 10–15 cm of the rectum.

LGV is an STD that is caused by *C. trachomatis* serovars L1, L2, or L3. The infection is prevalent in tropical areas, but may occur in the Western world, where outbreaks have recently occurred [63]. In contrast to the urogenital chlamydia infections that are caused by *C. trachomatis* serovars A–K and characterized by mild and often asymptomatic infection, LGV can cause severe inflammation and invasive infection, often with systemic symptoms. Depending on the site of inoculation, LGV can manifest either as an inguinal syndrome with a unilateral painful inguinal lymphadenopathy (buboes) or as an anorectal syndrome with hemorrhagic proctocolitis and hyperplasia of intestinal and perirectal lymphatic tissue. Clinical observations have identified three stages of disease. The primary lesion is a small (2–3 mm), painless, ulcerating papule. It is found in only 10–30% of patients because it persists for only a few days. The secondary stage is characterized by acute lymphadenitis, in which tender and enlarged lymph nodes, also known as buboes, can be found (the inguinal syndrome). A small proportion of patients will have a chronic, progressive inflammatory response leading to chronic ulceration, strictures, or fistulae, which may mimic idiopathic inflammatory bowel disease. In one study, LGV proctitis was associated with the following endoscopic findings: mucopurulent discharge (75%), ulcers (35%), and erythemas; in one case an inflammatory tumorous mass was found [63].

11.4.2.1 Specimen and Transport

When specimens are collected, epithelial cell specimens should be collected by vigorous swabbing or scraping of the involved sites. Purulent discharges that lack infected epithelial cells are inappropriate and should be cleaned from the site before the sample is collected. Dacron and calcium alginate swabs may both be used. Clinical material should be forwarded to the laboratory in a special chlamydial transport medium.

When specimens are collected for nucleic-acid amplification procedures, the description and procedural instructions given in the product's package insert should be followed. This includes the use of swabs or specific transport media specified by the manufacturers, since the use of other materials may impair the sensitivity and/or specificity of the test. First-void urine specimens from men and women are excellent specimens for detection of *C. trachomatis* by NAATs. However, physical examination remains essential, and more invasive specimens may be needed for diagnostic purposes in symptomatic individuals.

11.4.2.2 Laboratory Diagnosis

Isolation in Cell Culture

Chlamydia are obligate intracellular bacteria, and living cells are necessary to support their growth in vitro. The detection of intracytoplasmic inclusions corresponding to chlamydia growth is made by different techniques after 24–72 h of cell incubation.

Nucleic-Acid Amplification Tests

The nucleic-acid amplification assays are now the tests of choice for the diagnosis of *C. trachomatis* infection in routine clinical laboratories. The different commercial or noncommercial methods amplify nucleotide sequences of a cryptic plasmid, present in multiple copies in all *C. trachomatis* serovars. Definitive diagnosis of LGV requires complex serovar-specific testing [39]. Clinicians must request that testing be done for LGV specifically, as most laboratories will not automatically perform serovar typing. Nucleic-acid amplification is not officially approved for use with rectal swabs, therefore repeat testing is advised to confirm a positive test.

Serology

The serological methods used are the complement fixation (CF), the microimmunofluorescence (micro-IF) test, and recombinant immunoassays.

The CF serological test is rarely performed. It is based on antibody reactivity to the group-specific chlamydial lipopolysaccharide and has been useful in the

diagnosis of LGV. Paired sera are necessary to show at least a fourfold increase in antibody titers during an acute infection. It is often difficult to demonstrate rising antibody titers in patients with LGV, since patients usually present to physicians after the acute stage. In these cases, a single serum specimen that demonstrates titers greater than 1:64 can support the diagnosis in the appropriate clinical context. Compared with culture, the CF test lacks sensitivity for related genital infections caused by *C. trachomatis* serovars D–K.

Micro-IF testing is the current method of choice for the serodiagnosis of acute chlamydial infection. The technique is sensitive and has the advantage of being able to discriminate between chlamydial species and serovars of *C. trachomatis*. The micro-IF test assesses the reactivity of antibodies to chlamydial antigens or chlamydial elementary bodies fixed on a glass-slide solid support. It can be used for the diagnosis of genital tract infection from non-LGV as well as LGV serovars. A rise in antibodies does not occur frequently since patients are often chronically or repeatedly infected, making new seroconversions difficult to detect.

Serology is not useful for the diagnosis of acute genital chlamydial infections (non-LGV only). Comparative data between types of serologic tests are lacking, and the diagnostic utility of serologic methods other than CF and some micro-IF procedures have not been established. Serologic test interpretation for LGV is not standardized, tests have not been validated for clinical proctitis presentations, and *C. trachomatis* serovar-specific serologic tests are not widely available.

11.5 Proctocolitis

Microorganisms from various sources can infect the colon. These sources can be: (1) ingestion of contaminated food and drink, giving rise to enterocolitis, and (2) alteration of the normal colonic flora by antibiotics and the overgrowth of *Clostridium difficile*. Microorganisms may also be inoculated locally in the rectal area during anal intercourse or by oral–anal contact.

Enterocolitis usually results in diarrhea and abdominal cramping with or without anorectal pain, tenesmus, or rectal discharge. Most infected individuals will develop a self-limited, mild infection. Fever and bloody stools are markers of a more severe illness, indicative of dysentery, and are often seen with enteropathogens causing local inflammation or invasion.

The most common enteropathogenic organisms include *Campylobacter* spp., *Salmonella* spp., *Shigella* spp., diarrheagenic *E. coli*, *C. difficile*, *Yersinia enterocolitica*, and a parasite: *Entamoeba histolytica*.

11.5.1 Clinical Specimens (General Comments)

Stool specimen may be passed into a clean, dry, disposable bedpan or similar container and transferred into a leakproof container. The specimen is unsatisfactory if there remains any residual soap, detergent or disinfectant in the pan; 1–2 g of stool is sufficient for routine culture. If more than one specimen is taken on the same day, the specimens may be pooled. Swab specimens should be avoided.

11.5.2 Indication (General Comments)

A stool examination for the presence of leukocytes, by means of a Gram's stain or methylene blue stain of a fresh fecal smear, or a stool lactoferrin assay, is a reliable indicator of colonic inflammation. Specific diagnosis of pathogens is based on stool cultures. Culture of stool is not warranted in most cases, but should be considered for those patients with severe diarrhea, inflammatory diarrhea, and for whom antibiotics are being considered [35]. Most laboratories will routinely culture stool for *Salmonella*, *Shigella*, and *Campylobacter*. Culturing for *E. coli* O157:H7 may have to be specifically requested in the appropriate clinical setting. Laboratory isolation of *Salmonella*, *Shigella*, and *Campylobacter* from stool cultures usually requires a minimum of 48 h.

11.5.3 *Salmonella*

Salmonellae are responsible for two distinct diseases. Typhoid fever caused by *S. typhi* or *S. paratyphi* is characterized by an infiltration of mononuclear cells into the small-bowel mucosa and by a dissemination resulting in a systemic disease with bloodstream infection, fever, and abdominal pain. Infection with nontyphoidal *Salmonella* is characterized by massive polymorphonuclear infiltration into both the large- and the small-bowel mucosa, most often resulting in gastroenteritis that lasts 1 week or longer, accompanied by diarrhea, fever, and abdominal cramps [71]. Less commonly, nontyphoidal *Salmonella* can cause bacteremia, especially in immunocompromised patients, or cause localized infections (e. g., osteomyelitis).

The diagnosis of typhoid fever relies upon the isolation of the causative microorganism, generally from blood cultures. This diagnosis needs to be considered in any febrile traveler returning from a developing country, especially the Indian subcontinent, the Philippines, or Latin America [77]. Blood cultures are positive in up to 80% of patients during the 1st week of infection. The yield of blood cultures decreases to 50% by the 3rd week of infection in untreated patients. A diagnosis can also be based on positive cultures of stool, urine, rose spots biopsy, bone marrow, and gastric or intestinal secretions. Stool cultures, while negative in 60–70% of cases during the 1st week, can become positive during the 3rd week of infection in untreated patients.

Nontyphoidal *Salmonella* gastroenteritis is diagnosed when *Salmonella* is cultured from stool. In severe cases where there is concern about bacteremia (i. e., those including prolonged or recurrent fever), blood cultures are indicated.

11.5.4 *Shigella*

Shigellosis is an acute infectious inflammatory colitis due to one of the members of the genus *Shigella*. Most cases of transmission are by person-to-person spread, but infection is also caused by ingestion of contaminated food or water. Sexual transmission of *Shigella* among MSM also occurs [58]. Ingestion of as few as 10–100 organisms has been shown to cause disease in volunteers.

Shigella species invade the colonic and rectal epithelium of primates and humans, causing the acute mucosal inflammation characteristic of shigellosis. Infection is usually confined to the superficial layer of the colonic mucosa, where severe tissue damage leads to abscesses and ulceration. Destruction of the epithelial layer leads to the clinical symptoms of watery diarrhea, severe abdominal pain and cramping, and bloody mucoid stool characteristic of bacillary dysentery. Infection with *Shigella* is generally self-limited. The duration of untreated *Shigella* gastroenteritis averages 7 days. Rarely, patients may develop secondary complications such as septicemia, pneumonia, and hemolytic uremic syndrome.

The genus is divided into four species, *S. flexneri*, *S. boydii*, *S. sonnei*, and *S. dysenteriae*. These species are further divided into serotypes based on biochemical differences and variations in their somatic O-antigen. All four subgroups of *Shigella* are capable of causing dysentery, but *S. dysenteriae* serotype 1 has been associated with a particularly severe form of the illness, thought to be related to its production of Shiga toxin.

Definitive determination of the infecting organism can only be made by culture of the stool. *Shigella* is a fastidious organism; as a result, it requires prompt handling. Culture from a stool sample may give a better yield than culture from a rectal swab.

11.5.5 *Campylobacter*

Campylobacter species are Gram-negative, curved, non-spore-forming rods that are responsible for a variety of infections [2]. Although acute diarrheal illnesses are most common, these organisms may cause infections in virtually all parts of the body, especially in compromised hosts, and these infections may have late, nonsuppurative sequelae. The principal diarrheal pathogen is *C. jejuni*, which accounts for 80–90% of all cases of recognized illness due to campylobacters. Other organisms that cause diarrheal disease include *C. coli*, *C. upsaliensis*, *C. lari*, and *C. fetus*. The major species causing extraintestinal illnesses is *C. fetus*; however, any of the diarrheal agents may cause systemic or localized infection.

Campylobacter species are primarily zoonotic, with a variety of animals implicated as reservoirs for infection. In most cases, campylobacters are transmitted to humans in raw or undercooked food products or through direct contact with infected animals. After an incubation period of about 3 days (range 1–7 days), infection is established in the jejunum, ileum, and often the colon and rectum. Biopsies show an acute, nonspecific inflammatory reaction, with neutrophils, monocytes, and eosinophils in the lamina propria, as well as damage to the epithelium, including loss of mucus, glandular degeneration, and crypt abscesses. Symptoms and signs usually include fever, abdominal cramping, and diarrhea that lasts several days to more than 1 week. Some patients present with acute colitis and bloody diarrhea.

The clinical features of *Campylobacter* enteritis caused by *C. jejuni* and *C. coli* are indistinguishable from each other and are insufficiently different from diarrhea caused by other bacterial pathogens, such as salmonellae, for a reliable diagnosis to be made without laboratory tests. *Campylobacter* enteritis is generally self-limited; however, symptoms persist for >1 week in 10–20% of patients seeking medical attention, and relapses occur in 5–10% of untreated patients. Except in the case of infection with *C. fetus*, bacteremia is un-

common, developing most often in immunocompromised hosts and at the extremes of age. Guillain-Barré syndrome and reactive arthritis are both late-onset complications of *Campylobacter* infection.

11.5.5.1 Specimen

Fecal specimens are the preferred sample for isolating *Campylobacter* species from patients with gastrointestinal infections. However, rectal swabs are acceptable for culture of *Campylobacter*. Testing a single stool sample has high sensitivity for detection of common enteric pathogens. A transport medium (Cary-Blair) is recommended when a delay of more than 2 h is anticipated, and for transport of rectal swabs, specimen should be stored at 4°C until processing.

11.5.5.2 Laboratory Diagnosis

Because of their characteristic microscopic morphology, clinicians can ask the laboratory to attempt the visualization of campylobacters by Gram-stain examination of stools obtained from patients with acute enteritis. The direct examination has a sensitivity ranging from 70 to 90% and a specificity above 95% [87]. Fecal white blood cells have been reported in a frequency ranging from 25 to 80% depending upon the series.

Most *Campylobacter* species require a microaerobic atmosphere for optimal recovery. To achieve the highest yield of campylobacters from stool samples, a combination of selective media appears to be the optimal method.

11.5.6 Colonic Pathogenic *Escherichia coli*

E. coli are common normal inhabitants of the human gastrointestinal tract and are among the bacterial species most frequently isolated from stool cultures. Intestinal pathogenic strains of *E. coli* are rarely encountered in the fecal flora of healthy hosts and appear to be essentially obligate pathogens. At least six distinct syndromes of intestinal pathogenic *E. coli* exist:

1. Shiga-toxin-producing *E. coli* (STEC)/enterohemorrhagic *E. coli* (EHEC)
2. Enteroinvasive *E. coli* (EIEC)
3. Enterotoxigenic *E. coli*
4. Enteropathogenic *E. coli*
5. Enteroaggregative *E. coli*
6. Diffusely adherent *E. coli*

The colon is involved in STEC/EHEC and EIEC syndromes. These organisms differ from nonpathogenic *E. coli* by the acquisition of virulence factors, which contribute substantially to disease pathogenesis and complications.

STEC/EHEC strains constitute an emerging group of pathogens that can cause hemorrhagic colitis and the hemolytic-uremic syndrome (HUS). The pathogenicity is related to the production of one or more Shiga toxins (Stx2 and/or Stx1) or variant related toxins. The pathogenic *E. coli* are not distinguishable from other strains by their appearance on culture plates or by the results of the usual biochemical tests. The strains of *E. coli* are serotyped and classified according to a somatic antigen (O) and a flagellar antigen (H). O157:H7 is the most prominent serotype, but other serotypes have also been associated with this syndrome [41]. A grossly bloody diarrhea is present in > 90% of cases. Significant abdominal pain and fecal leukocytes are commonly present (70% of cases), but fever is usually absent. HUS characterized by the triad of acute renal failure, microangiopathic hemolytic anemia, and thrombocytopenia complicates 6–9% of STEC/EHEC infections and usually begins 5–10 days after the onset of diarrhea. Of patients with HUS, as many as 50% will require dialysis during the acute phase, 3–5% will die, and 5–10% will have permanent and serious renal or neurologic sequelae.

EIEC is a relatively uncommon cause of diarrhea. Initially, enterotoxins induce secretory small-bowel diarrhea. Secondary colonization and invasion of the colonic mucosa result in the development of inflammatory colitis characterized by fever, abdominal pain, tenesmus, and scant stool containing mucus, blood, and inflammatory cells very similar to shigellosis. Diagnosis of EIEC strains are not routinely available in clinical laboratories

11.5.6.1 Laboratory Diagnosis of STEC/EHEC Infection

STEC/EHEC infection should be suspected in all patients with acute bloody diarrhea, particularly if associated with abdominal tenderness and the absence of fever. Diagnosis is based on the isolation of pathogenic *E. coli* strains or detection of Shiga toxin by immunoassays. Screening media allow the detection of pathogenic strains based on the inability to ferment sorbitol by *E. coli* O157:H7 [45]. Suspected strains are further characterized by typing methods, and suspected strains should be sent to a reference laboratory for confirmation. Newer diagnostic approaches are focused on the

direct detection of Shiga toxins in stool by gene amplification or immunoassay. Because there is no selective isolation medium for non-O157 STEC, testing for Shiga toxin in the stool is an option for the laboratory in areas where the prevalence of the STEC disease warrants testing [28].

11.5.7 *Clostridium difficile*

C. difficile is a Gram-positive, spore-forming anaerobe that is commonly implicated in antibiotic-associated diarrhea (AAD); approximately 20% of cases of AAD are due to *C difficile*. These episodes are mainly nosocomial, but community-acquired episodes have been described [54]. *C. difficile* is approximately 4 and 60 times more common than *C. perfringens* and *Staphylococcus aureus* AAD cases, respectively [4]. The virulence of *C. difficile* is mainly due to the production of two toxins, A and B. Up to 11% of virulent strains may only produce toxin B [66]. Some *C. difficile* strains also produce a third, unrelated toxin (binary toxin CDT) [6, 85].

C. difficile causes a spectrum of illness, ranging from mild abdominal discomfort to fulminant pseudomembranous colitis. The disease occurs almost exclusively in the large bowel and causes distinguishing microscopic and gross lesions. Colitis is not the only consequence of *C. difficile* infection. Bacteremia, and liver and splenic abscesses have all been described. The main predisposing factor for *C. difficile* diarrhea is antibiotic therapy, notably with cephalosporins, clindamycin, and broad-spectrum penicillins. The adult carrier rate is about 3%, but increases for hospitalized patients to 20% among adult patients hospitalized for more than 1 week. Only one-third of all infected patients develop diarrhea, while the remaining two-thirds are asymptomatic carriers. Diarrhea is the most common symptom caused by *C. difficile*. Stools are almost never grossly bloody and range from soft and unformed to watery or mucoid in consistency. Clinical and laboratory findings include fever in 28% of cases, abdominal pain in 22%, and leukocytosis in 50%. The hallmark of *C. difficile* infection is the presence of pseudomembranes confined to the colonic mucosa and initially appearing as 1- to 2-mm whitish-yellow plaques. As the disease progresses, the pseudomembranes coalesce to form larger plaques and become confluent over the entire colon wall. The whole colon is usually involved, but 10% of patients have rectal sparing.

Emergence of atypical strains of *C. difficile* with increased virulence and antibiotic resistance may be associated with outbreaks in hospitals [59].

11.5.7.1 *Specimen*

Freshly passed fecal samples are the preferred specimen. Only liquid or unformed stool specimens should be processed. Swab specimens are inadequate because the volume of sample obtained is too small. For optimal recovery, the specimen should be processed rapidly. Toxins may degrade and become inactive in stool samples that are inadequately transported and processed.

11.5.7.2 *Laboratory Diagnosis*

The laboratory diagnosis is based on two kinds of test: fecal culture and toxin detection. Culture on selective medium is very sensitive but lacks specificity because of possible carriage of nontoxigenic isolates. Moreover, it requires a 40- to 48-h incubation time and is therefore a relatively slow technique. Toxin detection can be performed by inoculation of a fecal filtrate on cultured cells, which will display a typical cytopathic effect that is neutralized by specific antiserum if the toxin is present. The cell culture assays for cytotoxin (toxin B) is considered the gold standard, but require up to 4 days for results, and uses expensive cells and media and a labor-intensive expertise. Immunoassays directed to either toxin A alone or both toxins A and B are available. Their main advantage is speed; they provide a result within only 20–40 min. However, this method is less sensitive than cell cultures. Immunoassays are now offered by most laboratories and have a good specificity, but 100–1000 pg of either toxin A or toxin B must be present for the test to be positive. Therefore, there is a false-negative rate of 10–20%. Those tests that detect both toxin A and toxin B are preferred, since 3–11% of cases involve strains of *C. difficile* that produce only toxin B.

In few cases, it may be useful to test more than one stool specimen for *C. difficile* toxin. Performing enzyme immunoassays on two or three specimens, rather than one, increases the diagnostic yield by only 5–10%, but increases the cost. Detection of toxin in stool specimens by PCR has also been developed and must be evaluated in routine laboratory.

11.5.8 *Entamoeba histolytica*

Amebiasis is the infection of the human gastrointestinal tract by *E. histolytica*. This protozoan parasite is able to invade the intestinal mucosa and spread to other or-

gans. *E. histolytica* produces a spectrum of clinical syndromes ranging from dysentery or bloody diarrhea, to fulminating colitis, amebic appendicitis, and ameboma. The most frequent form of extraintestinal amebiasis is the amebic liver abscess. Asymptomatic *E. histolytica* infections are described, but epidemiological data are confusing since nonpathogenic species such as *E. dispar* and *E. moshkovskii* may be misdiagnosed as *E. histolytica* [76, 80].

Infection generally follows the ingestion of fecally contaminated water or food containing *E. histolytica* cysts. Excystation occurs in the bowel lumen, where motile and potentially invasive trophozoites are formed. Trophozoites live in the lumen of the large intestine, where they multiply and differentiate into the cyst forms. Cysts are excreted in stools and may be ingested by a new host via contaminated food or water. Intestinal disease results from the penetration of the amebic trophozoite into the colonic tissues and the necrosis of the epithelium. Endoscopic examination shows discrete round ulcers covered with white or yellow exudate over the normal-appearing mucosa of the entire colon and rectum. Patients with dysentery have mucosanguineous evacuations, with moderate colic pain preceding discharge, and rectal tenesmus.

11.5.8.1 Specimen

The laboratory diagnosis can be made on liquid stool or biopsy specimens from mucosal ulcers. Fresh specimens are mandatory for the recovery of motile trophozoites. Once the stool specimen is passed from the body, trophozoites do not encyst but may disintegrate if not examined rapidly. If the general time recommendation of 30 min is not possible, the specimen should be placed into a commercial fixative. Material obtained from sigmoidoscopy can be helpful in the diagnosis of amebiasis that has not been detected by routine fecal examinations (at least three routine stool examinations). Material from the mucosal surface should be aspirated or scraped and must not be obtained with cotton swabs. Other infectious causes of dysentery must be systematically investigated.

11.5.8.2 Laboratory Diagnosis

Methods include microscopy, antigen detection, culture and NAATs. Abscess aspirates and serologic testing are also useful for the diagnosis of extraintestinal amebiasis. Standard microscopic examination is based on the detection of trophozoites and cysts; however, morphologic examination does not allow the differentiation of *E. histolytica* from the nonpathogenic *E. dispar*. The only exception is the finding of red blood cells in the cytoplasm of trophozoites, which is diagnostic for *E. histolytica* [30].

Antigenic assay allows the specific detection of *E. histolytica* directly from feces. These tests are more sensitive than microscopy (90% compared to 25–60%) [36].

NAATs are promising diagnostic tools, but as yet they are restricted to research laboratory. In one study, using PCR as a reference test, the sensitivity of antigen tests were 60–70% with a specificity of 98–100% [84].

Serum antibody detection is useful in low-prevalence areas, but its utility is questionable in high-prevalence areas since antibodies against total amebic antigens can remain positive for years after infection [80]. In a recent series using a commercially available enzyme immunoassay for the detection of specific IgGs, the sensitivity was 97.7% for invasive amebiasis such as colitis and 100% for amebic liver abscesses, the overall specificity being 97.4% [50].

11.5.9 *Trichuris trichiura*

T. trichiura is the causative agent of trichuriasis, also known as whipworm [10]. This intestinal nematode may occur worldwide, but a high prevalence is observed in tropical and subtropical areas. Transmission occurs via fecal-oral spread, and is associated with poor sanitation. Once ingested, the eggs hatch and release larvae. The larvae reach the cecum and ascending colon and mature into adult worms. In heavy infections, the distal colon and rectum may harbor adult worms. Females produce eggs, which are eliminated out in the stool. Adult worms penetrate the intestinal mucosa and trigger minor inflammatory changes of the mucosa. Most infections with *T. trichiura* are asymptomatic. During heavy infections, diarrhea, abdominal pain, and anemia are observed. Diarrhea can be grossly bloody and can simulate the symptoms of inflammatory bowel disease [70]. A classical finding associated with trichuriasis is rectal prolapse. This condition occur when multiple adult worms are embedded in the rectum. An endoscopic procedure may be applied for diagnosis of trichuriasis when stool examination remains negative for ova [56].

11.5.9.1 Laboratory Diagnosis

The diagnosis of trichuriasis is made by stool examination for eggs. In mild infections, concentration procedures are applied and several stools have to be examined.

11.5.10 *Schistosoma mansoni, S. japonicum*

Schistosoma mansoni and *S. japonicum* are the two main causative agents of human intestinal schistosomiasis, also called blood flukes or bilharzia. Urinary schistosomiasis is caused by *S. haematobium* [11]. Intestinal schistosomiasis results from infection with *S. mansoni* (endemic to Africa, the eastern Mediterranean, the Caribbean, and South America) or *S. japonicum* (which predominates in eastern Asian area).

Schistosoma have a complex life cycle with a definitive mammalian (human) host and one or more intermediate hosts. Human are infected by larvae during exposition to parasite-infested water in endemic regions. Larvae penetrate the skin, migrate in the host, and mature into adult worms. Females and males form pairs and live in blood vessels. These vessels are mesenteric and hemorrhoidal veins for *S. japonicum* and *S. mansoni*. Female worms produce eggs, which are eliminated in stool. A portion of the eggs are trapped in host tissues and induce an inflammatory reaction of the host. Acute schistosomiasis, known as Katayama fever, is characterized by fever, coughing, generalized muscle pain, headache, and eosinophilia [14, 19]. In chronic disease, the morbidity is associated with inflammatory responses against parasite eggs trapped in host tissues. Hepatic manifestations are due to eggs embolized into the liver, where a granulomatous inflammatory response induces presinusoidal inflammation and periportal fibrosis [34]. Intestinal schistosomiasis affects predominantly the rectosigmoid area. Digestive symptoms are lower abdominal pain, and diarrhea episodes that alternate with constipation. Endoscopy may show mucosal inflammation, ulceration, microabscess formation, and pseudopolyps.

11.5.10.1 Laboratory Diagnosis

The diagnosis of schistosomiasis is made by stool examination for eggs. Concentration techniques or repeated stool analysis are recommended to enhance the sensitivity of microscopy. Quantification of eggs per stool volume is used for epidemiological purposes. In patients with a typical clinical presentation but negative feces specimens, a biopsy of rectal mucosa must be used for diagnosis.

Different serologic techniques have been developed (immunofluorescence, indirect hemagglutination, and enzyme immunoassay) for the detection of specific antibodies. These tests are particularly useful for travelers or in previously unexposed patients, since they cannot distinguish active infection from past infection. Cross-reaction with other helminths is minimized using immunoassay detecting egg antigens [18].

In one study with acute schistosomiasis (Katayama fever), diagnosis was established by serology in 65% of the patients and by egg detection in 22% [14].

11.6 Lower Digestive Tract Infections in Immunosuppressed Patients

The number of immunosuppressed patients is increasing, the two main causes being the HIV pandemic and the growing number of patients with profound immunosuppression due to cancer therapy or organ transplantation. Infections of the lower gastrointestinal tract in these immunocompromised hosts are associated with significant morbidity and mortality. All of these patients are at risk for most of the infections of the gastrointestinal tract presented in the first parts of this chapter. Moreover, some diseases are mostly or exclusively observed in immunosuppressed patients. These opportunistic pathogens are cytomegalovirus (CMV), human herpesvirus 8 (HHV-8 – Kaposi's sarcoma (KS)-associated herpesvirus), *M. avium* complex in patients with advanced HIV infection, and *Strongyloides stercoralis*, which is responsible for *Strongyloides* hyperinfection syndrome. Other parasites including *Giardia lamblia*, *Isospora belli*, *Cryptosporidium*, and *Microsporidium* are responsible for gastrointestinal diseases in immunosuppressed patients, but these pathogens will be not reviewed here since they infect essentially the small bowel.

11.6.1 CMV Colitis and Proctitis

CMV is a member of the herpesvirus group. Like other herpesviruses, CMV can cause primary infection and lifelong latent infection. CMV disease can occur during primary infection or reactivation. CMV can be transmitted via placental transfer or via organ-graft to recipient, but the main route of CMV transmission requires repeated and prolonged intimate exposure with

an asymptomatic infected patient (saliva, sexual contact). CMV causes a wide spectrum of disorders, ranging from inapparent infection to a mononucleosis syndrome in healthy individuals, to disseminated disease in immunocompromised patients [27].

Symptomatic gastrointestinal CMV disease occurs most often in immunosuppressed patients due to solid-organ or bone-marrow transplantation, or HIV infections. CMV disease generally occurs in HIV-infected patients when the CD4+ cell count falls below 100/ mm^3. A decrease in the incidence of colonic CMV disease has been observed since the introduction of highly active antiretroviral therapy [21]; however, cases may occur despite a moderate stage of immunosuppression [91]. CMV diseases have been associated with other pathologies such as inflammatory bowel diseases [43], or in immunocompetent individuals with other comorbidities [26]. The whole intestinal tract may be infected by CMV, ranging from esophagitis to colitis and proctitis [12, 68].

Diarrhea, fever, and abdominal pain are common presenting symptoms in CMV colitis. Complications such as intractable lower-gastrointestinal bleeding and perforation may be observed [64].

The spectrum of endoscopic lesions is variable and ranges from patchy erythema, exudates, and microerosions to diffusely edematous mucosa, multiple mucosal erosions, deep ulcers, and pseudotumors [57].

Diagnosis of CMV colitis is controversial, and definition criteria for infection and for disease have been developed [57]. The present authors suggest combining: (1) clinical symptoms, (2) findings of macroscopic mucosal lesions at endoscopy, and (3) demonstration of CMV infection in a biopsy specimen by different techniques.

11.6.1.1 Laboratory Diagnosis

A variety of methods are available for the laboratory diagnosis of CMV rectocolitis. These include the detection of the virus by antigenemia assay, cell culture (shell-vial centrifugation cultures), histologic and cytologic examinations, and by qualitative or quantitative NAATs.

Antigenemia Assay

Detection of CMV in leukocytes is a good indicator of symptomatic CMV infection. Blood leukocytes are collected and enriched through different techniques from freshly anticoagulated whole blood kept at 4°C. The CMV antigen pp65 is detected by immunofluorescence [13] within blood leukocytes. A quantitative result is obtained as the ratio of antigen-positive cells over the total number of leukocytes evaluated. The antigenemia assay is more sensitive than culture methods, but is labor intensive.

Cell Culture and Shell Vial Culture

Isolation of CMV using cell culture or shell-vial assay was until recently considered as the gold standard for the laboratory diagnosis of CMV, but the performance of the culture is lower than NAAT. Fibroblast cell lines are used to amplify CMV in vivo. Detection of the CMV cytopathic effect on the fibroblasts cell line depends on the amount of virus present in the specimen and appears generally during the 1st week postinoculation. The shell-vial culture may accelerate the diagnosis. In this technique, monoclonal antibodies are used to detect CMV early antigen before the appearance of a cytopathic effect.

Nucleic-Acid Amplification Tests

Several qualitative or quantitative NAATs have been developed for the diagnosis of CMV infection. Quantitative test are preferred to qualitative NAATs since the detection of CMV DNA in plasma or blood leukocytes using qualitative tests lacks specificity for the diagnosis of CMV disease [88].

Quantitative tests play an important role in the monitoring of high-risk patients [13]. Qualitative NAATs are useful in certain settings, such as tissue specimens, notably biopsy specimens of the digestive tract. Detection of CMV by NAAT alone is insufficient for the diagnosis of CMV gastrointestinal disease [57].

Histopathology

Sections of biopsy specimen are evaluated with the aid of microscopy for characteristic large cells called "cytomegalic cells" with "owl's eye" nuclear inclusion bodies. Immunohistology using anti-CMV monoclonal antibodies or in-situ hybridization may be used to confirm CMV infection. The sensitivity of histology is 80% and the specificity is 95% [8].

Serology

Enzyme immunoassay is the preferred technique for the serodiagnosis of CMV. Baseline value and follow-up tests are recommended for patients with high risk of CMV infection. Seroconversion occurring during primary CMV infection is reliable for diagnosis. Reactivation or reinfection with CMV is difficult to determine with serology. Determination of CMV IgM may be useful to diagnose a recent infection, but the results should be interpreted with caution since false-positive results have been described with rheumatoid factor and Epstein-Barr virus infection.

11.6.2 Human Herpesvirus 8

HHV-8, also known as KS-associated herpesvirus, is a member of the herpesvirus group. Unlike most members of this group, which are ubiquitous in most populations, HHV-8 is not widespread in the general population, but is endemic in certain geographic areas (Mediterranean basin and Africa), and a high prevalence is observed among homosexual men. In industrialized countries, the seroprevalence of HHV-8 is relatively low (2–8%) [38].

Four forms of KS have been described [1]. In the classical KS, multifocal, pigmented cutaneous lesions are observed on the lower extremities in elderly patients. The endemic-African KS may involve lymph nodes in addition to skin, and often affects HIV-negative hosts and children. The iatrogenic form of KS occurs after solid-organ transplantation in patients on immunosuppressive medications. The AIDS-related KS involves the skin and extracutaneous sites; this aggressive form may involve the gastrointestinal tract. In addition, HHV-8 is associated with other lymphoproliferative disorders [1].

Saliva and close interpersonal contact are the main routes of transmission in populations of endemic regions, whereas sexual transmission predominates among homosexual men [37]. An important reduction in KS incidence has been observed with the introduction of highly active antiretroviral therapy [15].

The gastrointestinal tract is the most common visceral site in the AIDS-related KS form. KS predominates in the upper digestive tract, but any segment of colon and rectum may be involved. Gastrointestinal KS is seldom symptomatic. In some cases, intestinal obstruction and bleeding may occur. At endoscopy, nodular and highly vascularized lesions are observed.

11.6.2.1 Laboratory Diagnosis

KS diagnosis is based on histopathologic presentation with proliferating spindle cells, neovascular spaces, and inflammatory cells. Several HHV-8 NAATs have been developed, but are as yet confined to research settings. Reliable procedures for isolation of the virus from KS lesions have not been developed.

Serology

The serological methods used are immunofluorescence assays and enzyme immunoassays. Serological tests are used for seroepidemiology, but are rarely performed in clinical practice.

11.6.3 *M. avium* Complex

Organisms belonging to the *M. avium–M. intracellulare* complex (MAC) are responsible for disseminated infections in severely immunosuppressed HIV patients [44]. During the natural course of HIV infection, up to 15% of patients will suffer from MAC infection, generally when their CD4 count is below 50/mm³. The introduction of highly active antiretroviral therapy has markedly reduced the risk of MAC for HIV-infected individuals [67]. Disseminated MAC infection has also been described after cardiac or hematopoietic stem-cell transplantation [20, 62].

MAC is acquired from the environment by inhalation or ingestion of organisms. The gastrointestinal tract is the most common site of colonization and source of dissemination. The bacteria penetrate the intestinal mucosa and are phagocytozed by macrophages. In patients with advanced HIV disease, MAC organisms persist and multiply within mononuclear phagocytes. Local replication of organisms leads to the formation of local foci that can be visualized endoscopically as granular lesions [79]. Involvement of the duodenum predominates, but all segments of the gastrointestinal tract may be involved [40]. In one series, rectal biopsies were positive in 20% of patients [32]. Disseminated MAC disease presents as fever, weight loss, night sweats, diarrhea, abdominal pain, anemia, and an elevated serum concentration of alkaline phosphatase.

11.6.3.1 Laboratory Diagnosis

The diagnosis of disseminated MAC infection is based on mycobacterial culture. Peripheral blood is inoculated into an appropriate liquid medium and incubation can be prolonged for up to 42 days. Bone marrow or liver biopsy specimens have also been used for diagnosis. Stool specimens can be used for the detection of MAC, but direct smears have a low sensitivity [61]. Culture for MAC from colonic biopsy samples is appropriate but, in one series, all HIV-infected patients with positive MAC culture had concomitant positive blood cultures, thus questioning the utility of biopsy culture [9].

11.6.4 *Strongyloides stercoralis*

S. stercoralis is an intestinal nematode that causes strongyloidiasis. This soil-transmitted nematode is endemic predominantly in tropical areas [73]. The infection is frequently imported into nonendemic areas by travelers and immigrants. The biology of the parasite cycle is complex, with free-living and parasitic stages. Following contact between human skin and contaminated soil, the filariform larva penetrates the skin and migrates through the lungs, before settling in the intestine. The larvae mutate into adult worms in the small intestine. Eggs produced by the female worms embryonate into rhabditiform larvae, which are shed in the stool [46]. *S. stercoralis* may cause autoinfection when larvae within the gastrointestinal tract penetrate the intestinal mucosa and then migrate again into the intestinal tract. Autoinfection may lead to chronic disease that can last for decades.

In immunocompetent hosts, infection by *S. stercoralis* may induce minor cutaneous, pulmonary, or gastrointestinal symptoms, but the majority of cases are asymptomatic. Two severe entities may be observed in immunosuppressed patients, particularly in patients treated with glucocorticosteroids. Hyperinfection syndrome is attributed to a massive invasion of larvae into the bowel and often into the lungs, and the disseminated form is due to the presence of worms in extraintestinal and extrapulmonary sites (e. g., cerebrospinal fluid, peritoneal fluid, liver) [24]. Sepsis due to digestive bacteria or yeast carried by worms has occasionally been observed [46].

Complicated strongyloidiasis in immunosuppressed patients may implicate any segment of the gastrointestinal tract, including the colon and rectum. Nonspecific symptoms are observed, notably abdominal pain, diarrhea, and bleeding. Ulcerations predominate in the small intestine, but may also be observed in the colon or rectum. Eosinophilia is often absent in severely infected patients [24].

11.6.4.1 Laboratory Diagnosis

The microscopic finding of larvae in stool is diagnostic of strongyloidiasis. In immunocompetent patients, several stool examinations are necessary since the parasite load is low. In immunosuppressed patients, the high load of larvae facilitates the diagnosis. Intestinal tissue biopsy samples may be submitted for diagnosis of strongyloidiasis. In these cases, adult worms and eggs may be observed. The examination of duodenal aspirate has been proposed to complement stool examination. In one study, larvae were found exclusively in the duodenal fluid (and not in the feces) in 67% of patients [29].

A recent serologic study with two commercially available *S. stercoralis* enzyme immunoassays has shown a sensitivity of 89–83% and a high specificity (97%) [83].

11.7 Concluding Remarks

Many pathogenic organisms may affect the colon and the rectum. The clinical symptoms and endoscopic findings have low specificities. Microbiological investigations are important in order to establish a precise etiology and lead to a specific treatment. Good communication between physicians and microbiologists is essential since the spectrum of potentially pathogenic microorganisms is increasing due to people traveling, the HIV pandemic, immigration, and iatrogenically immunosuppressed patients. Most clinical laboratories are not able to detect all of the microorganisms that potentially could be involved, and access to a network of reference laboratories through a local laboratory is important. The collection of appropriate specimens and their adequate transport to the laboratory are the two first steps to ensuring reliable diagnostic testing. Standard diagnostic procedures have been described in this chapter, but numerous new tests essentially based on NAATs are currently being developed to enhance both the sensitivity and the specificity of laboratory tests.

While some new etiologic agents of lower digestive tract infections have been observed and their incidence

established in selective high-risk patients such as MSM and/or HIV-infected patients, data on their prevalence is lacking for the general population. Prospective studies with broad microbiological investigations are thus needed to help the physician to look at the more prevalent infection agents in each clinical situation.

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Self-Assessment Quiz

Question 1

Select the best answer:

a. More than 80% of invasive amebiasis cases such as colitis are positive with serum antibody detection.
b. Morphologic examination of trophozoites and cysts allow differentiation of *Entamoeba histolytica* from the nonpathogenic *E. dispar*.
c. Culture for *Mycobacterium avium* complex (MAC) from colonic biopsy is systematically recommended for the diagnosis of disseminated MAC infection.
d. Sepsis due to intestinal bacteria or yeast is observed in 25% of immunosuppressed patients with strongyloidiasis.
e. Demonstration of cytomegalovirus by culture in endoscopic biopsy specimen allows the diagnosis of cytomegalovirus colitis.

Question 2

Select the best answer:

a. More than 80% of *Chlamydia trachomatis* infections in both genders are symptomatic.
b. Lymphogranuloma venereum (LGV) is caused by *C. trachomatis* serovars A–K.
c. Nucleic-acid amplification tests (NAATs) are the tests of choice for the diagnosis of *C. trachomatis* infections.
d. Identification of LGV serovars compared to other serovars are performed systematically when screening NAATs are positive.
e. Serology is useful for the diagnosis of acute genital non-LGV chlamydial infections.

Question 3

Select the best answer:

a. Eighty-five percent of rectal gonococcal infections are asymptomatic.
b. More than 50% of men who have sex with men with infectious proctitis are infected with two or more microbial agents.
c. Gram staining of rectal smears for *Neisseria gonorrhoeae* has a good sensitivity.
d. Nonculture tests such as NAATs are ideal methods when transport and storage conditions are not optimal for the viability of *N. gonorrhoeae*.
e. Serology is optimal for the follow-up of a patient's treatment.

Question 4

Select the best answer:

a. The prevalence of human papilloma virus (HPV) DNA in sexually transmitted disease (STD) clinic attenders is around 90%.
b. Biopsy is necessary for newly occurring acuminate lesions.
c. Annual screening for HPV lesions is commonly recommended for men who have sex with men.
d. HPV grows easily on a variety of cell cultures.
e. Low-risk HPV types are found in more than 90% of cases of anogenital condylomata acuminata.

Question 5

Select the best answer:

a. NAATs are the most sensitive techniques for the diagnosis of herpes simplex virus (HSV) infection.
b. Viral culture is the most sensitive technique for the diagnosis of HSV infection.
c. Education and counseling is recommended for persons with genital herpes who have positive serology for HSV-1.
d. Serology for HSV-1 is useful for investigation of asymptomatic patients (e. g. sexual partner).
e. A positive serology for HSV-2 is inconsistent with a diagnosis of anogenital infection.

1. Answer: a
Comment: in low endemic areas, serum antibody testing against *E. histolytica* is indicated in symptomatic patients, since the majority (more than 80%) are positive. IgG antibodies could be present within 1 week after the onset of symptoms in patients with amebic colitis. In high endemic areas, most patients may be positive due to persisting antibodies attributed to past infections. The best approach is to combine the direct microscopic detection of *E. histolytica* in stools with serum antibody detection.
2. Answer: c
Comment: *C. trachomatis* is an obligate intracellular bacterium. In-vitro culture is complex and limited to the research laboratory. Antigen detection by immunofluorescence or immunoassay has shown limited sensitivity compared to NAATs, which are considered the "gold standard." However, NAATs are not officially approved for use with rectal swabs. Positive tests should be repeated to confirm the diagnosis.
3. Answer: d
Comment: *N. gonorrhoeae* recovery upon culture is dependent on good transport conditions (appropriate transport medium, CO_2 requirements), which are difficult to obtain. Detection of *N. gonorrhoeae* by culture is also suboptimal with specimens such as rectal swabs. A clear advantage of NAATs is that they are not dependent on viable bacteria and they require less stringent transport conditions. A positive rectal NAAT should be repeated to confirm the diagnosis. For epidemiological reasons, appropriate antibiotic treatment must not be delayed. When a resistant strain is suspected, or in the case of treatment failure, culture is mandatory for the determination of antimicrobial resistance.
4. Answer: e
Genital warts are caused by HPV infection. Using NAATs, low-risk HPV types such as 6 and 11 are found in nearly all lesions. The distribution of these two types may differ between populations. More than 30% of condylomata acuminata lesions also contain high-risk HPV types, among which type 16 predominates. The influence of concomitant infection with high-risk HPV on the natural history of condylomata acuminata is unknown.
5. Answer: a
Comment: NAATs have become the new gold standard for HSV diagnosis. These tests are not dependent on a viable virus, and thus require less stringent transport conditions. According to one series, the sensitivity is increased from 10 to 30% compared to viral culture. The method may also be used on suboptimal specimens, such as those from patients with late-stage disease (e. g. crusted lesions, genital ulcer). A clear advantage is the ability of NAATs to reliably differentiate between HSV-1 and HSV-2. In the near future, NAATs will replace cell culture in the majority of laboratories.

12 Nutritional Evaluation and Care in Coloproctology

Laurence Genton and Claude Pichard

CONTENTS

12.1 Introduction

Protein calorie malnutrition (PCM) is prevalent in 30–80% of hospitalized patients in North America and Europe [9, 12, 16]. It is regarded as primary when it results from inadequate food intake, as usually happens in developing countries, and secondary when it is caused by illness, leading to decreased calorie and protein intake and increased nutrient losses and/or requirements. Severe PCM has deleterious physiologic consequences affecting nearly every organ system. Malnourished surgical patients are at greater risk for postoperative morbidity and mortality than well-nourished patients undergoing similar operations (Table 12.1). Several studies have shown that preoperative nutritional support in patients with severe depletion results in a reduction in major complications, thus justifying the need for evaluation of such patients and administration of perioperative nutritional support [26, 33, 36].

Table 12.1 Adverse effects related to protein calorie malnutrition

- Reduced postoperative complications (e. g., fistulas, wound dehiscence)
- Enhanced immunometabolic host response
- Reduced infection rate
- Improves tolerance to treatment
- Shortened length of the hospital stay
- Improved quality of life
- Reduced global therapeutic costs

12.2 Pathophysiology

12.2.1 Uncomplicated Fasting

During prolonged periods of fasting, in the absence of stress, the metabolism adapts by reducing the breakdown of lean body mass [3]. Fat and fat-derived fuels gradually replace glucose as the major source of energy. Initially, glucose requirements are provided by glycogen, which lasts for only 24 h. As glucose levels decline, insulin levels also decline and glucagon levels increase. Amino acids are released by skeletal muscle and used for hepatic gluconeogenesis, which provides glucose for the central nervous system. These changes in insulin and glucagon levels also favor lipolysis and mobilization of fatty acids as fuel. By the 2nd week of a complete fast, fatty acids form ketone bodies, which become the primary source of energy for the brain and reduce the need for glucose. Thus, muscle catabolism decreases, conserving their protein content. Energy expenditure is also reduced by as much as 35% by a process of adaptation [15].

12.2.2 Metabolic Changes Due to Stress

During an acute illness, inflammatory and hormonal responses alter this adaptive response and lead to protein and energy hypermetabolism, resulting in PCM [35]. The pathogenesis of PCM has been related to increased levels of proinflammatory cytokines (interleukin-1, interleukin-6, tumor necrosis factor-α, interferon-γ), reduced secretions of insulin-growth factor-1 and gonadotrope hormones, and increased secretions of glucocorticoids. These mechanisms lead to increased energy expenditure, nitrogen loss, and failure of ketoadaptation. Energy expenditure is increased by as much as 30% in acute illness such as trauma or sepsis [15].

12.3 PCM: Consequences

PCM has severe physiologic consequences, leading to morphologic and functional changes in virtually every organ system. When a subject reduces their protein and calorie intake under normal (nonstress) circumstances, the loss of nitrogen initially continues at the previous rate and exceeds the current intake. However, after a few days, the nitrogen excretion progressively falls and plateaus. This reduction in nitrogen excretion with progressive starvation appears to be mediated in part by the increasing availability of fat energy to meet requirements. This adaptive response is altered in the presence of stress (trauma, sepsis), and there is a preferential catabolism of lean body mass. The body's organs decrease in size to varying degrees, and body composition is altered. For example, studies of body composition in healthy humans have shown that total body potassium (TBK) and total body nitrogen (TBN) exist in a constant proportion. However, in malnourished patients, the TBK:TBN ratio is significantly lower [23]. Furthermore, malnourished patients exhibit a significant decrease in organ function (e.g., a decrease in cardiac stroke volume or in skeletal muscle contraction characteristics with consequences for respiratory function) [23]. Although wound healing is relatively well preserved in mild nutritional deficiency, it is impaired in severe PCM. Immunologic functions are decreased in severe PCM, with a diminution of total lymphocyte counts, and both B- and T-cell functions are depressed [4]. Other nonspecific host defense mechanisms, including gut mucosal integrity, interferon production, and opsonization, are also diminished in PCM. All of these abnormalities of the immune response, together with changes in the body's anatomic barriers, may contribute to an increased risk of infection. This may create a vicious circle by further increasing catabolism and loss of lean body mass, thus aggravating PCM and further compromising immune function (Fig. 12.1).

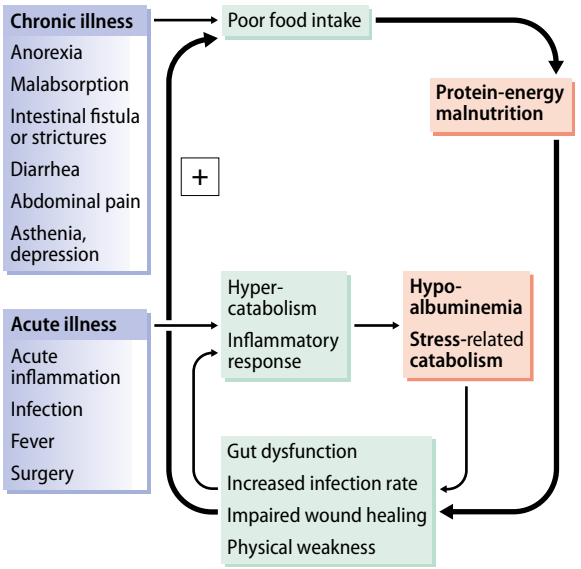

Fig. 12.1 Chronic colorectal disease leads to protein calorie malnutrition, which in turn increases vulnerability to secondary pathologies. Acute attacks of the disease result in hypercatabolism, which further aggravates protein calorie malnutrition and generate a vicious circle

The gastrointestinal system plays an important role in severe PCM because the small-bowel mass is decreased, primarily due to mucosal atrophy and loss of villi. Functionally, disaccharidase enzyme activity and the rate of amino acid absorption are decreased. This may lead to another vicious circle in the maintenance of PCM.

12.4 Evaluation of Patients

Advanced PCM is easy to recognize, but early PCM is difficult to define clinically, especially if nutritional support is to be initiated before the occurrence of complications. There are several methods that rely on objective anthropometric measurements (i.e., skin-fold thickness, arm circumference) and laboratory tests, but their lack of specificity in relation to their ability to predict a clinically significant adverse effect may lead to erroneous conclusions and treatments. The most sensitive diagnostic measure is a documented history of

Table 12.2 Subjective global nutritional assessment (SGA) for easy-to-use clinical bedside assessment

History	Weight change	Overall loss in the preceding 6 months in kilograms and as a percentage loss Change in the preceding 2 weeks in kilograms
	Dietary intake change	Duration in weeks; gradation from none to starvation
	Gastrointestinal symptoms for > 2 weeks	None, nausea, vomiting, diarrhea, anorexia
	Functional capacity	Optimal, duration and dysfunction, type (i. e., working, ambulatory, bedridden)
	Disease and its relation to nutritional requirements	Primary diagnosis, metabolic demand (none to high stress)
Physical examination		
	Loss of subcutaneous fat	
	Muscle wasting	
	Ankle edema	
	Sacral edema	
	Ascites	
SGA rating	Well nourished	
	Mildly malnourished	
	Severely malnourished	

Table 12.3 Warning signs for protein calorie malnutrition in colorectal diseases

- Weight loss: greater than or equal to 5% usual body weight during the previous 2 weeks
- Anorexia, hypophagia, intestinal losses: observed for > 5 days and/or in progression
- Hypermetabolism, persistent fever, chronic infection: observed for > 5 days and/or in progression
- Altered physical capacity and/or muscle force: decreased and/or deteriorating
- Albuminemia: ≤ 30 g/l

weight loss, quantified as a percentage of original body weight. No absolute standard amount of weight loss occurring over an established period of time clearly indicates clinically significant PCM. Nevertheless, most authors consider a 10% weight loss occurring during the preceding 12 weeks to be clinically significant. A practical way of assessing the risks of PCM is to evaluate the patient at the bedside using an established method known as the subjective global assessment (Table 12.2) [5, 22, 30] or the nutritional risk index [14]. Several laboratory tests are utilized to assess the nutritional status in PCM. The most valuable is the serum albumin level, and values below 26 g/l are generally associated with advanced PCM [2]. It is particularly important to carefully evaluate the nutritional status in pediatric and geriatric populations, who are at increased risk for PCM and have a higher associated morbidity and mortality rate.

In summary, clinicians should actively look for PCM as a routine procedure using simple nutritionally oriented patient histories, physical examination (Tables 12.2 and 12.3), and laboratory tests. This should be done with the aim of qualifying the degree of nutritional depletion and deciding whether or not nutritional support should be prescribed immediately.

12.5 Nutritional Requirements

Protein and energy utilization are interdependent. Any underadministration of one component cannot be substituted by overadministration of the other.

12.5.1 Energy Needs

The basal energy expenditure of a fasting subject is dependent on his or her weight, height, age, and gender, and can reasonably be predicted by the Harris-Benedict equation. It is increased by fever (i. e., by 10% for every degree over 37 C). During the last decade, indirect calorimeters have become available for clinical use and allow nutritional support to be customized to the patient's exact needs. Unfortunately, indirect calorimetry is time-consuming and not routinely applicable to all patients. From a practical point of view, energy requirements may also be calculated on the basis of body weight. Clearly these will be less accurate, but are adequate in most clinical situations except in patients with severe obesity or cachexia. The simplest method consists of using the estimate that, at rest, men require 30–35 kcal/kg/day, and women 25–30 kcal/kg/day [9]. The *actual* weight is used in most patients. In emaciated patients, a mean between the ideal and actual weights is computed, whereas for obese subjects the ideal weight plus 20% is used, up to a maximum of 35 kcal/kg/body weight/day. Excessive energy intake is associated with serious adverse effects such as acute liver steatosis and hyperglycemia [29, 32].

12.5.2 Protein Needs

Protein requirements may be calculated according to the body weight as 1.2–1.5 g/kg/day plus losses (abdominal drains, estimated protein losses from the gastrointestinal tract, urinary losses). The weight used for these calculations is the same as for energy requirements (see above; obese or emaciated individuals). It is worth mentioning that protein administration in excess of 1.8 g/kg/day has never been shown to be beneficial.

12.6 Gastrointestinal Disease and High Risk of PCM

Patients with gastrointestinal disease are particularly prone to PCM [14, 25]. This is due to decreased oral intake, increased energy demands, decreased absorption, and/or increased protein loss through their diseased intestine. This is further aggravated by an increased catabolic state in patients with inflammatory bowel disease with ongoing active inflammation, or in those with septic complications. The approach to patients with gastrointestinal disease encompasses a clear understanding of the physiology of the intestinal tract and objective measures to identify the site, nature, and extent of the disease. This is especially true in patients with Crohn's disease, who may present with the whole spectrum of gastrointestinal involvement with resultant PCM. This may include poor nutritional habits due to self-administered "exclusion" diets, and psychological problems, the presence of fistulas, strictures, malabsorption (including bile-salt malabsorption), short bowel, diarrhea, infection, and abscess formation. Furthermore, hospitalized patients undergo frequent radiological and endoscopic investigations that require gastrointestinal preparations and prolonged fasting, thus adding insult to injury (e. g., colonoscopy, computed tomography scan).

12.7 Nutritional Problems in Specific Colorectal Pathologies

The clinician often faces specific nutritional deficiencies depending on the nature of the underlying pathology. There may be an associated anorexia, food intolerance (e. g., lactose, high fiber), or exclusion of a particular food (i. e., patient's belief that a certain food item causes an acute attack, leading to exclusion of that food item). A frequent situation is avoidance of milk and all dairy products with concomitant use of corticosteroids, leading to precocious osteoporosis. The presence of abdominal pain and diarrhea are also two important factors that influence dietary habits and food intake, often leading to decreased calorie intake with avoidance of certain dietary elements, particularly in an attempt to control postprandial diarrhea, which can be a major social handicap. Previous gastrointestinal surgery or involvement of particular segments of the gastrointestinal tract can lead to specific deficiencies or malabsorption. During nutritional assessment in the presence of acute inflammation, common laboratory test values are very much altered (i. e., albumin and transferrin lowered) and poorly interpretable from a nutritional point of view. In these situations, the chronicity of disease and the intensity of the acute attack may be critical in evaluating PCM and the potential

need of nutritional support. Recently, the European Society for Clinical Nutrition has reviewed the literature published on perioperative nutritional support and published guidelines on its application [17, 34]. In the following sections, Crohn's disease, ulcerative colitis, fistulas, and diverticulitis will be reviewed separately.

12.8 Crohn's Disease

Nutritional management in patients with Crohn's disease is complex. During acute attacks, there is diarrhea with water, ion, and nutrient losses accompanied by stress, pain, and fever leading to catabolism and rapidly developing or progressing PCM. During acute attacks, there may be inflammatory narrowing of involved small intestine, or subacute obstruction. The use of a low-residue diet may reduce obstructive symptoms in these patients; however, if fibrotic obstruction is present, surgical resection or stricturoplasty may be required. Patients with extensive small-intestine disease or surgical resection may have fat malabsorption with steatorrhea. This may lead to severe diarrhea secondary to the irritating effect of hydroxyl fatty acids on the colon, in turn leading to significant losses of calcium, zinc, and magnesium. These patients may have a symptomatic improvement with reduction of dietary fat to about 70 g/day. If a low-fat diet is to be recommended, alternative calorie sources should be provided in the form of carbohydrate or medium-chain triglycerides. In patients with bile-acid-induced diarrhea, the bile acid-binding agent cholestyramine has been used, although this can lead to fat malabsorption with fat-soluble vitamin deficiencies in the long term. In such patients, an elemental diet has been shown to reduce fecal bile acid excretion and diarrhea [13]. Crohn's disease complicated by fistulas is particularly difficult to manage. Healing is very slow, and recurrence is frequent. In this situation, nutritional support may be initiated to promote healing and fistula closure, as risky surgical closure of the fistula is the only real alternative. Nutritional support can be given either by the enteral or the parenteral route. With this approach, however, only 15–20% of Crohn's fistulas close and they frequently break down when oral feeding is resumed. Perianal fistulas may considerably improve and even heal on elemental diets [31].

There is ongoing debate as to whether diet alone, and particularly oral or enteral feeding, can be used as primary therapy in Crohn's disease. Some of the larger, well-controlled studies have shown elemental diet to be as effective as prednisolone in improving disease activity in patients completing both the drug and diet treatments [11]. However, withdrawal from the study in the elemental diet group was high due to problems of unpalatability. The use of polymeric diets may circumvent this problem as they are more palatable, but are not hypoallergenic. In a more recent double-blind study, isocaloric polymeric or elemental diets administered by nasogastric tube feeding were compared in patients with Crohn's disease [18]. More patients in the polymeric diet group were in remission after 28 days of treatment. Although few patients remained in remission after 1 year of follow-up, this well-controlled study demonstrates that the benefits of enteral liquid diets are not restricted to elemental diets alone. In our experience, the constant rate of liquid diet administration is more important than the composition of the foods to promote gastrointestinal tolerance. On this basis, in our institution we have prescribed only polymeric diets for more than 10 years.

As a general rule, the enteral route is preferred to the parenteral mode unless obstruction, severe ileus, or a fistulous abscess is present or imminent surgery is contemplated. In patients with extensive small-bowel resection or proximal high-output fistula, parenteral nutrition alone or in conjunction with enteral nutrition, if feasible, is required to meet nutritional needs.

Special attention has to be paid to patients with Crohn's disease in remission. Some 20–40% of such patients may continue to lose weight despite no obvious malabsorption. This is largely the consequence of a decrease in energy and protein intake due to a reduction in intake of a large number of food items (especially those with a high fat and thus energy), poor appetite, and little pleasure related to eating, which is in part related to depressed mood. The advice given to most patients with inflammatory bowel disease is to eat adequate amounts of a well-balanced diet sufficient to maintain the body weight. Many patients think that particular food items exacerbate their pains or aggravate their diarrhea, and consequently exclude a long list of food items from their diet, which thus becomes nutritionally unbalanced. Some food items have objectively been shown to cause abdominal pains or relapses more frequently than others. These include melted cheese, lemon, orange, grapefruit, and pineapple. In spite of these findings, patients should be instructed to eliminate certain food items only if they repeatedly and consistently produce their symptoms. Patients with intestinal strictures should avoid high-fiber diets, and those with known lactose intolerance should be advised to use lactase-containing products. Vitamin

D, calcium, and cobalamin replacement is necessary in patients with terminal ileal disease or resection. On the other hand, substitution of potassium, magnesium, and zinc should not be overlooked when diarrhea is present, as these ions are lost in the stools (e. g., 10 mg zinc/l stool, a quantity that equals the daily normal requirements).

12.9 Ulcerative Colitis

PCM is generally less pronounced in patients with ulcerative colitis than in patients with Crohn's disease. During acute flare-ups, there is significant blood loss together with protein and nutrient losses through the inflamed colon. During mild-to-moderate attacks, oral feeding may be maintained with minor dietary modifications, such as a low-residue diet with liquid high-protein food supplementation. Iron and folic acid supplementation is important, especially when aminosalicylates are administered. This is continued until full clinical and often endoscopic remission is obtained. The situation is different with severe attacks, in which no oral nutrition may be given, with reliance on parenteral nutrition. In patients resistant to intensive medical therapy and requiring colectomy, administration of parenteral nutrition is related to a better hospital outcome, has a direct impact on total body protein sparing, and shortens recovery time (Fig. 12.2) [27].

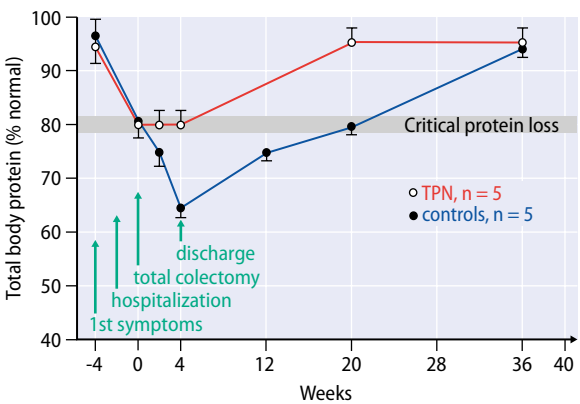

Fig. 12.2 Changes in body protein, as measured by in-vivo neutron activation analysis, in patients with acute colitis, from onset of symptoms (week –4), colectomy (week 0), discharge (week 4), and until full recovery. Patients were randomized to either total parenteral nutrition (TPN) or oral feeding at the start of their hospitalization. Restoration of body protein occurred about 18 weeks earlier in the TPN-fed patients (*open circles*, n = 5) than in those without nutritional support (*black circles*, n = 5). The horizontal grey zone indicates critical loss of body protein. Adapted from Hill et al. [13]

12.10 Fistulas and Ileostomies

Treatment of enteroenteric or enterocutaneous fistulas has improved over the past few decades due to improvement in parenteral nutrition and better control of water and electrolyte balance, together with newer, wide-spectrum antibiotics and surgical techniques. The notion of "bowel rest" to help close fistulas is an illusion. Even in the fasting state, there are migrating motor complexes resulting in intermittent mechanical activity, and "to heal a fistula, one should feed the gut" [6, 20]. Only symptomatic enteroenteric fistulas require nutritional support. If there is an associated inflammation, such as in Crohn's disease, corticosteroid administration together with enteral or parenteral nutrition is required. Whereas parenteral nutrition is necessary to compensate for water and electrolyte losses in proximal high-output fistulas, enteral nutrition may be sufficient in distal ones. Improving nutritional status with enteral nutrition has been reported to improve the closure rate of Crohn's and non-Crohn's fistulas by 15% and 60%, respectively [7]. The closure rate of fistulas may further improve with administration of somatostatin analogs that decrease gastrointestinal fluid secretion even in presence of enteral nutrition. Unfortunately, reopening of the fistulas is frequent, often requiring surgical resection.

As for patients with ileostomies, no special nutritional management is required unless there is preexisting PCM. Nevertheless, the patient's comfort can be increased by avoiding highly fermentable nutrients (e. g., cabbage, onions) and excessive fluid intake in order to reduce the risk of bag detachment due to abundant gas production and liquid output.

12.11 Diverticulitis

The nutritional management of diverticulitis depends largely upon the extent of inflammatory stenosis and on the presence or absence of severe peritonitic signs. In patients with mild cases not requiring hospitalization, in the absence of obstruction or suspicion of a perforation or abscess formation, a low-residue oral diet is appropriate, if tolerated, until complete resolution of all inflammatory signs. Thereafter, once other causes, such

as an underlying malignancy or residual stenosis, have been excluded, a high-residue diet should be proposed, as such patients will benefit from bulk-forming diets and good oral hydration enhancing transit [8]. In cases of complicated diverticulitis, where severe inflammatory stenosis or abscess formation is suspected, patients should be hospitalized and maintained nil per os with administration of parenteral nutrition. These patients are prone to PCM because of severe stress and ongoing infection leading to hypercatabolism.

12.12 Nutritional Management of Colorectal Disease

Colorectal disease and related treatments result in a decrease in lean body mass. Nutritional management is aimed primarily at limiting or restoring the protein loss before the threshold of PCM-related complications is reached (Fig. 12.3). It is quite easy to prevent or limit the amplitude of PCM, but always difficult and time-consuming to restore the nutritional status. Therefore, nutritional support should be initiated as soon as possible if PCM appearance or aggravation is anticipated. Oral, enteral, or parenteral nutrition should be encouraged or prescribed, according to the patient's specific needs and tolerance. If oral intake is insufficient, enteral nutrition is always indicated first, if the gastrointestinal tract is functioning. Otherwise, parenteral nutrition is indicated. Enteral or oral nutrition should be resumed as soon as possible according to patient's tolerance. Sometimes, insufficient oral feeding can be supplemented by nocturnal enteral or parenteral nutrition until oral intake is sufficient (Fig. 12.4).

12.13 Dietary Management

Oral food intake and nutritional management depend largely upon the underlying gastrointestinal disease [1, 17, 34]. In addition to eating a well-balanced diet, liquid food supplements are helpful to improve protein balance. These liquid supplements may be particularly effective in anorexia, because it is easier to drink than to eat and because there is a disproportionate decrease in protein intake as well as decreased total energy intake in this disorder. These supplements should be prescribed and taken as a drug and not as a food item, using a planned time schedule (i. e., not within 2 h before or after a meal) so as not to interfere with regular meals. Treatment of nutritional deficiencies should be managed by specific supplementation, such as iron, vitamin B12, folic acid, calcium, potassium, magnesium, and zinc.

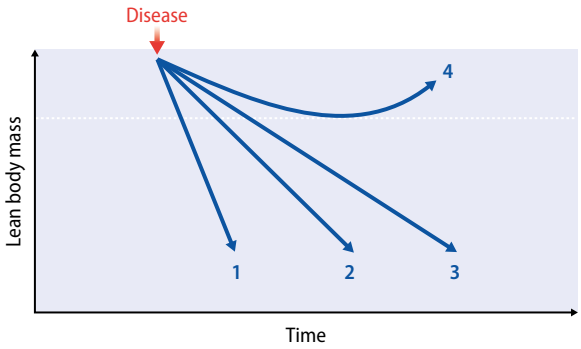

Fig. 12.3 Diseases result in decrease of body protein mass (*1*). Nutritional support and medicosurgical supportive treatments slow down catabolism (*2*, *3*). Experimental anabolic treatments such as testosterone or recombinant growth hormone may protect or even restore body protein mass in spite of disease-induced catabolism (*4*). The *dashed line* indicates the threshold of malnutrition-related complications

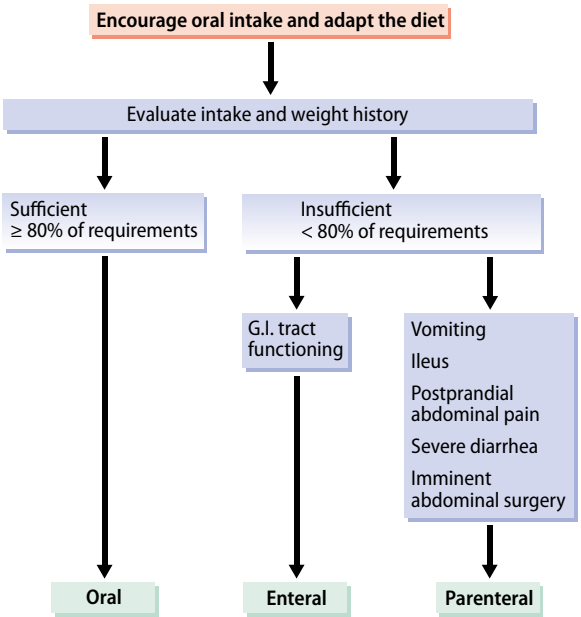

Fig. 12.4 Decisional tree to implement an optimal nutritional support in order to prevent malnutrition and/or to restore the nutritional status. *G.I.* Gastrointestinal

12.14 Enteral and Parenteral Nutrition Support

As a rule, the enteral route is the preferred route of nutrition if the gastrointestinal tract is patent (Fig. 12.4) [11, 34]. All enteral diets are lactose and gluten free, and low in residue, even in fiber-enriched diets. It is preferable to use nasogastric tubes rather than more complicated nasojejunal tubes; they are easier to position and less expensive [21, 28]. Enteral feeding is started with a small volume (i.e., 250 ml/24 h), and gradually increased in 250-ml daily increments according to patient tolerance. Enteral feeding should be complemented by parenteral nutrition if there is pre-existing PCM and poor tolerance to enteral feeding. Sometimes, insufficient oral feeding can be supplemented by nocturnal enteral or parenteral nutrition (Fig. 12.5). In case of prolonged duration of enteral nutrition (i.e., longer than 3–4 weeks), gastrostomy should be considered to avoid using nasogastric tubing, with the aim of optimizing the patient's tolerance [19].

In severely malnourished patients, enteral nutrition may be difficult to maximize. Additional parenteral nutrition to complement maximally tolerated enteral nutrition should be administered to avoid aggravation of malnutrition. This is of special importance to improve the disease outcome. Once enteral nutrition is better tolerated, parenteral nutrition should be gradually tapered to avoid overfeeding. When parenteral nutrition is administered, it is preferable to use an "all-in-one bag" containing all macronutrients, but in which multivitamins and trace elements have to be added. This approach has the advantage of avoiding dysglycemia, being able to turn the flow on and off without adverse metabolic effects, avoiding forgetting vitamin and trace-element substitution, and lowering the cost as a result of less manpower and materials and fewer laboratory tests for monitoring [10, 24]. The risks of infection related to administration of parenteral nutrition that do not exist with enteral nutrition should always be balanced against the benefits of nutritional support. Oral feeding should be resumed as soon as it can be tolerated.

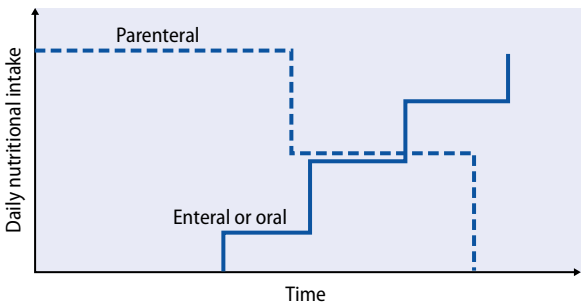

Fig. 12.5 A progressive shift from total parenteral nutrition to enteral or oral nutrition prevents a negative balance between nutritional requirements and intakes

12.15 Conclusion

Evaluation of the nutritional status of patients with colorectal disease is of the utmost importance because improvement of PCM and correction of nutritional deficiencies influence the clinical outcome of medical or surgical interventions and thus constitute a cost-effective strategy. Thus, clinicians should actively look for PCM, undertake early diet adaptation or nutritional support, and let their patients resume normal oral physiologic feeding as soon as possible.

Acknowledgment

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Self-Assessment Quiz

Question 1

Malnutrition results form a negative balance between nutritional requirements and intakes. Which of these consequences of malnutrition is not true:

a. Increased postoperative complications (e. g., fistulas, wound dehiscence)
b. Increased infection rate
c. Prolonged length of hospital stay
d. Decreased tolerance to oncology treatment
e. Increased risk of cancer

Question 2

What is the prevalence of malnutrition in adult patients at hospital admission?

a. <5%
b. 5–10%
c. 10–20%
d. 20–30%
e. >30%

Question 3

Why are colorectal diseases likely to be associated with malnutrition?

a. Acute attacks of the disease result in reduced food intake and hypercatabolism.
b. Abdominal pains.
c. Gluten intolerance.
d. Insufficient liver protein synthesis.
e. Exocrine pancreatic insufficiency.

Question 4

What condition is a mandatory indication for a nutritional support?

a. Patient older than 70 years
b. Abdominal pain
c. Food intake < 80% of requirement for > 2weeks
d. Chronic alcoholism
e. Bedridden patient

Question 5

In case of persistent insufficient food intake during inflammatory bowel disease, when is total parenteral nutrition (intravenous) indicated?

a. The gut is not functioning.
b. The patient has no appetite.
c. The patient has abdominal pain.
d. The patient has diarrhea.
e. The patient has lost 10% of his usual body weight.

1. Answer: e
   Comment: Cancer prevalence has never been shown to be associated with malnutrition.
2. Answer: e
   Comment: Numerous studies since 1979 in North America, Europe, and Asia have shown a prevalence of malnutrition of between 30 and 50% among adult patients and between 40 and 80% among the elderly (>75 years).
3. Answer: a
   Comment: Inflammation is associated with reduced appetite and food intake resulting in a negative nutritional balance with weight loss, aggravated by malabsorption and hypermetabolism.
4. Answer: c
   Comment: Persistent reduced food intake results in malnutrition and represents an indication for nutritional support. Other conditions such as great age, abdominal pain, and drug addiction, are only risk factors to develop malnutrition.
5. Answer: a
   Comment: Oral nutritive supplementation or tube-feeding best addresses insufficient food intake in case of inflammatory bowel disease, whereas parenteral nutrition is only indicated if the gut is nonfunctioning (persistent vomiting, ileus, failure of tube-feeding).

13 Preparation and Positioning for Surgery

Julien Vaucher and Jean-Claude R. Givel

CONTENTS

13.1 Introduction

Preparing and positioning patients for colonic and anorectal surgery are important preoperative steps. Preparation is crucial in order to perform an intervention in optimal conditions, on a stabilized patient and with minimal risk of post-operative morbidity and mortality. Despite new insights, many procedures in this field remain empirical and arise from evidence-based medicine [44]. Preparation includes bowel preparation (BP), and antibiotic and thromboembolic prophylaxis. Finally, adequate and optimal positioning of the patient on the operating table is mandatory for optimal intervention. The process of rendering the patient fit for surgery and his/her anaesthesiological management will not be discussed here; these topics are covered in Chaps. 12 and 14, respectively.

13.2 Bowel Preparation

BP has been used for a long time and is still practised extensively in colorectal surgery [23, 46]. In 2003, Zmora et al. reported that more than 99% of American colorectal surgeons use BP routinely [57]. In 2005, Kristoffer et al. reported that oral BP is still extensively used in North Europe [29]. Despite this, the procedure has been a subject of debate for more than 30 years, and there is mounting evidence suggesting that it should be abandoned. The purpose of BP is threefold: (1) to reduce the mass of faeces, making handling of the bowel easier; (2) to diminish post-operative faecal impaction, thus reducing the possibility of an increased luminal pressure with associated risk of anastomotic leakage; (3) to decrease the colonic bacterial load in case of contamination. The most popular oral preparations, in decreasing order, are polyethylene glycol (PEG; also known as macrogol) with or without mannitol, sodium phosphate and sodium picosulphate [49]. Preparation with a single enema is also used, mainly before rectal surgery [29, 35]. Sodium phosphate, senna and PEG are the most frequently administered solutions. Povidone-iodine and hypochlorite enemas have also been proposed [48].

13.2.1 Use of BP in Elective Colorectal Surgery

The search strategy used herein includes an electronic search on Medline and the Cochrane Library for English language papers referring to "bowel preparation for colorectal surgery". A selection of randomized control trials (RCT) and meta-analyses was made. The references were extended to the bibliography of the collated articles. Exclusion criteria were: case reports and non-randomized studies.

A total of seven RCT and four meta-analyses, published between 1994 and 2006, were identified and are summarized in Table 13.1 [9, 10, 13, 18, 22, 36, 38, 41, 54, 56, 59]. Two meta-analyses were performed by the

Table 13.1 Mechanical bowel preparation (*MBP*) – details of included trials. *RCT* Randomised controlled trial, *PEG* polyethylene glycol

Author	Type of study	Number of patients		Tested solution
		MBP	No MBP	
Santos et al. 1994 [41]	RCT	72	77	Laxative, enema† and mannitol‡
Burke et al. 1994 [13]	RCT	82	87	Sodium picosulphate
Zmora et al. 2003 [56]	RCT	187	193	PEG
Bucher et al. 2005 [11]	RCT	78	75	PEG
Ram et al. 2005 [36]	RCT	164	165	Sofodex
Fa-Si-Oen et al. 2005 [18]	RCT, multicentric	125	125	PEG
Zmora et al. 2006 [58]	RCT	120	129	PEG
Slim et al. 2004 [40]	Meta-analysis	720	734	–
Bucher et al. 2004 [9]	Meta-analysis	642	655	–
Wille-Jorgensen et al. 2005 [54]¶ Guenaga et al. 2005 [22]¶	Meta-analysis	789	803	–

† Water 900 ml and glycerine 100 ml
‡ 1 l as a 10% solution
¶ Same data

same group of authors, who found identical results [22, 54]. The four meta-analyses confirmed the methodological quality and homogeneity of the RCT [9, 22, 41, 54].

In terms of overall complication rates, six RCT found no statistical difference between BP and no BP [13, 18, 36, 38, 56, 59]; one study was in favour of the latter [9]. Nevertheless, the group sizes were not statistically significant. In terms of anastomotic leakage, RCT and meta-analyses found either no statistical difference or a benefit for no BP (Table 13.2). A stratification of the advantage of no BP for low anterior resection and colonic surgery was conducted [22, 54]. Separately, no difference emerges between rectal and colonic surgery. Combined results showed, nevertheless, a reduction of anastomotic leakage without BP (Table 13.3). No discrepancy was found concerning wound infection rate (Table 13.4).

Other outcomes were studied, but results were not homogenous. Zmora et al. [58] found that the absence of BP does not influence the length of hospital stay, and Bucher et al. [10] reported that it favours a shorter duration in hospital ($p = 0.024$). In terms of reoperation rate, Fa-Si-Oen et al. [18] found no statistical difference between the two groups, but a tendency towards a higher rate in the BP group is reported in other two

Table 13.2 Mechanical bowel preparation – overall infectious complications (including wound infection, anastomotic leak and abdominal abscess/peritonitis. *NS* Not significant, *NA* data not available

Author	MBP *n (%)*	No MBP *n (%)*	*p* value
Santos et al. 1994 [41]	24 (33)	11 (18)	< 0.5
Burke et al. 1994 [13]	7 (9)	7 (8)	–
Zmora et al. 2003 [56]	19 (10.2)	17 (8.8)	NS
Bucher et al. 2005 [11]	17 (22)	6 (8)	0.028
Ram et al. 2005 [36]	21 (13)	15 (9)	NS
Fa-Si-Oen et al. 2005 [18]	16 (13)	13 (10)	–
Zmora et al. 2006 [58]	NA (12.5)	NA (13.2%)	NS

Table 13.3 Mechanical bowel preparation – anastomotic leakage. *RR* Relative risk, *OR* odds ratio, *CI* confidence interval

Author	MBP *n (%)*	No MBP *n (%)*	RR (RCT)/OR* (meta-analyses)	95% CI	*p* value
Santos et al. 1994 [41]	7 (10)	4 (5)	–	–	<0.5
Burke et al. 1994 [13]	3 (4)	4 (5)	–	–	0.91
Zmora et al. 2003 [56]	7 (3.7)	4 (2.1)	–		NS
Bucher et al. 2005 [11]	5 (6)	1 (1)	1.68	0.91–2.49	0.21
Ram et al. 2005 [36]	1 (0.6)	2 (1.2)	–	–	NS
Fa-Si-Oen et al. 2005 [18]	7 (5.6)	6 (4.8)	0.86	0.30–2.48	0.78
Zmora et al. 2006 [58]	NA (4.2)	NA (2.3)	–	–	NS
Slim et al. 2004 [40]	39 (5.6)	23 (3.2)	1.75	1.05–2.90	0.032
Bucher et al. 2004 [9]	36 (5.6)	18 (2.8)	1.85	1.06–3.22	0.03
Wille-Jorgensen et al. 2005 [54] Guenaga et al. 2005 [22]	48 (6.2)	25 (3.2)	2.03	1.276–3.26	0.003

Table 13.4 Mechanical bowel preparation – wound infection

Author	MBP *n (%)*	No MBP *n (%)*	RR (RCT)/OR (meta-analyses)	95% CI	*p* value
Santos et al. 1994 [38]	17 (24)	9 (12)	–	–	NA
Burke et al. 1994 [13]	4 (5)	3 (3)	–	–	NA
Zmora et al. 2003 [56]	12 (6.4)	11 (5.7)	–	–	NS
Bucher et al. 2005 [11]	10 (13)	3 (4)	1.58	0.97–2.34	0.07
Ram et al. 2005 [36]	16 (9.8)	10 (6.1)	–	–	NS
Fa-Si-Oen et al. 2005 [18]	9 (7.2)	7 (5.6)	0.78	0.30–2.02	0.61
Zmora et al. 2006 [58]	NA (6.6)	NA (10.0)	–	–	NS
Slim et al. 2004 [40]	53 (7.3)	42 (5.7)	1.34	0.88–2.04	0.175
Bucher et al. 2004 [9]	48 (7.5)	36 (5.5)	1.38	0.89–2.15	0.15
Wille-Jorgensen et al. 2005 [54] Guenaga et al. 2005 [22]	59 (7.4)	43 (5.4)	1.45	0.97–2.18	0.07

studies: (1) 4.4% vs 2.7%; odds ratio (OR) 1.56, 95% confidence interval (CI) 0.68–3.59 [38], and (2) 5.2% vs 2.2%; OR 1.72 95%, CI 0.81–3.65, $p=0.16$ [9], respectively. Finally, only one meta-analysis calculated the "number needed to treat": 32 patients (95% CI 19–306) would have to be operated on without BP to prevent 1 single leakage in a patient receiving BP before surgery [9].

Concerning the single enema, Platell et al. showed in 2006 an increased risk of anastomotic leakage with sodium phosphate lavage compared to oral PEG, rendering its use potentially harmful [35]. Povidone-iodine and hypochlorite enemas have also been tried as antiseptic and antitumoral solutions [47]; however, wound infection rates remain elevated. Povidone-iodine has a better tolerance and avoids necrotic ulcerative colitis.

Despite the extensive use of BP, there is no clear benefit of its use in open elective colorectal surgery. Furthermore, it seems that BP generates a higher complication rate, in particular of anastomotic leakage. Hospital stay also tends to be shorter in patients without BP [10]. Although only unequivocal data are available concerning laparoscopic colectomy without BP, it seems that it can be performed safely [58].

These results are supported by studies describing the effects of BP. In addition to the discomfort of the patients and the economic costs, Holte et al. showed that BP is associated with a significant decrease in ex-

ercise capacity, body weight, and plasma calcium and potassium concentrations [25]. Plasma osmolality, phosphate and urea concentrations were increased. The putative effect of BP on bacterial load also has to be reconsidered since two studies have demonstrated that when BP is given there is no difference in the composition [32] or concentration of the bacterial flora [43]. Fa-Si-Oen et al. experienced no diminution of peritoneal cavity contamination during surgery after BP [18, 19]. In addition, structural alterations and inflammation of the mucosa have been described after BP with PEG [9]. Finally, after BP, the residual liquid bowel content tends to promote a spillage of the faecal residues into the peritoneal cavity [30].

Enemas have associated risks of anastomotic leakage and wound infection, even if administered with so-called antiseptic solutions, such as with povidone-iodine [37]. For these reasons, they should also be avoided.

Should BP be proscribed for all colorectal procedures? Some indications are still under debate. BP is mandatory when small lesions have to be searched perioperatively by palpation and when a perioperative colonoscopy is planned [10, 37]. Finally, a cautious attitude is requested with no BP before rectal surgery, as the amount of available data is too small to be significant.

13.3 Antibiotic Prophylaxis

Colorectal surgery is associated with a high risk of wound infection, better described as surgical site infection. It largely contributes to post-operative morbidity, mortality and augmented health-care costs [8]. Antibiotic prophylaxis is therefore an incontrovertible step towards colorectal surgery. It nevertheless carries a 15% risk of surgical site infection, with almost half of the cases occurring after hospital discharge [42]. A discrepancy also exists between colonic and rectal surgery, for which the respective incidence of infection is around 10% and 20% [28].

The definition of wound infection is not uniform, but most trials include diverse criteria such as swelling and reddening at the wound site and/or a temperature above 38°C, or the presence of purulent discharge with or without positive bacteriology [43]. The colonic lumen houses a myriad of bacteria, predominantly anaerobic (10^9–10^{10} organisms per gram of stool) followed by aerobic coliform bacteria (10^6–10^8 organisms per gram of stool) [34]. Even a small break of the intestinal wall allows the translocation of a large number of bacteria into the peritoneal cavity. Gram-negative aerobic and facultative anaerobic bacilli (*Escherichia coli*) and obligate anaerobes (*Bacteroides fragilis*) are the predominant organisms responsible for peritonitis [34]. The former generally induce an acute life-threatening infection, ending in many cases with septicaemia, which, after the acute phase, results in the development of abscesses.

13.3.1 Good Practice for Antibiotic Prophylaxis

In order to prevent infection, one should consider carefully the choice of antibiotic, its route and timing of administration, and its concentration around the potential site of infection. Many regimens have been proposed and most meet prophylaxis requirements [8, 43]. The choice should be supported by in vitro data, animal models, evidence from RCT, pharmacokinetics, mechanisms of action, a safety profile, local sensitivity patterns, ease of administration and costs. In order to be affective against both aerobes and anaerobes, a combination of molecules is preferable; for example, first-generation cephalosporin or gentamicin plus metronidazole [43]. No significant difference in the rate of infection was stated with new-generation cephalosporins. Different practices exist concerning the route of administration, some authors preferring oral, parenteral or systemic prophylaxis. The safety of oral administration, classically with non-absorbable erythromycin and neomycin, has to be reconsidered, as recent trials have demonstrated a low patient tolerance (e. g. increased nausea, vomiting, abdominal pain and risk of *Clostridium difficile* colitis) [17, 55].

The best timing of administration is within 30–60 min before surgery to allow it to become distributed within the tissues [15]. Further administration after the end the surgery is not proven to reduce the infection rate [21]. Another matter of concern is the readministration of antibiotics when anaesthesiological and surgical procedures yield a diminution of the efficient concentration of the molecule. A long operating time (> 3–4 h), blood loss, fluid volume replacement and blood transfusion are some of the criteria indicating perioperative readministration of antibiotics [21, 31, 45].

In our institution, 1500 mg cefuroxim (second-generation cephalosporin) plus 500 mg metronidazole are routinely administered intravenously 30–60 min before the incision. Cefuroxim 1500 mg is dissolved

in 20 ml of 0.9% NaCl and is injected over a period of 3–5 min. Metronidazole 500 mg, already diluted in 100 ml of 0.9% NaCl, is perfused over a period of 20 min. The concentration of cefuroxim is dependent on renal clearance (e. g. for a renal clearance of 20 ml/min, 750 mg cefuroxim must be administered), contrary to metronidazole. In the case of allergy, cefuroxim is replaced by amikacin 15 mg/kg plus clindamycin 600 mg, administered intravenously. For patients with methicillin-resistant *Staphylococcus aureus*, we add to the prophylaxis vancomycin 1 g diluted in 250 ml of 0.9% NaCl and perfuse it intravenously over a period of 60 min. Whatever the chosen regimen, we recommend defining the optimal antibiotic prophylaxis in a multidisciplinary fashion, considering each factor of success and of adverse events carefully.

13.4 Thromboembolic Prophylaxis

Deep vein thrombosis (DVT) and pulmonary embolism (PE) are encountered frequently in the general surgical population, the prevalence ranging between 15 and 30%, in comparison with medical patients, for whom the prevalence is 10–20% [20]. Moreover, colorectal surgery carries a higher risk of thromboembolic events compared with general surgery [52]. A large body of evidence, including numerous systematic reviews and meta-analyses, demonstrates the benefit of thromboembolic prophylaxis (TEP) [2, 14, 16, 20, 53]. These results have recently led to diverse conference consensus and recommendations on TEP [12, 20, 24]. Two types of prophylaxis are available: (1) mechanical (e. g. graduated compression stockings (GCS) and intermittent pneumatic compression) and (2) pharmacological.

13.4.1 Risk Factors

Multiple factors have to be taken into account with regard to evaluation of the thromboembolic risk in a specific patient (Table 13.5; the list is adapted from Geerts et al. and the Seventh ACCP Conference on Antithrombotic and Thrombotic Therapy, 2004 [20]). Three major risk factors exist for a surgical patient: anaesthesiological/surgical, individual and general. One can partially or totally influence the anaesthesiological/surgical and general factors. However, individual criteria are more difficult to control, especially age, which is a risk factor by itself. It is important to remember that risk factors are cumulative and, therefore, that their number has to be reduced as much as possible [50].

13.4.2 Open Colorectal Surgery

Mechanical methods are effective in the prevention of DVT and should be combined with pharmacological prophylaxis for high-risk surgery [2, 4, 20]. They could also be applied alone in patients with high risk of bleeding, until it is decreased [2, 20]. The use of pharmacologic drugs is based on the appreciation of risk factors for DVT (Table 13.5).

A summary of the recommendations of the Seventh ACCP Conference on Antithrombotic and Thrombotic Therapy adapted for colorectal surgery is available in Table 13.6 [20, 53]. The patients have been stratified according to three degrees of risk: low, moderate and high. These categories depend upon the presence and number of risk factors.

Low-dose unfractionated heparin (LDUH) or low-molecular-weight heparin (LMWH) can be administrated subcutaneously without distinction of safety or

Table 13.5 Risk factors for deep vein thrombosis (*DVT*) in colorectal surgery

Anaesthesiological and surgical factors

- Type of anaesthesia: risk is greater with general anaesthesia than spinal/epidural anaesthesia
- Duration of surgery: > 30 min of operating time
- Type of surgical positioning
- Type of surgery
- Hospitalized patient: ambulatory surgery carries a very low risk of DVT

Individual factors

- Age: independent risk factor
- Obesity
- Pregnancy
- Cancer
- Previous DVT
- Varicose veins
- Oestrogen medication
- Hypercoagulation states

General factors

- Perioperative care:
  - degree of mobilization
  - fluid status
  - transfusion practice

Table 13.6 Prophylaxis recommendations for open and laparoscopic colorectal surgery. *LDUH* Low-dose unfractionated heparin, *LMWH* low-molecular-weight heparin, *bis* twice a day, *tid* three times a day

Thrombotic risk		Prophylaxis
Low	• No risk factor (age < 40 years)* • Minor surgery • Spinal/epidural or general anaesthesia < 30 min	• Early and prolonged mobilisation
Moderate	• Limited risk factors to 1–2 (age 40–60 years) • Minor/major surgery • Spinal/epidural anaesthesia or general surgery < 30 min	• LDUH 5,000 U or LMWH ≤ 3,400 U 12 h prior to surgery • LDUH 5,000 U bid or LMWH ≤ 3,400 U daily minimum 12 h after surgery until mobilisation or 3 weeks after surgery
High	• Multiple risk factors plus • Age > 60 years, minor surgical procedure, spinal/epidural or general anaesthesia < 30 min • Age > 40 years, major surgical procedure, general anaesthesia > 30 min	• LDUH 5,000 U or LMWH 4,000 U 12 h prior to surgery • Mechanical methods • LDUH 5,000 U tid or LMWH 4,000 U daily minimum 12 h after surgery until mobilisation or 3 weeks after surgery

* Risk factors to consider are primarily those of Table 13.5 (individual factors); age is highlighted as it is a strong independent risk with a stratification according to the years

syndromeefficacy. Their preoperative administration seems to be advantageous with regard to its antithrombotic action [26]. LMWH is more practical, since administration only necessitates one daily injection and the risk of heparin-induced thrombocytopenia is smaller. It has been demonstrated that Fondaparinux, a new selective inhibitor of factor Xa, is as effective and safe as LDUH. It could be a promising option since it does not cause heparin-induced thrombocytopenia and because it is first administered 6 h after the surgical procedure [3, 24].

Prolonged prophylaxis over the 3-weeks period following discharge, for moderate- and high-risk patients, reduces the risk of DVT, since > 50% of all thromboembolic events occur during this period [6, 27, 51].

13.4.3 Laparoscopic Colorectal Surgery

Trials on thromboembolic prophylaxis for colorectal laparoscopic surgery are ongoing. The results of two RCT and one prospective study showed no significant difference between prophylaxis and nothing [39] or placebo [7]; no discrepancy was demonstrated between GCS alone and GCS plus LMWH [5]. However, these studies included only laparoscopic cholecystectomies and no colorectal procedures. The latter, even with a minimally invasive approach, involve major surgery and as such the associated risks for thromboembolic events should be considered.

Therefore, without any evidence-based data, recommendations should follow those of thromboprophylaxis for open colorectal surgery edited by the Seventh ACCP Conference on Antithrombotic and Thrombotic Therapy, as summarized and adapted in Table 13.6 [20].

13.5 Positioning

All surgical positions carry some degree of risk, which is increased in anaesthetized and curarized patients. Cardiorespiratory risks are magnified in the presence of comorbidities (cardiac insufficiency, obesity, chronic obstructive pulmonary disease), especially if the table is tilted in the Trendelenburg position and/or if the patient has a general or epidural anaesthesia (because of the associated loss of normal autonomic nervous system response). Compression of nerves and vessels also carry a high risk of complications and/or disability. Thromboembolic events can arise in dependent parts of the body, principally the legs, due to vessel compression and immobility. A urinary catheter is usually recommended in most cases of left colonic and rectal surgery. For all these reasons, professional and careful positioning of patients on the operating table is mandatory.

13.5.1 Supine Position

For most right and transverse colonic procedures, performed by laparotomy, the patient lies supine on the operating table [40]. Nevertheless, a strict supine position is often replaced by the Lloyd–Davies position (see Sect. 13.5.3) for some open and, obligatorily, laparoscopic procedures. The principal risks are those of cardiopulmonary complications due to position and anaesthesia.

13.5.2 Lithotomy Position

In this position, the patient lies supine and is moved down the table until the buttocks are beyond the lower edge of the operating table, the legs being elevated with supports (Fig. 13.1). This approach is convenient for rectal surgery, in particular abdominoperineal excision, and pelvic and anal procedures [40].

Hyperflexion of the hips has to be avoided, preventing any inguinal skin fold from causing difficulties for "abdominal" surgery [40]. Adequate padding between the legs and poles is mandatory to prevent decubitus ulcer, compression of the peroneal, saphenous and femoral nerves, or even compartment syndrome [1]. Stretching of the obturator nerve has also been described.

13.5.3 Lloyd–Davies Position

This corresponds to some sort of lithotomy position plus a head-down tilt (Trendelenburg position), with a gradient of 15–20% to gain a good access to the perineum (Fig. 13.2). In addition, the hips are less flexed. This position permits a good open approach for left colonic, rectal, especially low anterior resection, and pelvic surgery when both abdominal and perineal accesses are required [40]. This position allows a better positioning of the second assistant, the surgeon and the first assistant being on each side of the patient. The Lloyd–Davies position is used in most cases of laparoscopic surgery.

Potential complications are similar to those of the lithotomy position. Compartment syndrome has also been reported, especially when associated with factors compromising perfusion of the calf muscles (e. g. peripheral vascular disease, prolonged general and/or epidural anaesthesia or the Trendelenburg position) [33, 47].

13.5.4 Jack-Knife Position

The patient lies in prone position on the table. Providing that pressure points are alleviated, the table is separated into two pieces at the middle or a roll is placed under the hips in order to elevate the abdomen and the pelvis [40]. This position allows a convenient approach for anal, rectal, coccygeal and pilonidal surgery (Fig. 13.3).

Twisting the joints or cervical vertebral column while positioning an anaesthetized patient may have harmful consequences. One must also be aware of the reduced ventilatory capacity due to compression of the chest and the abdomen. Finally, potential compres-

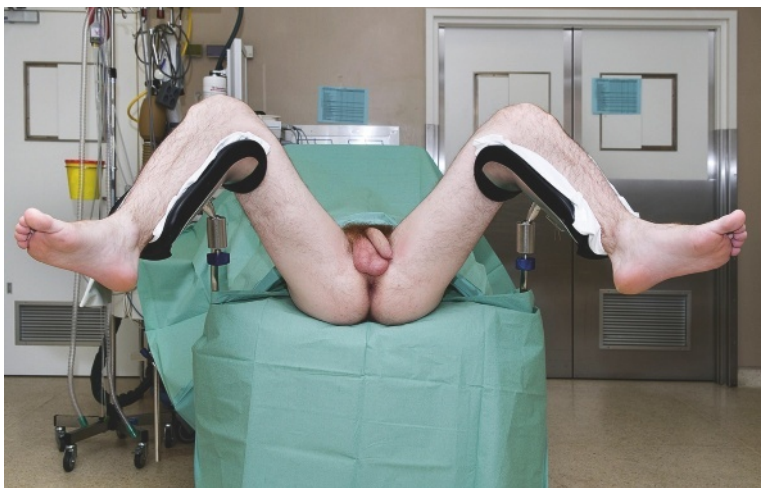

Fig. 13.1 Lithotomy position

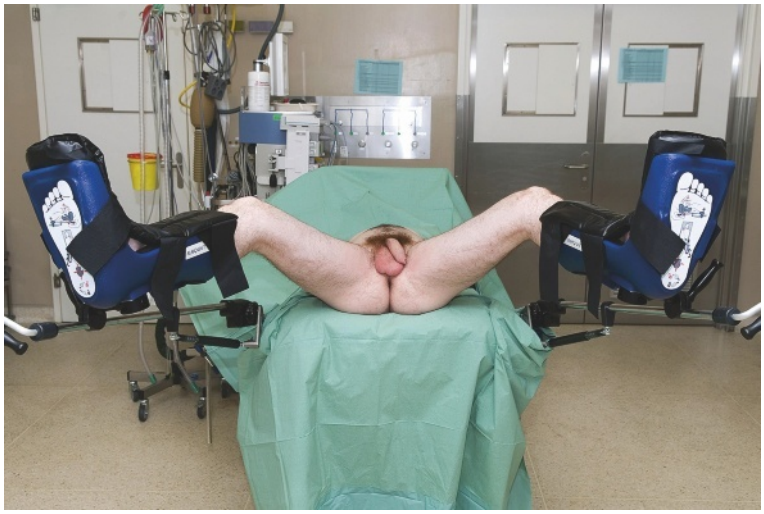

Fig. 13.2 Lloyd–Davies position

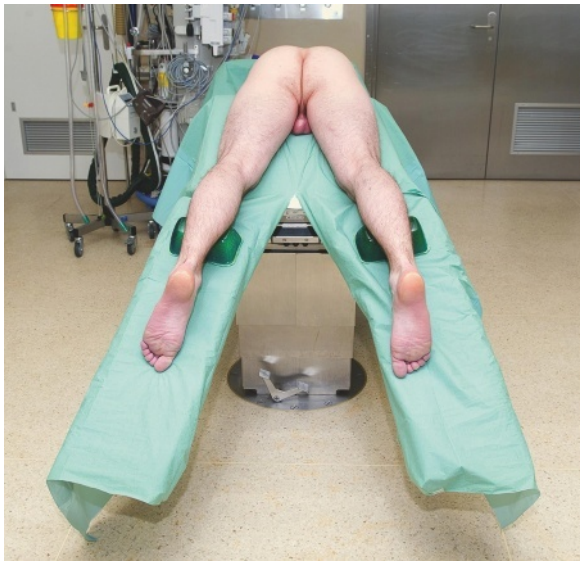

Fig. 13.3 Jack-Knife position

sion of the vena cava may result in increased surgical bleeding and reduced venous return to the heart, and is a risk for DVT. For all these reasons this position is rarely used nowadays.

13.5.5 Lateral Position (Sim's)

The patient lies on his side with the hips and knees flexed and the torso lying diagonally on the table (Fig. 13.4). This position permits good access for the treatment of pilonidal sinus. Attention must be paid to avoid straightening the knees as it can damage the lumbosacral nerves [40]. This position is often preferred to the Jack-Knife position because of the potential complications of the latter.

13.6 Conclusion

Patient preparation for any kind of surgery is mandatory; it allows an operation to take place under optimal conditions, for both the patient and the surgeon. Adequate preparation will moreover decrease post-operative morbidity and mortality.

BP should be restricted to few indications, such as perioperative colonoscopy and for the ease of detecting small lesions by palpation. The question of BP before rectal surgery is still a matter of debate since no evidence-based data are available. It is potentially harmful to the patient but, for rectal surgery, it is easier to handle an empty rectum. The potential side effects of BP should therefore be weighted against the ease with which the surgery can be performed following such a preparation.

Antibiotic prophylaxis is a cornerstone of preparation for colorectal surgery with its high risk of infection. An appropriate regimen should be chosen, administered within 1 h before surgery and discontinued after it. Antibiotic concentration should remain adequate throughout the operation. Readministration should be considered after 3–4 h of surgery, and if there is significant blood loss and fluid volume replacement is required.

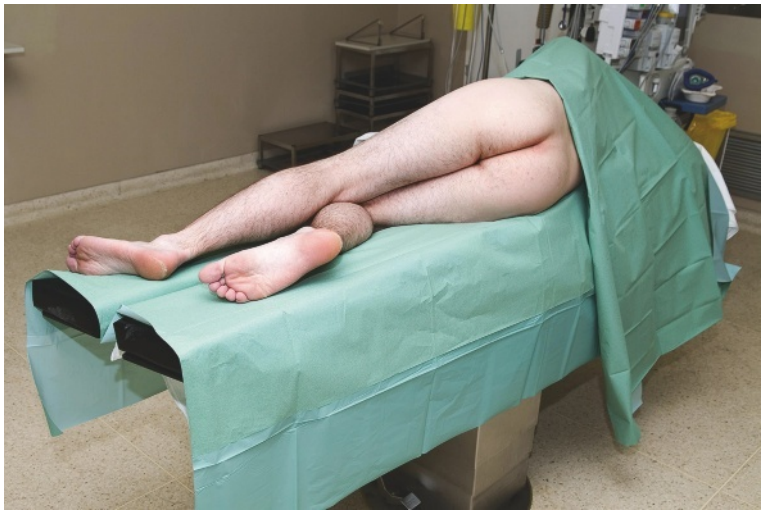

Fig. 13.4 Lateral position (Sim's)

Thromboembolic prophylaxis should be adapted to the individual patient's risk factors (Table 13.5). Anaesthesiological, surgical, individual and general factors have to be carefully evaluated. For low-risk procedures, a complete and prolonged mobilisation is sufficient. For higher-risk interventions, mechanical and pharmacological methods should be combined. The effectiveness of thromboembolic prophylaxis is dependent upon the timing of its administration. LDUH and LMWH have to be given 12 h before the operation and should be continued until full mobilisation or 3 weeks after surgery. The thrombotic risk associated with laparoscopy should be considered similar to that of open surgery, and the same prophylaxis applied.

Adequate positioning for colorectal surgery is mandatory to gain a good access to the surgical site and to prevent potentially harmful complications.

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Self-Assessment Quiz

Question 1

For which purpose is colonic bowel preparation still recommended?

a. Reduction of bacterial load of the colon.
b. Colonic preparation for perioperative colonoscopy.
c. Reduction of post-operative anastomotic leakage risk.
d. Comfort of the patient.
e. Reduction of costs.

Question 2

What applies to antibiotic prophylaxis for colorectal surgery?

a. Patient tolerance to oral non-absorbable antibiotic is superior to that of parenteral regimens.
b. New-generation cephalosporins are more efficient than first-generation cephalosporins.
c. Surgical site infection is low (<5%) and antibiotic prophylaxis is not systematically required.
d. Prolonged prophylaxis after surgery (at least 5 days) has been shown to reduce infection rate.
e. Antibiotic prophylaxis has to be administrated 1 h before surgery.

Question 3

Which timing is correct concerning thromboembolic prophylaxis (with low-dose unfractionated heparin (LDUH) or low-molecular-weight heparin (LMWH)) for high-risk colorectal surgery?

a. No administration before surgery/maximal doses immediately after surgery for 10 days.
b. First administration 12 h before surgery/continuation (next dose minimum 12 h after surgery) for 3 weeks, despite intensive mobilisation.
c. First administration 12 h before surgery/continuation (next dose minimum 12 h after surgery) for 3 weeks or until an intensive and prolonged mobilisation.
d. First administration 12 h before surgery/next dose in function of mobilisation during the first 3 days following surgery.
e. No administration before surgery/continuation (next dose minimum 12 h after surgery) for 3 weeks until intensive mobilisation.

Question 4

Which answer is *not* correct regarding thomboembolic prophylaxis for colorectal surgery?

a. Age is an individual risk factor.
b. Mechanical methods are effective in the prevention of deep vein thrombosis and should be combined with pharmacological prophylaxis for high-risk surgery.
c. LDUH is more convenient than LMWH since it only requires daily administration and has a lower risk of heparin-induced thrombocytopenia.
d. More than 50% of all symptomatic thromboembolic events occur after hospital discharge.
e. Patients undergoing laparoscopy should receive the same prophylaxis as for open surgery.

Question 5

Which complication is not directly due to positioning for colorectal surgery?

a. Peroneal nerve compression.
b. Acute renal failure.
c. Deep vein thrombosis.
d. Compartment syndrome.
e. Calf muscle ischaemia.

1. Answer: b
   Perioperative colonoscopy and detection of small lesions are the only two situations for which colonic preparation is still recommended.
2. Answer: e
   Most efficient antibiotic concentrations depend on the dosage of the molecule, the route and the timing of injection (30–60 min before surgery).
3. Answer: c
   Efficient antithromboembolic prophylaxis is only achieved when the drugs (LDUH and LMWH) have been administered a minimum 12 h before surgery, to modify the targeted blood-clotting factors. It should be continued after surgery since most antithrombotic events occur post-operatively; even > 50% occur after discharge from hospital.
4. Answer: c
   LMWH is more practical since administration necessitates only one daily injection and the risk of heparin-induced thrombocytopenia is smaller.
5. Answer: b
   Acute renal failure is not directly due to positioning. Veins/arteries, muscles, nerve compressions and cardiovascular events (e. g., thromboembolism, myocardial infarctus) are the most encountered complications due to positioning.

14 Anaesthesia and Perioperative Management for Anorectal and Colonic Surgery

Patrick Yves Wüthrich and Jean-Patrice Gardaz

CONTENTS

14.1 Introduction

The aim of this chapter is to give an overview of specific aspects dealing with anaesthesia for ano- and colorectal surgery. First we will recall some relevant elements of applied pathophysiology for anaesthesia and then we will discuss specific aspects of anaesthesiology. Combined anaesthesia and cardiorespiratory effects of laparoscopic surgery in particular will be discussed in depth. We will end with anaesthesia-related complications that are relevant to colorectal surgery.

14.2 Specific Aspects of Pathophysiology Applied to Anaesthesia and Colonic Surgery

14.2.1 Splanchnic Microcirculatory Blood Flow and Sepsis

Before commenting on the impact of pressors and inotropes on splanchnic perfusion in sepsis, we will review briefly the distribution and the mechanisms of control of intestinal blood flow. In the unfed state, total intestinal blood flow represents 20–25% of the cardiac output, 70–80% of which is distributed in the mucosal layer, 15–25% in both the muscular and serosal layers together and less than 5% in the submucosal layer. The prevailing mechanisms involve metabolic control by oxygen (O_2), hydrogen ions and carbon dioxide (CO_2), as well as metabolic mediators such as lactate and ad-

enosine [1]. During post-prandial hyperaemia, blood flow increases by up to 200% above baseline values, with a shift to the mucosal layer. Mechanisms involved in post-prandial hyperaemia include enteric nervous system effects, gastrointestinal (GI) peptides and hormones, and local non-metabolic and vasoactive mediators, in particular nitric oxide (NO), which plays a pivotal role in the homeostasis of GI tract function. NO produced by various NO synthase enzymes dilates mucosal blood vessels, prevents leucocytes aggregation, decreases the susceptibility of the GI tract to injury, blocks apoptosis and reduces inflammation [1].

Enteral nutrition is well-tolerated in post-operative cardiac patients; the effects of post-pyloric enteral nutrition might also be harmless in septic patients. However, the consequences of enteral nutrition in septic patients with compromised splanchnic perfusion could be deleterious. Increases in intestinal metabolic demand can trigger intestinal ischaemia, leading to non-occlusive bowel necrosis [2].

Intestinal hypoperfusion due to the redistribution of regional blood flow induced by shock leads to decreased barrier function and increased epithelial apoptosis. This results in the translocation or production of toxic substances into the blood stream, causing secondary organ failure.

The first-line of treatment of septic shock includes correction of intravascular hypovolaemia, arterial hypotension and low cardiac output states by pressors and inotropes that do not restore systematically regional blood flow, and the splanchnic in particular. The increased cardiac output and systemic flow induced by dopamine, dobutamine or dopexamine does not reach the microcirculation in the GI tract. Vasopressin (VP) and adrenaline should be avoided because of their adverse effects on splanchnic perfusion [3–5].

There is no clear-cut reason based upon splanchnic perfusion to choose noradrenaline or dopamine as a first agent in septic shock. The combination of noradrenaline and dobutamine, however, is recommended because it has the same positive effects on regional gut perfusion.

14.2.2 Toxic Megacolon

Toxic megacolon (TM) can occur in any patient with acute colitis of inflammatory, infectious of ischaemic origin. It is defined as segmental or colonic distension associated with acute colitis and signs of systemic inflammatory response [6, 7]. TM must be differentiated from other situations that slow bowel motility, like narcotics or anticholinergic drugs. Before the new treatment era with anti-tumour necrosis factor (TNF)α antibodies, TM induced by inflammatory bowel disease had a reported incidence of 5–10%.

The treatment of TM includes complete bowel rest, intravenous fluid perfusion, correction of electrolyte disturbances, and withdrawal of narcotics, antidiarrhoeal and anticholinergic drugs. If the initial medical therapy fails, surgery should be untaken. The appropriate timing of surgery in patients with TM remains a matter of debate, but perforation, progressive dilatation, uncontrollable bleeding and progressive systemic toxicity are absolute indications for subtotal colectomy with an end ileostomy and a Hartmann closure of the rectum [6].

The perioperative management of these patients with fever, tachycardia and leucocytosis (often with a left shift), and also suffering from anaemia, hypokalaemia and hypoalbuminaemia remains a challenge for anaesthesiologists. The timing of surgery often has to be delayed, which can result in perforation, peritonitis and sepsis, conditions that are often the cause of post-operative mortality.

In these cases of severe sepsis or septic shock, aggressive volume expansion to correct intravascular hypovolaemia, vasopressors to blunt peripheral vasodilation and myocardial depression should be administrated to prevent or treat global tissue ischaemia [8]. Early normalisation of mixed venous O_2 saturation (data that is collected via a pulmonary-artery catheter), arterial lactate and pH are key elements to improve the outcome of patients with severe sepsis or septic shock [8].

14.2.3 Post-operative Ileus

The definition of ileus and methods of assessment are not well defined. Whereas we speak of bowel atony when bowel mobility is disturbed for up to 2 days, ileus is considered as a pathological process when GI mobility is impaired for 3 days or more. It is characterised by abdominal distension, lack of bowel sounds and accumulation of gas and fluids in the bowel. Symptoms are nausea, vomiting and stomach cramps, and are a major contributor to post-operative discomfort. No single variable has been found to predict the resolution of post-operative ileus (PI). The most adequate definition of resolution depends on a combined functional outcome of normalisation of food intake and bowel motility [9]. In particular, the return of the migrating myoelectric complex (MMC) or specific MMC pattern changes

defined as an assessment of the electrical activity of the bowel, does not correlate with the clinical resolution of PI. PI occurs mainly after intraperitoneal surgery, but can also happen after extra-abdominal or retroperitoneal surgery. PI is most extensive after colonic surgery. It is a problem because it delays oral feeding, decreases subject satisfaction related to pain and discomfort, and increases the risk of post-operative nausea and vomiting (PONV). PI has a substantial economic impact as a result of increases in the length of hospitalisation and utilisation of healthcare resources [9, 10].

14.2.3.1 Pathogenesis

The pathogenesis of PI is multifactorial [11]:

1. Activation of inhibitory reflexes [12]
2. Inflammatory mediators [13]
3. Endogenous/exogenous opioids [14]
4. Intraoperative fluid excess, starvation [15]
5. Manipulation of the intestines [16]

Activation of Inhibitory Reflexes

Two types of reflex are involved: afferent stimuli to the spinal cord (somatic fibres of the incision site and visceral fibres of the intestines) and efferent stimuli to the intestines through the sympathetic nervous system; the latter inhibit the motility of the intestinal tract. The contribution of the sympathetic nervous system in PI has substantial clinical implications, as these reflexes can be largely blocked by epidural anaesthesia. Circulating catecholamines contribute less to the control of intestinal motility. Different reflexes seem to be involved: ultra-short reflexes (confined to the wall of the gut), short reflexes (involving the prevertebral ganglia) and long reflexes (involving the spinal cord). The long reflexes are of importance because several studies have shown that spinal anaesthesia, sectioning of the splanchnic nerve and other abdominal sympathectomies prevent or reduce the development of PI. In contrast to spinal afferent-fibre ablation, ablation of vagal fibres may not influence GI transit. Afferent reflexes originate from the peritoneum.

Inflammatory Mediators

Numbers of neutrophils, macrophages, mast cells, T-cells, natural killer cells and dendritic cells are increased if the intensity of surgical manipulation is increased. Release of inflammatory mediators, locally or as a response to surgery, contributes to PI [13]. Leucocyte-derived NO, vasoactive intestinal peptides (VIP), substance P, calcitonin gene-related peptide (CGRP), corticotrophin releasing factor and prostaglandins are released locally in the GI tract and may contribute to PI. Post-operative GI transit is improved if VIP and substance P receptor antagonists, and inhibitors of NO synthesis are given.

Exogenous/Endogenous Opioids

Exogenous and endogenous (encephalin, β-encephalin, dynorphin) opioids contribute greatly to the pathogenesis of PI. The presence of opioid receptors in the gut has been well known since 1972. They are located on the presynaptic nerve terminals in the myenteric plexus. Their effect is mediated directly by receptors in the bowel (μ_2, κ and δ) [14] and so affect not only the motility, but also the secretion, absorption and blood flow of the gut. The μ-opioid receptor is the key receptor involved in GI motility and intestinal transit time. Opioids increase the resting tone to spasm and decrease the propulsive peristaltic waves. Initially, opioids induce an atony followed by sequences of hypertonicity by changing the coordinated reflex motor activity into a segmenting and non-propulsive motility pattern. Some parts of the intestines are more sensitive than others; the jejunum is particularly sensitive. Stimulation caused by abdominal surgery (laparotomy and manipulation of the small intestines and caecum) but not skin incision alone induces the release of endogenous opioids in guinea pigs [17]. The ratio between the analgesic and constipating effects of morphine is nearly 4:1 [18]. The plasma concentration of endogenous morphine increases after surgical injury and may play a role in PI. Centrally mediated anti-transit effects have been implicated. Alterations in the autonomic outflow of the gut seem to occur.

Intraoperative Fluid Excess, Starvation

Delaying motility can be attributed to the presence of excess fluid in the intestinal wall as a result of perioperative fluid excess [15]. Increased gut permeability after surgical trauma may also contribute to PI because of enhanced uptake of luminal bacterial products.

Manipulations of the Intestines

Intestinal manipulation was found to transiently increase the mucosal permeability, so that endogenous bacterial products may act synergistically with the inflammatory response [16]. Selective small-bowel manipulation leads to a molecular, cellular and functional panenteric phenomenon in the unmanipulated gastric and colonic muscularis, which can cause PI [19].

The duration of PI is variable and is correlated with the degree of surgical trauma and kind of surgery; as mentioned earlier, for example, it is most extensive after colorectal surgery. Each section of the GI tract recovers after different periods. Small-bowel function returns first (4–8 h after surgery, up to 24 h), then the function of the stomach (24–48 h) and finally the colon (48–72h) [9]. The duration of the PI is dependent mainly on the return of the motility of the left colon. The paralytic response to surgery consists of a short initial paralysis, with NO as an important mediator, followed by a longer-lasting impairment of the muscle activity, which is paralleled by the local tissue concentration of inflammatory cells [20].

14.2.3.2 Perioperative Management, Anaesthesia/Analgesia

Classic Approach

Intraoperative analgesia, if not treated with an epidural or spinal block, essentially comprises opioid treatment, which may influence the GI motility in the post-operative period. The effects of NO and volatile anaesthetic agents on bowel motility are transient and it has been demonstrated that they are not of clinical importance [21]. No data from clinical trials concerning the perioperative use of remifentanil and post-operative GI motility are available. Opioids only provide sufficient static pain relief after major abdominal surgery.

The nasogastric tube has been the traditional supportive treatment for PI. Atelectasis and pneumonia were significantly less common, and days to first oral intake were significantly fewer in patients treated without nasogastric tubes, so that routine nasogastric decompression is not supported by meta-analysis of the literature [22].

In an analysis of the risk factors associated with the development of post-operative pulmonary complications following general elective non-thoracic surgery, Mitchel et al. revealed (in a multivariable analysis) that post-operative nasogastric intubation is a strong risk factor, with an odds ratio of 22 [23]. The nasogastric tube causes gastroesophageal reflux and a reduced ability to clear refluxed acid from the distal oesophagus, in patients undergoing elective bowel surgery [24].

Combined Anaesthesia

As noted above, it is established that abdominal surgery leads to activation of inhibitory sympathetic splanchnic reflexes. After major abdominal surgery, effective dynamic pain relief is only obtained with a continuous epidural anaesthesia with local anaesthetics. It is essential that the necessary neural segments are blocked. The positive effect of epidural local anaesthetic administration is related to the segmental afferent/efferent blockade, which can only be achieved, for abdominal surgery, by thoracic administration of the local anaesthetic. Epidural anaesthesia offers several advantages to improve PI:

1. Superior pain relief, allowing mobilisation by blocking the afferent and efferent limbs of the nociceptive spinal reflex arc and so having an opioid-sparing effect
2. Blocking afferent inputs from the wound and so reducing the stress (increasing the splanchnic blood flow)
3. An anti-inflammatory effect [25]

The vagally mediated parasympathetic innervation of the colon will be preserved. The systemic resorption of epidurally administrated local anaesthetics may improve bowel motility via a direct excitatory effect. The development of chemical peritonitis after administration of hydrochloric acid is inhibited by amide local anaesthetics [26]. Local anaesthetics shorten bowel paralysis after ischaemia in the rat [26, 27]. Continuous thoracic epidural anaesthesia (TEA) with local anaesthetics (>24 h) decreases PI compared with systemic opioid administration [28]. No positive effect of epidural analgesia on ileus has been demonstrated using lumbar epidural administration. In a meta-analysis of 261 patients, epidural local anaesthetics alone reduced the duration of PI by 54 h compared with systemic opioids [29]. It was reduced by 21 h as a result of epidural local anaesthetic treatment compared to epidural opioids, and by 16 h when compared with a mixture of epidural opioids and local anaesthetics. Opioid-based epidural anaesthesia does not improve the duration of PI as compared the systemic opioids [30].

Opioids and Opioids-Antagonists

As shown above, opioids have a profound inhibitory effect on GI motility. These effects are seen with intravenous patient-controlled analgesia (PCA), and conventional intramuscular, subcutaneous opioid or epidural administration. The duration of PI is directly proportional to the amount of opioid given perioperatively [31], so it makes sense to reduce to the maximum the amount of opioids administered and to promote the use of opioid-sparing analgesia. It is well established that administration of a non-steroidal anti-inflammatory drug (NSAID) spares 15–55% of opioids and so results in reduced PONV and an improvement in overall GI motility [32, 33]. Another advantage of the NSAID is the direct anti-inflammatory effect mediated by the inhibition of prostaglandin synthesis. For example, ketorolac, a parenterally administered NSAID, prevents PI if given preoperatively in a rat model [34].

Among the several mechanisms that are thought to contribute to the pathogenesis of PI, the release of endogenous opioids together with opioid use for effective pain control in subjects undergoing surgery leads to a significant reduction in the propulsive activity in the GI tract. The μ-receptors in the GI tract are activated by morphine and other opioids, causing reduced GI motility. It is the activation of the same μ-receptors in the brain that allows for the analgesia induced by the same medications. Several compounds have been developed in order to dissociate the desired and adverse effects of opioids by increasing the number of opioid μ-receptors agonists or antagonists.

Alvimopan is a peripherally restricted opioid with high affinity for the μ-receptors, and is a competitive μ-receptor antagonist [35]; it is 200-fold more potent at antagonising the inhibitory effects of morphine on GI transit compared with centrally located receptors. Alvimopan does not antagonise centrally mediated opioid analgesia, as measured by visual analogue scale (VAS) score [36]. It has a very low systemic absorption after oral intake (oral bioavailability of only 0.03%) and a long duration of action, with a slow dissociation rate from the μ-opioid receptor compared to other shorter-acting antagonists (methylnaltrexone, naloxone). It does not demonstrate any biological affinity for non-opioid receptors such as adrenergic, dopaminergic, benzodiazepine, serotonergic, histaminic and muscarinic receptors. It is effective at antagonising the inhibitory effects of morphine on the GI transit and may be more potent if given prior to dosing with exogenous opioids. The dissociation rate of the alvimopan-μ-receptor complex follows first-order kinetics and is 100-fold slower than that of methylnaltrexone. Clinical trials have demonstrated that at 6 mg or 12 mg, it can accelerate time to recovery of GI function. Alvimopan accelerated GI function and time to hospital discharge in patients undergoing laparotomy for bowel resection or partial colectomy, and was well tolerated [36–38].

Methylnaltrexone was the first peripheral opioid receptor antagonist and is a quaternary derivative of naltrexone; it is only slightly demethylated. It reverses morphine-induced contractility changes in a dose-dependent manner. Intravenous methylnaltrexone prevents the morphine-induced delay in GI transit time. Intravenous administration of 0.45 mg/kg methylnaltrexone prevented the effect of intravenous morphine 0.05–0.1 mg/kg on the delay in oral-caecal transit time [39]. Repeated administration of intravenous methylnaltrexone was well tolerated with no significant side effects in 12 healthy subjects. However, the significant reduction in the gut transit time after repeated administration of methylnaltrexone suggests that endogenous opioids modulate human gut motility [18].

The development of specific peripheral κ-receptor agonists is a promising approach to reducing PI. One such drug, fedotozine, was shown to relieve hypersensitivity to colonic distension in patient with irritable bowel syndrome [40].

Lee et al. found that epidural administration of naloxone for 48 h (0.208 μg/kg · h) significantly reduced the epidural morphine-induced intestinal hypomotility at about 20 h for flatus and 30 h for faeces without reversing its analgesic effect (no difference found in resting and active VAS scores) in patients having a combined anaesthesia for subtotal gastrectomy [41].

Further large-scale studies should be undertaken to assess whether these new opioid agonists and antagonists offer significant improvements in patients care after segmental colectomy.

Peripheral opioid antagonists are contraindicated in patients who have been treated for several days with opioids or who have not stopped opioid treatment for at least 7 days prior to the initiation of therapy. Opioids may lead to sensitisation of the gut, and so administration of an opioid antagonist may lead to GI symptoms of opioid withdrawal [42].

Prokinetic Pharmacological Approaches

Propranolol, a non-selective β-blocker, has been advocated to reduce the length of PI, but its efficacy

was not confirmed in a recent randomised trial of 27 patients [43].

Neostigmine, an acetylcholinesterase inhibitor, stimulates colonic motility, as shown recently in 12 patients undergoing colorectal surgery [44], and has a similar effect post-operatively as in healthy volunteers [44]. However, leakage of the anastomosis occurred in 17%, which is higher compared with the usual range of 3–10% after anterior rectal resection. The clinical usefulness of neostigmine is limited because of its side-effects (abdominal cramps, salivation and bradycardia), and the associated potentially increased risk of leakage of the anastomosis needs to be clarified.

Experimental studies demonstrated that agonists to VIP, antagonists of substance P or immunoneutralisation (CGRP) may reverse PI. The GI transit is ameliorated in experimental studies with the GI peptide octreotride [45, 46]. No clinical studies have investigated the effect of octreotride on PI. VP should not be used to treat this condition [47].

Erythromycin has prokinetic effects as an agonist of the prokinetic peptide motilin, but only in the small intestine. Prospective randomised trials showed no effect of erythromycin on the duration of PI [48]. Metoclopramide, which is used largely as prokinetic agent, has no impact on the duration of PI in colorectal surgery [49]. Cisapride is not recommended for treatment of PI because it can prolong the electrocardiographic Q–T interval and can induce ventricular dysrhythmias [50]. Novel prokinetic agents, like the mixed serotonin-4 (5-HT4) receptor agonist prucalopride and the new serotonin-2B (5-HT2B) receptor agonist tegaserod show promise for the management of PI in the critically ill population [51, 52]. Further studies are required before these agents can be recommended.

Early Post-operative Oral Feeding

The 4–5 days of starvation or semi-starvation that is traditionally recommended in major abdominal surgery is unfortunate because it leads to catabolism, and thus to fatigue [53]. Early nutrition may improve immune function and reduce the chance of post-operative infectious complications. Ingestion of fibre-enriched foods may improve PI as a result of the stimulatory effect on the GI motility. Trials have shown that the institution of early enteral feeding to be safe and to reduce PI [9].

Minimally Invasive Surgery

Experimental studies have shown that laparoscopic colonic surgery leads to earlier return of the GI motility and earlier normalisation of bowel movement compared with open colectomy [9], and in clinical studies earlier resolution of PI has been demonstrated after laparoscopy.

14.3 Anaesthesia for Laparoscopic Surgery

The advantages of laparoscopic-assisted colectomy over open colectomy are shorter hospital stay, a reduction in narcotic use, a faster return of bowel function and a faster return to normal life. A selective benefit of laparoscopic left colectomy in the elderly (>75 years) and laparoscopic right colectomy in the young (<75 years) was found in a retrospective controlled study [54, 55]. Laparoscopy induces particular pathophysiological changes in response to pneumoperitoneum. Although it has been introduced as a simple and safe procedure that may be performed on an outpatient basis, it demands extreme caution regarding anaesthetic management. Thus, laparoscopic surgery presents several challenges for the anaesthesiologists, for whom an appraisal of the potential problems (haemodynamic, pulmonary, renal, splanchnic and endocrine pathophysiological changes) is essential for optimal anaesthetic care.

14.3.1 Pneumoperitoneum

The ideal insufflation gas should be readily available, inexpensive, colourless, highly soluble in blood, chemically stable, physiologically inert and associated with a low risk of intravascular embolisation [56]. CO_2 approaches being the ideal insufflating gas. Haemodynamic and acid-base changes are mild and clinically negligible for most patients with CO_2. Residual CO_2 peritoneum is cleared more rapidly than that created with other gas (e. g. nitrous oxide (N_2O), argon, helium, nitrogen). N_2O may be advantageous if regional anaesthesia is used and in case of depressed pulmonary function, but it does not suppress combustion. Argon may have unwanted haemodynamic effects, especially on hepatic blood flow. Helium, air and nitrogen have no haemodynamic or acid-base consequences, but they dissolve slowly and carry a potential risk of lethal venous emboli formation. Significant vascular absorption across the peritoneum arises with CO_2, leading to hy-

percapnia and intravascular embolisation. Monitoring of end-tidal CO_2 concentration is mandatory. The gasless laparoscopic technique (abdominal wall lift) provides better cardiovascular conditions; furthermore, abdominal wall lifting combined with low-pressure insufflation might be a good alternative for elderly patients or those with cardiopulmonary problems [57]. Abdominal wall-lifting devices, however, have no clinically relevant advantages to low-pressure (5–7 mmHg) pneumoperitoneum. The European Association for Endoscopic Surgery guidelines recommend using the lowest intra-abdominal pressure (IAP) to allow an adequate exposure rather than using a routine pressure. An IAP lower than 14 mmHg is considered as safe in healthy patients [58].

The clinical benefits of warmed and humidified gas are minor, particularly during short procedures. Heat loss during surgery has pathophysiological sequelae. Perioperative hypothermia has been reported to increase peripheral vasoconstriction and have a substantial impact on the coagulation capability, and can impair the myocardial contractibility. Hypothermia has been identified as an independent risk factor of postoperative wound infection [59].

14.3.2 Pathophysiological Cardiovascular Changes

CO_2 is highly soluble and creates hypercarbia, which can only be avoided by compensatory hyperventilation. This manoeuvre is impeded by the Trendelenburg position or by high IAP, which cause a cephalad displacement of the diaphragm and a reduction of lung volume. IAP plays a major role in the development of hypercarbia. In most healthy patients, the rise of CO_2 and the drop in pH is clinically insignificant, but individuals who have low reserves, such as those with chronic obstructive pulmonary disease or poor cardiac function are at increased risk of developing hypercarbia and acidosis. Activation of the sympathetic nervous system can lead to an increase in blood pressure, heart rate, myocardial contractibility and arrhythmias [60].

The haemodynamic and cardiovascular changes, particularly arterial hypertension, occur because IAP stimulates the neurohumoral vasoactive system (VP) and the renin-aldosterone-angiotensin system. A reduction in cardiac index (CI) and an increase in mean arterial pressure (MAP) and systemic vascular resistance index (SVRI) have been shown to occur in association with laparoscopic cholecystectomy and gynaecological laparoscopy. VP concentration increases markedly in patients undergoing laparoscopic cholecystectomy immediately after the initiation of pneumoperitoneum, and decreases soon after it is released. Typical responses to excess VP concentration are an increased SVRI and MAP with decreased CI [61]. The same results were found by Joris et al.; clonidine given before induction of pneumoperitoneum reduced catecholamine release and attenuated haemodynamic changes during laparoscopy [62].

In addition, changes in body position (head-up or Trendelenburg position) modify these effects [63]. Gutt et al. recommend a moderately low IAP (<12 mmHg) as it limits alterations in splanchnic perfusion, and so organ dysfunction will be minimal and not influence the outcome [60]. In American Society of Anaesthesiologists (ASA) I and ASA II patients, the haemodynamic and circulatory effects of 12–14 mmHg IAP are generally well tolerated [58]. Due to the haemodynamic changes in ASA III and ASA IV patients, invasive measurement of blood pressure should be considered. These patients should receive adequate preoperative volume loading, cardioprotection with β-blockers, and intermittent sequential pneumatic compression of the lower limbs.

Arrhythmias can be provoked by insufflating gas into the peritoneal cavity. The incidence of arrhythmias is higher than in open surgery [60]. Sinus tachycardia and ventricular extrasystoles are due to the release of catecholamines and hypercarbia. The more life-threatening bradyarrhythmias (sinus bradyarrhythmias, nodal rhythm, atrioventricular dissociation and asystole) are attributed to vagal stimulation caused by peritoneal stretch or to massive intravascular CO_2 embolisation [64]. Most arrhythmias are transient and respond to reduction of the IAP and 100% O_2 hyperventilation.

Preoperative intravascular volume loading (10 ml/kg), slow insufflation of the peritoneum in a horizontal position, intermittent pneumatic compression of the lower limbs and low IAP are established preventions of cardiovascular complications.

14.3.3 Respiratory Changes During Laparoscopy

Changes includes reduction in lung volume, increase in peak airway pressure and decrease in pulmonary compliance (up to 27–40%) secondary to patient position and increased peak inspiratory pressure [65]. Elevated IAP shifts the diaphragm cephalad, resulting in intraoperative atelectasis and so a decrease in functional

residual capacity, which promotes ventilation-perfusion mismatch and intrapulmonary shunting, which in turn leads to hypoxaemia. Alveolar collapse can be prevented by a recruitment strategy consisting of manual ventilation to an airway pressure of 40 cmH_2O over 10 s for ten breaths followed by normal mechanical ventilation with low positive end-expiratory pressure (PEEP; 5 cmH_2O). In the presence of elevated IAP, PEEP increases the intrathoracic pressure and produces a marked reduction in cardiac output. If refractory hypoxaemia, hypercapnia or high airway pressures occur, the pneumoperitoneum should be released followed by slow reinsufflation using a lower IAP. In the case of recurring complications, a conversion to open surgery is mandatory [57].

CO_2 embolism is a rare complication of laparoscopy surgery (<0.6%) but it is associated with high lethality (28%). The major cause of gas embolism is the misplacement of the Verres needle directly into a vein or a parenchymatous organ; 60% of cases occur during the initial insufflation. A sudden decrease in end-tidal CO_2 and blood pressure during abdominal insufflation are signs of gas embolism. Small CO_2 emboli probably occur frequently without clinical consequence. If a gas embolism is suspected, the following steps must be taken:

1. Deflation of pneumoperitoneum
2. Placing the patient in the Trendelenburg position or Durant's position
3. Hyperventilation with a fraction of inspired O_2 (F_iO_2) of 100%
4. Aggressive cardiopulmonary reanimation with placement of a central venous catheter in order to aspirate the gas

A higher IAP reduces the thoracic compliance and can cause pneumothorax or pneumomediastinum [57]. The presence of subcutaneous emphysema (noted in 0.3–3% of all laparoscopic procedures) should always lead to the suspicion of a capnothorax (CO_2 pneumothorax). In both cases the end-tidal CO_2 pressure is increased. Only moderate to severe capnothorax requires the placement of a chest tube.

14.3.4 Perfusion of Intra-abdominal Organs

Changes in kidney, liver or splanchnic perfusion due to an IAP of 12–14 mmHg may have no clinically relevant effects on healthy patients. In the case of already impaired perfusion, IAP should be as low as possible to reduce microcirculatory disturbances. Renal function in particular is gradually depressed with increasing IAP. The decrease in renal blood flow is due to a decrease in cardiac output, increased antidiuretic hormone level and/or compression of the renal vessels and its parenchyma. It is also likely that the hepatoportal circulation is gradually decreased with increasing IAP. So, keeping the IAP below 12 mmHg is helpful in preserving post-operative hepatic and renal function [58]. Schilling et al. assessed the splanchnic microcirculation during high-pressure CO_2 pneumoperitoneum in 18 patients undergoing routine laparoscopy. They found that an increase in IAP from 10 to 15 mmHg resulted in a decrease in blood flow to the peritoneum of 60%, and decreases of 40–54% to the stomach, 44% to the colon, 39% to the liver and 32% the jejunum [66].

14.3.5 Anaesthetic Techniques for Laparoscopy

Rapid- and short-acting volatile anaesthetics such as desflurane and sevoflurane, along with the ultra-short-acting opioid-like remifentanil, enable a recovery profile that facilitates fast tracking after general anaesthesia. General anaesthesia performed without tracheal intubation using a Proseal laryngeal mask is proposed for non-obese, healthy patients, and that it should be restricted to short procedures using a low IAP [67]. We do not recommend this strategy; controlled ventilation with an endotracheal tube is certainly the safest technique. During the procedure, controlled ventilation must be adjusted to maintain the end-tidal carbon dioxide concentration at nearly 35 mmHg, requiring no more than a 15–25% increase in the minute ventilation. In order to reduce IAP, the patients must be curarised throughout the procedure. Regional anaesthesia has also been advocated for laparoscopic surgery, but should be performed only by a very skilled surgeon-anaesthetist team in selected patients for specific procedures. It potentially offers several advantages, like decreased PONV, less post-operative pain, cost effectiveness and quicker recovery. It requires a relaxed and cooperative patient, low IAP to reduce pain and ventilatory disturbance, a supportive operating-room staff and a precise and gentle surgical technique. In daily clinical practice, however, patient safety and comfort outweigh these potential advantages, and full control of respiratory function with tracheal intubation remains the gold standard. Supplemental sedation is dangerous; in combination with pneumoperitoneum it leads to hypoventilation and arterial O_2 desaturation. In fact, respiratory changes are less evident when laparoscopy

is performed in conscious patients under regional anaesthesia and arterial blood gas analysis proves normal, even with the patient in a Trendelenburg position [68]. Extensive epidural block is required from T4 to L5 and may also lead to discomfort. Laparoscopic surgery results in substantially less severe and prolonged discomfort compared with open procedures. Post-operative pain can still be considerable and a multimodal analgesia procedure is the most effective pain relief, combining opioids, local anaesthetics, and NSAIDs. PONV, extremely common after laparoscopic surgery, can be blunted if propofol is used for maintenance of anaesthesia.

14.3.6 Contraindications for Laparoscopy

Absolute contraindications include shock, markedly increased intracranial pressure (head trauma, hydrocephalus and brain tumours), severe myopia and/or retinal detachment. Relative contraindications are bulleous emphysema, life-threatening emergencies and prolonged laparoscopy procedure lasting more than 6 h, which is associated with acidosis and hypothermia.

14.4 Anaesthesia for Anorectal Surgery

The choice of anaesthetic technique for anorectal surgery depends on both surgical and patient factors. The optimal anaesthetic technique comprises excellent operating conditions, a rapid recovery, and no post-operative side effects, improved operating room efficiency and a high level of patient satisfaction. Local infiltration, which fulfils all of the requirements for the ideal ambulatory anaesthetic technique (early discharge, low side effects), caudal spinal anaesthesia and general anaesthesia are commonly used techniques for anorectal surgery. Regional anaesthesia techniques offer numerous advantages (superior analgesia, decreased PONV, reduced post-operative length of stay, improved patient satisfaction – which positively influences post-operative sleep, cognitive and immunological function) that may be beneficial for patients undergoing ambulatory surgery [69, 70].

14.4.1 Local Anaesthesia and Monitored Anaesthesia Care

In recent years, improved sedation techniques to complement local anaesthetic infiltration have increased the popularity of surgery performed with monitored anaesthesia care (MAC). The use of local infiltration has numerous advantages (Table 14.1).

The pharmacology and dosage of the most frequently used local anaesthetics are shown in Table 14.2. Lido-

Table 14.1 Advantages of local anaesthetic infiltration

- Safe, simple, inexpensive.
- Affects only the surgical area.
- Early rehabilitation.
- Elimination of risk of damage to extremity due to motor block.
- No post-operative urinary retention.
- No post-operative nausea and vomiting.

Table 14.2 Comparative pharmacology of local anaesthetics [121–124]

Classification	Potency	Onset	Duration after infiltration (min)	Maximum single dose (mg/kg body weight)
Procaine	1	Slow	45–60	12
Chloroprocaine	4	Rapid	30–45	12
Lidocaine	1	Rapid	60–120	5 7*
Prilocaine	1	Slow	60–120	8
Mepivacaine	1	Slow	90–180	5 7*
Bupivacaine	4	Slow	240–480	3
Levobupivacaine	4	Slow	240–480	3
Ropivacaine	4	Slow	240–480	3

*Maximum dose with adrenaline 1:200,000 (0.5 mg of adrenaline added to 100 ml of local anaesthetic)

caine is the most often used local anaesthetic, but infiltration of 0.25% ropivacaine or bupivacaine is equally effective in the management of pain at the operative site. The rapidity of onset of sensory anaesthesia into tissues around a peripheral nerve depends on the dissociation constant of the drug, which determines the amount of local anaesthetic that exists in the active ionised form at the pH of the tissue. Thus, the time to onset of action of lidocaine is 3 min, whereas the time to onset of anaesthesia after injection of bupivacaine, ropivacaine and levobupivacaine is 15 min.

The aim of adrenaline, a mixed α-/β-adrenergic receptor agonist, when added to local anaesthetic solutions is to delay the absorption of the local anaesthetic drug and to prolong and enhance its anaesthetic effect. The pharmacodynamic analgesic effects of adrenaline in peripheral blockades have been demonstrated via its peripheral α_2 agonist effect. Adrenaline prolongs local anaesthetic duration in a dose-dependent manner up to a concentration of 5 μg/ml; higher concentrations are associated with increased haemodynamic side effects. The duration of infiltration anaesthesia can be approximately doubled by adding 1:200,000 adrenaline to the local anaesthetic solution [71, 72]. A predominant β-receptor response will occur after subcutaneous or intramuscular injection of a single dose of 200–1000 μg adrenaline.

The use of a combination of a short-acting and long-acting local anaesthetics (for example 15 ml of 2% lidocaine with 15 ml of 0.5% bupivacaine and 1:200,000 adrenaline) combined with propofol sedation is the most cost-effective form of anaesthesia for anorectal surgery in the ambulatory setting with respect to recovery time, post-operative side effects, patient satisfaction and total cost to the healthcare institutions [69, 73]. In the study of Li et al., the anaesthesia time was 44–47% shorter in the local anaesthesia/sedation group compared to spinal anaesthesia with 30 mg lidocaine and 20 μg fentanyl and general anaesthesia with sevoflurane. In addition, the times to home-readiness and duration of hospital stay were more than halved. The major contributors to delays in discharge after anorectal surgery are PONV, dizziness, pain and prolonged motor blockade, and all of these problems could be ameliorated with local anaesthesia and MAC. It should be remembered that it is important to determine patient acceptance of the MAC technique before widespread acceptance of this fast-tracking approach to providing ambulatory surgical care. The success of local anaesthesia/sedation may be related to good control of post-operative pain and the absence of side effects such as urinary retention and PONV, and is dependent on the skills of the surgeon in providing effective infiltration analgesia and gentle handling of the tissues. Extensive local anaesthetic infiltration of the surgical field can reduce rectal sphincter spasms and provides better post-operative analgesia.

A subcutaneously infused solution containing 200 ml Ringer's solution, 50 ml of 2% mepivacaine and 2.5 ml of adrenaline diluted 1:10,000 has been proposed for day-case proctologic procedures using tumescent local anaesthesia [74]. Slow infusion (application time nearly 14 min) of local anaesthesia was applied locally and complete pain relief was achieved after 18 min. Anaesthesia was maintained for up to 14 h post-operatively.

14.4.2 Spinal Anaesthesia

Proper use of spinal anaesthesia in the outpatient setting is simple, effective and extremely safe. Precise control of onset and offset are highly desirable characteristics. The technological advances in needle design (small-gauge spinal needles (25–29G), non-cutting pencil-point tips) have been associated with a very low incidence of post-dural-puncture headache (1–2%) among outpatients.

Small doses of intrathecal lidocaine or mepivacaine, with or without addition of 12.5 μg fentanyl are recommended for short-duration outpatient anaesthesia [75]. Hyperbaric 5% lidocaine should be avoided due to its proven neurotoxicity (cauda equina syndrome). Addition of adrenaline to either mepivacaine or lidocaine is not recommended because of the associated prolongation of recovery times. It is suggested that a 7.5-mg dose of hyperbaric bupivacaine is the best anaesthesia; it still allows early discharge and is associated with a much lower incidence of transient neurological symptoms. Hypobaric spinal anaesthesia with 0.1% bupivacaine induces selective sensory block for anorectal surgery with excellent perioperative analgesia without motor blockade [76].

14.4.3 Caudal Anaesthesia

Anal surgeries like haemorrhoidectomy sphincter repair and anal dilatation are appropriate indications [77] for caudal anaesthesia, which is a form of epidural anaesthesia. Caudal epidural blocks are largely restricted to sacral and low lumbar dermatomes and are expected

to cause minimal physiological modifications. Visceromotor function in the bladder and bowel distally from the splenic flexure of the colon will be blocked. A coexistent sympathetic block is often seen. Randomised, prospective and controlled studies are still needed to characterise many aspects of caudal anaesthesia. This is a technique that is easy to perform on children, and has a high success rate [78]; the failure rate in adults is inevitably higher than that for lumbar epidural block.

14.5 Anaesthesia for Colorectal Surgery

14.5.1 Epidural Analgesia

TEA is increasingly being used for major abdominal surgery using combined anaesthesia. TEA allows the patient to be mobilised early, to breathe deeply and to cough freely so that their post-operative outcome will be improved. Not only are noxious afferent stimuli from the surgical site blocked, but also a bilateral selective sympathicolysis will occur. Autonomic nerve fibres are more susceptible to the effects of local anaesthetics than are sensory and motor fibres because the postganglionic C-fibres are thin and unmyelinated. This explains why the level of sympathetic blockade after epidural or spinal administration of local anaesthetics is cephalad to the level of sensory or motor blockade.

Lumbar epidural analgesia is inappropriate for abdominal surgery because it induces enhanced sympathetic activity in sympathetically intact areas and is associated with increased incidence of the Bezold-Jarish compared with TEA. This reflex (bradycardia, and hypotension associated with venous pooling and heightened cardiac contractibility) induces a reflex vasoconstriction to areas cephalad to the block, increasing the likelihood of coronary vasoconstriction and myocardial ischaemia. During TEA, the lower cardiac blood flow seems to be compensated by a decrease in myocardial O_2 demand and cardiac work. Benefits of epidural sympathetic blockade can only be achieved with the placement of the catheter above Th12. Epidural catheters have to be placed at a vertebral level congruent with the incision because of superior analgesia and faster recovery from ileus.

14.5.1.1 The Effect of the TEA on Bowel Function

The contractile activity of the bowel is modulated by humoral and neuronal factors. Parasympathetic stimulation increases the GI motility. Tonic inhibitory sympathetic control normally predominates, and opening the peritoneum and manipulating the intestines result in a striking inhibition of the contractile elements of GI transit. TEA may promote bowel motility via mechanisms like:

1. Blockade of nociception [79]
2. Blockade of the thoracolumbar sympathetic efferent nerves [79]
3. Unopposed parasympathetic efferent nerves [79]
4. Reduced need for opioids [79]
5. Increased GI blood flow [79]
6. Systemic absorption of local anaesthetics [80]

TEA with regional agents during and after major abdominal surgery has been shown to protect the gut from decreased microvascular perfusion and to decrease the time to the return of normal GI function [81]. It has beneficial effects on intestinal microvascular perfusion during haemorrhagic hypotension and after resuscitation in rats [82]. TEA has to block Th5–Th10 to result in a complete block of the sympathetic nerves in the splanchnic region. Despite a decreased MAP, the capillary perfusion is maintained. The surgical stress response is also attenuated with intraoperatively activated TEA, thus indicating no impairment of local tissue perfusion and metabolism [83]. TEA attenuates the endocrine and metabolic responses to major surgery, as demonstrated by its suppressive effect on whole-body lipolysis after colorectal surgery [84].

To summarise, the following effects of thoracic anaesthesia and analgesia with local anaesthetics may improve GI function after abdominal surgery by:

1. Inhibition of thoracolumbar sympathetic efferents to the bowel (increased intestinal motility and intestinal blood flow)
2. Inhibition of somatic and visceral afferent nociception (reduced requirement for perioperative opioids, depression of reflex arcs mediating post-operative ileus, improved patient mobilisation)
3. Systemic local anaesthetic effects (depression of reflex arcs mediating post-operative ileus) and possible opioid-sparing effects from systemic activity

14.5.1.2 TEA and the Risk of Anastomotic Leakage

The stimulating effect of the TEA on GI motility has led to concerns regarding the potential increased risk of anastomotic leakage. Anastomotic breakdown has

been reported only rarely in patients with TEA. In 2001, a review was published of all reported controlled randomised trials in which the post-operative administration of TEA with local anaesthetics or a mixture of local anaesthetics and opioids compared with a systemic opioid or opioid TEA treatment [85]. Of the patients receiving post-operative TEA or a mixture of local anaesthetics and opioids, 6% developed an anastomotic leakage, versus 3.4% in the systemic opioid or opioid TEA treatment group; however, the difference was not significant. Few patients were included in these trials, and so there is a need for more studies to validate these results.

14.5.1.3 TEA and the Post-operative Analgesia

The aim of the post-operative pain management is to provide freedom from pain, allowing mobilisation, deep breathing and coughing without any restriction and minimal side effects, thus improving patient outcome. There are two common techniques for post-operative pain management after major intra-abdominal surgery: patient-controlled analgesia (PCA) with intravenous opioids and patient-controlled epidural analgesia (PCEA).

Epidural analgesia with local anaesthetic in combination with opioids can provide complete dynamic analgesia. Drugs administered in the epidural space have to be in sufficient concentration and volume that afferent inputs from the entire surgical field are blocked. A combination of a local anaesthetic and an opioid seems to be ideal. Alternative adjuvants can be clonidine and adrenalines, which itself through its spinal cord α_2-agonist effect, attenuates sensory block regression and reduces opioid plasma concentration. In a large review of the Cochrane library, which included 9 studies involving 711 participants, PCEA was found to be superior to opioid PCA in relieving post-operative pain for up to 72 h [86]. However, PCEA is associated with a higher incidence of pruritus. Pain scores on the 10-cm VAS were significantly lower in the epidural group than in the control group at rest on day 1 and after coughing on days 1–3 in the Multicentre Australian Study of Epidural Anaesthesia (MASTER) Trial, and the conclusions of the authors were that the improvement in analgesia and the reduction in respiratory failure suggest that many high-risk patients undergoing major intra-abdominal surgery will gain substantial benefit from combined general and epidural anaesthesia with continuing post-operative epidural analgesia [87]. However, in a subgroup analysis, they found no difference in outcome between the epidural group and the control group in subgroups at increased risk of respiratory or cardiac complications [88]. Even in the elderly patient, PCA, regardless of the route, is effective. In patients older than 70 years after major abdominal surgery, PCEA provided better pain relief at rest and coughing during the 5 post-operative days and improved the mental status without any effect on the incidence of delirium [89].

14.5.1.4 TEA and Post-operative Catabolism and O_2 Consumption

TEA may reduce excessive post-operative energy consumption. Major abdominal surgery results in an increase of nearly 50% above normal of the O_2 consumption, and this increase is prevented with a combined general anaesthesia with TEA. Patients with TEA are still able to increase their O_2 extraction in order to increase the O_2 consumption. Patients without TEA and with already increased O_2 consumption are more dependent on an increase in cardiac output to maintain adequate tissue oxygenation.

The perioperative stress response is characterised by increases in hypermetabolism and release of cortisol and glucose, altered insulin resistance and accelerated protein turnover. TEA inhibits intraoperative glucose elevation and cortisol levels. Sensory block up to Th4 during and after colorectal surgery over 24 h minimised the post-operative protein breakdown [90]. A significant decrease in the muscle protein fractional synthetic rate of nearly 40% was found in patients undergoing surgery of the sigmoid and rectum under general anaesthesia. Combined anaesthesia with TEA arrested the post-operative decline of tissue protein synthesis [91].

14.5.2 General Anaesthesia and Multimodal Anaesthesia

14.5.2.1 Perioperative Fluid Management

Perioperative fluid management for visceral surgery is the subject of controversy, and current standard fluid therapy is not at all evidence-based. In perioperative fluid management we should understand perioperative fluid optimisation, the objective of which is a reduction

in post-operative morbidities (e. g. cardiopulmonary, GI motility, wound healing, length of hospital stay). Volume deficit leads to alterations in and redistribution of blood flow, inflammation and organ hypoperfusion, which ultimately lead to organ failure, particularly of renal function. On the contrary, volume overload leads to cardiac dysfunction – increases in the interstitial space and capillary permeability with tissue and interstitial oedema, and low O_2 tension – which also can lead to organ dysfunction. Therefore, correction of hypovolaemia and prevention of volume overload are likely to improve outcome.

Water makes up 60% of the total body weight, one-third of it being extracellular fluid volume (ECV: interstitial fluid and plasma) and two-third intracellular fluid. In response to surgery, serum colloid pressure is decreased, primarily as a result of increased capillary permeability, causing fluid shifts from the vascular bed to the interstitial space. Dilution secondary to crystalloid infusions may also be a contributing factor. Despite 30 years of research, perioperative ECV changes have not been clarified. The endocrine response to surgery leads to conservation of sodium and water and to excretion of potassium, because of increasing secretion of antidiuretic hormone, aldosterone, cortisol and the renin-angiotensin II system. Inflammatory mediators like interleukin (IL)-6, TNF and substance P act as vasodilators and increase capillary permeability. Hormonal release therefore leads to a shift towards water and sodium retention, while the excretion of potassium is increased, paralleling the increase in catabolism.

Current Fluid Therapy

Standard fluid therapy includes replacement of basal fluid requirements, loss by perspiration and exudation through the surgical wound, and loss of the third space. Both perspiration and deficit from fasting involve water loss, and replacement with a water preparation seems logical. So, preoperative rehydration with glucose-containing fluids have been shown to reduce post-operative insulin resistance, increase well-being and improves post-operative muscle strength [92]. Administering preoperative glucose-containing fluids either orally or intravenously improves outcome. A deficit due to fasting should not occur. The administration of glucose intraoperatively remains controversial.

"High Volume" Versus "Dry Regimen"

Current standard fluid therapy is not at all evidence-based and the benefit of the preloading before the neuroaxial blockade has been challenged [93]. A review of the data on the effect of "high-volume" perioperative fluid therapy suggests that the resulting overhydration has deleterious effects on cardiopulmonary function (excessive shift to the right on the Starling myocardial performance curve, pneumonia and respiratory failure) and on recovery of GI motility (prolonged post-operative ileus), tissue oxygenation and wound healing (anastomosis leakage). The post-operative weight gain of 3–7 kg in patients undergoing major elective surgery therefore seems to represent a genuine fluid overload [15]. A randomised, assessor-blinded, multicentre trial for colorectal surgery found a significant reduction in post-operative complications following by restricted fluid therapy (no preloading of epidural anaesthesia, no replacement of the third space, 500 ml of 5% glucose in water, less oral fluid intake during fast, volume-to-volume blood loss replacement), the aim of which was unchanged body weight, and a dose–response relationship between administered fluid volume and post-operative complications (cardiopulmonary and tissue healing) [94]. The restricted regimen did not result in haemodynamically unstable patients, and administration of pressor substances was similar. No significant differences in urinary output were demonstrated on days 1 and 6. However, the results of a new clinical trial suggest that supplemental hydration 16–18 ml/kg/h versus 8–10 ml/kg/h did not impact wound infection rate (similar results in both groups) [95]. This review shows that the restricted literature on a limited volume-replacement strategy in abdominal surgery patients cannot clearly support the "dry" approach. It should be emphasised that fluid preload before spinal anaesthesia or just after epidural anaesthesia is a common and recognised practice in clinical anaesthesia.

Body weight measurements are the most reliable tool for estimation of fluid balance in surgical patients and should consequently guide the quantity of perioperative fluid administration. Documentation of the fluid losses on the fluid chart should guide the quality of fluid replacement. Clinical judgement is indispensable: body weight does not recognise internal loss of vascular volume. If low diuresis and hypotension are the consequences of loss of volume, intravenous fluid administration should be performed. If the cause is vasodilatation, the treatment is not fluid, but correction of the provoking factors (e. g. anastomotic leakage with

sepsis, extended sympathetic block after TEA, habitual antihypertensive medication).

14.5.2.2 Effects of Volatile Agents and Induction Drugs on Bowel Motility

Anaesthetic drugs could influence gut physiology. The effects could be mediated indirectly through haemodynamic effects, leading to diminished perfusion and O_2 delivery to the viscera, or directly by impairing the motor activity of the intestines.

Thiopental increases the motor activity in the colonic wall in dogs, whereas a slightly prolonged transit time was found in mice. Ketamine and propofol have no discernible effect on bowel motility [96, 97], but little is known of the GI effects of propofol when given continuously over a long time. The effects of a propofol-N_2O, a propofol-ketamine or an isoflurane-based anaesthesia on gastrocaecal transit was compared in a clinical study and no significant difference was found [97].

N_2O has been shown to delay bowel function after colonic surgery in humans [98]. In rats, the GI transit of charcoal was reduced by approximately 50% 2 h after isoflurane exposure [99]. A significant decrease in the gastric motility index was found 18 h post-isoflurane exposure in a study that investigated the gastric myoelectric and motor activity in dogs after they were given 1.3 MAC isoflurane for 4.5 hours [100]. Jensen et al. found a similar impairment of bowel function after elective colonic surgery between three experimental groups (isoflurane-N_2O, propofol-N_2O and propofol-air), but the incidence of complications and the length of post-operative hospital stay did not differ [101].

14.5.2.3 Optimal Perioperative Oxygenation

Oxygenation can be impaired in the perioperative period because of the surgery and the anaesthesia itself, and in the post-operative recovery period. Most patients are given 30% O_2 during surgery, but it can vary up to 100%. There are no common guidelines regarding the optimal F_iO_2, but perioperatively high risks of gas embolisation, wound infections or severe haemorrhages are commonly accepted as indications for high F_iO_2. However, improved outcome without risks has been demonstrated in recent studies [102–104]. It is well known that perioperative factors influence the incidence of infections.

O_2 is critical for tissue repair and wound healing, and is an important substrate for oxidative killing by neutrophils. Smoking, surgical pain, obesity and vasopressor administration decrease tissue oxygenation. Positive effects on tissue oxygenation are perioperative normothermia, adequate fluid administration, mild hypercapnia and, as discussed extensively in this chapter, epidural anaesthesia. Greif et al. showed in a population of 500 patients that an administration of 80% O_2 intraoperatively and 2 h post-operatively markedly increased tissue oxygenation and halved the incidence of wound infection in colon surgery [102]. In a randomised controlled trial of 291 patients, Belda et al. showed that the risk of surgical-site infection was 39% lower with an F_iO_2 of 80% in colorectal surgery [105]. In both studies the ASEPSIS score was significant lower in the 80% F_iO_2 group. Pryor et al. did not find the same result in for more general major intra-abdominal surgery, including gastrectomy, pancreas surgery and large gynaecologic staging/debulking procedures, but did not consider factors such as fluid management, normocapnia, duration of surgery, intraoperative serum glucose and post-operative pain control [106]. Intraoperative and immediate post-operative subcutaneous tissue O_2 tension was significantly less and critically low (around 40 mmHg) in obese patients (body mass index > 30) with an arterial oxygen tension of 150 mmHg. A subcutaneous tissue oxygenation of 40 mmHg is associated with a high risk of infection [107].

Supplemental O_2 significantly increases the expression of inflammatory cytokines, which stimulate phagocytosis and oxidative killing by alveolar macrophages. Leucocyte bacterial killing capacity, as measured by O_2 consumption and superoxide production, are substantially impaired at the low O_2 tensions often found in wounds [108]. Mechanical ventilation impairs phagocytosis and bacterial killing by alveolar macrophages. Phagocytosis and oxidative killing are better maintained in patients given 100% than 30% O_2.

As discussed in this chapter, administration of supplemental O_2 reduces the risk of PONV. Greif et al. showed in a population of 231 (colon resection) patients that the incidence of PONV was halved in those patients given an F_iO_2 of 80% [103]. Administration of an F_iO_2 of 80% (versus 30%) again halved the incidence of PONV (22% vs. 44%, respectively) in another randomised clinical trial involving 240 patients undergoing laparoscopic gynaecological surgery, and was as effective as prophylactic administration of 8 mg ondansetrone [104]. There was no significant differ-

ence between the 30% F_iO_2 group (overall incidence of PONV 44%) and the ondansetrone group (30%).

Despite the benefits of supplemental O_2 administration, there are some associated risks. Near-100% F_iO_2 can cause pulmonary toxicity after 5 h of exposure (diminution of the mucociliary function, augmentation of the IL-6 and IL-8 production) and after several days of exposure can lead to pulmonary fibrosis and pulmonary and intestinal oedema (increasing the alveolocapillary permeability). The major complication associated with a high F_iO_2 is pulmonary atelectasis, which itself can lead to pneumonia. However, a perioperative F_iO_2 of 80% has no effect on post-operative pulmonary function and atelectasis rate in patients undergoing colon surgery [109]. O_2-free radicals play an important role in the pathophysiology of O_2 toxicity, and free-radical damage can be worsened by hyperoxia. Large randomised trials in humans concerning O_2 administration before, during and after tissue ischaemia are lacking. The administration of an F_iO_2 of 80% is safe for less than 24 h, well tolerated and beneficial for patients undergoing colorectal surgery. It is a simple, inexpensive, well-tolerated treatment that improves patient outcome.

14.5.2.4 Anaesthesia for Fast-Track Surgery

The aim of this approach is to reduce the physiological and psychological stresses associated with operations, and so reduce the stress response and thus complications. Fast-track surgery combines modern concepts in patient education with newer anaesthetic and analgesic methods and minimally invasive surgical techniques.

For colonic surgery, current evidence advocates no bowel preparation, epidural anaesthesia and analgesia for 1–2 days post-operatively, no gastric decompression tube post-operatively, avoidance of sodium/water overload and free oral intake from post-operative day 1 [110]. A restrictive fluid management (4 ml/kg/h of Ringer lactate) positively affects the outcome after intra-abdominal surgery [111], reduces post-operative morbidity and shortens hospital stay.

Intravenous lidocaine, given intraoperatively and during the first 24 h post-operatively, improves post-operative analgesia, and is also effective at shortening PI after laparoscopic colectomy [112].

Median hospital stay after abdominal rectopexy could be reduced to 3 days with post-operative multimodal rehabilitation (thoracic epidural analgesia for 48 h, early mobilisation and nutrition) in ASA III– ASA IV patients [113]. In the "48-h colectomy" programme [114], the thoracic epidural catheter was inserted at T6–7 for right hemicolectomy and T8–10 for left-sided sigmoid resection, bupivacaine was administered hourly, intraoperative fluid administration was standardised to 1500 ml isotonic saline and 500 ml of 6% hydroxyl-ethyl starch, and 30 minutes before the end of the operation, 30 mg ketorolac and 4–8 mg ondansetrone were administrated and intraoperative normothermia was maintained. After surgery, pain control was achieved with paracetamol (acetaminophen) and continuous epidural anaesthesia with bupivacaine and morphine for 48 h. No cardiopulmonary complications occurred in 60 patients and the median hospital stay was 2 days, with a high readmission rate of 15%.

Multimodal rehabilitation programmes may significantly reduce the post-operative hospital stay and complications in patients undergoing colonic resection.

14.6 Post-operative Anaesthesia-Related Complications

14.6.1 Post-operative Urinary Retention

Acute urinary retention is the most common complication after surgery for benign anorectal disease. It is linked to several risk factors including increased intravenous fluids, post-operative pain and type of anaesthesia. In a review of 2000 anorectal surgeries performed under spinal anaesthesia, the urinary retention rates were as follows: haemorrhoidectomy 22%, fistulectomy 6%, incision and drainage 2%, sliding skin graft/internal sphincterotomy 17% [115]. Independent risk factors were haemorrhoid resection, female gender, presence of preoperative urinary symptoms, diabetes mellitus and need of post-operative analgesics.

Studies on the urodynamic effects of various anaesthetic agents are rare. The parasympatholytic drugs increase bladder capacity, decrease the rate of bladder contraction and cause a downward trend in urethral resistance. The barbiturates produce similar effects on urethral resistance. The anaesthetic agents decrease the IAP and inhibit the micturition reflex; this is a side effect of opioids, especially if given intrathecally or epidurally (spinal opioids influence the function of the lower urinary tract by direct spinal action on the sacral nociceptive neurons and autonomic fibres). Urinary retention is less common after short-acting agents (lidocaine) than after long-acting agents (bupivacaine 0.5%). There is no consensus on the best catheterisa-

tion strategy for the management of post-operative urinary retention. In a prospective randomised trial of 1448 patients, where the overall incidence of urinary retention was 4.1%, in-out catheterisation was compared with overnight catheterisation [116]. Significant risk factors associated with post-operative urinary retention included old age, anorectal surgery and spinal anaesthesia. They found no difference between the two groups and postulated that urinary retention should therefore be managed by in-out catheterisation.

14.6.2 Anaphylactic and Anaphylactoid Reactions Occurring During Anaesthesia

Hypersensitivity reactions – IgE-mediated (anaphylaxis) or non-IgE-mediated (anaphylactoid) reactions occurring during anaesthesia – remain a major cause for concern for anaesthesiologists. These reactions usually remain unpredictable and may be potentially life-threatening even when appropriately treated. The incidence of anaphylaxis is estimated to be between 1:10,000 and 1:20,000 anaesthesia inductions, and any drug administered in the perioperative period can potentially produce life-threatening immune-mediated hypersensitivity reactions. Neuromuscular blocking agents, latex and antibiotics represent the most frequently involved substances [117]. However, anaphylactic reactions cannot be clinically distinguished from non-immune-mediated reactions, which account for 30–40% of hypersensitivity reactions. Atopy, asthma and food allergy occur significantly more frequently in the case of latex allergy. In a French study, the positive predictive value of tryptase for the diagnosis of anaphylaxis was found to be 92.6%; the negative predictive value was 54.3% [117].

14.6.3 Post-operative Nausea and Vomiting

The incidence of PONV remains between 20 and 35%, despite the introduction of new anti-emetic medications [118]. Significant improvements towards a better control of PONV have been achieved in recent years. A rational approach to this issue includes three steps: identification of patients at risk, keeping the baseline risk low, and prophylactic administration of anti-emetics in those patients who are most likely to need them. For patients who are identified as being high risk, all treatments should be initiated simultaneously (multimodal anti-emesis) [119]. The rule of three as described by Tramer [120] serves as a good approach to improve dissemination and implementation:

1. First, patients at risk have to be identified (non-smoking females with a history of PONV, opioids, urological, gynaecological or abdominal surgeries).
2. Second, the baseline risk has to be kept low: avoidance of potentially emetogenic drugs (N_2O, opioids, and neostigmine).
3. Third, if anti-emetic drugs have to be given, then concentrate on drugs that are effective (5-HT3 receptor antagonists, dopamine D2 receptor antagonists – droperidol – and steroids –dexamethasone) and, because it results in improved efficiency, combine them.

Table 14.3 Comparison of thoracic epidural analgesia versus opioid-controlled analgesia during the post-operative period

	Thoracic epidural analgesia	Opioid-controlled analgesia
Dynamic analgesia (mobilisation)	↑↑	↓
Static analgesia (at rest)	↑↑	↑
Post-operative ileus	↓↓	↑
Pulmonary complications	↓	↔
Cardiac complications	↓	↔
Post-operative nausea and vomiting	↓	↑
Pruritus	↔	↑
Urinary retention	↑	↔
Post-operative catabolism	↓↓	↑
Post-operative somnolence	↓	↑

14.7 Conclusion

Anaesthesia is an important factor that contributes to morbidity and mortality for procedures in high-risk patients. Improvements in anaesthesia techniques improve convalescence and reduce hospital stay after major surgical procedures. There is some evidence to support regional anaesthesia over general anaesthesia if the former is extended into the post-operative period to provide neuroaxial analgesia. Epidural with local-anaesthetic-containing solutions is recommended to reduce the duration of PI and to promote a quicker return of normal bowel activity. This has been shown to be particularly effective when the catheter has been sited at Th12 or higher. Epidural analgesia preserves aerobic conditioning and improves short-term quality of life after open colon surgery (Table 14.3). Fast-track clinical pathways including epidural analgesia are recommended to reduce hospital stay using multimodal patterns in colorectal surgery.

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Self-Assessment Quiz

Question 1

Which of the following is not a complication of epidural anaesthesia?

a. Meningitis
b. Hypotension
c. Backache
d. Paralytic ileus
e. Spinal anaesthesia

Question 2

If 0.5 mg of adrenaline is added to 100 ml of lidocaine for local-infiltration anaesthetic, which of the following concentrations will be present?

a. 1:200
b. 1:2000
c. 1:20000
d. 1:200000
e. 1:50000

Question 3

Higher concentrations of local anaesthetics are necessary for epidural than for spinal anaesthesia because:

a. The C_m of epidural nerve fibres is greater than that of the intrathecal roots.
b. The spinal rootlets float in aqueous medium.
c. The intrathecal area is well perfused.
d. The epidural space has a constant capacity.
e. The subarachnoid space has a generous blood supply.

Question 4

Which of the following is true? The spread of local anaesthetics within the thoracic epidural space:

a. Is greater in the elderly
b. Follows a linear relationship with dose
c. Is similar for both high- and low-thoracic epidurals
d. Should avoid cardiac sympathetic innervation if possible
e. Necessitates urinary catheterisation

Question 5

Which of the following is true? Thoracic epidural analgesia:

a. Is superior to patient-controlled analgesia with morphine or post-operative dynamic analgesia
b. Can be inserted safely in an anticoagulated patient
c. Provides optimal analgesia with opioid alone
d. Has a high incidence of associated respiratory depression when opioids are given
e. Cannot improve post-operative pulmonary function

1. Answer: d
Comment: Sympathetic block by epidural or spinal anaesthesia may cause an increase in gastrointestinal motility and muscle tone.
2. Answer: d
Comment: Adrenaline should be kept in the range 1:150,000–1:30,0000.
3. Answer: b
Comment: The rootlets are covered by a light, filmy tissue and float in an aqueous medium, allowing ready diffusion of the anaesthetic solutions into the nerves.
4. Answer: a
Comment: Spread of local anaesthetics in the thoracic epidural space is greater in the elderly. High-thoracic epidurals have a more caudal spread than low-thoracic epidurals because of the narrowing of the epidural space in the cervical region. Urinary catheterisation is not necessary if the epidural block is limited to the thoracic segments.
5. Answer: a
Comment: Epidural analgesia is the only method of analgesia currently available that can predictably provide dynamic analgesia. Epidural catheters should not be inserted in anticoagulated patients because of the risk of epidural haematoma. Optimal analgesia is achieved with a "local anaesthetic and opioid" combination. Thoracic epidural analgesia has been shown to have a beneficial effect on post-operative pulmonary function.

15 Transanal Endoscopic Microsurgical Excision

Nicolas Demartines

CONTENTS

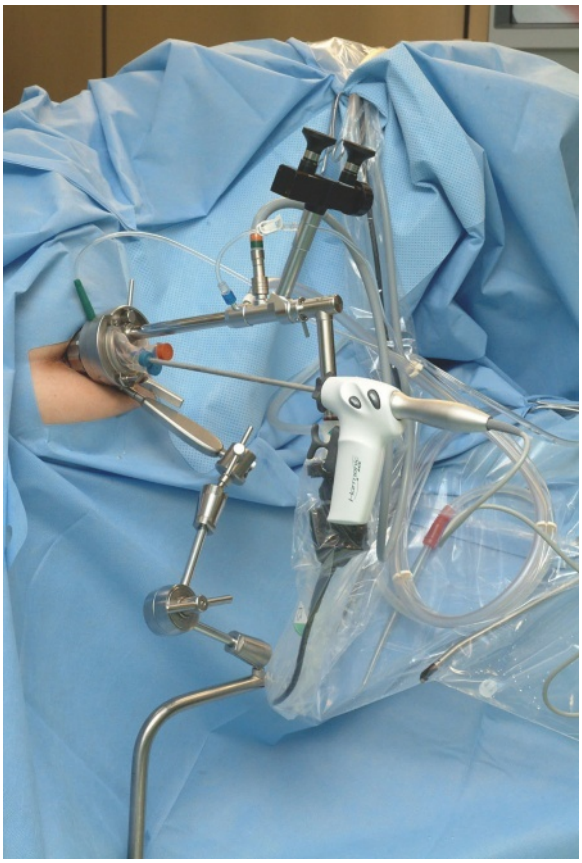

Fig. 15.1 Transanal endoscopic microsurgery (TEM) setting

15.1 Introduction

15.1.1 Description of Transanal Endoscopic Microsurgery

Transanal endoscopic microsurgery (TEM) allows the minimally invasive local excision of rectal tumors located between 2–4 and 18 cm above the anal verge with the aid of a special operative rectoscope and a magnified view. This technique is not yet generally established because of the necessary special instrumentation and tools, unusual technical aspects of the approach, and stringent patient selection criteria (Fig. 15.1).

Compared with conventional transanal resection, TEM provides superior exposure of tumors higher up in the rectum (i. e., up to 18 cm from the anal verge). The greater precision of resection, combined with low (relative to anterior resection) morbidity (5–10%) and short duration of hospitalization make this technique a reliable, and in some cases, more effective surgical approach than laparotomy or laparoscopy with low anterior resection, provided careful patient selection is performed.

The acronym "TEM" for transanal endoscopic microsurgery should not be confused with "TME" for total mesorectal excision [16]. These techniques and more important indications are very different!

15.1.2 History of TEM and its Development

TEM excision may be regarded as one of the first natural orifice transluminal endoscopic surgery applied to humans: it was developed in Germany by Gerhard Buess in 1983 and used by him and his coworkers to perform several transanal rectal procedures some years before the rise of laparoscopic surgery [4]. About 300 scientific publications regarding TEM are available (remove) on Medline, as a demonstration of the limited spread of the technique among the surgical community.

Buess developed an operative rectoscope with direct binocular magnified vision, which allowed a nice view within the gas-insufflation-dilated rectum, and an important depth of vision. The procedure was initially conceived to perform mucosectomy, but very quickly it appeared that full-thickness resection was safe and reproducible with this technique, and of surgical importance. In the initial period, Buess even intended to cure rectal prolapse with TEM, but aside from experimental surgery, this procedure was never established. Thus, current accepted TEM procedures are mainly resections of endoscopically nonresectable benign tumors and low-risk T1 rectal cancer, as well as fistulae and anastomosis strictures.

Nowadays TEM is still performed with the original tool developed by Buess with minor improvement. Some simplified and cheaper tools were developed recently by another company and may be used in the same way. It is interesting to note, however, that the basic principle of TEM and the tool required have remain similar over the three decades since its inception, while laparoscopic surgery has further developed for use in advanced surgical procedures like resection of the esophagus or pancreas. Recent developments of laparoscopic materials, like ultrasound scissors or some staplers, have also been applied to TEM. Future development of TEM may include some robotics, but this remains hypothetical to date, due to the limited potential of TEM, the limited good indications, and the specialized technique requiring expertise and training.

15.2 Indications and Work-up

15.2.1 Indications for TEM

The ideal indication for TEM is all types of adenoma located between 2–4 and 18 cm from the anal verge that cannot be resected by colonoscopy. Ideal tumor size ranges in diameter from 20 mm to 100% of the lumen circumference (Fig. 15.2). Tumors located between 2 and 4 cm from the anal verge are considered inappropriate for TEM because this setting prohibits proper introduction of the 40-mm operating rectoscope. These patients must undergo conventional surgical local treatment with the use of the Lone Star Retractor (Lone Star Medical Product, Houston Texas USA).

A full-thickness resection is recommended to ensure an appropriate margin of safety. In addition, this procedure is technically easier to perform than mucosectomy and decreases the risk of missing a small rectal cancer that may be located inside a villous adenoma (Fig. 15.3). Such small, "encapsulated" cancers have

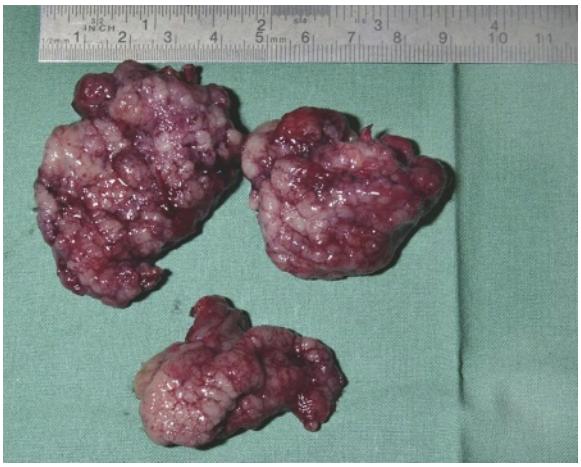

Fig. 15.2 Tubulovillous adenoma: 100% lumen circumference

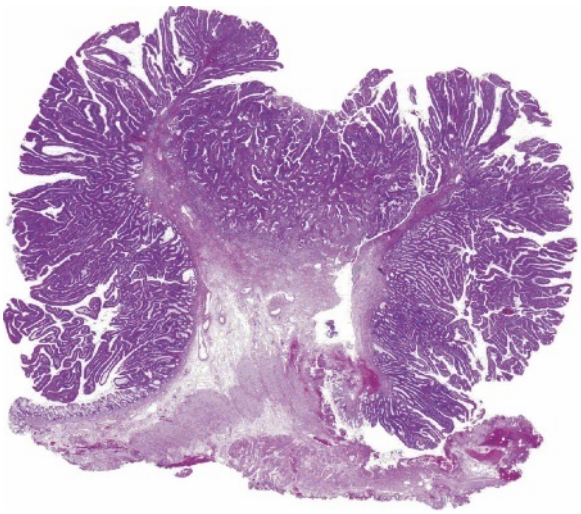

Fig. 15.3 T1 cancer inside an adenoma

been reported in up to 31% of cases [34]. Since the rectal wall is sutured after full-thickness resection, the removal of a large segment of the rectum is not high-risk, based on the low morbidity reported in the literature.

Treatment of rectal cancer by TEM may be appropriate for T1 low-risk cancer [22]. The recurrence rate following this application lies between 4 and 8% [5, 13–15, 22, 24, 35], which is similar to the recurrence rate after resection of a benign tumor, compared with a local recurrence rate of up to 30% for T1 high-risk cancer [1, 6]. Patient selection and appropriate tumor characteristics are therefore crucial to good local and oncologic results.

Table 15.1 Indications for transanal endoscopic microsurgery

Indications:
• Benign tumors of any type (> 2 cm in diameter) located between 4 and 18 cm above the dentate line
• Adenoma recurrence
• Low-risk T1 rectal cancer (see Table 15.2)
• Fistulae and stenoses
Relative indications:
• T2 rectal cancer in high-risk patients
• Palliation in rectal advanced cancer

Table 15.2 Low-risk rectal cancer

• T1 sm 1 or 2 (see Chap. 7)
• Well- or moderately differentiated (G1, G2) T1 tumor
• No lymphovascular tumor infiltration

Table 15.3 Predictor of lymph-node metastasis in rectal cancer [23]

• Deep mucosa $p = 0.001$
• Lymphovascular invasion $p = 0.005$
• Lower third of the rectum $p = 0.007$
• Poor differentiation (G3) $p = 0.001$ (invariable)

Table 15.4 Patient work-up

• Complete colonoscopy
• Clinical examination: digital and with rectoscopy
• Endorectal sonography using a 360° endoprobe (7 MHz)
• Assessment of patient's sphincter function and continence
• Fine slice pelvic IRM

If the primary indications for TEM remain villous or all types of adenomas [24], TEM may be a suitable method for resection of intrarectal stenoses (e. g., inflammatory stenosis after a high fistula) [3, 5] or colorectal anastomotic stenosis [9].

Although transanal rectopexy by TEM was originally proposed by Buess [26], this indication no longer appears in the literature. Table 15.1 summarizes the current accepted indications and Tables 15.2 and 15.3 the criteria for low-grade T1 rectal cancer.

15.2.2 Preoperative Diagnosis

A careful patient selection is mandatory to achieve a safe procedure and good outcome. The local work-up is of importance and should include rectal digital examination by the surgeon, as well as endoscopy and endoluminal ultrasound with a 360° endoprobe (7 MHz) and fine slice IRM of the pelvis. The localization above the dentate line, the localization clockwise and the dimension of the tumor should be established preoperatively in order to determine the adequate position of the patient on the operating table and the appropriate operative rectoscope (12 or 20 cm in length). A complete colonoscopy should have been performed prior to the local work-up. Table 15.4 summarizes patient work-up.

The goal of the preoperative diagnosis is to establish whether the tumor is benign or a T1 cancer (Figs. 15.4 and 15.5) [20]. T2 tumors and above are currently not accepted indications outside from neoadjuvant protocols, even though some authors have published interesting preliminary results. The use of TEM in a palliative situation may be advised [1]; however, great caution is mandatory due to possible local extension and the potential of bleeding.

15.3 TEM Technique

15.3.1 Patient Preparation

Until recently complete bowel preparation as for a formal laparotomy was performed by lavage over 4 h with 3–4 l of polyethylene glycol solution. Since this is no longer recommended for elective colonic surgery, we suggest preparing the rectum with the application of a 250-ml enema prior to the operation. Moreover, transanal lavage should be performed on the operating table once the patient is under anesthesia.

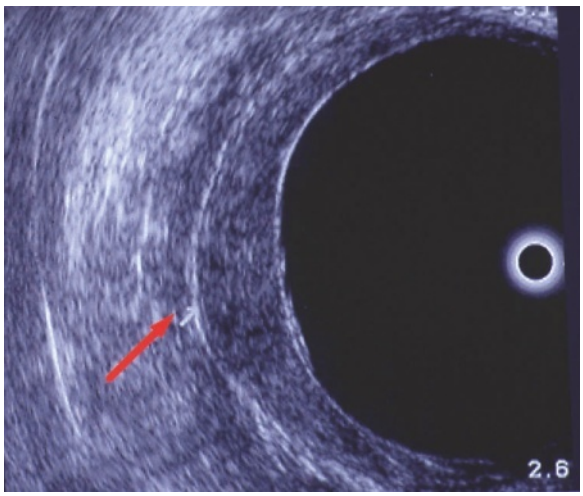

Fig. 15.4 Endoluminal ultrasound: benign tumor (*red arrow*), mucosa intact

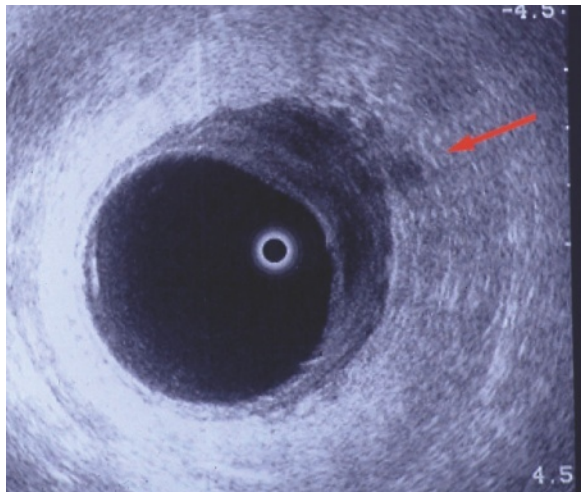

Fig. 15.5 Endoluminal ultrasound: submucosa invasion (T2 cancer; *red arrow*)

For this kind of operation, locoregional anesthesia is a possibility; however, due to the position on the table as well as the duration of the procedure, we prefer for the comfort of the patient to request a general anesthesia whenever possible. Patient position for surgery therefore depends on the anteroposterior and lateral orientation of the tumor.

Single-shot antibiotic prophylaxis against Gram-negative and anaerobic strains is given at the time of anesthetic induction.

15.3.2 Material

Following the technique described by Buess, we use the original operative rectoscope of diameter 40 mm and length 120 or 200 mm (Fig. 15.6a), with a sixfold-magnified stereoscopic view (Fig. 15.6b). The end of the rectoscope is beveled downward to allow an appropriate angle of approach to the tumor (Fig. 15.7). An additional camera allows the operating room staff to follow the procedure on a TV monitor. Intrarectal insufflation

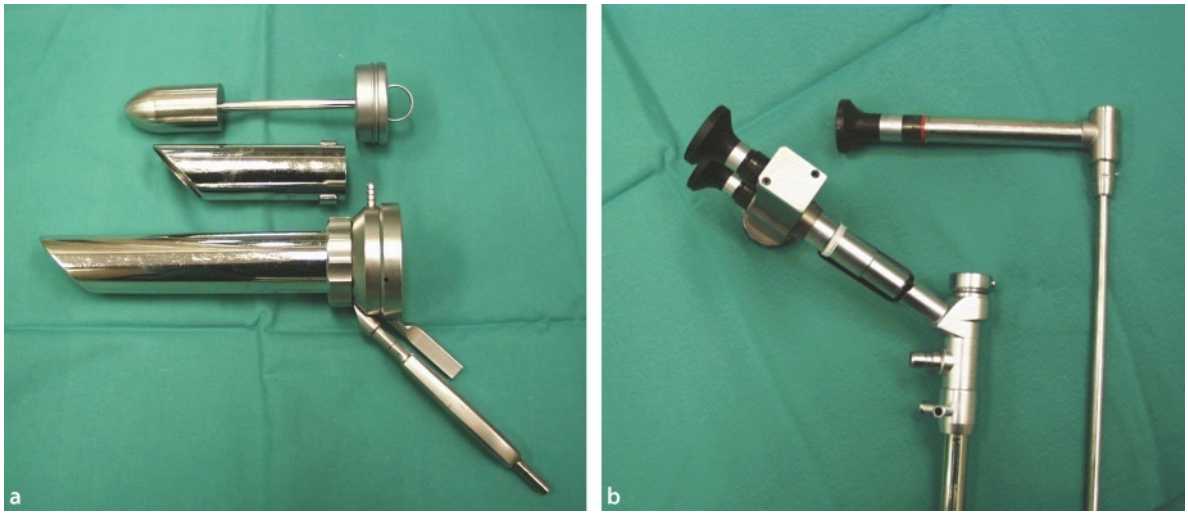

Fig. 15.6 **a** Operative rectoscope. **b** Binocular

is maintained by a Laparo-CO_2-Pneumo and TEM pump combination unit that maintains pneumorectum, while applying continual suction to evacuate liquids and smoke (Fig. 15.8). The proctoscope is affixed to the operating table using a U-shaped arm; this arm can be loosened by the surgeon to adjust positioning of the scope during the operation. This original material was manufactured by Richard Wolf (Germany) and in 2007 in the complete setting cost around 60,000 Euros. Since 2005, Karl Stortz Germany, developed a similar tool in a somewhat "light" version without a binocular view and based on a standard laparoscopic tower (Fig. 15.9).

The surgical instruments available for use through the operative rectoscope are similar to those used for laparoscopic surgery. However, the surgical end of these instruments is angled at 40° to enhance the view of the tumor (Fig. 15.10). Two instruments (i. e., a grasper and coagulation scalpel or suction or needle holder) are introduced simultaneously, in parallel, into the rectoscope. The operation may be performed with angulated TEM instruments (either Stortz or Wolf), although standard laparoscopic instruments have often been used.

15.3.3 Surgical Technique

To visualize the anatomic relationship between tumor and healthy mucosa, carbon dioxide is insufflated to enlarge the intrarectal space and facilitate precise resection. Small coagulation marks are placed around the lesion to imprint the line of resection with a 5-mm safety margin. This is of particular importance for large tumors. Precise resection is then achieved by gently grasping near the tumor base with the appropriate instrument and excising it with a high-frequency scalpel,

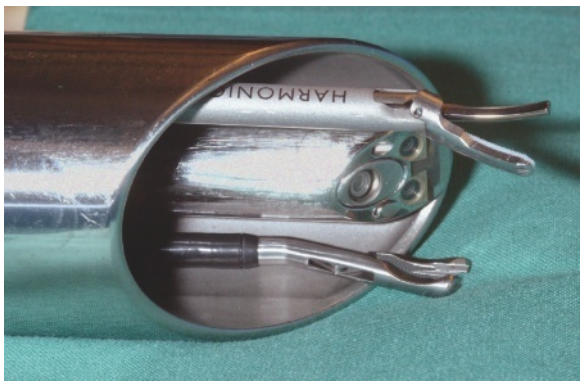

Fig. 15.7 Downward beveled rectoscope end with optic and instruments

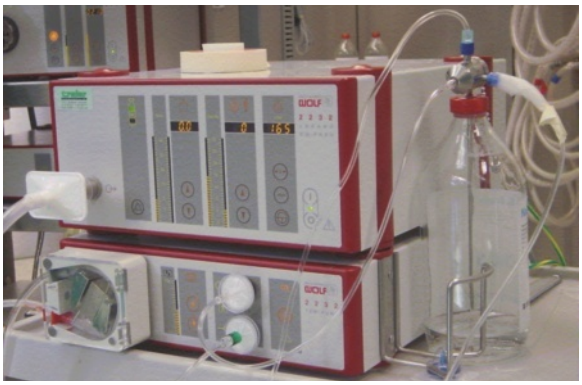

Fig. 15.8 TEM pump unit (Richard Wolf, Germany)

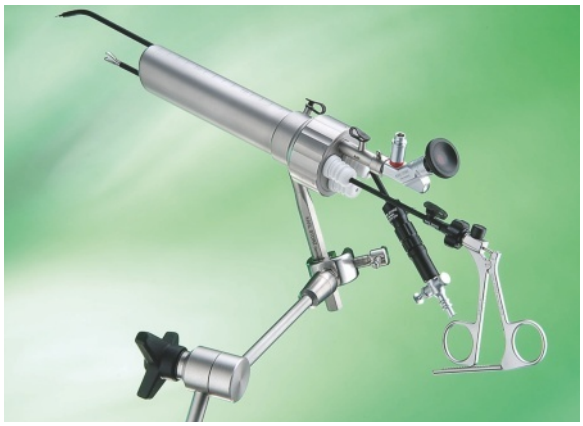

Fig. 15.9 TEM unit: "light system" (Karl Stortz, Germany)

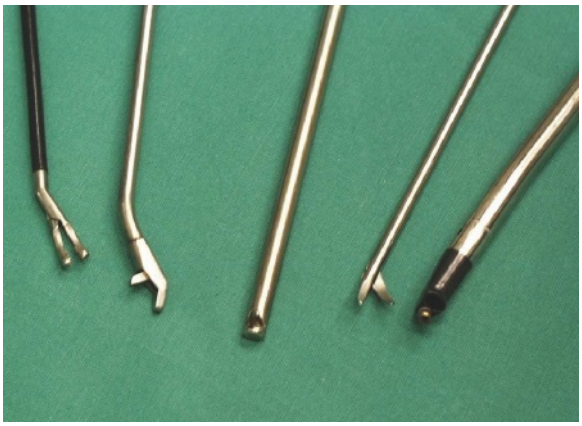

Fig. 15.10 Surgical instruments (Richard Wolf, Germany)

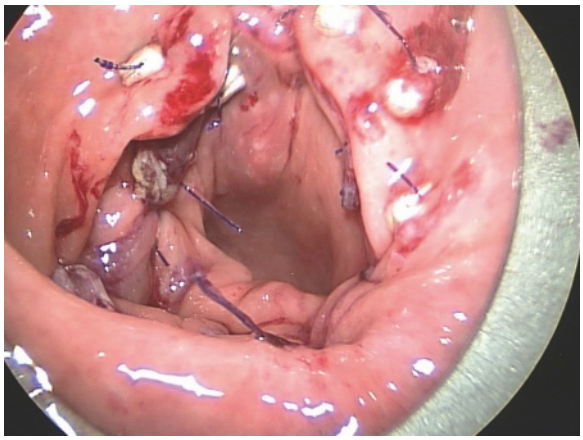

Fig. 15.11 Anastomosis after full thickness resection by TEM (see Fig. 15.2)

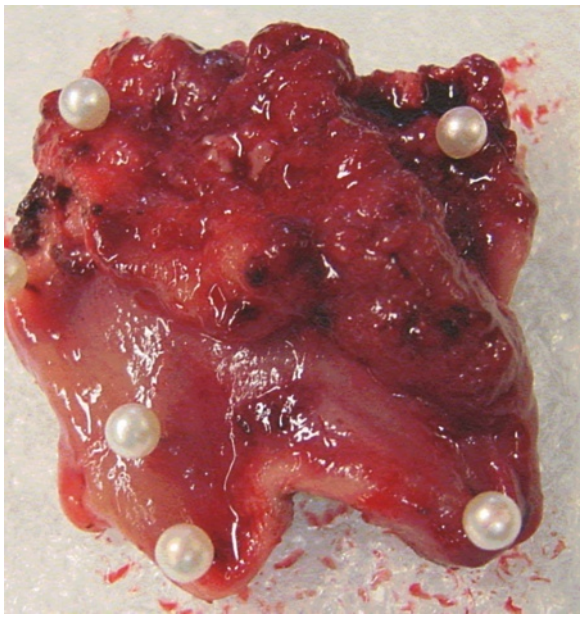

Fig. 15.12 Affixed specimen

or better with a Harmonic scalpel, which allows excellent hemostasis and speeds up the procedure.

After controlling hemostasis, the rectal wall is sutured with 3/0 resorbable monofilament synthetic polyglycol continuous sutures that are closed with silver clips, since the small operative space precludes the use of an intrarectal knot (Fig. 15.11).

To optimize access to the entire tumor and to ease the continuous suture, the rectoscope orientation must be changed frequently to compensate for the limited operating field and length of the surgical instruments, especially with large tumors. The use of the U-shaped multiangular supporting arm makes such frequent shifts in perspective possible.

Finally, the specimen is affixed to a preparation plate to allow the pathologists a precise description of the resection margin in 5 mm of healthy tissue around the resected specimen (Fig. 15.12).

15.3.4 Postoperative Management

Postoperatively, patients are allowed to sit and walk as soon as they are fully recovered from anesthesia. A liquid diet is allowed on the evening of the operation, followed by normal food intake from day 1 on. Patients are usually discharged on postoperative day 2 or 3. Initial clinical follow-up occurs at 6 weeks postoperatively and final clinical examination, including rectoscopy and endorectal sonography, at 3, (6), and 12 months depending on final histology.

15.3.5 Personal Tips

TEM distinguishes itself from other endoscopic or laparoscopic procedures in various ways and the technique is particular:

1. Surgical instruments are inserted and moved in parallel planes in a reduce space of 4 cm in diameter as demonstrated on Fig. 15.6. Full tumor exposure can therefore be difficult to obtain without specialized training and skill. Prior laparoscopic experience and participation in a TEM training course will ease the introduction of TEM and speed up the learning curve (about 25 procedures are necessary to feel confident with TEM).
2. The use of a magnified binocular stereoscopic device eases the learning of the procedure: Compared with that obtained with monocular instruments or video cameras, the view of the operating field obtained with TEM provides a depth of field of extremely good quality. With increasing experience, however, this is no longer necessary and the procedure may be performed with the easier tool based on a normal laparoscopic tower.
3. The pathologies treated with TEM are by far less frequent than those treated by laparoscopy. Because TEM equipment is costly, worldwide promotion of this technique is actually limited to a few teams, and collaboration with other teams may thus be of interest

15.4 Operative Results

The clear advantage of TEM is an uneventful postoperative course. The postoperative analgesic requirement is slight, generally limited to a few doses of paracetamol [35], and the duration of hospitalization short (in the only existing prospective randomized study comparing TEM with TME for T1 tumor: 5.7 days for TEM vs. 14.5 days for laparotomy and anterior resection, $p<0.0001$) [35]. The reported complication rate varies between 8 and 21% [5, 35] and is significantly lower than that reported for anterior resection, even with laparoscopy. Overall, the rate of localized complication associated with transanal resection lies between 4 and 8.3% of cases [22, 25], and that of systemic complication between 14 and 21% [1, 28, 30, 35].

Results in our own patients are comparable (i.e., a hospital stay of 5.5 days and localized and systemic complication rates of 4% and 11%, respectively, with no mortality) [5]. In fact, mortality is exceptional and is lower than 2% in the large nationwide databases [1]. One single publication reports precisely a fatality due to retroperitoneal phlegmon after TEM resection. The indication was an adenoma located 7 cm above anal verge in a 55-year-old patient who died of septic shock 28 days postoperatively [10].

15.5 TEM Limitations in Cancer Treatment

The primary factor limiting the effectiveness/success of local treatment of early rectal cancer is lymph-node invasion. The lymph-node metastasis rate of T1 rectal tumors lies between 0 and 15.4%, depending on tumor grading [6, 18, 27], and age < 45 years is recognized as a significant risk factor for this metastasis [23, 27].

The second important factor is the local recurrence rate, which is similar for benign tumor and T1 low-risk cancer, at about 8.3% [1, 5]. The local recurrence rate for all T1 cancers together is about 20% [1], thus demonstrating the limitation of local excision in rectal cancer and showing the importance of differentiating between T1 low- and high-risk cancers (Table 15.5).

Table 15.5 Recurrence rate according to tumor type

Tumor characteristic		Recurrence rate
Benign		0–8.8%
Cancer:	T1 low risk	0–8.3%
	T1 high risk	3–31%
	T2	5–75%

The important risk factor for recurrence seems to be technical, however, as the clearance of the resection margin is of significant importance [33]. If it is unclear whether the TEM resection was radical, it is essential to subsequently perform an anterior resection.

Despite this, local excision appears to offer a significant advantage. The rate of recurrence for T1 tumors resected by TEM is 3.8% at 13 months follow-up [22], compared with a recurrence rate of 23% after conventional transanal surgery [31]. Some recent single-center publications could not find any recurrence 40 months after resection of T1 cancer [19]. To date, the only published prospective, randomized study comprised 52 patients with T1 tumors treated either by TEM or anterior resection [35]. There were no significant differences in group outcome: 5-year survival was 96%, the local recurrence rate was 4.1% for TEM and 0% for anterior resection, and the metastasis rate was 0% for TEM and 4.1% for anterior resection. Thus, TEM appears to offer some advantage relative to anterior resection for T1 rectal cancer, with similar oncologic results [35, 36].

15.6 TEM and Neoadjuvant and Adjuvant Therapy

Conservative management of rectal cancer with radiotherapy or endocavitary contact radiotherapy has a failure rate of up to 30% [17, 21]. Consequently, the indications for neoadjuvant or adjuvant radiochemotherapy following local resection of rectal cancer by TEM remain controversial. However, the group of Lezoche claimed recently in a cohort study a 5% local recurrence rate after 55 months [13–15]: 100 patients were treated with neoadjuvant radiotherapy followed by TEM excision. If confirmed by others, these results may be regarded as excellent. The large Dutch study for total mesorectal excision showed a 2-year local recurrence rate of 1% for neoadjuvant radiochemotherapy compared to 5.7% for surgery alone in T2 rectal cancer [8].

Currently it should be noted that most of the literature on this subject is dominated by single-institution reports, and the extended indications for TEM in T1 high-risk and upper stadium should be given in controlled protocols only.

15.7 Risks of TEM

TEM is not a risky operation and postoperative bleeding or infection is very rare. It is not rare to observe

some fever in the first postoperative days, but this remains irrelevant and the large majority of patients recover uneventfully.

15.7.1 Effect on Sphincter Function

Minor postoperative incontinence episodes are described, but without long-term consequences. It is surprising that prolonged anal dilatation of 4 cm diameter (the operative rectoscope) induces few sphincter function problems. We observed only a postoperative, transitory, grade II incontinence in 15% of our patients, with full postoperative recovery after 3 months (excluding one elderly patient with chronic incontinence in whom the problem did not resolve with surgery) [5]. This is comparable to other reports [2, 7, 11]. In fact, existing manometric analyses of the effects of anal dilatation indicate a decrease in sphincter tonus ranging from 25 to 37% of preoperative sphincter pressure, with complete recovery to clinical continence within 6–16 weeks postoperatively [2, 7, 11].

15.8 Perspectives

TEM may be considered as the first natural orifice transendoscopic surgery (NOTES) performed. It has become part of the historical development of this recently developed approach. TEM still has his own indications and has the benefit of rigid instruments in direct contact with the hand of the surgeon, while NOTES uses the currently available two- or three-channel flexible endoscope, with important limitations with regard to haptic force and feedback.

The next few years will see how the NOTES technology evolves, but the first transanal colonic resection by TEM in the NOTES philosophy has already been performed [29].

15.9 Conclusion

TEM is not only an additional tool for transanal resection of rectal tumor, but also a minimally invasive technique for treating tumors in the low, middle, and upper rectum. Compared with conventional transanal resection, TEM provides superior tumor exposure higher in the rectum (up to 18 cm), a lower local recurrence rate and a lower complication rate [12]. The greater precision of resection, low (relative to anterior resection) morbidity (5%), and short duration of hospitalization (2–5 days) make this technique a reliable, and in some cases more effective surgical approach than laparotomy or laparoscopy and low anterior resection.

With strict patient selection and precise preoperative staging, the use of TEM for the treatment of low-risk T1 carcinoma is a safe and reproducible technique.

According to the literature and to our own surgical experience, all the other types of rectal cancer should be treated by total mesorectal excision [16]. The contribution of adjuvant therapy to local treatment of rectal cancer is still under evaluation [13–15, 32], but patients should be included in controlled protocols only.

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Self-Assessment Quiz

Question 1

Which is true of local excision techniques and transanal endoscopic microsurgery (TEM)?

a. TEM was introduced 50 years ago.
b. Conventional transanal excision is not limited to the lower third of the rectum.
c. TEM gives a magnificent view 2× the original.
d. The TEM scope is 2 cm in diameter.
e. TEM uses conventional laparoscopic instruments.

Question 2

Which of the following techniques have not been described for use with TEM?

a. Mucosectomy of villous tumors
b. Full-thickness disc excision of villous tumors
c. Full-thickness disc excision of a low-risk T1 rectal cancer
d. Incision and widening of an anastomotic stricture
e. Lateral pelvic side-wall node biopsy

Question 3

For TEM work-up and patient preparation – which is true?

a. Digital rectal exam, colonoscopy, and assessment of the height and location of the lesion are not mandatory.
b. Full bowel preparation prior to TEM is essential.
c. Local anesthesia is suitable.
d. The patient's position on the operating table is not important.
e. Endoluminal ultrasound is not the best imaging technique for the assessment of early invasion.

Question 4

Using TEM in practice, which is true?

a. A 5-mm margin around an adenoma or carcinoma is sufficient.
b. The defect in the rectal wall is always sutured closed.
c. There is no risk of perforation of the rectum anteriorly at 10–15 cm from the anal verge.
d. The specimen does not need to be pinned out.
e. Carbon dioxide insufflation can cause life-threatening hypercapnia.

Question 5

Complications and outcomes of TEM – which is true?

a. Postoperative bleeding, stenosis at the TEM site, and minor postoperative incontinence have not been reported.
b. Complication rates are higher than for equivalent open procedures.
c. Locally excised T1 cancers have a recurrence rate of 2–10% depending on the depth of invasion of the submucosa.
d. Adjuvant chemoradiotherapy has been shown in large randomized trials to reduce recurrence rates.
e. Immediate classical resection following an unfavorable "big biopsy" by TEM is associated with poor outcomes.

1. Answer: b
TEM is not limited to the lower third of the rectum as the middle third can sometimes be reached.
2. Answer: e
This is not possible for technical reasons.
3. Answer: a
Digital rectal exam to feel for an area of thickening or induration suggesting a cancer focus is essential. Colonoscopy is important to rule out synchronous polyps and cancer and to assess the lesion for a further attempt at polypectomy. Assessment of the height and location by quadrant of rectum is essential for choosing the length of scope and positioning of the patient on the operating table.
4. Answer: a
A minimum 5-mm, and preferably 10-mm, margin should be left around a tumor.
5. Answer: c
Depth of invasion of the submucosa is a guide to lymph-node metastases.

16 Laparoscopic Colorectal Surgery

Willem A. Bemelman and Andre D'Hoore

CONTENTS

16.1 Introduction

The introduction of laparoscopic techniques might be the most important development of recent decades in surgery. It has changed the face of surgery, and many procedures that used to require a laparotomy are now routinely performed with a minimally invasive approach. The laparoscopic approach is the gold standard in cholecystectomy, live kidney donation, fundoplication, Heller's myotomy, splenectomy, adrenalectomy, diagnostic laparoscopy combined with appendectomy, and rectopexy.

In contrast to many of these laparoscopic techniques, the (broad) implementation of laparoscopic colorectal surgery has been slow and troublesome. Many surgeons embarked on laparoscopic colorectal surgery with great enthusiasm, but stopped because of operative time constraints, waiting lists, lack of evidence of the benefits of laparoscopic colorectal surgery, a competitive "enhanced recovery after surgery" programme (fast track, FT), increased procedural costs and above all, the long learning curve. Most of these issues reflect a lack of adequate training.

Furthermore, the "temporary" problem of port-site metastasis in laparoscopic cancer surgery virtually stopped the performance of laparoscopic colorectal surgery outside prospective randomised trials. Others proceeded, and mastered the difficulties of setting up a

laparoscopic colorectal programme. Now, 15 years after the first laparoscopic colectomy, laparoscopic colorectal surgery is performed in only a relatively small number of centres by a small group of dedicated surgeons.

It is well recognised that the safe implementation of difficult novel techniques requires the surgeon to undertake an extensive educational programme consisting of hands-on courses as a start-up, followed by a long period of proctoring. Lack of trainers and a financial reimbursement structure are logistical problems that hamper a side-by-side education in laparoscopic colorectal surgery.

Seeing a good operation is believing in it. A good laparoscopic operation is superior to a good open operation because of its minimal invasiveness, its superior image and superior haemostatic (anatomic) dissection techniques. However, a bad laparoscopic operation compromises all we have accomplished in open surgery. The objective of this chapter on laparoscopic colorectal surgery is to contribute to the future safe and responsible implementation of the technique by summarising the evidence for laparoscopic colorectal surgery and by providing technical guidelines.

16.2 Laparoscopic Techniques

16.2.1 General Considerations

Advanced laparoscopic procedures require extensive preoperative planning. Indeed, planning the preoperative preparation of the patient, preoperative imaging and patient and surgical team positioning, and ensuring the availability of laparoscopic instruments and the presence of laparoscopic expertise are the keys to a successful advanced laparoscopic operation. Surgical strategy depends not only on the indication for surgery (e. g. benign versus malignant disease), but also on the availability of experienced assistance (e. g. total laparoscopic – TL – approach versus hand-assisted laparoscopic – HLA – approach).

16.2.2 Perioperative Management and Technical Considerations

16.2.2.1 Preoperative Localisation of the Lesion

The surgeon has to estimate whether the tumour can be localised easily during laparoscopy. When in doubt, either preoperative tattooing proximal and distal to the lesion must be carried out, or a perioperative endoscopy must be organised; the latter requires full preoperative bowel cleansing. The absence of tactile feedback can make the laparoscopic localisation of smaller, non-transmural invasive lesions difficult. An X-ray of the colon can serve as a road map.

Perioperative colonoscopy is most suitable for left-sided lesions. The bowel insufflation needed to progress the colonoscope to the right colon significantly compromises further laparoscopic dissection.

16.2.2.2 Enhanced Recovery Programmes

A recent development in elective large-bowel surgery is the introduction of FT perioperative care, also referred to as "enhanced recovery after surgery" [1, 2]. FT perioperative care combines several elements aimed at enhancing recovery and reducing the profound stress response after surgery. Kehlet et al. [2–8] developed a multimodal FT recovery programme for elective large-bowel surgery to enhance post-operative recovery and to avoid the common hindrances to early hospital discharge, such as the need for parenteral analgesics or fluids, delayed patient mobilisation and the lack of home care. The main elements of this and similar FT programmes in colonic surgery are extensive preoperative counselling, avoidance of mechanical bowel preparation, no premedication, antibiotics administered before surgery, avoidance of prolonged preoperative fasting but carbohydrate-loaded liquids until 2 h before surgery, tailored anaesthesiology encompassing thoracic epidural anaesthesia and short-acting anaesthetics, perioperative high inspired oxygen concentrations, avoidance of perioperative fluid overload, limited (transverse) incisions, non-opioid pain management, no routine use of drains and nasogastric tubes, early removal of bladder catheters, standard laxatives and prokinetics, and early and enhanced post-operative feeding and mobilisation [1–13]. Based on six comparative single-centre studies, FT programmes were found to reduce the time spent in the hospital and to be safe in major abdominal surgery.

Since both FT programmes and laparoscopic surgery aim to enable an earlier recovery, both modalities should be combined. So, rather than compare the outcome of laparoscopic surgery with open surgery within an FT protocol, the minimally invasive laparoscopic approach can be a main pillar within an FT protocol. Minimally invasive surgery fits perfectly into an FT programme aimed at reducing perioperative stress to

the patients. At the same time, the optimal benefit of laparoscopic surgery can only be achieved by combining it with an FT programme.

16.2.2.3 Definitions

Laparoscopic colorectal operations include a range of procedures where (parts of) the operations are performed laparoscopically. Laparoscopic operations can be carried out in a facilitated manner, meaning that mobilisation of the bowel is achieved laparoscopically. Vascular ligation, bowel transection and creation of the anastomosis are carried out using an open technique; for example, laparoscopic-facilitated ileocaecal resection for Crohn's disease (CD). Laparoscopic-assisted (LA) procedures generally include laparoscopic mobilisation and vascular ligation. Bowel transection and anastomosis are carried out extracorporeally. A TL procedure comprises a laparoscopic operation wherein mobilisation, vascular ligation, bowel transection and creation of the anastomosis are performed laparoscopically. An incision is still required to exteriorise the specimen. In hand-assisted surgery, a hand port is used to insert the non-dominant hand for palpation and retraction. A lateral approach means mobilisation of the bowel by dissection of the lateral peritoneal attachments followed by vascular division (a strategy commonly used in open colorectal surgery). A medial approach means vascular ligation first followed by mobilisation of the bowel and mesentery.

16.2.2.4 Equipment and Positioning

Due to budget restraints, most hospitals have a limited amount of specific equipment that may or may not be available at a particular time (e. g. due to breakdown, not sterile or in use). Therefore, before starting the procedure, the surgeon must ensure that the required equipment, including the disposables, is available.

Patient position on the operating table is of paramount importance. A properly positioned patient allows the laparoscopic colorectal surgeon to approach all fields of dissection without unnecessarily increasing the number of trocars used. Part of the exposure on laparoscopic procedures is based upon gravity. Proper positioning will allow a steeper Trendelenburg position or sided tilting, which allows the surgeon to reposition the small bowel away from the dissection field. Advanced laparoscopic procedures might take several hours of operating time, and patients with their legs in the stirrups having a total proctocolectomy or low anterior resection, in particular, have an increased risk of developing compartment syndrome.

The best position fulfilling the needs of most laparoscopic operations is the French position with both arms strapped alongside the body. The patient is fixed to the table using a short, mouldable beanbag and two straps around the legs. Both legs are flat on the table, avoiding any compression or stretching of the legs; there is also no disturbance of the upper legs while manipulating the laparoscopic instruments, and the spread position of the legs allows the surgeon to access the anus for palpation or double stapling. The surgical team can stand on both sides of the patient and in between the legs. The one exception is the patient who needs an abdominoperineal resection. A full Lloyd-Davis position is required to access the perineum.

More recently, a prone position has been shown to improve the oncological proctectomy during abdominal perineal rectum resection, and to reduce the incidence of inadvertent tumour/bowel perforation. In this setting, the laparoscopic approach (including the stoma creation) has to be fully completed before repositioning the patient.

16.2.2.5 Medial-to-Lateral and Lateral-to-Medial Approaches

In open surgery, most surgeons start a bowel resection by mobilising the bowel by dissecting the lateral peritoneal attachments (development of the white line of Toldt), followed by vascular ligation and transection. This lateral-to-medial approach can also be applied during laparoscopic surgery. For technical reasons, the approach is in general from lateral to medial in hand-assisted surgery. The advantages of this approach are that it is similar to open surgery, and that the anatomic landmarks remain the same. An important disadvantage is that the affected bowel must be retracted for exposure; retraction of the bowel with laparoscopic instruments is potentially dangerous.

The medial-to-lateral approach aims to enable vascular control at the beginning of the laparoscopic procedure (Fig. 16.1a–e). The bowel remains attached to the lateral wall and the vessels are approached at their origin. After vascular ligation, the mesentery is loosened, often by applying blunt dissection, creating a submesenteric tunnel. Finally, the peritoneal attachments are dissected. This is a "no-touch" technique.

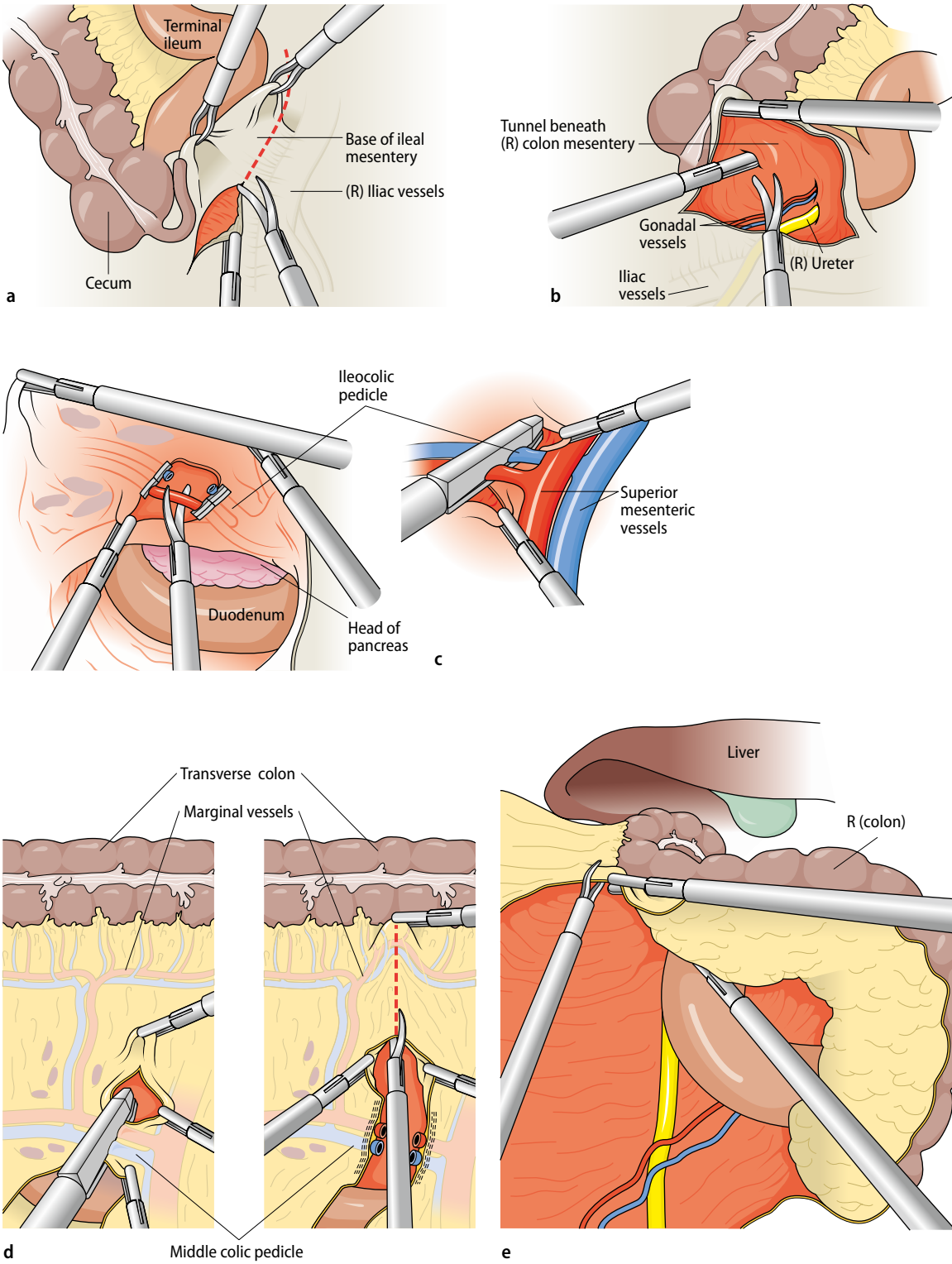

Fig. 16.1a–e Medial-to-lateral approach in right (*R*) colectomy

The affected colonic segment is not touched only after vascular ligation and dissection of the mesentery. This has a theoretical advantage in that tumour cells will be unable to enter the systemic circulation during the resection. Since the feeding vessels are ligated close to their origin, an optimal mesenteric lymph-node excision can be done. Another advantage is that exposure is obtained by lifting the mesentery, rather than retracting the bowel and mesentery tissue with risk of tear. The medial-to-lateral approach is also superior from an ergonomic point of view. The disadvantages of the technique are that it is more difficult, and surgical anatomy is different from what we are used to in open surgery.

Liang et al. [14] investigated the surgical efficacy of a lateral versus a medial approach in patients having laparoscopic anterior resection for cancer. They concluded that the medial approach was 1 h faster, cheaper and was associated with a lower proinflammatory response.

16.2.2.6 Hand-Assisted Laparoscopic Surgery

To address the problems associated with a long learning curve and long operating times, hand ports have been introduced. The surgeon's hand can be introduced through the hand port into the abdomen while preserving the pneumoperitoneum (Fig. 16.2). Procedures requiring an incision to remove a specimen or organ are those most suitable for hand-assisted laparoscopic surgery (HALS). The most important advantage of HALS is that the surgeon regains tactile feedback. In these procedures the surgeon's hand can be used for palpation, blunt dissection, retraction, control of bleeding and organ removal. This modified minimally invasive procedure has the potential to benefit both the patient and the surgeon: the patient retains all the advantages of minimally invasive surgery, including a more rapid convalescence [15–18], while the surgeon is able to perform complex laparoscopic procedures more easily because of the ability to use one hand, as in open surgery. The disadvantages of hand-port techniques are a slightly larger incision compared to pure laparoscopic procedures, bad ergonomics, loss of working space and loss of pneumoperitoneum due to leakage [19]. A variety of hand ports is available (e. g. Omniport – Covidien, Boulder, USA; Lapdisc – Johnson Medical, Arlington, USA; GelPort – Applied Medical General Surgery, Margarita, USA; HandPort – Smith & Nephew, Andover, USA; Dexterity Device – Dexterity, Roswell, USA). Not all surgeons have embraced HALS or have used HALS as a step-up for laparoscopic procedures.

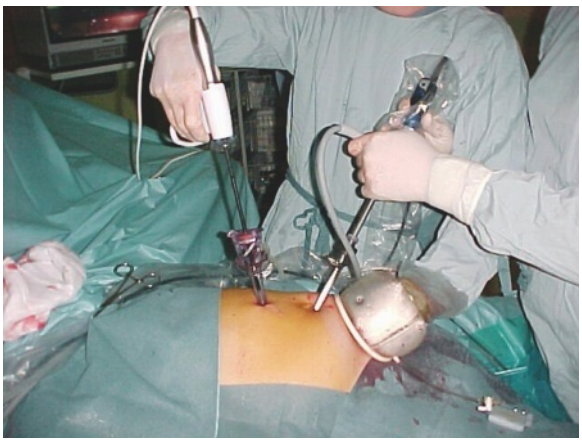

Fig. 16.2 Hand port in position

16.2.2.7 Extraction Sites

Extraction of a part of the bowel requires an additional minilaparotomy to exteriorise the specimen. Although some report the possibility of extraction via the rectal stump, the only true procedure where an additional incision can be avoided is the laparoscopic abdominoperineal rectum resection, where the specimen is retrieved through the perineal wound.

Different considerations can influence the choice of extract sites. The most important factor is the type of laparoscopic procedure. As a rule of thumb, the more that is done laparoscopically, the freer the choice for the location and size of the extraction site. If the procedure is carried out in a facilitated manner, for instance, the extraction site must be near the mobilised bowel in order to perform the vascular ligation, bowel transection and creation of the anastomosis extracorporeally. The incision is located over the base of the vascular pedicle to avoid extensive tension and haematoma formation into the bowel mesentery.

If the total procedure is done laparoscopically, the extraction site is only used for extraction and can be anywhere. The location of the incision in hand-port surgery depends on the type of procedure, the dexterity of the surgeon and the possibility of extending the incision in case of conversion.

The most frequently applied incisions are the up-and-down transumbilical incision, left-lower and right-lower split incision and the Pfannenstiel incision. It might be important to protect the wound edges with a wound protector; although scientific evidence is lacking regarding the use of wound protectors, it seems quite logical to take measures to avoid tumour spillage or bacterial contamination of the wound.

16.2.2.8 Vessel-Sealing Equipment

The implementation of laparoscopic techniques has urged the development of new laparoscopic tools. Tools enabling a safe, fast and easy vascular control, obviating the use of laparoscopic clips, are of particular interest. Several devices were developed for ultrasonic dissection and vascular sealing (e. g. Endoshears – Covidien; Ultracision– Johnson & Johnson Endosurgery, Cincinnati, USA; Sonosurg – Olympus Optical, Tokyo, Japan). Vascular structures up to 4 mm can be controlled safely using these devices. Smart bipolar haemostatic clamps enabling tissue vessel sealing and cutting (Ligasure – Valleylab, Boulder, USA) were developed at the same time, taking care of vessels up to 7 mm [20]. It was claimed that the avoidance of monopolar current would reduce the risk for collateral diathermic damage.

However, in contrast to what manufactures of vessel-sealing devices initially claimed, the sealing device did generate heat. It has been reported that after repetitive activation of ultrasonic devices, the temperature could rise up to 140 C [21]. Users of these devices must be aware of possible collateral thermal damage.

16.2.2.9 Conversion

Conversion is defined as every procedure where the size or position of the planned minilaparotomy has to be changed. Conversion can be interpreted as an act of wisdom, but can also reflect bad planning or an act of self-overestimation. Every procedure can be started as a laparoscopic procedure. However, if the laparoscopic approach does not appear feasible, an early conversion is warranted. Many studies have reported that the converted cases do worse than the laparoscopic and open cases; late conversion might be one of the reasons for this [22].

Early conversion to laparotomy appears to avoid any prolonged potentially dangerous dissection. Furthermore, the laparoscope can be used to surgically stage a tumour (including perioperative echography) and to judge whether a laparoscopic resection will be feasible within an acceptable time frame.

16.2.2.10 Learning Curve

With the wide implementation of laparoscopic surgery, it became clear that surgical procedures have a learning curve, which is associated with reduced performance, and results in prolonged operating times, increased costs and morbidity. Several authors have tried to evaluate the learning curve using conversion rates, operating times and morbidity rates as outcome parameters. The learning curve will vary from surgeon to surgeon and will depend upon the basic laparoscopic skill of the surgeon and his/her experience in other advanced laparoscopic procedures. The substantial number of procedures required to overcome the learning curve indicates that a minimum "caseload" is a prerequisite that allows the surgeon to minimise the time to overcome the learning curve. For example, it is now well established that a learning-curve prerequisite caseload of at least 50–60 procedures must be anticipated for a left- or right-sided segmental colectomy [23]. This argument could be one of the reasons for the rather slow implementation of laparoscopic colorectal surgery.

16.2.3 Right-Sided Resections

Right-sided resections include the ileocolic resection mostly done for CD, and right-sided colectomies for colorectal malignancy.

16.2.3.1 Ileocolic Resection for CD

A thorough preoperative evaluation of the small bowel (small-bowel series) is imperative to determine other small-bowel strictures besides ileocolic involvement. A colonoscopy must be performed to evaluate the presence of Crohn's colitis and/or colonic strictures. If an abscess is suspected, a computed tomography (CT) scan must be done. Percutaneous drainage resulting in resolution of the abscess and inflammatory mass must precede any surgical intervention. Timing of surgery in CD is important and should be discussed together with a dedicated gastroenterologist.

(Relative) contraindications are a prior midline laparotomy (because of the likelihood of adhesions), a fixed mass at palpation (a large mass is difficult to mobilise, and a large incision is required to exteriorise it), enteroenteric, enterovesical, enterovaginal, enterocutaneous and enterosigmoidal fistulae, and multiple strictures requiring multiple stricturoplasties or resections.

No bowel preparation is required prior to surgery. Patients can be prepared with one or two enemas. The patient can be positioned either in the French position on a short mouldable bean bag with the legs strapped

to the table or with the legs parallel to the table. The French position enables the surgeon to stand beside the table and in between the legs. At the same time, it is even possible to advance a circular stapler through the anus in case an anterior resection is required due to the presence of an enterosigmoidal fistula. Antibiotic prophylaxis is given according to local protocols.

Laparoscopic ileocolic resection for CD is essentially a laparoscopic-facilitated operation. The right colon is mobilised laparoscopically and exteriorised via a mini-laparotomy. The location of the extraction site determines how far the right colon must be mobilised. If the inflammatory mass is relatively small, it can be exteriorised through a small up-and-down incision through the umbilicus (Fig. 16.3). For cosmetic reasons, a Pfannenstiel incision is the preferred site if the mass is relatively large and a larger incision is required to exteriorise the specimen. However, this requires a complete mobilisation of the right colon including the hepatic flexure. Special care should be taken not to exert too much traction upon the middle colic vessels. Other indications for choosing a Pfannenstiel incision are enterovesical, enterovaginal or enterosigmoidal fistulae.

Mobilisation of the right colon can be done in three ways: using the lateral approach, the medial approach or hand-assisted. The extraction site and trocar positions vary according to the applied method. If a Pfannenstiel incision is chosen for extraction, the right flexure must be mobilised completely. This can best be done using a medial-to-lateral approach or a hand-assisted technique. In the presence of enterovesical, enterovaginal or enterosigmoidal fistulae, the Pfannenstiel incision can be used to deal with these fistulae first, prior to mobilising the right colon. A hand port can be inserted into the Pfannenstiel incision to mobilise the right colon, or it can be closed using a wound protector followed by laparoscopic mobilisation of the right colon.

Once the bowel is sufficiently mobilised, it can be exteriorised, enabling open vascular ligation, transection of the bowel and creation of the anastomosis.

The transumbilical incision in particular is often relatively tight (too small), making exteriorisation difficult. Once the inflamed bowel with its thickened mesentery is exteriorised, the mesentery has more space in the umbilical incision. At the time of extraction and mesenteric-vessel ligation, adequate muscle relaxation is required to avoid venous congestion.

Once the ligations, transection and the anastomosis are done, the anastomosis is carefully repositioned in the abdomen. The umbilical fascia is closed and the umbilical skin is reconstructed. Most of the incision will disappear in the shallow of the umbilicus (Fig. 16.4).

The Pfannenstiel incision can be enlarged to facilitate removal of a relatively large inflammatory mass without compromising cosmetics. The Pfannenstiel incision is closed in layers. It is important to close Scarpa's fascia to align the skin superiorly and inferiorly of the incision.

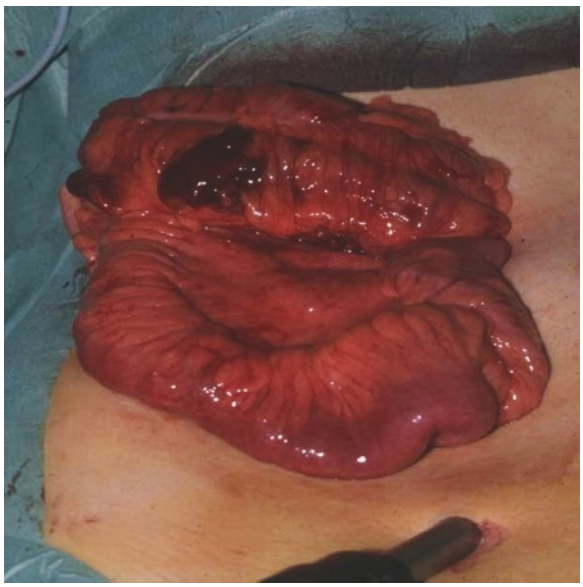

Fig. 16.3 Exteriorised bowel in laparoscopic ileocolic resection

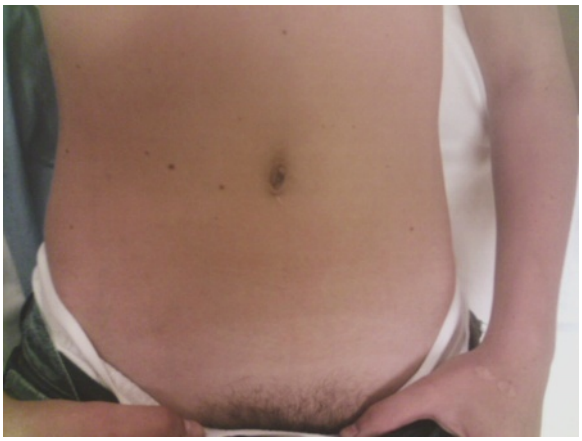

Fig. 16.4 Up-and-down transumbilical incision

16.2.3.2 Right Colectomy for Cancer

It has been well established that segmental colectomy for cancer is feasible and safe, with similar oncological results when compared to open surgery. Institutional trials indicate even superior results for the laparoscopic approach. Contraindications (relative) are prior midline laparotomy (because of the likelihood of adhesions) and finding of a fixed mass on palpation. A large fixed mass is an indication of abdominal-wall invasion (sT4) or tumour perforation with an inflammatory mass. If exteriorisation of the tumour/mass requires a relatively large incision, there might be no benefit of a laparoscopic approach.

The exact location of the colonic cancer must be clear. If the tumour is localised using a colonoscopy, one must be sure that the caecum has been reached; if not, the location has not reliably been assessed. In these circumstances either a barium enema or a CT scan must be performed. If the tumour is relatively small, it must be localised either by tattooing or a perioperative colonoscopy. Routine assessment for metastatic disease, for example liver ultrasound or CT scan and plain X-ray of the thorax, is common practise in most hospitals. CT scan is preferred because then the tumour can also be staged locally. Measurement of carcinoembryogenic antigen can be performed preoperatively for later follow-up.

The right colectomy for cancer can be done laparoscopically assisted, hand-assisted or totally laparoscopically. In the "assisted" procedure the right colon is devascularised, transected and exteriorised; an anastomosis is then created in an open procedure. In the hand-assisted procedure the right colon is mobilised completely, and devascularisation, transection and creation of the anastomosis are performed extracorporeally, like in open surgery. A TL procedure including the laparoscopic creation of the anastomosis is possible, but unnecessary, since the anastomosis can easily be done via a transumbilical extraction excision.

In dealing with cancer, most surgeons nowadays prefer a medial-to-lateral approach, applying a vessels-first, no-touch technique. The procedure can be started by creating a submesenteric tunnel from below (the inferior submesenteric approach) or by ligation of the ileocolic pedicle (the anterior submesenteric approach). The most difficult part is ligation of the right branch of the middle colic artery. This can be approached from below (medial-to-lateral approach) or from above through the lesser sac after detachment of the omentum from the greater curvature. Traction can lead to trouble some bleeding at the venous confluence, which often necessitates conversion to laparotomy to control the bleeding.

The devascularised and transected specimen can be extracted via a transumbilical up-and-down midline incision using a wound protector. After exteriorisation of the specimen, the stapled terminal ileum and transverse colon are exteriorised to create the anastomosis, which is either hand sewn or created using staplers. Care must be taken that the exteriorised bowel ends are not twisted. A final laparoscopic exploration before closure will allow the surgeon to check on the vascular control of the ligated pedicles and the positioning of the anastomosis.

16.2.4 Left-Sided Resections

Left-sided resections are mostly performed for colorectal cancers. Benign indications are complicated diverticulitis and CD. Where resection for cancer requires an en-bloc resection of the affected bowel and mesentery, in benign disease the mesentery can be ligated close to the gut, sparing the vascularisation (and avoiding the inherent risk for autonomic nerve injury).

As a general rule the left flexure is mobilised. It is of great importance that there is enough length not only to create a tension-free anastomosis, but also to exteriorise the bowel to perform a safe proximal transection. If there is not enough length, the mesentery of the afferent bowel can tear during exteriorisation. Furthermore, once the anastomosis has been created it is more difficult to obtain more length.

16.2.4.1 Left Colonic Flexure Mobilisation

Left colonic flexure mobilisation can be subdivided into partial and full mobilisation. Loosening the lateral attachments and gastrocolic and splenocolic ligaments does not allow the left colon to descend fully. The transverse colon will rotate around the middle colic pedicle, enabling full descent of the left colon, only if the inferior mesenteric vein is taken at the lower border of the pancreas and close to the aorta, respectively.

16.2.4.2 Sigmoidectomy

Sigmoidectomy for cancer is performed preferentially by a medial-to-lateral approach; a proximal ligation of the superior rectal artery (SRA) can be performed as a

first step. In the case of sigmoidectomy for benign indications, a lateral-to-medial or hand-assisted approach can be applied, saving the IMA and its branches (the superior rectal and left colonic arteries). Partial left-flexure mobilisation generally suffices to create a tension-free colorectal anastomosis. Tocchi et al. [24] compared IMA-sparing sigmoidectomy with a proximal ligating sigmoidectomy in patients requiring sigmoidectomy for diverticulitis. A higher incidence of anastomotic leakage was found in the patients where the IMA was severed. For technical reasons, most laparoscopic surgeons perform an identical operation for diverticulitis or CD as for cancer. Mobilisation from medial to lateral is easier and advancement of the circular stapler is facilitated if the proximal rectum is transected. After protection of the wound, the specimen is usually extracted through a left lower-abdominal split or Pfannenstiel incision. A wound protector with a sheet can be used to close the minilaparotomy and reinstall the pneumoperitoneum. The surgical steps are described in more detail in Sect. 16.2.4.4.

16.2.4.3 Anterior Resection

Anterior resection is mostly performed because of malignancy. Other indications are CD and endometriosis.

16.2.4.4 Work-up

The routine work-up for rectal cancer comprises a magnetic resonance imaging (MRI) scan for local staging, ultrasound/CT scan of the liver, and plain chest X-ray for distal staging. The MRI findings can be used to assess whether a sphincter-saving procedure is possible and to determine whether the patient needs a short course of radiotherapy or a long course of radiotherapy combined with chemotherapy.

There is evidence that bowel preparation can safely be omitted in colonic resection and is associated with less anastomotic leakage and wound infection [25]. Since double stapling after rectum resection requires an empty rectum, the patient must be prepared at least with enemas. In case of a high likelihood of a defunctioning ileostomy, the bowel must have a full bowel cleansing in order to have an empty bowel distal to the covering ileostomy.

The patient is positioned on the operation table on a short, mouldable beanbag with the legs in the Lloyd-Davis position. A transurethral (women) or a suprapubic catheter (men) is inserted. The surgeons and the first assistant (camera) stand on the right side, the second assistant on the left side.

Pneumoperitoneum is introduced in an open procedure and 3–4 additional trochars are placed. A 30° optic is used and the patient is positioned in the Trendelenburg position in the right lateral tilt. The omentum is displaced cranially to expose the lower border of the transverse colon and Treitz ligament. The small bowel is displaced in the right upper abdomen. The second assistant grasps the sigmoidal vascular pedicle to expose the superior rectal artery arch. The overlying peritoneum is opened parallel to the right iliac artery and the aorta close to the origin and lower border of the superior rectal artery. A submesenteric tunnel is developed cranially and caudally by blunt dissection. When the superior rectal artery arch is almost perpendicular to the aorta, its base is dissected free to control the IMA. Care is taken to preserve the autonomic nerve plexus. The IMA/rectal superior artery is ligated using vessel sealing or ultrasonic transection, clips, or vascular stapling depending on the size of the artery.

The submesenteric tunnel is further developed towards the lower border of the pancreas and left flexure. The inferior mesenteric vein is ligated either just below the border of the pancreas (high tie) or distal to the branching of the left colonic vein. The middle colic artery pedicle is lifted by the assistant. The transverse mesocolon is opened as it enters the lesser sac, left of the middle colic vascular pedicle on top of the pancreas. The lesser sac is opened further by connecting the lesser sac with the submesenteric tunnel. Next, the omentum is dissected from the left transverse colon.

The lateral peritoneum is incised starting at the rectosigmoidal angle. The dissection proceeds up to the left flexure to free the left colon. The assistant grasps the ligated vascular pedicle of the SRA and pulls the proximal rectum anteriorly and swings it to the right and left. With diathermic scissors, the total mesorectal excision (TME) plane is entered and the rectum is dissected in the circumferential TME plane.

About 5 cm below the lower border of the tumour, the mesorectum is transected using ultrasonic scissors. Next, the rectum is cross-stapled with a linear endostapler (green cartridge). There are two optional positions for the minilaparotomy: a left lower abdominal split incision or a Pfannenstiel incision. A Pfannenstiel incision requires sufficient mobilisation of the afferent bowel for exteriorisation, which is not a problem when employing a high tie. The split incision is more suitable for a limited mobilised left flexure and a colorectal anastomosis. The disadvantage of this incision is that

one cannot reach the proximal rectum in case of a technical problem.

The wound is protected by a wound protector. The bowel is exteriorised. The transverse staple line is checked for integrity. The mesentery is further ligated and the proximal bowel divided. The specimen is sent for pathology. The anvil is inserted and fixed with a 2-0 Prolene purse string. The afferent colon is repositioned in the abdomen. The sheath of the wound protector is twisted and the pneumoperitoneum reinstalled.

The afferent bowel is repositioned in the abdomen. Care is taken that the bowel is not twisted. The circular stapler is advanced through the rectum and the cross-stapling line. The anastomosis is made by connecting the anvil with the circular stapler gun.

The anastomosis is checked by inspection of the donuts and by insufflation of air into the rectum with a saline-filled pelvis. Care must be taken that the small bowel is not herniated under the mesentery of the colon.

16.2.5 Total (Procto) Colectomy

Several techniques can be applied, including a LA approach, a hand-assisted laparoscopic (HAL) approach and a TL approach. The operation usually involves complete laparoscopic medial-to-lateral mobilisation of the colon with intracorporeal vascular ligation, after which the specimen is extracted via a small midline or Pfannenstiel incision. Surgeons applying an LA or HAL approach use the Pfannenstiel incision for proctectomy, pouch formation and fashioning of the anastomosis. Those applying a TL approach perform complete intracorporeal dissection of the colon and rectum, but will eventually need a small incision for specimen extraction and pouch formation. There have been some reports of removing the specimen via the anus followed by a hand-sewn ileoanal anastomosis, thus avoiding the minilaparotomy.

16.2.6 Abdominoperineal Rectum Resection

Abdominal perineal rectum resection is indicated when the MRI shows tumour infiltration nearby or into the anal sphincter complex. There is hardly any mesorectum left at the level of the pelvic floor. Here, the distance from the tumour to the circumferential margin can be increased by resecting the levator muscle en bloc with the specimen. A cylindrical resection results in a large perineal (muscle) defect with a high likelihood of wound-healing problems and associated perineal incisional hernia, particularly after (chemo)radiation. This defect can be filled with an omentoplasty.

Positioning and placement of the patient, surgeons and trocars are as for laparoscopic (low) anterior resection. The future ostomy site is used for insertion of the trocar in the lower abdomen. The legs are placed in the stirrups to ensure a good exposure to the perineum.

As a first step of the operation, the omentum is dissected from the transverse colon using ultrasonic devices. Next, the right gastroepiploic artery is divided at the level of the pyloric muscle. The greater curvature is ligated, creating a long omentoplasty that is well vascularised by the left gastroepiploic artery.

Next, the vascular pedicle of the rectosigmoid is lifted using the trocar in the left lower abdomen. The submesenteric tunnel is created, mobilising the rectosigmoid. The superior rectal artery is transected and the lateral peritoneal attachments are loosened. The midsigmoid is transected using endostaplers. The rectum is dissected according the TME principle, including Denonvillier's fascia anteriorly. Posteriorly, the levator muscle is transected flush with the coccygeal bone using ultrasonic dissection. The levator muscle is transected laterally on both sides on the posterior side of the rectum.

The perineal phase of the operation is performed using ultrasonic dissection, taking advantage of its haemostatic capacity. When the specimen is extracted through the perineum, the hole is filled with the prepared omentoplasty. Non-vital parts of the omentum are resected. The stoma site is prepared and the colon is exteriorised to mature the colostomy.

More evidence points towards the importance of a cylindirc excision. This can best be achieved by performing proctectomy in the prone position. The laparoscopic dissection therefore should stop at the level of the coccyx posteriorly and at the seminal vesicles or upper part of the rectovaginal septum anteriorly.

16.2.7 Ostomies

For stoma creation, either a two- or three-trocar approach can be used. Optimal visualisation and the possibility of laparoscopic mobilisation of the selected loop of bowel are advantages of the laparoscopic procedure [26–28].

16.2.8 Laparoscopic Reinterventions

Recovery after laparoscopic operation is generally fast. Anastomotic leakage must be suspected if the patient is not able to tolerate a normal diet within a couple of days in combination with signs of sepsis. A CT scan is often performed to establish the diagnosis. A relaparoscopy rather than a relaparotomy might be of benefit, avoiding a laparotomy and its sequelae (wound infection, "burst abdomen").

While installing the pneumoperitoneum, a blunt trocar must be inserted through one of the prior trocar incisions, thus avoiding injury to the dilated bowel. All additional trocars are inserted by blunt insertion through prior trocar sites. The first step in the reintervention is laparoscopic rinsing of the peritoneal cavity. Draining the infected abdominal fluids together with the counterpressure of the pneumoperitoneum increases the exposure gradually. Leakage after a right-sided colectomy requires exteriorisation of the afferent and efferent bowel loop, creating an ileostomy and mucous fistula of the transverse colon. This can be done laparoscopically, avoiding opening the extraction incision. Leakage after left-sided resection requires either dismantling of the anastomosis and fashioning of an end colonostomy, or a defunctioning loop ileostomy in the case of a small hole. Leaving the anastomosis in place warrants on-table lavage of the large bowel to avoid leakage of the faecal contents through the anastomotic defect despite the defunctioning ileostomy. The efferent loop of the ileostomy can be used to insert a Foley catheter for the infusion of saline. A ventilation tube is inserted into the anus to drain the rectum. Fluid spilling through the anastomotic defect can be drained using laparoscopic suction.

16.3 Laparoscopic Surgery for Colorectal Cancer

The first laparoscopic resection for colorectal cancer was described in 1991 by Jacobs et al. [29]. For a long time the implementation of laparoscopic colectomy for cancer has been controversial. Reports on port-site metastases and technical difficulties urged many surgeons to proceed carefully, treating patients with colorectal cancer laparoscopically. Institutional series of patients treated for colorectal cancer by expert laparoscopists reported less post-operative pain, a shorter hospital stay and less morbidity. In 1994 the first multicentre trial evaluating the laparoscopic approach for colorectal cancer was initiated. With longer time after initiation of the laparoscopic approach, the incidence of port-site metastases gradually decreased down to levels reported for open surgery, reflecting increasing experience.

16.3.1 Indications and Contraindications

16.3.1.1 Colon

Polyps and colonic cancers can be approached laparoscopically. Appropriate localisation by preoperative tattooing or preoperative endoscopy is mandatory if laparoscopic localisation is thought to be in doubt. Contraindications for laparoscopic surgery are colonic tumours that are suspected to invade adjacent organs. If in doubt, the procedure can be started with a diagnostic laparoscopy. If preoperative imaging indicates a large tumour of such a size that an extraction incision is required large enough to facilitate an open resection, a laparoscopic approach is futile. Other contraindications are inadequate experience, general condition precluding the installation of the pneumoperitoneum, and prior midline abdominal surgery (relative).

16.3.1.2 Rectum

Theoretically, the laparoscopic approach to malignancy of the rectum might be advantageous. Patients with malignancies in the proximal rectum require partial mesorectal excision with colorectal anastomosis. When the malignancy is located in the distal two-thirds of the rectum, a TME with coloanal anastomosis is required. If the tumour is invading the sphincters, an abdominoperineal resection is necessary. Sphincter-saving resection requires in open surgery a full upper- and lower-midline incision. This can be limited to a 4–6 suprapubic incision if performing the operation laparoscopically. In the case of a laparoscopic abdominoperineal resection, no abdominal incision is required since the specimen can be retrieved via the perineal wound.

Since local control is the main objective in surgery for rectal cancer, the radicality of the resection must not be compromised by the applied technique. A thorough preoperative evaluation of the rectal cancer must be done by MRI in order to determine the optimal strategy with respect to preoperative (chemo)radiation and type of operation.

Indications for laparoscopic surgery are all (pre) malignant tumours of the rectum, provided that the circumferential margin on the preoperative MRI is not compromised. Large T3 and T4 rectal cancers are contraindications for laparoscopic surgery. Other contraindications are inadequate experience, the patient's general condition precluding the installation of pneumoperitoneum, and prior midline abdominal surgery (relative contraindication).

16.3.2 Evidence

16.3.2.1 Colon

The evidence for laparoscopic surgery for colonic cancer is based mainly on three large, multicentre, randomised trials (COST (Clinical Outcomes of Surgical Therapy), Medical Research Council Conventional versus Laparoscopic-Assisted Surgery in Colorectal Cancer (MRC-CLASSIC) and Colon Carcinoma Laparoscopic or Open Resection (COLOR) I [30–32]) and several systematic reviews/meta-analyses. The most recent review of Reza et al. [33] demonstrated reduced perioperative blood loss (±70 ml), reduction of postoperative pain, earlier return of bowel function and a 2-day earlier discharge in favour of the laparoscopic approach. Operating time was significantly longer laparoscopically (>30–60 min). A pooled relative risk for anastomotic leakage of 1.27 (95% confidence interval (CI) 0.70–2.31) can be calculated based on four studies [31, 32, 34, 35]. Overall morbidity did not differ between the two procedures.

A limitation of all these studies is that the perioperative treatment was not optimised according to modern FT principles. To determine long-term results, a meta-analysis of six studies [30, 31, 34, 36–38] was conducted that did not show any differences with respect to total and disease-free survival.

The pooled relative risk for a recurrence was calculated based on seven studies and was not significantly different (relative risk 0.92 with a 95% CI 0.74–1.14). Three studies [31, 36, 39] separately reported on the converted cases, indicating increased blood loss, longer operating times, longer hospital stay, and higher risk for recurrence in comparison to the completed laparoscopic and open procedures.

16.3.2.2 Rectum

In a recent Cochrane review by Breukink et al. [40], 48 series of laparoscopic treatment of rectal cancer were included. Most of the studies were of poor methodological quality. Only three randomised trials were included with a limited number of total patients. No significant differences with respect to number of harvested lymph nodes, morbidity and mortality, and resection margins were found. Recovery was faster at the expense of longer operating times and costs. The largest randomised study (MRC-CLASICC) indicated a high conversion rate, a non-significant higher positive circumferential margin and more urogenital complications in the laparoscopic group.

16.4 Laparoscopic Colorectal Surgery for Inflammatory Conditions

Laparoscopic colorectal surgery for malignancy has been controversial for a long time, particularly after the first reports of port-site metastases. No such controversy exists when dealing with benign diseases. Therefore, laparoscopic colorectal surgery for benign diseases has met with great enthusiasm and widespread acceptance. Although a variety of laparoscopic intestinal procedures has been performed in different settings, many surgeons have been reluctant regarding its application in patients with inflammatory bowel disease (IBD). Thickening of the intestinal mesentery, inflammatory adhesions and masses, and unsuspected fistulae or abscesses can significantly complicate what is already a technically challenging procedure.

In contrast to laparoscopic surgery for cancer, the evidence for the laparoscopic application in diverticulitis and IBD is less robust. An easier acceptance of laparoscopic techniques in benign disease is probably one reason. Another explanation might be the lower number of procedures done for diverticulitis and IBD compared to surgery for colorectal cancer.

16.4.1 Diverticulitis

Diverticulosis of the colon is an acquired condition that results from herniation of the mucosa through defects in the muscle layer. It is primarily a disease that occurs in industrialised and westernised countries due to a lack of fibre in the diet and a lack of exercise.

Diverticulitis is subdivided into uncomplicated (80%) and complicated diverticulitis (20%). Compli-

cated diverticulitis comprises diverticular bleeding, diverticular abscesses, diverticular free perforation, diverticular stenosis and diverticular fistula to the vagina, bladder, skin and adjacent bowel.

16.4.1.1 Indications and Contraindications

The Standards Task Force American Society of Colon and Rectal Surgeons has summarised the best evidence with respect to the surgical treatment of diverticulitis in a paper published in 1995, and revisited in 2000 [41, 42]. The guidelines for surgical treatment of complicated diverticulitis regarding symptomatic enteric fistulae, stenotic diverticulitis, and free perforated diverticulitis were quite obvious. The guidelines for surgery for recurrent diverticulitis, and contributing factors such as young age and immunologic deficiency were less supported by solid data. In 2005 Janes et al. [43] criticised the scientific basis for the indications for surgery, in particular after uncomplicated diverticulitis. As a practical guideline, elective surgery is indicated in symptomatic patients with a documented diverticulitis. Symptomatic fistulae to the bladder, vagina, skin and other bowel, stenotic diverticulitis, recurrent diverticular abscesses refractory to percutaneous treatment and recurrent bleeding require surgery in the patient who tolerates surgery. The indications for surgery are less clear in the patient who has had one or more conservatively treated attacks. The decision to operate depends on the number of attacks, the time interval between the attacks, comorbidity, age and occupation (travelling abroad) of the patient, co-existing disease and medication. Since evidence is lacking, the decision must be made by the attending surgeon and the patient after extensive counselling. All operations done for (un)complicated diverticulitis have been described as applying a laparoscopic approach.

Free diverticular perforation is generally dealt with via an emergency laparotomy. The most commonly performed procedures are Hartmann's procedure and sigmoidectomy with anastomosis with or without defunctioning ostomy. Patient and surgeon variables dictate the choice for either procedure. Both procedures have been done laparoscopically. Mutter et al. [44] described a small series of fit patients with Hinchey IIb–III diverticulitis who were treated successfully with laparoscopic irrigation and antibiotics only. Only patients without an overt perforation were included.

Contraindications for laparoscopy are general conditions precluding pneumoperitoneum, prior major abdominal surgery, abdominal distension in emergency cases and inexperience in laparoscopic surgery.

16.4.1.2 Evidence for Sigmoidectomy

At present no randomised trials have been published comparing open with laparoscopic sigmoidectomy for diverticulitis. Two randomised trial are currently being conducted, one in The Netherlands (SIGMA trial) [45] and one in Germany (LAPDIV-CAMIC Study) [46]. Various authors report retrospective and prospective series indicating conversion rates of mostly less than 10%, operating times between 2.5 and 3 h, morbidity figures of 10–20% and a hospital stay of 4–14 days (Table 16.1). Conversion seems to be associated with the presence of stenosis, fistula (pelvic diverticulitis), severity of inflammation on pathologic examination and inexperience of the surgeon [47]. A limited number of comparative studies [48–52] is available that indicate longer operating times and significantly shorter hospital stays and morbidity rates compared to open surgery (Table 16.2). It is quite remarkable that conversion rates are lower than reported for laparoscopic colectomy for cancer. With the exception of a few reports, hospital stay is still relatively long, indicating the absence of modern perioperative care (e. g. enhanced recovery after surgery programmes). Remarkably, the only existing systematic review is published in Yugoslavian [53].

Some authors have compared the HAL approach with the LA approach [54–56]. They concluded that hand-assisted sigmoidectomy for diverticulitis reduces conversion rates and operative times compared to the LA approach. The HAL approach is probably particularly helpful in diverticulitis with inflammatory adhesions and fistulae to avert conversion and speed up the procedure.

16.4.2 Inflammatory Bowel Disease

IBD is the second most common syndrome of chronic inflammatory disease in Western countries, encompassing ulcerative colitis (UC) at one end of the spectrum and CD at the other. In Europe the incidences of UC and CD are $10.4{:}10^5$ and $5.6{:}10^5$, respectively [57].

Despite improvements in medical management, surgery still plays an important role in the management of IBD: between 30 and 40% of patients with UC require an operation in the course of their disease. For CD, surgery is required in 70% of cases, and in one-third sequential operations are necessary. Most patients are

Table 16.1 Laparoscopic treatment of diverticulitis. *OR* Operating room

Author	Patients (*n*)	Conversion (%)	OR time (min)	Post-operative hospital stay (days)	Morbidity (%)
Stevenson [114]	100	8%	180	4 days	21%
Kockerling [115]	304	7.2 %	–	–	17%
Bouillot [116]	179	14 %	223	9.3	14.9%
Trebuchet [117]	170	4 %	141	8.5	8.2%
Schwandner [118]	396	6.8%	193	11.8	7.6%
Le Moine [119]	168	14.3%	–	–	21%
Reissfelder [120]	203	5%	160	13.5	21%
Pugliesi [121]	103	3%	190	9.6	10%
Scheidbach [122]	1545	4.4–7.7%	152–184	?	15.9–18.6%
Blake [123]	100	16%	196	4.6	–

Table 16.2 Comparative studies: laparoscopic (*L*) versus open sigmoidectomy (*OS*) for diverticulitis

Author		Patients (*n*)	Conversion (%)	OR time (min)	Post-operative hospital stay (days)	Morbidity (%)
Dwivedi [48]	L	88		143	8.8	23
	OS	66	19.7%	212	4.8	16
Senagore [49]	L	71		101	6.8	30
	OS	61	6.6%	109	3.1	8
Gonzalez [50]	L	80		156	12	32
	OS	95	?	170	7	19
Lawrence [51]	L	215		140	9	27
	OS	56	7.1%	170	4,1	9
Alves [52]	L	169		166	18	31%
	OS	163	15%	204	10	16%

young at the time surgery becomes necessary and their quality of life (QOL) is negatively affected by the disease. After surgery, the QOL of IBD patients improves to a level comparable with that of the general population [58–62].

16.4.2.1 Ulcerative Colitis

The first reports of a laparoscopic approach for restorative proctocolectomy (RP) were described in the early 1990s [63, 64]. Supposed short-term advantages were reduced pain, decreased morbidity and an accelerated recovery resulting in a shorter hospital stay. Supposed long-term advantages included an improved cosmesis, less formation of adhesions leading to a decreased incidence of small-bowel obstruction (SBO) and fecundity difficulties, and a lower incidence of incisional hernia.

Indications and Contraindications

RP is considered the procedure of choice in patients with UC. Total colectomy with ileorectal anastomosis and proctocolectomy with end-ileostomy are reserved for older patients and those with compromised sphincter function. In a minority of patients with UC, emergency colectomy is necessary if severe colitis does not respond to medical treatment. The treatment of first choice is a subtotal colectomy with end ileostomy. At a

second stage, completion proctectomy and ileal pouch–anal anastomosis can be done. All operations can be done by a laparoscopic approach. Relative contraindications for laparoscopic surgery are obesity, prior midline laparotomy and emergency colectomy. Patients are generally young and will tolerate pneumoperitoneum.

Evidence

Short-Term Outcome After Laparoscopic RP

Early reports of laparoscopic RP (LRP) have described significantly longer operating times, high morbidity and conversion rates, and increased requirement of blood transfusion [63, 64]. None of these studies reported the expected benefits with respect to early recovery. With increasing experience and advancements in endoscopic equipment, the results of several experienced laparoscopic teams have become available [65–68]. The outcome results vary substantially among studies, but the increased operating time persists in all of them. Only one randomised controlled trial (RCT) comparing open and a HAL-RP has been published [69]; there were no conversions. This RCT indicated that there were no significant benefits with respect to early recovery, morbidity and hospital stay (10 vs 11 days), but operating time was significantly increased by 81 min. No differences in QOL between these approaches were found. A recently published meta-analysis of ten studies by Tilney et al. [70] comparing laparoscopic and open RP showed that the results of the only RCT are representative. The meta-analysis, which included a total of 329 patients, showed that the laparoscopic approach reduced operative blood loss (–84 ml) and time to normal diet (–1.3 days). There was only a trend towards a reduction in hospital stay (–1.66 days), a low conversion rate (one conversion in one study), but a significant increase in operating time (+86 min). Interestingly, a sensitivity analysis of studies published after 2001 showed a reduction in hospital stay of 3 days, indicating that experience with laparoscopic surgery and recent improvements in endoscopic tools and techniques might be of significant importance.

Currently, there is no evidence to suggest that one technique is better than the other with respect to recovery. Polle et al. [71] compared 35 patients undergoing TL-RP with a series of 30 patients undergoing HAL-RP. This study showed that operating time after TL-RP increased substantially compared to HAL-RP (298 vs 215 min, $P<0.001$). Although morbidity after TL-RP did not increase significantly and recovery was similar, more patients required a reoperation after the initial TL-RP. Studies comparing conventional laparoscopic and HAL approaches for other colonic resections (e.g. sigmoidectomy or left hemicolectomy) also indicate that the HAL approach reduces operating time and conversion rates without affecting recovery [25, 29, 30].

Long-Term Outcome After Laparoscopic Versus Open RP

Most studies comparing LRP and open RP (ORP) have focussed on short-term outcome, but only few have described long-term outcome after LRP. Long-term functional results and QOL after LRP have only been reported in a retrospective study in which it was concluded that QOL and functional outcome were similar. Recently, long-term results of the previously conducted RCT comparing HAL-RP with ORP were assessed prospectively with a median of 2.7 years. No differences were found between the HAL-RP and the ORP group with respect to QOL and functional outcome.

Long-term data regarding female fecundity, incisional hernia and SBOs after LRP, which is a significant clinical problem after ORP (13–35%), are lacking [72, 73]. The sample sizes of the few available studies with long-term follow-up after LRP are too small to draw robust conclusions on these issues. Future pooling of good-quality studies with large numbers of patients and adequate follow-up may provide an answer to these important questions.

In contrast to cosmetic surgery, body image (BI) and cosmesis are unconventional outcomes in the field of general surgery. It must be realised that for the patient these issues are long-lasting advantages of the laparoscopic approach (Fig. 16.5). The importance of cosmesis is substantiated by the increasing number of patients requesting a referral for LRP to medical centres with expertise in laparoscopic surgery. Only one surgical unit evaluated BI and cosmesis from the patient's point of view in such cases. Dunker et al. developed a BI questionnaire (BIQ) to evaluate patients' BI and cosmesis [74]. The results of the BIQ of 60 patients who underwent ORP versus HAL-RP were evaluated. This study showed that cosmesis scores were significantly higher in the laparoscopic group. The open approach had a significant negative impact on the BI of female patients, whereas the BI scores of female patients in the laparoscopic group were as good as preoperatively.

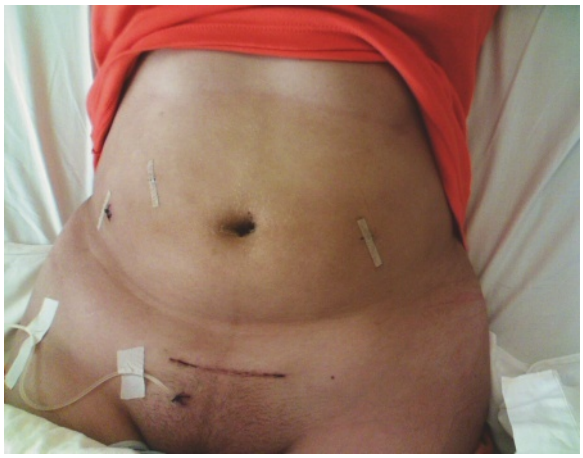

Fig. 16.5 Cosmetic result after pouch surgery

The impact of a long-lasting improved cosmesis and BI after LRP compared to ORP must therefore not be underestimated.

Role of Laparoscopy in (Severe) Acute Colitis

Only three comparative studies have described results after laparoscopic versus open colectomy for acute colitis [75–77]. These studies concluded that operating times after the laparoscopic approach were longer, but that hospital stay was significantly reduced. The postoperative complication rate ranged between 16 and 50% in the laparoscopic groups, but was not different compared to open controls.

16.4.2.2 Crohn's disease

Indications and Contraindications

The application of laparoscopic surgery for CD encompasses diversion procedures (ileostomy, colostomy), stricturoplasty and resectional procedures (segmental or (sub)total colectomy, ileocolic (re)resection and segmental small-bowel resections), or a combination of these procedures. Laparoscopic stoma creation can be performed in cases of severe perianal sepsis. Various studies have described the laparoscopic procedure to be feasible, safe and effective [73–76]. Segmental colonic resections for CD have also been proven feasible, although studies comparing a laparoscopic and open approach of a single procedure are lacking. The most frequently performed resection for CD is, however, ileocolic resection. Several studies have been published showing that conventional ileocolic resection (CIR) can also be performed safely by a laparoscopic approach (LIR) [78–86]. LIR might be of particular benefit in those young patients with a high risk of reoperation. The contraindication (relative) is prior midline laparotomy because of the likelihood of adhesions. One should bear in mind that there is no cosmetic advantage of a laparoscopic approach in the presence of a midline incisional scar. A fixed or a large mass on palpation might necessitate a large incision. Fixation increases the likelihood of conversion, and the size of the mass demands a large extraction incision. A large mass generally indicates the presence of an undrained abscess or the presence of an enteric fistula, increasing the likelihood of conversion.

Evidence

Short-Term Outcome After LIR

Several studies have compared short-term outcomes after LIR and CIR [78–86]. Of these, only two were RCTs [5, 57]. The first, by Milsom et al., showed a reduction in hospital stay of 1 day and a reduction in morbidity at the expense of an increase in operating time (+55 min). A more recently performed RCT by Maartense et al. [5] also resulted in a reduction in hospital stay by 1.5 days, a reduction in morbidity and an increase in operating time by 25 min [5]. No less than three meta-analyses comparing the short-term outcomes after LIR and CIR have been published over the last year, indicating the need for clarity regarding the role of laparoscopy for ileocolic resection for CD [87–89]. None of the included study patients were treated with an enhanced recovery after surgery programme. Only one of these meta-analyses included both available RCTs; this study concluded that there is evidence that LIR for CD is associated with a faster recovery resulting in a shorter hospital stay compared with CIR (–1.9 day), while morbidity rates are equal and reported conversion rates are acceptable (0–16.7%). However, there currently exists no evidence with respect to other outcome parameters such as earlier return to full liquid diet, first bowel movement, first flatus, estimated intraoperative blood loss, and early complications requiring reoperation.

Long-Term Outcome after LIR

In contrast to the numerous studies on short-term outcomes after LIR, the evidence regarding the long-term results after LIR is very limited. Supposed advantages include attenuated adhesion formation reducing the incidence of SBO, reduced incidence of incisional hernia, and an improved cosmesis.

The influence of primary laparoscopic resection on the surgical recurrence rate is unknown. Three studies with a medium long-term follow-up of between 20 and 60 months after primary LIR are available [80, 90, 91]. No significant differences between LIR and CIR were found with respect to surgical recurrence of CD in these studies. However, follow-up in these studies is too limited to draw any conclusions. Another study by Lowney et al. [92] evaluated long-term results after LIR versus CIR with a median follow-up of 60.4 months versus 81.2 months. This study found a higher recurrence rate after the initial CIR (9.5% vs 24%); however, more patients in the open group had additional procedures at the time of initial ileocolic resection, indicating a potential selection bias of patients with a lower disease severity in the laparoscopic group. The difference in follow-up between both groups presumably also contributed to the demonstrated difference in recurrence rate. A recent analysis that we performed on 78 patients (48 CIR, 30 LIR) undergoing ileocolic resection between 1995 and 1998 in two academic medical centres in The Netherlands, showed that recurrence rate at a median follow-up of more than 8 years was comparable (22% vs 23%, P = not significant). Importantly, the period between the first operation and the first re-resection (re-resection-free survival) was also identical. Although no significant differences were found in the number of incisional hernias, only three incisional hernias were encountered after CIR. This study could not substantiate the lower incidence of SBO after LIR that was suggested by others. Conclusions on differences in the incidence of SBO should be interpreted with caution since it can be difficult to differentiate between adhesion-related morbidity and disease recurrence.

Although several studies have evaluated long-term QOL after CIR for CD, limited data on long-term QOL after LIR are available. Little is known about patient satisfaction with cosmesis and BI, although it is generally expected that LIR has better cosmetic results. A study by Thaler et al. [93] comparing outcome after LIR and CIR at a mean follow-up of 42.6 months showed that QOL was not significantly different between the two procedures. However, long-term QOL in both the open and laparoscopic groups was significantly reduced compared to healthy individuals from the general population. The long-term QOL of our own patient population of 78 patients (48 CIR, 30 LIR) with a follow-up of more than 8 years also showed that there was no difference between the approaches. However, similar to the study of Thaler et al., we also found significantly lower QOL scores compared to a healthy control group matched for age and gender. These results are in contradiction with previous studies comparing long-term QOL after CIR. A possible explanation for the difference could be that in other studies data were not stratified for age and gender. The reduction in QOL might be explained by the chronicity of CD, which can recur at any time. This is in contrast to patients with UC, who have a QOL that is comparable to the normal population after RP, probably because these patients are "cured" after their operation. We also found that at a follow-up of more than 8 years, cosmesis and BI were significantly better after LIR compared to CIR. A previous study by Dunker et al. has already shown that cosmesis and BI scores at a follow-up of 7 months were higher in patients who underwent LIR [74].

In summary, with the exception of an improved cosmesis, no clinically relevant differences with respect to long-term results after LIR versus CIR have been demonstrated. There is, however, evidence that results of long-term QOL in patients with CD (after both LIR and CIR) have been overestimated. Although it can be expected that the incidence of incisional hernia decreases after LIR, larger studies with adequate follow-up are needed to confirm this hypothesis.

Laparoscopic Surgery for Recurrent and Complicated CD

Few studies specifically address the question of whether laparoscopic surgery for recurrent and complicated CD is justified. Initially, prior surgery was considered a contraindication for laparoscopic surgery, but recently, a study by Wu et al. [94] showed that patients with CD requiring a second operation after previous ileocolic resection had a better outcome when a laparoscopic approach was chosen; the laparoscopic approach was associated with less blood loss, lower morbidity and a reduction in hospital stay. Similar findings applied for patients requiring a first resection for complicated CD. A study by Hasegawa et al. [95] showed that outcome after laparoscopic re-resection for recurrent CD was

comparable with that after open re-resection. The authors concluded that laparoscopic re-resection for recurrent CD is feasible and safe, but no clear advantages could be demonstrated. Although different studies have shown that laparoscopic re-resection for CD is associated with an increased risk of conversion, other studies have shown that conversion in laparoscopic resection for CD does not necessarily adversely affect outcome, provided that there is an appropriate threshold to convert to open surgery [96–100]. Another study on 17 patients with complex CD reported a 0% conversion rate [101]. However, there is no unequivocal definition for conversion, leading to a wide variation in the reported conversion rate. In summary, there is some evidence that in experienced hands, laparoscopic re-resection can be offered safely.

16.5 Laparoscopic Surgery for Endometriosis

Estimates of the incidence of endometriosis vary widely [102–104]. The prevalence of the condition is around 10% in fertile women. Endometriosis is a disease most prevalent among nulliparous women and women with short and vigorous menses. These epidemiological findings support the menstrual reflux hypothesis. In 5–12% the endometriosis is localised to the gut. Most prevalent is involvement of the rectosigmoid (74%) followed by the rectovaginal septum (12%). Endometriosis grows from the outside into the bowel and causes an extensive fibrotic reaction.

16.5.1 Indications and Contraindications

Indications for surgery are blood loss and obstructive symptoms due to stenosis. If the lesion is localised in the bowel, a segmental resection can be done. If the lesion is localised in the rectovaginal septum, the endometriosis must be considered as a multidisciplinary problem. The gynaecologist is involved in resection or ablation of endometriosis in the vagina, uterus and fallopian tubes, the urologist might be involved in ureterolysis and neoimplantation of the ureter, and the surgeon might be involved in local excision of the endometriosis up to a low-anterior resection. All of these procedures can be done laparoscopically, but an extensive combined expertise is required to treat this condition laparoscopically in a multidisciplinary way. Lack of expertise is the most important contraindication.

16.5.2 Evidence

There are only a few groups who have reported on laparoscopic treatment of colorectal endometriosis, located mainly in the rectovaginal septum. The largest series involves 142 patients, but most series are quite small (Table 16.3). Reported conversions rates vary from 10 to 15%. Results are generally good with a low but consistent incidence of rectovaginal fistula [105–110; C. Meuleman and A. D'Hoore, personal communication].

Table 16.3 Laparoscopic treatment of colorectal endometriosis. *RVS* Rectovaginal septum, *RVF* rectovaginal fistula, *pers comm* personal communication

Author	Patients (*n*)	Conversion (%)	Type of surgery	Morbidity (%)
Campagnacci [105]	7	0	Rectosigmoid resection	14%
Darai [106]	43 (7 × RVS localisation)	11%	Resection (40%), ureterolysis, partial vaginectomy (30%), hysterectomy (10%)	3 (7%) RVF
Meuleman/D'Hoor (pers comm)	56	–	Resection (43)	6/56 (11%) 2/56 (4%) RVF
Keckstein [107]	142	–	–	2.8% Leakage 5% Stenosis
Chapron [108]	29	–	Partial vaginectomy	1 (3%) RVF
Donnez [109]	34		Low anterior resections	2/34 (6%) Leakage
Jerby [110]	30	13%	Local excision Resections	1 (3%) RVF

16.6 Conclusion

There is sufficient evidence that laparoscopic surgery for colorectal cancer is at least as good as open surgery. The results of the laparoscopic approach in inflammatory bowel disease are equal or better, with the great benefit of a superior cosmesis important in these relatively young patients. There is no evidence for the laparoscopic approach for rectal cancer, diverticulitis or endometriosis. Laparoscopic surgery for rectal cancer can therefore only be done in the controlled setting of a colorectal audit or a trial setting.

With increasing surgical experience, virtually every patient can be treated laparoscopically. The issue is not whether laparoscopic surgery is feasible, but whether it is advisable. Patients who have had prior surgery via a major incision will not benefit further from improved cosmesis, while after laparoscopic surgery the recovery is only slightly faster than after an open approach, particularly if FT perioperative care is applied. The only established long-term advantage of laparoscopic colorectal surgery is a better BI and superior cosmesis. Robust data on the incidence of incisional hernia and SBO after laparoscopic colorectal surgery are lacking and need to be awaited.

It can be expected that a minimally invasive approach performed by expert surgeons in the FT setting will provide the most optimal treatment. However, many obstacles have to be conquered before laparoscopic colorectal surgery can be implemented safely into general practise. The most important obstacle is the long learning curve and the lack of teachers who need to be available for side-by-side proctoring. Robust evidence in favour of laparoscopic surgery can only be obtained by randomised comparisons of laparoscopic with open colorectal surgery in an FT setting done by surgeons who can perform a procedure laparoscopically as well as they do open surgery. In the end the intelligent patient will ask for laparoscopic surgery if the results are even or better than open surgery.

Careless implementation of laparoscopic surgery in surgical units will not stop further implementation of laparoscopic surgery, but will frustrate the movement. The laparoscopic community is enthusiastic and optimistic, saying "laparoscopic colorectal surgery; the end of the beginning" (Pappas et al. [111]), "the future is bright" (Roger Motson [112]), and describing it as "the new gold standard" (Myriam Curet [113]). However, proper guidelines, training programmes, certification and accreditation, and best-practise guidelines are required to ensure the safe implementation of this technique.

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Self-Assessment Quiz

Question 1

Which statement is correct?

a. The hand-assisted approach allows a medial-to-lateral approach.
b. With the currently available linear endostaplers, a true transverse cross stapling of the distal rectum can be done.
c. The medial-to-lateral approach ensures an optimal lymph-node dissection.
d. Total laparoscopic procedures have superior short-term results compared to hand-assisted procedures.
e. There is sufficient long-term data regarding laparoscopic total mesorectal excision.

Question 2

Which statement is incorrect?

a. There is evidence that fast-track perioperative care reduces hospital stay more than laparoscopic surgery.
b. There is evidence that laparoscopic colon surgery is as safe as open surgery.
c. There is no evidence that laparoscopic rectum surgery is as safe as open surgery.
d. There are data from randomised trials comparing laparoscopic with open surgery for diverticulitis.
e. Significantly better cosmesis and body image are found for laparoscopic restorative proctocolectomy compared to the open approach.

Question 3

Which statement is correct?

a. The learning curve for segmental colectomies amounts to 20 procedures.
b. Port-site metastases are a reflection of the learning curve.
c. Port-site metastases are still a problem.
d. The learning curve can be overcome by completing hands-on courses and using training simulators.
e. Learning-curve problems are typically seen in laparoscopic surgery.

Question 4

Which statement is correct? The most optimal laparoscopic operation for diverticulitis:

a. Includes an inferior mesenteric pedicle-sparing operation.
b. Includes transection of the proximal rectum.
c. Can be done from medial to lateral.
d. Is performed by an expert laparoscopic surgeon.
e. All answers are correct.

Question 5

Which statement is incorrect?

a. Laparoscopic restorative proctocolectomy has superior short-term results compared to the open approach.
b. Laparoscopic ileocolic resection is associated with better short-term results than the open approach.
c. Superior cosmesis and body image after laparoscopic surgery for inflammatory bowel disease are the only established long-term advantages.
d. The size of the inflammatory mass in Crohn's disease determines the surgical approach.
e. Enteroenteric fistulae in Crohn's disease are not a contraindication for laparoscopic surgery.

1. Answer: c
   Comment: When applying a medial-to-lateral approach, the vessels are ligated close to their origin, ensuring an optimal lymph-node dissection.
2. Answer: a
   Comment: There is no evidence that fast-track is superior to laparoscopic surgery with respect to reduction of hospital stay.
3. Answer: b
   Comment: Since the incidence of port-site metastases decreases with time, these are probably a reflection of the learning curve.
4. Answer: e
   Comment: In order to have a lower rate of recurrence, the distal transection line should be at the rectum. The medial-to-lateral approach enables clearance of the ureter. There is one study indicating the superiority of the medial-to-lateral over the lateral-to-medial approach in cancer.
5. Answer: a
   Comment: The short-term results of restorative proctocolectomy are similar for the open compared to the laparoscopic approach.

17 Stomas and Related Problems

Bruce D. George and Angie Perrin

CONTENTS

17.1 Introduction and Nomenclature

The word "stoma" is from the Greek word for mouth. It is an opening, usually surgically created, between a hollow viscus and the body surface. In describing a stoma, the suffix -ostomy is used; the prefix indicating which structure has been exteriorised (e. g. tracheostomy, oesophagostomy, ileostomy, colostomy, nephrostomy). This chapter focuses on gastrointestinal stomas, namely ileostomy and colostomy.

The earliest record of surgical formation of a colostomy was by Littre in 1710 as treatment for an obstructing colonic carcinoma [1]. Ileostomy was first described by Brown in 1913 [2] as a temporary measure to rest the colon in severe ulcerative colitis; major problems with skin excoriation around the ileostomy prevented its general acceptance. In the 1940s, Koernig, a chemistry student who had an ileostomy, designed a rubber-latex appliance that prevented the ileostomy effluent from contacting the skin [3]. In 1952, Brooke [4] described spouting of the ileostomy to facilitate collection into a bag without damaging the adjacent skin.

Accurate data regarding the current prevalence and incidence of ostomies are difficult to obtain. In England and Wales, it is estimated that there are about 100,000 people with a stoma and that about £135,000,000 is spent annually on stoma appliances.

17.2 Classification of Gastrointestinal Stomas

Gastrointestinal stomas may be described according to the segment of bowel that is exteriorised, the local anatomy, the planned duration and whether or not any form of continent control of the stoma is incorporated (Table 17.1). In describing a stoma, the segment of bowel exteriorised and the local anatomy are generally indicated (e. g. end-sigmoid colostomy or loop ileostomy).

Table 17.1 Classification of gastrointestinal stomas

Segment of bowel exteriorised	Ileostomy Caecostomy Transverse colostomy Sigmoid colostomy
Anatomy of stoma	End Double-barrelled Loop Split
Planned duration of stoma	Permanent Temporary
Control of stoma	Spontaneous (incontinent) Continent stoma

Table 17.2 Indications for stoma formation

Following anal sphincter failure or removal
- Congenital anorectal atresia
- Surgical removal
  - Abdominoperineal excision of the rectum (e. g. for low rectal carcinoma)
  - Proctocolectomy (e. g. for ulcerative colitis)
- Destruction
  - By tumour
  - By disease (e. g. anal Crohn's disease)
  - Severe faecal incontinence

To protect a distal anastomosis
- Loop ileostomy proximal to low anterior resection
- Loop ileostomy proximal to ileoanal pouch

When anastomosis is not appropriate
- Hartmann's procedure (e. g. for perforated diverticulitis)
- Colectomy and ileostomy for fulminant colitis

To reduce disease activity distally [24]
- Severe anal Crohn's disease
- Severe Crohn's colitis

17.3 Indications for Stoma formation

Indications for stoma formation may be considered in three categories, as indicated in Table 17.2. One of the most common situations is to "protect" or "defunction" a distal anastomosis, such as after anterior resection (AR) or ileal pouch–anal anastomosis. Factors that tend to indicate the need for a defunctioning stoma after AR include:

1. Low anastomosis
2. Narrow male pelvis
3. Intraoperative technical difficulties
4. General factors (e. g. ischaemic heart disease, diabetes, steroids)
5. Neoadjuvant chemoradiotherapy

A recent Swedish trial randomised patients after a technically successful low AR to either a defunctioning stoma or not. A defunctioning stoma significantly reduced the rate of symptomatic anastomotic leakage (from 28 to 10.3%) and urgent abdominal reoperation (from 25.44 to 8.6%) [5].

Controversy exists regarding the choice of a loop ileostomy or a loop transverse colostomy following AR. Several trials and a Cochrane meta-analysis have shown no major differences between the two techniques apart from a higher incidence of stoma prolapse after loop transverse colostomy [6].

The decision to defunction or not following ileal pouch–anal anastomosis is also difficult. Most surgeons agree that the use of a defunctioning ileostomy reduces the catastrophic consequences of anastomotic leakage. This must be weighed against the additional morbidity of the ileostomy and its subsequent closure. Furthermore, small-bowel obstruction following pouch surgery is slightly more common in patients who have had a defunctioning ileostomy [7]. In practice, most surgeons adopt a selective policy, omitting loop ileostomy when the procedure has been technically smooth and factors such as steroids, nutrition and age/comorbidity are favourable.

17.4 Preoperative Assessment

Ideally, the specialist nurse should meet the prospective ostomy patient several weeks prior to their planned surgery. The assessment will ascertain the patient's ability to cope practically with stoma management, establish what existing lifestyle the patient has and identify any compromises or modifications that the patient may have to consider for rehabilitation. Chaudhri et al. [8] demonstrated improvements in hospital stay and unplanned stoma-related interventions when preoperative stoma education was compared with traditional post-operative care. Factors to consider preoperatively

include the patient's manual dexterity and eyesight, psychological adjustments, cultural factors and siting of the stoma.

17.4.1 Manual Dexterity

It is important to assess the patient's manual dexterity to ascertain the individual's ability to self-care for their stoma post-operatively. Conditions such as arthritis, Parkinson's disease or stroke will often impair self-care. Asking simple questions, such as "Can you do buttons or tie your own shoelaces?" will often provide the nurse specialist with adequate information to make an assessment.

There are currently numerous commercially available products from which patients may choose, all with differing adhesive techniques and fastening mechanisms. Appliance selection is vital to the patient's ability to self-care for their stoma.

17.4.2 Eyesight

Patients who wear spectacles, especially bifocals, often find it difficult to look downwards in order to manage their stoma. If that is the case, it is sometimes easier to use a magnifying mirror to assist in changing the appliance. Visually impaired or blind ostomists will often use touch to carry out their stoma care.

17.4.3 Psychological Adjustments/ Body Image

The impact of having a stoma formation can be profound for many individuals. Preoperative counselling should involve discussion about how the patient currently perceives him-/herself and feelings towards self-image. Post-operatively, the patient should have access to a specialist stoma care nurse, who will discuss differing aspects of body image, adaptation and potential coping mechanisms with the individual concerned.

17.4.4 Cultural Awareness

Cultural background influences a patient's perceptions, behaviour and concepts of and attitudes to disease, illness and pain. Prior to stoma formation, a thorough cultural assessment should be performed, as cultural and religious beliefs and values can often have implications on an individual's subsequent care and treatment.

17.4.5 Siting of the Stoma

The stoma should be sited through the rectus muscle, approximately halfway along an imaginary line drawn between the umbilicus and the anterior superior iliac crest. Skin folds and creases, scars, bony prominences, pendulous breasts and the umbilicus should be avoided, ensuring that there is an adequate flat skin surface area to adhere a flange. The patient should be assessed carefully whilst sitting, standing and lying, as movement may alter body contours.

The waistband should also be identified and where possible avoided, as continuous rubbing of the trouser or skirt waistband on the stoma may be troublesome.

17.5 Surgical Technique

Stoma formation involves suturing of the relevant part of the bowel to the skin. Satisfactory healing requires that the bowel has a good blood supply and is not under tension. Stomas may be constructed by a trephine approach [9], laparoscopically or by laparotomy. The decision as to which approach to use will depend upon individual circumstances, such as body habitus, previous surgery/adhesions and whether the stoma is being formed in isolation or as part of a more major procedure (Table 17.3).

17.5.1 General Principles of Surgical Technique

A disc of skin and underlying cylinder of fatty tissue is excised at the site of the marked stoma. The anterior rectus sheath is exposed and a cruciate incision made. The rectus muscle is split longitudinally, taking care to avoid damage to the inferior epigastric vessels. The underlying posterior sheath/parietal peritoneum is opened. The abdominal wall defect should admit one thumb (for an end stoma) or two fingers (for a loop stoma) [10]. Creation of the stoma lateral to the rectus muscle may be associated with an increased incidence of parastomal hernias. The appropriate segment of

Table 17.3 Comparison of methods of stoma formation

	Advantages	Disadvantages	Comments
Trephine only	Minimal surgery Early return of bowel function Short hospital stay	Difficult to mobilise the bowel Difficult to check the proximal/distal orientation Unable to inspect the rest of the abdomen Committed to the site of stoma	Reasonable in non-obese patients with no previous surgery
Laparoscopic	Minimally invasive Early return of bowel function Allows bowel mobilisation Allows inspection of the peritoneal cavity Short hospital stay	Risk of port-site herniation Risk of obstruction at the abdominal wall Risk of rotation/twisting of the ileum	Technique of choice for most patients
Laparotomy	Allows full bowel mobilisation	Increased surgical morbidity, with associated risks	Appropriate if extensive previous surgery

bowel is then identified using conventional landmarks. The bloodless fold of Treves, which runs from the antimesenteric border of the terminal 4–5 cm of ileum to the caecum, close to the base of the mesoappendix, is sometimes helpful in identifying the terminal ileum, especially when using a trephine or laparoscopic technique. During ileostomy formation the terminal ileum may need to be mobilised out of the pelvis. For loop ileostomy formation, a mobile segment of ileum 10–20 cm from the ileocaecal junction should be selected. If a loop is formed too close to the caecum, subsequent closure may be dangerous. For end-ileostomy formation, the ileum may be divided close to the caecum. The relevant segment of bowel is exteriorised using atraumatic tissue forceps. An ileostomy should be spouted 2–3 cm above the skin surface without tension. It is important to ensure that the bowel is correctly orientated, with no twists in the mesentery. Arguments about which end should be superior/inferior are probably less important than ensuring that the bowel is orientated correctly with no twists.

The avascular adhesions between the sigmoid and pelvic sidewall often need to be divided for sigmoid colostomy formation. The apex of the sigmoid loop is usually selected as the stoma site. A colostomy should reach the skin surface without tension.

When forming an end stoma with closure of the distal end, the surgeon must be 100% certain about which end is which! It is surprisingly easy to make this potentially catastrophic mistake, especially using the trephine-only technique in patients with a long sigmoid colon. Techniques to check which end is which include:

1. Passing a colonoscope to identity the distal end
2. Irrigating fluid into the distal end until it flows freely *per anum*

If any doubt exists, then either forming a loop stoma or converting to laparotomy/laparoscopy is appropriate. When forming a stoma, a potential space is created laterally, which may result in internal herniation. This lateral space may be avoided by exteriorising the bowel through an extraperitoneal tunnel or by suturing the defect closed. It has been claimed that closure of the lateral space is associated with less stoma prolapse, less parastomal herniation and less internal hernia risk, although no trials exist to support these claims and most surgeons today make no attempt to close the lateral space.

There is some recent evidence to suggest that placing a subperitoneal lightweight mesh at the time of permanent end-colostomy formation reduces the incidence of paracolostomy hernia formation [11].

When forming a loop stoma, many surgeons use a rod or similar supportive device to prevent stoma retraction. The rod is removed about 5–7 days post-operatively. One recent small, randomised trial showed no benefit in using a rod, but stressed the importance of adequate bowel mobilisation [12]. Another recent small trial has recommended wrapping the two limbs of a loop ileostomy with anti-adhesive film (Seprafilm) to reduce adhesions and facilitate early stoma closure [13].

17.6 Routine Post-Operative Care

17.6.1 Checking Viability

In the initial post-operative phase it is vital that the stoma is observed very carefully. If the stoma is "plum" coloured or appears a darker purple, this may well indicate that the blood supply has been reduced. The use of a glass test-tube and pen torch may be helpful in distinguishing between a slightly dusky and a purple/black stoma. It has been suggested that the use of glycerine trinitrate (Rectogaesic) applied topically during the initial phase may enhance the blood supply of a "borderline ischaemic" stoma. It is important to ensure that the post-operative appliance has been adequately cut, ensuring that the blood supply is not occluded.

17.6.2 Choice of Stoma Appliance

Stoma appliances are either drainable or closed. Drainable appliances are usually advised for patients with an ileostomy or patients with a liquid or semi-solid output. These appliances have a drainage facility at their end. The patient will be required to empty the bag on average five times daily. Most modern appliances are fastened with a Velcro closure; however, some older drainable products require a separate clip, which can be a hard plastic or a soft wire tie. Closed products are typically recommended for patient with a colostomy or those with a solid stool. This appliance does not have a drainage facility and is usually changed two or three times daily.

Both drainable and closed products are available in a one-piece or two-piece system, and all products are obtainable in "cut-to-fit" or "pre-cut" sizes. One-piece systems incorporate the bag (either closed or drainable) and the hydrocolloid skin-protection wafer together, and the complete system is applied as one unit. It is necessary for the hydrocolloid skin-protection wafer to be cut to fit the exact size of the stoma, or they can be obtained in pre-cut sizes if the stoma is round. This is often selected due to its ease of application.

Two-piece systems have a separate bag and skin-protection wafer. The hydrocolloid skin-protection wafer or "flange" is again cut to fit over the stoma or obtained in pre-cut sizes, and adhered to the skin around the stoma. A closed or drainable bag is then attached to the wafer. This attachment is achieved by clipping the bag onto a hard plastic ring, which is incorporated into the wafer itself.

Recent advances in design and technology in stoma care manufacturing have resulted in the introduction of a new "hybrid" product, which is essentially a two-piece system, as it has a skin-protection wafer and a separate bag. The bag, however, either drainable or closed, adheres to the wafer, making the profile consistent with that of a one-piece appliance. It also has the advantage of allowing reapplication if the ostomist has difficulty with alignment.

17.6.3 Planning for Hospital Discharge

Discharging a patient into the community setting following stoma formation can often pose great anguish. Patients are often apprehensive that they will be unable to change their own bag independently or that they will not have adequate supplies if leakages are experienced. Other areas that give rise to concern include fear of family rejection, bag leaking whilst out, feeling unattractive and not being able to carry out their usual activities. It is imperative that any patient has direct access to a nurse specialist who will be able to allay certain fears and worries, as well as providing essential support for the patient over the first few challenging weeks.

It can be useful for patients to talk to other individuals who have experienced life with a stoma; this can be initiated at a local level through the specialist nurse, or the patient can be given details of national organisations that provide an excellent source of support for many individuals. In the UK there is the Colostomy Association, Ileostomy Association and Pouch Support Group and the National Association for Colitis and Crohn's.

17.7 Complications of Stoma Formation

Complications following stoma formation are unfortunately very common (Table 17.4). Some are relatively minor or transient, others can be managed by skilful stoma care, and yet others require surgical reoperation. At least 15–20% of patients with a stoma require reoperation long-term follow-up [14, 15]. The importance of meticulous surgical technique in preventing complications cannot be overemphasised.

17.7.1 Psychological

McVey et al. [16] estimate that about 20% of patients with a stoma have significant psychological problems.

Table 17.4 Complications of stoma formation

Psychological
Early functional
Not working
Overworking
Early leakage/sore skin
Later local complications
Stenosis
Prolapse
Parastomal hernia
Peristomal fistula
Granuloma
Late functional
High output
Metabolic disturbances
Miscellaneous
Pyoderma gangrenous
Drug malabsorption
Malignancy

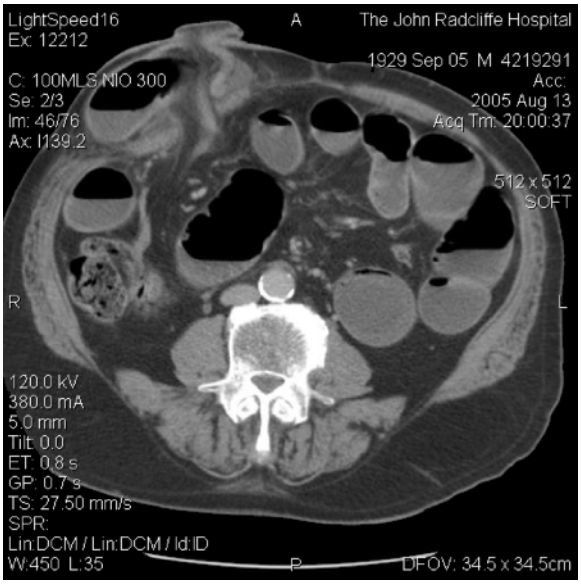

Fig. 17.1 Parastomal hernia with trapped small bowel causing a small-bowel obstruction

The severity and type of problem will vary according to many factors, including: prior personality traits, cultural and social factors, reason for requiring a stoma, age, gender, marital/relationship status, whether the stoma is planned to be temporary or permanent, the quality of the stoma and coexistent illness. Gooszen et al. [17] demonstrated that local stoma complications such as leakage and skin irritation are associated with higher levels of social restriction.

The importance of awareness of psychological and psychosexual problems after stoma formation by doctors and stoma-care nurses is becoming increasingly recognised. Improved communication with patients and a more holistic rather than purely mechanistic approach to stoma care may help to address these issues.

17.7.2 Early Functional

17.7.2.1 Stoma Not Working

Failure of a stoma to function in the early post-operative period may be due to intra-abdominal problems unrelated to the stoma or due to problems with the stoma such as obstruction at the abdominal wall level, parastomal herniation of a loop of small bowel or retraction of the stoma from the skin. Preliminary assessment should include careful inspection of the stoma and digital examination. Significant retraction or ischaemia requiring surgical revision should be obvious. If it is suspected that the obstruction is at the abdominal wall level, insertion of a large Foley catheter into the bowel beyond the abdominal wall level may be helpful to temporarily relieve the obstruction while post-operative oedema settles. If the cause of a non-functioning stoma is not clear, computed tomography (CT) scanning might be helpful to distinguish mechanical obstruction from ileus (Fig. 17.1).

A parastomal hernia causing early small-bowel obstruction will require surgical reintervention to reduce the bowel and repair the parastomal defect. The management of ileus and other early small-bowel obstructions are along conventional surgical lines.

17.7.2.2 High-Output Stoma

Management of a high-output ileostomy requires accurate fluid balance charts to ensure sufficient fluid replacement. Intravenous fluid replacement and possibly restriction of oral fluid intake should be considered. The consumption of caffeine-rich beverages should be restricted. The patient should be commenced on rehydration replacement solutions (e.g. Diorralyte). H2 blockers or proton-pump inhibitors and stool-thickening medication such as loperamide should be prescribed. To prevent leakage of the ostomy appliance it is advisable for the patient to be placed on a high-output man-

agement system, which can be placed on free drainage. It is also advantageous to use a hydrocolloid protective barrier ring directly around the high-output stoma, as this will prevent seepage and often minimise leakages. The use of thickening agents (e. g. Asorbogel, Gel-X or Morphorm) placed into the bag is also of benefit.

17.7.2.3 Early Leakage/Sore Skin

Problems with soreness of the skin around the stoma are common shortly after stoma, and especially ileostomy formation. Combined assessment by the stoma-care nurse specialist and surgeon is important. Causes include:

1. Stoma sited in skinfold/crease
2. Retracted/inadequately spouted stoma
3. Mucocutaneous separation
4. Local trauma from an ill-fitting appliance or over-zealous appliance removal
5. Allergy to the appliance

There are many accessory products, pastes, powders, lotions and wipes available to assist in the treatment of sore skin; however, specific treatment is very much dictated by cause. Some stoma-care departments are now using a Patient Group Direction in order to treat simple conditions such as contact dermatitis, possibly as a result of an allergy to a product. Using this protocol allows the nurse to offer immediate treatment to an ostomy patient without consulting a doctor to prescribe certain creams.

Figure 17.2 is a simple flow-chart designed and implemented by stoma-care nurse specialists in Oxford as a teaching aide to assist ward nurses in making their assessment of sore skin, to establish a potential cause and offer possible solutions.

Mucocutaneous separation (Fig. 17.3) is seen commonly within the first few days/weeks after surgery, creating a cavity or "moat" immediately around the stoma. Risk factors include emergency surgery, steroid therapy, poor nutritional status and recent adjuvant or palliative chemo-/radiotherapy. It is recommended

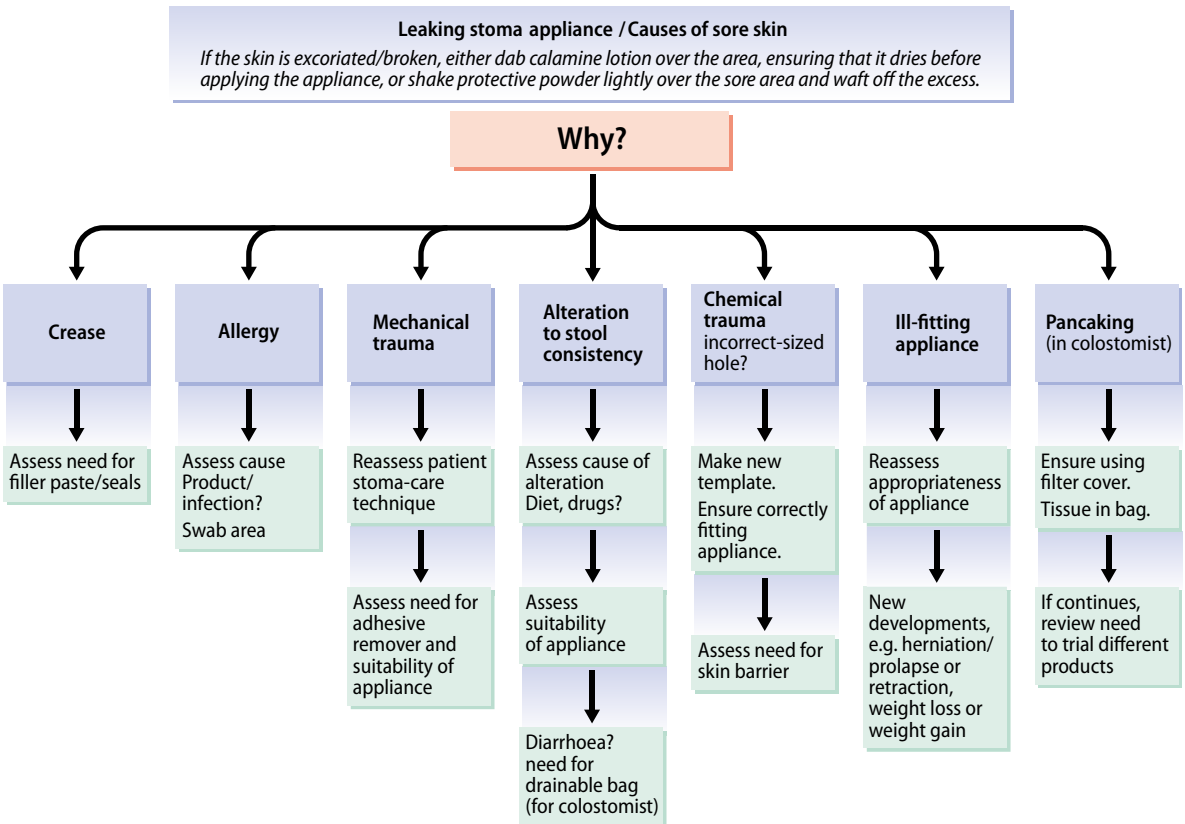

Fig. 17.2 Flow chart to assist in the management of leaking stoma/sore skin

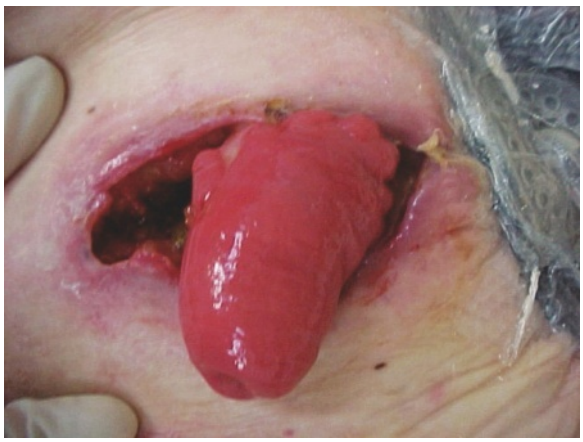

Fig. 17.3 Mucocutaneous separation

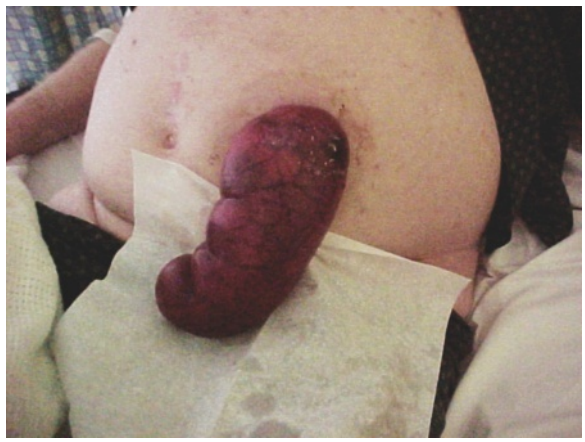

Fig. 17.4 Prolapsing stoma

that this situation be managed by irrigation of the cavity with saline, drying the area and then placing either some carmellose sodium paste (e.g. Orabase paste) or calcium alginate packing into the cavity, depending on its depth. This may then be covered with a secondary dressing and the selected appliance cut to fit over the stoma.

Retraction occurs when the stoma falls flush with, or below the level of the skin surface. This is often due to the bowel being placed under a certain amount of tension, either from the surgical procedure or as a result of post-operative abdominal distension (or later weight gain).

Management of a slightly retracted stoma can be enhanced with the use of an additional seal, convex appliance and/or the application of an elastic belt to provide further support. Retraction significantly below the level of the skin surface usually requires surgical revision.

17.7.3 Later Local Complications

17.7.3.1 Prolapse

A stomal prolapse occurs when the bowel intussuscepts or "telescopes" from the skin opening, becoming longer (Fig. 17.4). It is commonly seen in transverse colostomies, with the distal bowel being typically affected; however, both limbs of a loop stoma may potentially prolapse.

The prolapse itself can appear very distressing for the patient and can cause numerous management issues. The stoma may become oedematous and the blood supply restricted, as is shown in Fig. 17.4. If the blood supply is affected the patient must be hospitalised and monitored carefully, and surgical intervention may become necessary. However, if the stoma remains viable the patient is advised to ensure the aperture size on their appliance is cut adequately to prevent constriction. A protective paste or Vaseline is often recommended to prevent trauma to the stoma. A protective shield or guard can also be worn to the same effect. The prolapse can occasionally be manipulated back, although it is vital that this procedure is carried out with a good deal of caution and expertise. Icing sugar may facilitate reduction of an acutely prolapsed stoma, using osmosis to reduce the oedema [18].

A persistently prolapsing stoma that cannot be managed conservatively may require surgical repair (or stoma closure if appropriate). Repair usually involves resecting the excessive prolapsing segment of bowel and repair of the almost inevitably associated parastomal hernia (see Sect. 17.7.3.3). It is often sensible to convert a loop stoma to an end stoma at the same time. Precautions must be taken to ensure correct identification of proximal and distal ends before closure of the distal limb.

17.7.3.2 Stenosis

This situation occurs when the lumen of the stoma becomes narrowed at either the fascial or cutaneous level (Fig. 17.5). Recognised causes in the early post-operative stage include ischaemia and mucocutaneous separation. "Ribbon-like" stools or pain on defaecation are symptoms indicative of stenosis. Use of laxatives is often recommended to keep stool soft to prevent con-

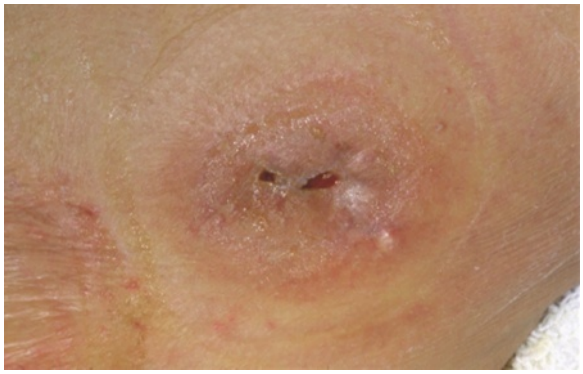

Fig. 17.5 Stenosis of a colostomy

stipation and subsequently a potential blockage. For an ileostomist with stenosis, partial obstruction can often occur secondary to a food bolus.

Treatment with dilators or digital dilatation is often an effective method of opening the lumen. Regular dilatation is recommended to maintain patency. Care must be heeded when using dilators to ensure that the surrounding skin is not split, causing further scarring. If this is not effective surgery may well be indicated. If the stenosed segment is only 1–2 cm in length it is usually possible to refashion the stoma by a peristomal approach only. In this procedure the bowel is mobilised to the intraperitoneal level, the stenosed segment excised and the stoma resutured to the skin, ensuring no tension and a good blood supply. If the ischaemic segment is more extensive, then re-laparotomy or laparoscopy will be required to mobilise enough bowel to refashion the stoma.

17.7.3.3 Parastomal Hernia

A parastomal hernia occurs commonly after any stoma formation, although it is more common with colostomies (Fig. 17.1). Predisposing factors include increasing age, obesity, heavy lifting and increased abdominal pressure such as coughing or sneezing.

Patients often report the parastomal hernia or "bulge" to be unsightly, which can cause numerous problems with an individual's self-image. A "dragging" sensation and a heavy feeling at the side of the abdomen caused by the presence of a parastomal hernia are common symptoms described by patients. Support belts/girdles are available to provide differing levels of support to the abdominal muscles. Management of a stoma for an individual with a parastomal hernia can be troublesome. Some ostomists find the flexibility of a one-piece system more advantageous, along with the use of an appliance with a larger skin-protection wafer. Conversely, others prefer the use of a two-piece system, thus allowing the skin-protection wafer to be left in place for 2–3 days and the bag applied to the wafer.

The diagnosis is usually obvious, but if doubt exists, a limited CT scan at the level of the stoma can clarify the situation.

Several surgical repair techniques have been described, with overall success rates in only about 50% of cases [19]. Simple local repair has a high recurrence rate. Subperitoneal mesh techniques have improved success rates. More recently, laparoscopic techniques, particularly using biological meshes such as Permacol, have given better results [20]. Relocation of the stoma to another part of the abdominal wall remains the last surgical option.

17.7.3.4 Parastomal Fistula

A fistula between the bowel and the peristomal skin occurs most commonly after ileostomy formation in patients with Crohn's disease. Management involves a thorough investigation, usually with contrast studies per stoma and ileoscopy to determine the precise site of the fistula and the presence of recurrent Crohn's. Treatment may involve medication such as anti-tumour necrosis factor-alpha (TNF-α) therapy, although surgical resection of the fistulating segment is often necessary.

Local peri-ileostomy fistulation may also occur as a result of the technique of picking up the seromuscular layer of bowel a few centimetres proximal to the bowel end to facilitate eversion. This technique is not recommended. Adequate bowel mobilisation obviates the need for such sutures. Local fistulation of this type usually requires local revision of the stoma.

17.7.3.5 Granuloma

Granulomas are "lumpy" protrusions commonly seen at the mucocutaneous junction (Fig. 17.6). Granulomas can be caused by repetitive trauma, typically as a result of friction from the stoma appliance. This overgranulation is friable and bleeds readily, and can be extremely painful for the patient. The usual treatment is topical silver nitrate. Unfortunately, recurrence is

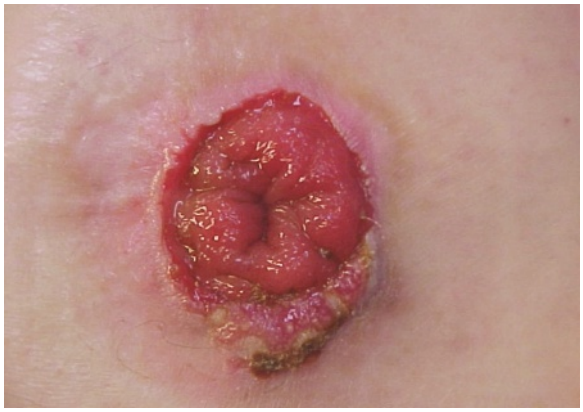

Fig. 17.6 Granulomas around a colostomy

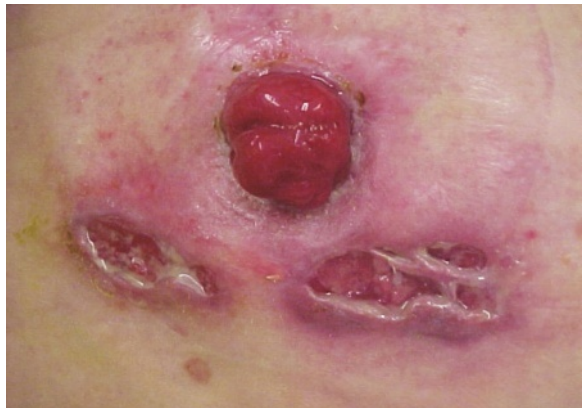

Fig. 17.7 Peristomal pyoderma gangrenosum

likely. Large granulomas may require surgical removal if management of the stoma becomes problematic for the patient.

17.7.4 Late Functional

Patients with an ileostomy are in a chronic salt-/water-losing state. Most patients compensate for this by increased renal tubular reabsorption of sodium. Ileostomy patients, however, are at risk of dehydration during intercurrent febrile illness or when in hot climates. Patients should be advised to maintain adequate fluid and salt intake.

A small proportion of patients with an ileostomy, particularly if there has been significant small bowel resection, may develop a persistent high-output state that cannot be managed with normal oral fluid replacement. Management is as outlined above (early high-output stoma). The late development of a high-output ileostomy should prompt investigation of other causes.

Patients with an ileostomy are also at increased risk of developing renal calculi, especially due to uric acid. Ileostomy patients should have their uric acid levels checked occasionally and consideration of allopurinol treatment if they are raised.

17.7.5 Miscellaneous

17.7.5.1 Pyoderma Gangrenosum

Pyoderma gangrenosum is an ulcerative, inflammatory skin disorder with undermined edges and purple margins [21] and is associated predominantly with concurrent inflammatory bowel disease, although the aetiology is unknown.

Parastomal pyoderma gangrenosum (PPG; Fig. 17.7) can be painful and management can be problematic. The use of additional pastes, powders, hydrocolloid seals and other accessories is often necessary to ensure that the appliance remains intact. It has been suggested that convex appliances induce PPG; these should therefore be avoided or usage discontinued if PPG occurs.

Topical treatments include the use of Tacrolimus ointment as well as steroid tapes (e. g. Haelan tape) and steroid creams. For severe cases, anti-TNF-α therapies are indicated.

17.7.5.2 Malignancy

Rarely, a tumour may develop close to the mucocutaneous junction of an ileostomy or colostomy. Patients with previous large-bowel resections for malignancy are clearly at risk of metachronous tumours. Early biopsy of any unusual lumps or ulcers related to stomas is recommended and can often be easily undertaken using endoscopy biopsy forceps (without the endoscope or sedation).

17.7.5.3 Drug Malabsorption

Poor absorption of the oral contraceptive pill after ileostomy, particularly low-dose agents, resulting in ineffective contraception [22] has been described.

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Self-Assessment Quiz

Question 1

Which of the following is not an indication for a defunctioning ileostomy?

a. Severe ulcerative colitis after failed medical therapy
b. Severe Crohn's colitis after failed medical therapy
c. Before a long course of downsizing chemoradiotherapy for locally advanced rectal carcinoma
d. After ileoanal pouch reconstruction for familial adenomatous polyposis
e. After low anterior resection

Question 2

Management of a high-output ileostomy may include all of the following except?

a. Loperamide
b. H2 blockers
c. Magnesium replacement
d. Increased oral hypotonic fluids
e. Intravenous potassium replacement

Question 3

Mucocutaneous separation is associated with all of the following except:

a. Emergency surgery
b. High-dose steroids
c. One-piece stoma appliance
d. Stoma retraction
e. Malnutrition

Question 4

Which of the following statements is true?

a. There are about 10,000 people in the UK with a stoma.
b. Mucocutaneous separation is always due to poor surgical technique.
c. Parastomal herniae may be detected in over 50% of patients with a stoma.
d. Peristomal pyoderma gangrenosum occurs most commonly after surgery for complicated diverticulitis.
e. Loop ileostomies are more likely to prolapse than loop transverse colostomies.

Question 5

Which of the following statements is false? Diversion colitis:

a. May occur following defunctioning of a previously normal colon
b. Is clinically insignificant in most patients
c. May mimic inflammatory bowel disease histologically
d. Is easily treated by butyrate enemas
e. May be treated by stoma closure

1. Answer: a
Comment: Severe ulcerative colitis does not respond to defunctioning, unlike severe Crohn's colitis.
2. Answer: d
Comment: Increased hypotonic fluids is contraindicated in the management of a high-output stoma. Oral fluids should be restricted in severe cases to less than 500 ml/day. Isotonic fluids with a high sodium concentration should be used.
3. Answer: c
Comment: The use of a one-piece, rather than a two-piece stoma appliance has no bearing on the occurrence of mucocutaneous separation.
4. Answer: c
Comment: Computed tomography scanning detects parastomal herniation in over 50% of patients. There are about 100,000 patients in the UK with a stoma. Patients who are malnourished or using steroids are predisposed to mucocutaneous separation. Peristomal pyoderma gangrenosum is most commonly seen in patients with Crohn's disease. Loop transverse colostomies are most prone to prolapse.
5. Answer: d [23]
Comment: Pathological changes occur commonly after defunctioning of a normal large bowel, but rarely cause clinical problems. Histological changes include lymphoid follicular hyperplasia, a chronic inflammatory infiltrate and aphthoid ulceration, which may cause confusion with inflammatory bowel disease. Diversion colitis has been shown to respond to butyrate enemas, although this treatment is difficult to obtain and is poorly tolerated by patients. The condition generally responds to stoma closure, although this may not be appropriate.

18 Psychological Assessment of the Coloproctology Patient

Julian Stern

CONTENTS

18.1 Introduction

In this chapter some of the key features of a psychological and psychiatric assessment of the coloproctology patient will be presented, illustrated throughout by appropriate case examples. Whilst it is recognised that most patients presenting to a gastroenterologist or coloproctologist will neither undergo nor require such an assessment, there are frequently occasions where such an assessment will help in the total management of the patient and his/her symptoms. In some instances it will substantially alter the planned management of his/her gastroenterological (GI) symptoms.

The chapter is based predominantly on the author's clinical experience at St Mark's Hospital, UK (all of the cases described have been disguised to protect patient confidentiality). This is a hospital in which there is a history, going back for well over 20 years, of the involvement of a psychiatrist trained also as a psychotherapist, and latterly psychologists, in the clinical assessment and management of coloproctology patients, as well as in providing psychological understanding and teaching for the hospital staff [3, 5, 6, 10, 19, 43–46, 48–50].

18.2 The Psychological and Psychiatric Assessment of the Coloproctology Patient

Psychological assessment of the coloproctology patient requires a confidential setting that gives the patient a sense of being respected, carefully attended to and not rushed. It is helpful if the patient recognises that he or she is being seen by a professional associated with a gastroenterology team who has an interest in and empathy for such problems and is aware of the shame, embarrassment and fear experienced by many patients with bowel problems. Patients are very sensitive to the reactions of others to their symptoms or disease and may (correctly in some cases) fear that the mental-health professional will be disgusted by the symptoms, just as other members of the public may be (in fantasy or reality).

The initial moments in the assessment may involve understanding something of the illness and symptoms – its origins, its aetiology and the impact on the various spheres of the patient's life (e. g. family, friends, work associates, occupation, sex, leisure, travel). Usually, the patient is relieved to be able to talk about it and sometimes will become tearful or very angry, especially when there is a grievance (justified or unjustified) against a surgeon, physician, nurse or hospital. It is always important from the beginning to look for features of depressed mood as well as resentment, anger or the inability to express anger. In some cases there is a manic attitude, which incorporates denial of the anguish involved, denial of the losses as well as of the pain and stigma.

It is important to take a full personal and family history, understanding something of the main relationships and attachment figures in the patient's past and present, as well as an educational and occupational history. It is crucial to understand aspects of the patient's social and psychosexual, medical, psychiatric and drug and/or alcohol history, as well as the specific cultural and religious factors in the background that may colour the patient's symptoms, coping mechanisms and support structures. Furthermore, an understanding of the patient's present circumstances is also required. The patient's own personality structure and habitual way of coping and dealing with difficulties and interpersonal relationships will crucially colour his or her "relationship" to, and mode of coping with, the illness and symptoms.

In order to fully understand the impact of the illness and its meaning on the individual patient, one must also look for issues of shame, guilt and stigma. Is there any sense that the patient feels that he or she is to blame for the condition? Does he or she "deserve it"? Is there any "secondary gain" involved? Are there any symptoms or behaviours that might worsen the symptoms, such as an unhelpful diet or any self-destructive behaviour [43–46, 48]?

Other features of the assessment will include a brief assessment of the patient's cognitive functioning and a mental-state examination to assess the presence of a formal psychiatric condition. This assessment requires expertise, patience, empathy and time.

18.3 Impact of a Pre-existing Psychiatric Condition/Personality Structure on Patients and Their GI Symptoms

In the psychiatric assessment of any patient, there is a hierarchy of diagnosis, with a need to exclude or diagnose the most serious conditions (e. g. psychosis, organic brain syndromes). Albeit relatively uncommon, these conditions will fundamentally affect the patient's cognition, judgement and appraisal of their GI syndrome [33].

18.3.1 Psychotic Disorders

18.3.1.1 Psychosis Affecting the GI Tract

A 35-year-old woman (Mrs. A) was admitted to the ward complaining of severe abdominal pains, constipation with no bowel action for 3 weeks, and inability to swallow. Gastroscopy and other investigations were normal, and a psychiatric opinion was requested due to her insistence for a repeat gastroscopy, and for oesophageal manometry.

She was a thin (body mass index, BMI = 17) woman of South Asian origin. She described a sensation of her oesophagus being blocked off and an unshakeable belief that any food or drink bypassed her GI tract, and instead went down the sides of her thorax into her flanks. Her "proof" was that she could hear tinkling and gurgling noises. It became clear that she was profoundly depressed and a diagnosis was made of depression of psychotic intensity with somatic delusions [35, 58]. She was treated with antipsychotic and antidepressant medication, transferred to the psychiatric ward and made a good recovery. No further medical investigations were required.

18.3.1.2 Dysmorphic Disorders

A 40-year-old man with a history of circumcision at age 38 years for "erectile impotence" presented with a 2-year history of anal symptoms. He was convinced that he leaked foul-smelling fluid from his anus and that everyone close to him could smell him. He carried wipes and cleaning equipment with him, washed his perineum five times daily and bathed whenever he could. He requested surgery to his anus, and had already seen four specialists. Like Mrs. A above, he suffered from a fixed delusional belief that could not be

swayed, and it is likely that following the circumcision this had "shifted" from beliefs and thoughts about his penis to beliefs surrounding his anus and sphincters. He was seen for regular psychotherapeutic meetings for 2 years, during which time substantial psychological issues from his past were uncovered. The diagnosis of body dysmorphic disorder [39] was made. On discharge his delusions had diminished to the extent that he no longer washed more than once a day and no longer believed others could smell any odour emanating from his anus. He was happy with this outcome. However, he announced that he now knew "the reason for not being able to get a girlfriend" was his teeth and he had arranged to undergo expensive cosmetic dental surgery the following week (symptom substitution)!

18.3.2 Non-psychotic Disorders

Much more common than psychoses are the non-psychotic disorders, in particular depression and anxiety. The comorbidity of patients with functional bowel disorders (and other functional syndromes) [16, 52, 55] and depression/anxiety is well-recognised.

18.3.2.1 Depression Following Loss

A 48-year-old White, English, married man presented with intractable anal and abdominal pain, altered bowel habit and low mood, lasting 2 years. All investigations were normal. He had suffered substantial emotional deprivation in his past, including the early loss of his mother. He had coped well on the surface, married, built up a business and brought up two children, being especially close to his 25-year-old daughter. She had fallen in love with a man from Africa and had gone to live there, in her husband's homeland. The patient felt increasingly alienated from her, describing how he felt he had "lost her", and had virtually cut off contact with her when she had finally converted to her husband's religion, 2 years previously. In the assessment, a link was made for him between this emotional loss and the onset of his functional symptoms. "Do you mean", he asked "that there could be things which bypass my brain and go straight into my bowels and my anus?" He was immensely moved by the consultation, and at follow-up reported a diminution in his physical symptoms, an increase in his anxiety, and a plan to re-establish contact with his daughter.

18.3.2.2 Anxiety and Panic Disorder

A 28-year-old woman of Spanish origin presented to the clinic with a 1-year history of urgency, fear of incontinence and panic. Her main problem was that she had to travel to her well-paid job an hour away from her home in London, and her symptoms and fears were so severe that she had to sleep 4 nights/week (Monday–Thursday) in a hotel close to her workplace, rather than catching the train to and from work.

Like many patients with this symptom complex, her thoughts were of catastrophes, predominantly of public episodes of faecal incontinence (FI), of being trapped in a train or closed space with no escape, no toilet and no privacy. The anticipated humiliation was immense. In reality, there had been no actual episodes of incontinence, but in her past there had been terrifying experiences of being trapped with a violent and unpredictable man, and fears of being brutally attacked with no escape possible.

The presenting symptoms started after an episode of gastroenteritis on holiday (a common precursor to irritable bowel syndrome – IBS – symptoms) [28], with mild diarrhoea and subsequent IBS symptoms, which had mainly resolved over time. In the assessment she was able to see the links between her past traumas and her current symptoms and opted for a course of cognitive behavioural therapy (CBT), which would address her cognitions (e. g. "catastrophising") as well as her behaviours (e. g. her avoidance of travel and of closed spaces). The CBT was allied with some relaxation and hypnotherapy techniques and she made a good recovery [37]. Subsequently, she chose to pursue a more in-depth psychotherapy (psychoanalytic psychotherapy), which dealt with unresolved issues from her past [27, 46, 47].

18.3.2.3 Anxiety, Depression and Sexual Abuse

A 21-year-old nurse of Irish Catholic origin presented with symptoms of functional bloating [36], abdominal pains and vomiting. All investigations were normal. She was thought by the referring gastroenterologist to be depressed and anxious. She came into the consultation tremulous, anxious but co-operative. She had been sexually abused by an uncle from age 8 to 12 years, and had never been able to talk about it. She hated the idea of sex now as an adult, and was in turmoil about her relationship with her very caring, sensitive boyfriend, a psychologist 10 years her senior. They had been away

on holiday, she had agreed to have sexual intercourse with him, but had felt very uncomfortable physically, with symptoms of vaginismus, as well as psychologically feeling she was dirty and "a bad girl". She felt nauseous soon after the sex, and was relieved to be able to vomit. Her symptoms of nausea, abdominal pain and incomplete evacuation persisted for 6 months and she requested a surgical consultation, hoping for some surgery. She had also tested herself for pregnancy three times, even though the intercourse had not been repeated after the episode on holiday.

Diagnostically, she was suffering from several comorbid conditions, including features of anxiety, depression and somatisation disorder [51]. Underlying these diagnoses were substantial long-standing personality difficulties, including a deep-seated mistrust of others and her own body, sexual anxieties and a tendency to want a concrete (e. g. surgical) " solution" to her problems, rather than dealing with them psychologically. Although she seemed moved by her initial consultation, she chose not to return for further psychological exploration, and it later emerged that she has subsequently presented to (at least one) another gastroenterology department requesting a colonoscopy and possible colectomy.

Other than depression, generalised anxiety disorder and panic disorder, patients suffering with obsessive-compulsive disorder (OCD) may present with fears of contamination, excessive need for cleanliness and rituals associated with their bowels, for example [30]. The links between a preoccupation with bowels, cleanliness and obsessionality have a long tradition in psychoanalytic writings, and remain clinically relevant today [1, 2, 24, 25, 40].

Post-traumatic stress disorder (PTSD) is an increasingly "popular" diagnosis within psychiatry, with strict criteria [58] for its diagnosis. It arises "as a delayed or protracted response to a stressful event or situation… of an exceptionally threatening or catastrophic nature, which is likely to cause pervasive distress in almost anyone" [59, p.167]. Typical features include episodes of repeated reliving of the trauma in intrusive memories. "Flashbacks", dreams or nightmares, occurring against a background of a sense of numbness and emotional blunting, detachment from other people, unresponsiveness to surroundings, anhedonia and avoidance of activities and situations reminiscent of the trauma are additional symptoms. There is usually autonomic hyperarousal, hypervigilance, insomnia, and commonly anxiety and depression.

18.3.2.4 PTSD, OCD and Depression

Mrs. F, a 28-year-old married woman, was referred to the hospital with cleaning obsessions, particularly around her perineum, but also in her house (especially the toilets), substantial sexual inhibition and avoidance, and a constant sense of incomplete evacuation and internal "contamination". She had requested and been granted a colectomy in another hospital, and now had bowel frequency of eight times daily, urgency, some passive FI and some incontinence to wind.

In her past she had had an unremarkable childhood until she was violently raped whilst on holiday at age 15 years. She had felt unable to tell either of her parents as she feared she would be blamed, and since that time had become preoccupied with cleanliness. She dressed in a very "unexposing" manner, with high polo-necks, and always wore trousers rather than dresses, avoided parties or work situations where men would be able to look at her, and managed to marry a man who was much older than her and who made very few sexual demands on her. She had flashbacks of the rape, terrifying nightmares and suicidal thoughts. Her unconscious "solution" was to have her colon removed, and she planned to have a hysterectomy by age 30 years.

The medical team who saw her recommended that she continue with her antidiarrhoeal medication, avoid further surgery and undergo a psychological assessment. A course of psychotherapy followed the initial assessment, and she learnt to express more anger, more assertiveness and more sadness, without resorting to as much somatisation.

18.3.3 Personality Disorders

In the community, the prevalence of personality disorders has been estimated to be approximately 6% [40]. However, in medical out-patient populations this figure is increased, and of those patients who fulfil the diagnostic criteria for somatisation disorder, 72% also fulfil criteria for one or other personality disorder [51]. Personality disorders are described as "enduring and deeply ingrained ways of behaving, thinking, feeling and relating" [21] that deviate significantly from the norm. They are sufficient to cause significant personal and social distress and disruption, and are usually present from adolescence, and persist throughout most of adult life [58].

18.3.3.1 Borderline Personality Disorder

Ms. G, a 40-year-old Portuguese woman, presented to the out-patients department complaining of chronic constipation over the past 20 years. She was found to be thin (BMI = 16), constipated with slow transit times, amenorrhoeic, and had many of the features of bulimia nervosa (see below). She, like Mrs. F above, had sought opinions regarding a colectomy for her constipation. She was referred for biofeedback and a psychiatric opinion.

Her past was characterised by violence and abuse within her family, substance abuse, unstable personal relationships, and a propensity towards self-harm, with two substantial overdoses in her 20's. A lively, intelligent woman, she showed many of the features of an "emotionally unstable personality disorder" (International Classification of Diseases [58]), and her wish for a colectomy was, as in the case of Mrs. F, seen as part of a self-destructive, punitive part of her personality, which could draw health-care professionals into a complex and destructive relationship with her.

She improved substantially with the biofeedback [11]. However, after the break-up of a relationship with a female partner, she began drinking heavily and then organised to have the colectomy performed in her home country.

18.3.4 Eating Disorders

Whilst the majority of patients with anorexia nervosa and bulimia nervosa will seek help through their general practitioners and then through mental-health professionals, there is a substantial number who present to gastroenterologists. In a study of 20 patients with "atypical" anorexia nervosa at St Mark's Hospital, Emmanuel et al. found these patients to have a poor prognosis, and in their past history had presented to multiple "alternative" practitioners as well as to multiple hospitals, underwent multiple investigations and had often denied the presence of an eating disorder [20]. The denial of anorexic behaviour by the patient does not preclude the diagnosis of anorexia nervosa!

18.3.4.1 Atypical Anorexia Nervosa with Crohn's Disease

Ms. H is a 33-year-old health-care professional with a 5-year history of mild Crohn's disease affecting the terminal ileum. She complained of passive fuecal incontinence (FI), diarrhoea, bloating and a variety of other symptoms and syndromes including chronic fatigue syndrome, generalised aches and pains, and amenorrhoea. She described herself as suffering from several other diagnoses including hypothyroidism, an undifferentiated connective-tissue disorder, asthma and polycystic ovaries, but careful review of the notes indicated no clear documentation of any of these; nonetheless, they had "slipped into" her medical history and were now repeated by one doctor to another as if they were "facts".

Admission to the ward for a week was arranged. During her admission she was noted to be hiding food, emptying meals into the toilet, consuming up to 5 l water/day and exercising whenever possible. Her weight remained very low, with a BMI of 14, and she was found to be ingesting laxatives, contrary to doctors' recommendations. Her inflammatory markers were normal and colonoscopy showed very mild ulceration only.

She said she wished to put on weight, and that it was purely due to the feeling of bloatedness and constipation that she was unable to do so. Despite her protestations, she was diagnosed as suffering from "atypical anorexia nervosa" and referred to an outpatient eating-disorder unit for management of this condition.

The presence of Crohn's disease (or another medical condition) does not preclude comorbidity with a psychiatric condition – in this case anorexia nervosa. Indeed, the presence of a condition such as Crohn's makes the diagnosis more difficult, especially as some of the symptoms of Crohn's disease (e. g. weight loss, malaise, fatigue) are also present in anorexia nervosa. Nonetheless, it is important to be alert to the possibility of comorbidity, and to try to treat both conditions appropriately.

The majority of patients presenting to a gastroenterology department with an eating disorder will be suffering from either anorexia nervosa and/or bulimia nervosa (there is frequently a mixed anorexia/bulimia syndrome); however, given the recent increase in the prevalence of obesity in many parts of the world, and the increased popularity of surgery for obesity, there is also an increasing number of patients presenting with the complications of obesity surgery [35].

18.3.4.2 Obesity Surgery

Mrs. K is a 47-year-old white Scottish lady. She had been morbidly obese for most of her adulthood and pre-

sented as a severely depressed, overweight divorcee, living apart from her 2 teenage children, smoking 20 cigarettes daily and working as an administrator. She had undergone gastric bypass surgery and had developed a post-operative anastamotic breakdown with fistulation. She was admitted to the ward for nutritional support and possible surgery. On the ward, her behaviour was described as "weird". She continued to smoke, seemed unmotivated to mobilise, developed repeated chest infections and had very poor self-care and hygiene.

This patient was suffering from severe depression and was treated with a combination of antidepressant medication and counselling on the ward. Her motivation improved, and eventually she was able to undergo reconstructive surgery with continuity restored. She went on to continue with her counselling after discharge, and was able to understand the deep-seated origins of her over-eating, self-destructive tendencies and relationship difficulties.

18.3.5 Self-Harm

Patients who self-harm may have no gastroenterological disease (e. g. patients who ingest caustic substances or insert objects into their anus/rectum); alternatively, there may be a pre-existing gastroenterological condition, in which case the self-harm may be potentially extremely serious.

18.3.5.1 Self-Harm via Central Venous Catheters

Mr. L is a 42-year-old Irishman who suffers form short-bowel syndrome and is on total parenteral nutrition (TPN) following a massive superior mesenteric infarction 6 years ago. His domestic life is complex; he has a wife and four children, but discovered that when he was in hospital 4 years ago, his wife had had an affair and that at least one of his children is not biologically his. He is very dependent on his wife; she supports him financially and emotionally, but still gives him cause for jealousy by dressing provocatively and meeting up with her ex-lover on a regular basis. On at least three such occasions, Mr. L has injected faeces into his central line and waited for her to come home, before asking her to take him to Casualty. On each occasion he was been severely unwell, septic and shocked, and required long admissions to hospital.

Mr. M is a 60-year-old Welshman, also on TPN following loss of his bowel due to small-intestinal malignancy. He is socially isolated, drinks alcohol to excess and finds it difficult to restrict his fluid intake. He presented to the hospital having cut his central line one afternoon with a pair of scissors, and then clamped it as best he could. On that day, his stoma bag had leaked on three different occasions, each time requiring a change of clothing. On the third occasion his T-shirt was soiled, he cut it off with the scissors so that he did not have to pull the soiled shirt over his head, and in desperation and fury, cut his central line. He denied being actively suicidal, but on review of his notes it became clear that there had been an escalation in the frequency of visits to the clinic with bizarre complaints, at least three unexplained injuries to the central line and brief comments about his alcohol intake.

Although neither of these men claimed to be actively suicidal, their fragile mental state combined with the requirements for strict aseptic technique and careful self-care puts them both at high risk of premature death. The repeated infections and the increased need for revision or re-siting of their central catheters [56] are at least in part a consequence of their mental states, and unless this is addressed, the prognosis is poor.

Whilst it is more difficult to prove the connection between low mood, self-neglect and catheter infections in patients who harm their catheters in a less overt manner than these two men, there is little doubt that the mental state of some of those TPN patients who manage their own central lines does impact on their rate of line infection, and ultimately on their longevity.

18.3.6 Other Conditions

The presence of any one of several other psychiatric conditions will impact on the care of the patient. In particular, alcohol dependency (and drug dependence) may not only be aetiological in the gastroenterological condition, but will also have a substantial impact on the patient's motivation and ability to comply with medication, post-operative management, rehabilitation and so on. Organic brain syndromes, such as a dementing illness, and learning difficulties will also influence compliance with treatment.

The impact of psychotropic medication on the GI tract also needs to be taken into account, in particular some of the effects of antidepressants, which are amongst the most widely prescribed drugs in the world. The most commonly described side-effects of psychotropic agents, as they pertain to the GI tract, are shown in Table 18.1.

Table 18.1 Side-effects of psychotropic agents pertaining to the gastrointestinal (GI) tract

Psychotropic agent	Side effect
Selective serotonin reuptake inhibitors	Nausea, dyspepsia, abdominal pain, constipation, diarrhoea, anorexia with weight loss (weight gain and increased appetite also reported)
Fluoxetine, sertraline, paroxetine	
Tricyclic antidepressants (TCAs)	
Amitryptiline, Dosulepin (previously known as Dothiepin)	Dry mouth, constipation
Lofepramine (a less sedative TCA)	Infrequent association with hepatotoxicity
Other antidepressants	
Mirtazapine	Increased appetite and weight gain
Venlafaxine	Dry mouth, nausea, constipation, abdominal pain, dyspepsia, anorexia, vomiting
Antipsychotics (phenothiazines)	
Chlorpromazine	Dry mouth, constipation, weight gain
Newer antipsychotics	
Olanzapine, Risperidone	Weight gain, constipation, nausea, vomiting, dyspepsia; hyperglycaemia and sometimes diabetes (clozapine, olanzapine)
Mood-stabilisers	
Lithium	Anorexia, vomiting, diarrhoea
Carbamazepine	Nausea, vomiting, constipation or diarrhoea, hepatic impairment
Sodium valproate	Liver toxicity; gastric irritation, nausea, vomiting, increased appetite and weight gain
Monoamine oxidase inhibitors[a]	Dry mouth, constipation and other GI disturbance, weight gain with inappropriate appetite [35]

[a] Beware the effects of other foods and drugs containing amines, which may potentiate the pressure affect of tyramine

18.4 Impact of GI Symptom/Disease/Intervention on the Patient's Psyche (Using FI as an Example)

Up until now, what have been described in this chapter are various psychological or psychiatric syndromes, which may have an impact on the patient's symptoms, presenting complaint, compliance with medication or surgery, and attitude to health professionals. But what are the effects of the GI condition on the patient's psyche?

Even here, the impact of the GI condition will be fundamentally flavoured by the patient's premorbid personality and mental well-being. For this chapter, the meaning of FI and its impact on the individual has been chosen. A similar approach to patients on TPN is described elsewhere [48].

18.4.1 Development of Bladder and Bowel Continence

Development of bladder and bowel continence is intimately tied up with the development of the child and his or her role as a competent human being. Freud wrote about the power, pride and control of the little prince on the potty: "His Majesty the Child" [25]. The development of continence in a child is an important developmental step and is praised and rewarded throughout cultures. A crucial part of the child's development is the development of a sense of self and the boundaries between "me" and "not me". Children learn that defaecating in the wrong place (pants), at the wrong time, or in public is punished or is the cause of humiliation or mockery and that there is pervasive disapproval of incontinence. Even the word incontinence is linked with loss or lack of control, with phrases in common parlance such as "emotional incontinence" or "verbal incontinence".

We also know that secondary enuresis or encopresis (i. e. the development of enuresis or encopresis after the achievement of continence) is often associated with emotional or physical trauma in childhood. So it should not surprise us that even when there is an obvious physical aetiology for FI, this is sometimes exacerbated by psychological factors and can be (at least partially) ameliorated by treatments that address the patient's psychology.

18.4.2 The Individual Behind the Diagnosis

There are many routes to becoming a patient with FI, many aetiologies of the disorder and many personal histories. The "meaning" of the FI will be different for each patient, and his or her way of managing it will depend not only on aetiology, but also on several personal, social and medical factors. Is the FI secondary to a medical or surgical mishap, or is it the by-product of a life-saving surgical resection, an "act of God", or an "act of man"? Has the FI been with the patient since childhood, and has he or she developed coping strategies; or is it of recent onset and as yet "new", foreign and unmanageable? What medical support is available to the patient? What emotional support – from family, partner, friends and work associates – is available? Is the partner supportive or resentful? What habitual defence mechanisms does the patient use in order to deal with adversity, and are these mechanisms overall successful or counterproductive?

These are but a few of the questions we need to ask each time a patient with FI presents in the clinic: in other words, beyond the generalisations applying to "patients" with FI lie individual men and women, boys and girls, each with his or her own personal, family, medical, psychological and social histories, and what applies to one patient or what works for a particular patient may not apply to or work for another.

18.4.3 Stigma and Quality of Life

People with FI have been found to live in a restricted world, often describing it as being like "imprisonment". The limits to their world are often dictated by access to toilets, the need to carry a change of clothing with them at all times, and attempts to conceal the problem from family and friends alike.

A study of teenagers with FI [8] found that the powerful social rules associated with this area of life mean that families of teenagers with FI faced public distaste, embarrassment, ridicule, general ignorance and little opportunity for discussion. A community-based research programme [34] explored the feelings of exclusion in a group of women suffering from multiple sclerosis (MS), with FI. This study ran over 5 years and some of the main concerns in this group were in managing double incontinence, the effects of MS on sexuality and sexual relationships, and trying to live well despite their chronic illness. The shared group experience gave them the freedom to talk openly about sex and incontinence; subjects about which they had previously felt compelled to be silent.

Norton and Chelvanayagam [9] ran two focus groups at St. Mark's Hospital in the UK to develop a research questionnaire titled "Effects of Bowel Leakage". For many participants, this was the first time they had ever spoken openly about their FI, and it was found to be mutually supportive to be able to speak openly to peers about the ever-present stress and risk of potential humiliation. Access to toilets, and sexual relationships were cited as issues of concern. However, what emerged was evidence of the extent to which all aspects of life were affected – skin care, shopping, food, employment, travel, appearance and socialising, to name but a few. Additional groups have been conducted at St. Mark's Hospital for patients with FI, and these groups have shown that common themes include "symptom checking" within the group, envying people with normal continence, sporadic anger towards the medical profession (as well as gratitude), problems with body image, sexuality and sexual functioning, as well as more complex intragroup dynamics such as envy, rivalry and resentment [10].

Until a study by Bharucha et al. [4], the relationship between FI and its impact on quality of life (QOL) had been studied in the clinic, but not in the community. In that study, 23% of the subjects with FI reported that the symptom had a moderate-to-severe impact on one or more domains of QOL. This figure is similar to the proportion of subjects (32%) who reported that FI had "a lot of impact" on QOL in a UK-based study [37]. The impact on QOL was clearly related to the severity of FI. Thus, 35% of patients with moderate FI and 82% with severe FI reported a moderate-to-severe impact on QOL [4].

The stigma involved probably accounts for the startling finding that only 10% of women with FI had discussed the symptom with a physician in the past year. Whitehead [54] described this finding as "astonishing", especially as the patients with milder symptoms who

are least likely to present to their physicians are most likely to be helped by conservative measures. Whitehead speculates that "patients may be too embarrassed or they may be too sceptical that anything can be done about it" ([54] p. 6), and suggests that researchers need to investigate why patients with FI do not report this symptom to their physicians and that there is a need for the development of public education methods of addressing this issue.

18.4.3.1 Sexuality

Little research has been performed on the effects of bowel problems and FI on psychosexual functioning in women [53]. Collings and Norton [13] conducted a study to explore the psychosocial and psychosexual aspects of women living with FI. This was a small, exploratory study using a semi-structured interview format. The participants reported a range of psychosexual issues, including current lack of arousal or desire and abstinence. Surprising to the researchers is that this was not a uniform problem, and 7 of the 20 participants said it was not really a problem unless FI occurred during sexual contact.

18.4.3.2 Depression, Shame and Isolation

In the study by Collings and Norton [13], shame and embarrassment were common, and depression, stress, isolation, secrecy, poor self-image and sexual avoidance or aversion were also reported. These narrative-based findings tie in well with results form other studies.

Amongst adolescents with FI, psychosocial impairment was significant on the Child Assessment Schedule, the Child Behaviour Checklist and the Youth Self Report [14]. In a study of community-dwelling adults, FI was found to have a marked negative effect on sexuality and job function, and in some cases led to near-total social isolation as a result of embarrassment.

Fisher et al. [22] used the Hospital Anxiety and Depression Scale on patients with FI. They found that patients who had unsuccessful surgical intervention had significantly higher scores than subjects with FI who had successful surgical outcomes. This finding mirrors several investigations in the urinary incontinence literature in which patients showed elevated levels of distress when treatment for incontinence was unsuccessful, and no longer showed such elevations when treatment was successful [7, 29, 36, 41]. Additional associations exist between FI and anxiety, a fear of going out (which needs to be distinguished from the more traditional psychiatric syndromes of agoraphobia/panic in the absence of FI), poor sleep (especially in those patients who suffer from nocturnal FI) and in some cases, the use of alcohol and drugs such as hypnotics or illicit drugs.

Coping mechanisms identified by 20 patients with FI in the study by Collings and Norton [13] included practical and psychological measures, such as (numbers in brackets): restricting activity (5), knowing the location of toilets when out (5), care of diet or fasting (3), separate bedrooms (3), wearing pads (5), denial (5), counselling (5) and turning to religion (1).

GI disorders share some common features with disorders of other organ systems, and thus some of the psychological sequelae are common to any illness – such as the risk of depression, anxiety, low self-esteem, and appetite and sleep disturbance. The particular nature of GI disease, concerning as it does in areas of the body and bodily functioning generally kept private and out of the sight, smell and earshot of others, means that there are particular psychological sequelae more likely to be found in patients suffering from these conditions. In particular, the areas mentioned above pertaining to stigma, shame and isolation, are especially pronounced in patients with GI conditions. Resentment and a state of aggrievedness are particularly difficult to shift [42].

Furthermore, the presence in particular of a stoma or fistula, and/or faecal incontinence is particularly challenging to patient and family alike, and when the "normal" separations between faeces and abdomen, faeces and sexual functioning, faeces and vagina (rectovaginal fistula) are broken down, this may cause substantial disturbance to the patient.

18.4.4 Cauda Equina Syndrome Misdiagnosed

A 27-year-old mother of two young children had presented to her GP complaining of backache over 6 months and a recent onset of paraesthesiae in the saddle area. She felt she had been "fobbed off". Within the next 36 h the full blown syndrome of cauda equina compression developed, and she required emergency neurosurgery, albeit with some further avoidable delays. She never recovered bowel continence, genital sensation, or full power in her legs and presented to the hospital with these problems. Her mood was low, but most pervasive was her sense of resentment and

aggrievedness. Over several sessions, it emerged how closely this linked with difficulties from her past, her complaint over many years that her mother had not listened to her when she was in emotional turmoil as a child, an adolescent. The grievance against the doctors resonated with this earlier grievance and a state of resentment, depression and entitlement was set up. This state of mind is very difficult to shift, and impacts not only on her relationships outside the hospital (with her children, parents, friends and erstwhile colleagues), but also with health-care professionals who are always left feeling that they have not done enough for her.

18.5 Therapeutic Options

Following the assessment described above, management strategies can be devised. This depends not only on the patient's psychological state, but also on the availability of treatments in each particular case. For some patients, formal psychiatric management is required, especially if there is severe depression (or bipolar disorder or an anxiety disorder) that might benefit from pharmacotherapy. Whether or not pharmacotherapy is indicated, it is almost invariably helpful for the patient if there is also some psychological treatment available.

18.5.1 Psychotherapy and Bowel Retraining

Psychological treatment may take place in an individual, family or a group setting. Individual psychotherapy or counselling can take many forms, and may be derived from one of several psychotherapeutic traditions including: psychodynamic/psychoanalytic psychotherapy [27, 43, 46], CBT [17, 32] and hypnotherapy [26]. It is beyond the scope of this chapter to describe these modalities of therapy, but the interested reader is directed to the aforementioned references, which describe these therapies for patients with bowel disorders.

Biofeedback/bowel retraining has also been proven to have a beneficial effect on patients with many colorectal disorders including constipation [11] and FI [38]. This is discussed elsewhere in this volume. One should not underestimate the beneficial effects of the nurse–patient relationship in biofeedback therapy, one that provides the patient not only with the specific techniques taught in the biofeedback sessions, but crucially, also a safe place in which to talk to a confidante. The similarities between this and the importance of the so-called "non-specific factors" in psychotherapy are obvious [23].

Not all psychotherapeutic treatments are conducted one-to-one. Group therapy and psychoeducational groups for patients with FI have recently been described [9, 10]. Some of the main themes from a brief psychotherapy group for women with FI are listed here [9, 10]:

1. Symptom checking
2. Disclosure of bowel and physical symptoms
3. Experiences with health services
4. Litigation
5. Loss
6. Sexual functioning
7. Disability and hidden disability
8. Employment

The experience from these group settings was that not only do patients feel more empowered following group treatment; they also on occasion report a lessening of the severity of their symptoms, indicating a superadded psychogenic component to at least some of the severity of the symptomatology.

In cases where there is evidence of severe personality disturbance or disorder, the patient may require "partial hospitalisation" [3] or admission to a therapeutic community. Once again, a description of these treatment approaches is outside the remit of this chapter.

For patients with chronic pain, multidisciplinary pain management centres may provide comprehensive assessment and rehabilitation. One controlled study followed up a group of patients suffering from chronic pelvic pain who underwent a multidisciplinary pain-management programme. Six months after treatment, these patients had decreased pain scores, decreased depression and anxiety and improved psychosocial functioning [31].

18.5.2 Pharmacotherapy

Pharmacotherapy is a crucial part of the psychiatrist's armamentarium. Both tricyclic antidepressants (TCAs; e.g. amitryptiline, dosulepin, imipramine) and selective serotonin-reuptake inhibitors (e.g. fluoxetine, sertraline, paroxetine) are frequently used in gastroenterology, the TCAs usually in doses lower than those used by psychiatrists in the management of depression. Drugs from both groups may be useful in the management of functional bowel disorders [12, 17, 18], and the choice of tablet is often based on tolerability and the side-effect profile. Patients are often reluctant to take

such a tablet, often complaining of feeling "fobbed off" by the prescriber, and a substantial group of patients tend to prefer psychological treatments in the first instance. Each prescriber should address the anxieties of the patient carefully, and ascertain whether the resistance to taking medication is understandable, and whether there is a viable alternative to medication. Drossman describes approaches that may be helpful in this regard [15].

18.6 Contribution of this Service to Professionals and Family Members

Whilst the main focus so far in this chapter has been on the patient's psychological needs, we should not forget the needs of two other groups – the professionals looking after these patients and their family members.

Professionals, for example surgeons, physicians, and nurses on the wards or in the community, caring for these patients also have needs. The impact of dealing with the patient who is incontinent or terminally ill, or having chronic fistulating Crohn's disease cannot be underestimated. None of us are immune to emotions ranging from disgust to empathy, irritation to overidentification, and sadness to reparative wishes. With this in mind, at St. Mark's Hospital we have developed programmes to support specialist coloproctology nurses deal with the impact of their work on their own psyches, addressing issues such as their own feelings (countertransference) [47, 57], as well as providing all members of the multidisciplinary team with a weekly forum in which to discuss problematic patients or patient–staff interactions. This "care of the staff" is crucial in allowing staff members to work productively and empathetically and to minimise the risk of staff "burnout". It is provided in recognition of the fact that even in the best-resourced unit imaginable, the majority of coloproctology patients will not have access to a mental-health professional. The surgeons, physicians and nurses, and other members of the multidisciplinary team (e. g. dietician, social worker, pharmacist, physiotherapist) have to manage the explicit and implicit demands, requests and pressures from their patients, and the provision of a thinking space to reflect on one's patients and one's own reactions to them allows one to feel less alone, less overwhelmed and less prone to dramatic actions and reactions to the difficult patient.

The impact on the family, spouse and children of a patient with GI symptoms or disease can be immense, and support, be it through a social worker, family therapist or groups for family members, should be considered and made available where appropriate [48].

18.7 Conclusion

What is proposed in this chapter is a psychological approach to the coloproctology patient, recognising that for each patient, his or her illness and symptoms will have a unique meaning based on that individual's history, relationships and psychological state. Assessment of the patient's psychological needs is a time-consuming but rewarding experience, and patients can be helped by a variety of means to feel less alone, less stigmatised and less disempowered. Medical staff members can also benefit from a forum in which these issues can be discussed. If these psychological factors are denied, they may appear to have gone away, but for the patient and for staff members, this disappearance is illusory.

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Self-Assessment Quiz

Question 1

A patient presents to your clinic complaining of a dry mouth, constipation and drowsiness. She says she has recently been started on antidepressant medication. The following drug is a likely contributor to these symptoms:

a. Diazepam
b. Risperidone
c. Dosulepin (Dothiepin)
d. Fluoxetine
e. Olanzapine

Question 2

A 30-year-old man presents with a history of recent weight loss, excessive exercise (2–3 h/day) and severe dietary restriction as he believes "the food in the shops these days is radioactive and harms the intestines". He lives with his parents, is unemployed and has lost 20 kg (from 70 kg to 50 kg) in the past 4 months. He says he would like to gain the weight he has lost. The most likely diagnosis is:

a. Alzheimer's disease
b. Classic anorexia nervosa
c. Panic disorder
d. Munchausen syndrome
e. Encapsulated delusional state

Question 3

A 30-year-old woman presents with abdominal bloating, constipation, abdominal pains and some gynaecological symptoms (dysmenorrhoea, vaginismus, pruritus). All investigations are normal, including transit studies, colonoscopy and endoscopy. Despite these investigations, she requests a colectomy. Management options include which of the following?

a. Referral for hypnotherapy
b. Referral to biofeedback
c. Contacting the general practitioner (GP) to ensure an adequate and accurate past history is available
d. Antidepressant medication
e. All of the above

Question 4

A 26-year-old man was caught in a random attack by a knifeman, who stabbed him repeatedly in the abdomen, outside the patient's home in the middle of the day. The patient suffered from a perforated duodenum and was admitted to the intestinal failure unit for nutritional support, wound management and preparation for surgery. It was thought that he was suffering from post-traumatic stress disorder (PTSD). In PTSD, the following features are typically present:

a. A sense of euphoria
b. Good motivation
c. Excessive sleeping with a sense of being refreshed on waking up
d. Avoidance of situations that re-evoke the trauma
e. Absence of dreams

Question 5

Childhood sexual abuse (CSA) has not been associated with an increased risk of later development of which of the following conditions?

a. Bowel cancer
b. Irritable bowel syndrome
c. Bulimia nervosa
d. Non-organic seizures
e. Anorexia nervosa

1. Answer: c
Dosulepin (like amitryptiline) is a tricyclic antidepressant (TCA), and is associated with anticholinergic side effects such as dry mouth, constipation and drowsiness. Dry eyes, urinary retention, sexual dysfunction closed angle glaucoma are also described. Diazepam is a benzodiazepine and not an antidepressant, fluoxetine is an antidepressant in the selective serotonin uptake inhibitor class (SSRI), and olanzapine and risperidone are antipsychotics.
2. Answer: e
The severe weight loss is probably as a consequence of psychotic (paranoid) beliefs (i. e. he believes "the food in the shops these days is radioactive and harms the intestines"). This delusional belief is causing him to lose weight and diagnostically could be an "encapsulated delusional state" or a more global psychosis such as schizophrenia. It is possible that he has an organic brain syndrome (e. g. a tumour), although this would also probably manifest with other signs and symptoms. It is rare for Alzheimer's disease to present at 30 years of age! This picture is not one of

classic anorexia nervosa, in which the beliefs include an intense fear of gaining weight or becoming fat. Munchausen syndrome is characterised by recurrent, feigned dramatic presentation of a medical condition in order to obtain investigation and treatment. The presence of delusional beliefs and the "bizarreness" of this presentation make "panic disorder" a less plausible diagnosis (i. e. in any hierarchical diagnostic system, the presence of psychosis "trumps" a less severe diagnosis).

3. Answer: e
This patient is at high risk of multiple invasive procedures and surgery, including hysterectomy and colectomy, and at high risk of adopting a chronic "sick role". Liaison with the GP is crucial not only to gain further information, but also to ensure that her care is co-ordinated and not fragmented. Psychological treatment could help her to understand what is driving this behaviour, and hypnotherapy or biofeedback could help to symptomatically reduce her symptoms. In some cases pharmacotherapy (e. g. a TCA or SSRI antidepressant) can be of help. There are very few cases in which a referral for a colectomy would be recommended.

4. Answer: d
Sleep in patients with PTSD is often poor with insomnia, dreams or nightmares, and is often accompanied by being unrefreshed on waking. There are other typical features including episodes of repeated reliving of the trauma in intrusive memories. "Flashbacks" that occur against a background of a sense of numbness and emotional blunting, detachment from other people, unresponsiveness to surroundings, anhedonia and avoidance of activities and situations reminiscent of the trauma are additional symptoms. There is usually autonomic hyperarousal, hypervigilance, insomnia, and commonly anxiety and depression. All of these features could have a negative impact on the patient's ability to train in the care of his parenteral nutrition, care for his stoma or abdominal wound, and generally motivate him in rehabilitation.

5. Answer: a
The sequelae of CSA are multiple and include emotional and psychological effects, difficulties in sexual adjustment, and problems in interpersonal relationships and social functioning. There are also many somatic symptoms and syndromes that are more prevalent in people who have suffered CSA than in the general population. These include chronic pelvic pain, functional bowel disorders, non-epileptiform seizures and eating disorders (both bulimia and anorexia nervosa), but not bowel cancer.

Section II Anal and Perianal Diseases

19 Hemorrhoidal Disease

Jean-Claude R. Givel and Yannick Cerantola

CONTENTS

19.1 Introduction

Hemorrhoids, or piles, have been recognized and treated since antiquity. This condition represents the most frequently presenting anal disease, 50–90% of people experiencing them at least once in their lives. Although most patients present with symptoms, many do not and some never have complaints. The incidence of hemorrhoids seems to increase with age, but the disease is by no means confined to older individuals, being encountered in patients of all ages, even in childhood [1, 2]. Men seem to be affected twice as frequently as women. The peak prevalence for both genders occurs between 45 and 65 years of age. The occidental lifestyle predisposes us to piles. Patients suffering from the condition belong to a heterogeneous group and 5–10% will need surgical treatment to resolve their problem.

The cardinal features of hemorrhoids are bleeding, anal pruritus, prolapse, and pain due to thrombosis. Although the symptoms may strongly suggest a diagnosis of hemorrhoids, confirmation by anoscopy, flexible sigmoidoscopy, or colonoscopy should be performed systematically if bleeding is present.

Diagnosis and treatment are based on symptoms rather than appearance and should be guided by two principles:

1. Colonic or rectal disease must be excluded.
2. Asymptomatic hemorrhoids should not be treated [3].

The aim of treatment is not that all lesions should disappear.

There are many conservative and surgical ways to treat hemorrhoids. No single method is suitable for all degrees of hemorrhoids. Dietary measures should be prescribed in every case. Many reports of trials that compare different types of treatment are available. Results must be assessed for longer than 6 months, since any symptomatic improvement noted after a few months falls by 15–30% after 1 year [4].

19.2 Definition

Hemorrhoids have an internal and an external component (Fig. 19.1). The internal component is located in the upper part of the anal canal, above the dentate line. It comprises a thick submucosa that contains blood vessels, elastic and connective tissue, and smooth muscle covered by mucosa. The vessels show a glomerular pattern, and consist of arteriovenous communications mainly between the terminal branches of the superior rectal and superior hemorrhoidal arteries, and (to a lesser extent) between branches originating from the middle and inferior hemorrhoidal arteries and the surrounding connective tissue. The external component is located in the lower third of the anal canal and at the anal verge, distal to the dentate line. It consists of the blood vessels that form the perianal subcutaneous venous plexus covered by skin. These two components are in vascular communication. These definitions of internal and external refer to the site of origin of the hemorrhoidal disease rather than the site at which they are found on examination because after they have been present for some time and have enlarged, internal piles also appear externally at the anus.

Hemorrhoids should be considered as a hypertrophy of the normal anal cushions lying in the upper part of the anal canal. Because of their apposition with each other, these cushions are responsible for the precise closure of the anal canal [5]. At the level of the dentate line, the submucosal space is divided into two parts by the ligament of Parks and the muscle of Treitz. This muscle is made up of smooth muscle originating from the longitudinal muscle of the rectum and crossing the internal sphincter. Its action is reinforced by the muscle fibers of the internal sphincter. These muscle fibers end in the submucosa and prevent mucosal prolapse during defecation [6].

The position of the cushions is constant, and has no relation to the branching of the superior rectal artery: left lateral at 3 o'clock, right posterior at 7 o'clock, and right anterior at 11 o'clock in the gynecological position [7]. Smaller accessory cushions may be located in between.

The very names used to describe the pathology of hemorrhoids indicate that their assessment is mostly subjective and symptom-oriented. The term "hemorrhoidal disease" should describe all patients with enlarged anal cushions who complain of symptoms.

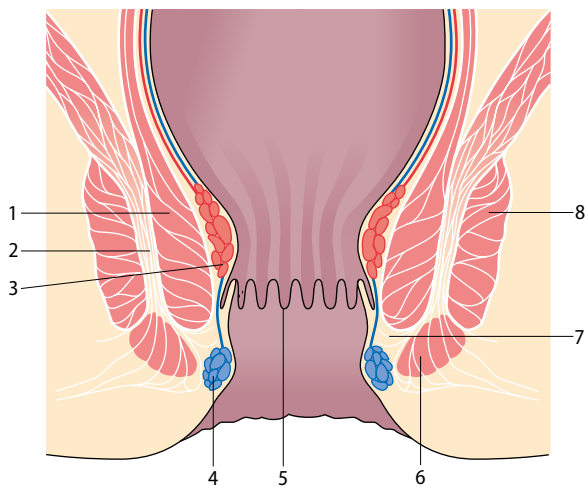


Fig. 19.1 Anatomy of the anorectum and hemorrhoids. *1* Internal anal sphincter, *2* intersphincteric plane, *3* internal hemorrhoidal plexus, *4* external hemorrhoidal plexus, *5* dentate line, *6* external anal sphincter, subcutaneous layer, *7* Parks' ligament, *8* external anal sphincter, deep layer

19.3 Pathophysiology

Hemorrhoidal disease appears to result from the congestion and hypertrophy of the cushions located above the dentate line, also named "corpus cavernosum recti" [8]. Two factors have been proposed to explain the enlargement of these structures: venous congestion and distal sliding of the anal canal lining [5, 9]. Both may occur from straining at stool, and venous congestion may also be due to the constricting action of the anal sphincter or to impedance of venous return (for example by a pelvic mass). Resting anal pressure is raised in patients with hemorrhoidal disease and there is histological evidence of hypertrophy of the external sphincter muscle fibers [10]. However, whether anorectal physiology changes are the result or the cause of hemorrhoidal disease remains controversial [11, 12]. Chronic or repeated congestion results in stretching of the ligament of Parks and hypertrophy followed by breaking of the muscle of Treitz. As the mucosa is no longer fixed to the muscular coat, an intermittent prolapse may appear, followed by a permanent phenomenon. Enlargement of the external component happens through subluxation of the cutaneous lining of the lower anal canal.

Hemorrhoids may be the result of several different mechanisms:

1. Dysregulation of the arteriovenous shunt at the level of the glomerular formation
2. Insufficient return of blood through the superior rectal veins, resulting in a swelling of the cushions (i. e., a mass effect)
3. Increased intra-abdominal pressure with compression of the venous pedicle (during straining in constipation, efforts to empty the bladder in prostatic adenoma, and pregnancy)
4. Prolonged sphincter hypertonicity, diminishing return of blood through the transsphincteric shunts
5. High resting pressure leading to incomplete relaxation during defecation and increased shearing forces on anal cushions (i. e., spasm)

19.4 Classification

Hemorrhoidal disease can be graded according to the extent of the prolapse (first-, second-, third-, and fourth-degree hemorrhoids) [13]. Unfortunately, this traditional staging has only limited value as it refers to one aspect of the disease and does not distinguish patients with occasional or mild symptoms from those with persistent trouble. It also does not take into account the fact that the severity of the disease can be related to the amount of blood loss, the importance of discomfort, or the degree of prolapse. Another important reality with the staging of prolapse on the basis of examination is the day-to-day variation in the size of the vascular cushions and their tendency to exteriorize. Furthermore, the individual cushions may be present at different stages in the same patient.

First-degree hemorrhoids, also referred to as simple hypertrophy of the corpus cavernosum recti, can be observed only by proctoscopy and are said to be present when they bulge into the lumen of the anus, without prolapse. They usually result in painless bleeding. Second-degree hemorrhoids prolapse upon straining during bowel movements, but then reduce spontaneously. At this stage, the corpus cavernosum recti loses its properties of continence; patients complain of intermittent watery and mucosal exudate. Third-degree hemorrhoids may lead to the prolapse becoming permanent, but it can be digitally replaced. The protruding cushions may become sclerotic with painful epidermal metaplasia. As prolapsed vessels are no longer under intra-anal pressure, but under atmospheric pressure, surface venectasia may develop. Fourth-degree hemorrhoids are prolapsed and can no longer be replaced digitally; they are irreducible, sclerotic, and frequently accompanied by skin tags.

Another classification with four subgroups referring to clinical symptoms and morphology gives a more useful guide to treatment modalities:

1. Light occasional symptoms (first episode of bleeding)
2. Severe recurrent bleeding
3. Prolapsing internal hemorrhoids without an external component
4. Prolapsing internal hemorrhoids with a symptomatic external component

19.5 Predisposing Factors and Etiology

Different predisposing factors to hemorrhoidal disease have been proposed, including heredity, climate, age, sex, pregnancy, constipation, abuse of laxatives, repeated enema, mucosal irritation, sedentary lifestyle, obesity, chronic use of suppositories, and cirrhosis [5, 14]. No occupational group seems to be particularly prone to hemorrhoids, with the exception of military aircraft pilots subjected to high gravitational pressures [15].

Hemorrhoids are not caused by one individual mechanism but by the interaction of many factors. Among all of those proposed, dietary factors seem to play a major role. In epidemiological studies, Burkitt has demonstrated that a highly refined, low-fiber, high-carbohydrate diet leads to a significant increase in abdominal and intrarectal pressure, resulting in the formation of small and hard stools, which are therefore the main cause of constipation [16]. On the other hand, a fiber-rich diet stimulates defecation and reduces the risk of hemorrhoidal congestion.

This hypothesis is not totally satisfactory and does not explain, for example, the occurrence of hemorrhoidal disease in patients not suffering from constipation or chronic diarrhea. Increases in intra-abdominal or intraportal pressure do not necessarily result in a hypertrophy of the anal cushions. A prostate adenoma or an intrapelvic tumor may produce an increase in the intra-abdominal pressure, especially during micturition, but this does not always result in the development of hemorrhoids. A chronic respiratory insufficiency with chronic coughing results in a rise in intra-abdominal pressure, but does not seem to produce more frequent anal disease. Factors other than mechanical and dietetic must therefore be considered (e. g., vascular fragility and abnormal sensitivity to estrogens).

19.6 Symptoms

Hemorrhoidal disease may cause almost any anal symptoms, but the most common are bleeding, prolapse discomfort and pruritus ani.

Bleeding is usually the earliest symptom in the development of the disease. Bright red, painless bleeding occurs at the end of defecation and is often first noticed on lavatory paper after passing a non-blood-stained hard stool [9]. Bleeding may also be occult. Later in the evolution of the disease, the bright red bleeding may become profuse, dripping into the pan like a tap or spattering the sides like a jet to mark the end of defecation. Chronic iron deficiency anemia may occur as a result. Any other cause of bleeding must be excluded [17].

Prolapse develops during straining and probably indicates a more advanced stage of the disease. A prolapse predisposes to soreness, mucous and fecal soiling inducing pruritus [18], skin excoriation, and secondary mycotic infection. When there is a large external component, anal hygiene might be difficult. If irreducible, a prolapse may become strangulated and result in necrosis, secondary fistula, and gangrene. Pylephlebitis is a potential, but rare complication. Prolapse may be confused with perianal swelling caused by an external component of the disease.

Discomfort is common, above all when there is a prolapse. It may be felt as a fullness in the perineum or anus or as a sensation similar to the desire to defecate. The patient may strain excessively in an attempt to get relief, worsening the hemorrhoidal prolapse.

Pain becomes a marked feature of the disease when thrombosis occurs, when a prolapse with severe edema develops, or when the prolapse becomes strangulated [19]. Severe pain also suggests the presence of a coexisting painful anal lesion such as a fissure, an abscess, or a thrombosed perianal varyx.

Functional bowel symptoms may also be associated with hemorrhoids [14]. Symptoms of hemorrhoidal disease usually come and go with spontaneous exacerbation and remission.

19.7 Examination

Correct local examination is necessary to ensure the diagnosis, to evaluate the stage of the disease, and to exclude any other associated lesion. Inspection should be carried out first with the patient at rest and then during straining, which will reveal the enlarged external component and any prolapsed internal hemorrhoids.

After inspection, palpation is the next step of assessment. The digital examination must be performed slowly, with adequate lubrication. In the absence of thrombosis, acute anal pain is rare in uncomplicated hemorrhoidal disease. Its presence should make one suspect another diagnosis.

Proctoscopy should be performed with a side-window anoscope, which is more accurate than an end-viewing anoscope or flexible sigmoidoscope [20, 21]. It will reveal swellings corresponding to the normal anal cushions, as seen in normal individuals. It may be difficult to decide whether they are sufficiently large to be diagnosed as hemorrhoids. The mucosa over a hemorrhoid is often reddened and may bleed. Areas of white plaque formation are sometimes seen on its surface. They correspond to squamous metaplasia of the mucosa caused by trauma and are diagnostic of repeated prolapse.

Sigmoidoscopy will demonstrate the normality of the rectal mucosa and exclude an inflammatory bowel disease or any other significant cause. If there is any doubt concerning the diagnosis, the whole colon should be investigated by colonoscopy [19]. Nowadays, barium enema has very little to offer in such a situation and should be used only if colonoscopy is not available.

Manometry and anorectal ultrasound play an important role in the assessment of patients suspected of having impaired sphincter requiring hemorrhoidectomy, since they can influence the type of surgery [22]. A quick general examination should not be omitted, as hemorrhoidal disease might be the tip of the iceberg of another more serious medical condition.

19.8 Treatment

Not all patients with hemorrhoidal disease require active treatment; they will merely learn from their physician that they do not have a tumor. Treatment should not be thrust on a patient who does not want it. The choice of method should be based on the severity and type of symptoms, the degree of prolapse, the expertise of the operator, and the equipment available. As a general principle, the aim of treatment is not that all lesions should disappear, and therefore that normal structures with minimal symptoms should not be overtreated.

As many as 75% of patients consulting for the first time with prolapsing hemorrhoidal disease will remain symptomatic or will have recurrent symptoms if not treated [23]. Various treatment modalities are currently available with the following goals:

1. To correct dietetic factors, in order to avoid straining during defecation and to stimulate the regular production of bulky, large, and soft stools
2. To diminish any swelling of the submucosa and corpus cavernosum recti
3. To stimulate the venous return of blood through the reduction of sphincter spasms and intra-abdominal pressure
4. To stimulate adhesion between the mucosa and muscular coats
5. To reconstruct the normal anatomy and physiology of the anal canal
6. To avoid scars, skin tags, and stenosis
7. To treat any concomitant lesion

19.8.1 Conservative Management

Provided the correct diagnosis has been made, the first step of conservative management is to give advice to patients who have only minor symptoms and incorrect diet or hygiene habits. Alimentary behavior, especially changing food habits toward a high-residue diet, and eventual use of laxatives play an important role at this step. If the patient is infringing the rules of common sense, it is also reasonable to try to correct inappropriate defecation habits. Many patients treat themselves with preparations or drugs purchased from various sources, including local therapies and suppositories, as well as vasotopic drugs.

19.8.1.1 Bowel Regulation

It is essential to regulate bowel movement in a patient with hemorrhoidal disease. Both constipation and diarrhea should be avoided. The passage of hard stools results in congestion of the corpus cavernosum recti; diarrhea irritates the mucosa, which becomes less resistant and predisposes to the development of hemorrhoids or to the aggravation of preexisting disease.

The logical first line of therapy would be recommending adequate hydration and an increase in the intake of bulk in the form of vegetables or unprocessed cereal fibers, for example bran. Such a treatment might be followed indefinitely, even after surgical treatment, in order to avoid recurrence. A meta-analysis of seven controlled trials has shown significant and consistent benefit from fiber supplementation in improving symptoms, in particular bleeding [24].

A variety of fiber supplements is available, above all containing psyllium or methylcellulose. A dosage of 20–30 g/day together with increased fluid intake is usually effective and safe.

19.8.1.2 Defecation Habit

Three errors of defecation habit are prevalent in patients with hemorrhoidal disease:

1. Insistence on having at least one bowel movement daily
2. Neglect of the first urge to defecate in the morning
3. Insistence on trying to pass the last portion of stool from the rectum or anal canal, to prevent the persistence of a discomfort

It is worth taking a detailed defecation history and advising the patient about the disadvantages of any habits that might be considered unwise. The avoidance of straining and reading on the toilet should be emphasized.

19.8.1.3 Topical Treatment

To be useful, any topical treatment should be applied in the anal canal and not on the skin or into the rectum. Creams may be introduced using a smooth cannula or a glove. Suppositories protrude too far into the rectum and therefore have no local efficacy. Their main action is to lubricate the anal canal and to produce soft stools. All commercial preparations currently available comprise a base, cream, or jelly, to which antiseptic, anesthetic, and steroidal or nonsteroidal anti-inflammatory, vasoactive, or antithrombotic drugs are added. Topical treatment may be useful in acute exacerbation of hemorrhoidal disease at any stage, but never helps in reducing a prolapse or changing the stage of the lesion. Allergic reactions may result from the excipient or from any of the other components. As the same components may be used by different drug suppliers, some patients develop allergic cross-reactions to several commercially available preparations.

Corticosteroids may decrease local perianal inflammation, but no data suggest that they reduce hemorrhoidal swelling, bleeding, or protrusion. Long-term use of high-potency steroid creams is deleterious and should be avoided, as they may induce contact dermatitis, mucosal atrophy of the anoderma and the skin, and favor mycotic infection and chronic eczematic changes.

Most of the topical treatments help the patient to maintain personal hygiene, and may alleviate symptoms of pruritus and discomfort. There are no prospective randomized trials suggesting that they reduce bleeding or prolapse [25, 26].

19.8.1.4 Warm Sitz Baths

Warm sitz baths help relieve irritation, pruritus, and anal pain. They also contribute to anal hygiene. Their effectiveness is mostly related to internal anal sphincter relaxation. They are widely available in drug stores, and should be used in warm water two to three times per day [27, 28].

19.8.1.5 Oral Vasotopic Drugs

Calcium dobesilate and purified micronized semisynthetic flavonoid, two products used in the treatment of chronic venous insufficiency of the lower limbs, have been shown in open-label, placebo-controlled studies to equally improve the symptoms of acute hemorrhoidal episodes, and are now a common alternative treatment [29, 30].

Calcium dobesilate regulates the impaired physiological functions of capillary walls of functional origin or those caused by constitutional or acquired metabolic disorders. It acts by normalizing the resistance and permeability of the capillary vascular wall and improves venous blood flow. Flavonoids act to improve venous tone, lymphatic drainage, and capillary resistance, and normalize capillary permeability. Their indications are acute/recurrent hemorrhoidal attacks [31]. As an adjunct, their use has also been shown to reduce acute symptoms and postoperative bleeding after hemorrhoidectomy [32]. A recent meta-analysis showed apparent beneficial effects in reducing symptoms (bleeding, pain and itching) and recurrence. However, these conclusions need to be confirmed by further high-quality studies [33].

19.8.2 Invasive Procedures

19.8.2.1 Sclerosing Injection Therapy

Sclerosing therapy, a technique developed during the second half of the 19th century, is one of the oldest forms of nonoperative treatment for hemorrhoidal disease. Its aim is to fix the mucosa and submucosa to the underlying muscle by fibrosis, thus preventing further prolapse and congestion. Inflammation with subsequent fibrosis around the blood vessels leads to a reduction of the blood supply and fixation of the mucosa. It is mainly recommended for patients with symptomatic nonprolapsing grades I–II hemorrhoidal disease [25]. Two different procedures have been described: submucosal injection around the vascular pedicle of the hemorrhoid at the anorectal junction and direct injection into the submucosa of the cushion.

Submucosal Sclerosis According to Bensaude

This method is the most commonly used [34]. The solution is injected into the interstitial tissue of the submucosa (not into the veins) above the anal cushions, at the anorectal junction, and around the pedicles of the efferent vessels (Fig. 19.2). It produces scarring in the submucosa that will fix to the muscular layers, with a retraction and atrophy of the cushions, preventing fur-

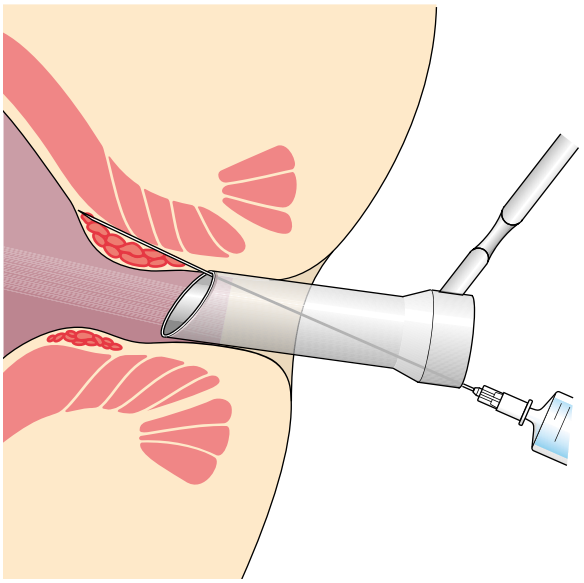


Fig. 19.2 Submucosal sclerosing injection therapy

ther prolapse. The most commonly used solution is 5% phenol in almond or arachide oil, with a few drops of menthol to remove the unpleasant smell of the solution. It is nontoxic and harmless. The injection of 2–5 ml in a single area produces good interstitial fibrosis without necrosis.

Identification of the anorectal ring is allowed by sliding the endoscope up and down within the anal canal. The needle is inserted through the mucosa into the submucosa just above the anal cushions. The three cushions are injected in one session. If painful, the injection should be stopped, since this indicates that the needle has been incorrectly positioned. Replacement and injection can be immediately performed in the correct way. Instead of phenol solution, many authors use a small amount (0.5–1 ml) of quinine urea, iodides, or 0.5–1 ml polidocanol (30 mg/ml) with the same efficacy. Subsequent injection with smaller doses can be given if symptoms reappear, but previous sites of sclerosis should be avoided.

Complications following sclerotherapy are rare and result mainly from an incorrect technique. Injections that are too superficial may produce necrosis and rectal ulceration, resulting in pain, bleeding, and delayed healing. Too deep an injection may be damaging, especially after injection of the right anterior hemorrhoid plexus in the male, resulting in hematuria by direct trauma to the urinary tract and prostate. Injuring the periprostatic parasympathetic nerves can cause erectile dysfunction [35]. Life-threatening sepsis and rectosigmoidal necrosis following injection sclerotherapy have been reported [36, 37]. Extrarectal injection can result in stricture by scarring. Abscess and fistula-in-ano may occur. Minor or moderate allergic reaction to quinine solution may occur in about 4% of cases.

Sclerosis According to Blond

Blond and Hoff described a technique with direct injection into the submucosa of the cushion [38]. Using a proctoscope with a lateral window and a special needle, 0.2 ml of 20% quinine solution is injected into the submucosa at two to three different levels in each cushion. Only one cushion should be treated during each session. Stein [39] used this technique with success, even in the treatment of prolapsed third-degree hemorrhoids.

Complications are more frequent with this technique than with Bensaude's procedure. Injection of too large an amount of solution may result in necrosis and bleeding. Allergic reactions are possible depending upon the drug used: quinine hydrochloride results in more complications than a solution of 10% polidocanol in 50% alcohol. Rectosigmoidal necrosis has been described after accidental injection within hemorrhoidal vessels.

Sclerosis is contraindicated in advanced-grade internal hemorrhoids, during pregnancy, and when coagulopathy, inflammatory bowel disease, abscess, or any concomitant anal disease is present.

The results of cure by injection seem above all to be dependent upon the extent of the hemorrhoidal disease. Many patients treated by injection might have ex-

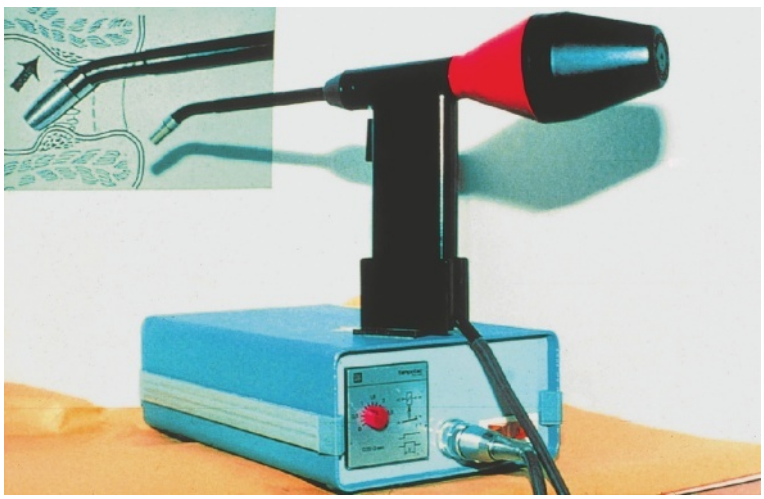


Fig. 19.3 Infrared coagulation

perienced equally good results if they had been given simple dietary advice and no injections [40]. Nevertheless, it seems likely that if injection is used in the management of first- or second-degree piles, particularly those in which bleeding is the principal symptom, more than 70% of patients will be quite satisfied.

19.8.2.2 Infrared Coagulation

Photocoagulation of mucosa and submucosa by infrared light was introduced by Neiger [41]. It produces thermal necrosis followed by ulceration, which heals by cicatrisation within 2–3 weeks. The scar fixes the mucosa to the underlying tissue and thus prevents prolapse. Infrared coagulation has a hemostatic effect that is superior to the usual methods of sclerosis.

The apparatus consists of a power source connected to a pistol (Fig. 19.3). A tungsten–halogen bulb is activated by a trigger switch. The infrared irradiation is concentrated along a quartz fiber shaft to its tip. A switch on the power source allows the duration of exposure to be adjusted between 0.5 and 2.0 s.

Photocoagulation is performed through an anoscope. Three to four areas of mucosa at 2, 4, 8, and 10 o'clock, just above the internal cushions and usually above the inner anal ring, are coagulated in one session. Two sessions are usually sufficient to also coagulate at 3, 6, 9, and 12 o'clock. The tip of the infrared photocoagulator, which is coated with a polymer to prevent tissue adherence, is applied for 1–1.5 s to ensure sufficient effect.

Infrared coagulation is a simple, fast, and effective method with fewer complications and side effects than sclerosis by injection or rubber-band ligation. Postoperative pain and secondary bleeding are rare, resulting in less time off work than after rubber-band ligation. Cure at 12 months can be achieved in 75% of first- and second-degree hemorrhoids. Fifteen percent of all patients experience a recurrence of their symptoms within 3 years. Treatment may then be repeated. Ambrose et al. found no difference between photocoagulation compared with sclerotherapy for first- and second-degree hemorrhoids [42]. According to a meta-analysis based on 5 prospective trials including 862 patients with grade I–II hemorrhoids treated by infrared coagulation, rubber-band ligation, or sclerotherapy, the authors concluded that infrared coagulation is the most favorable nonsurgical treatment for hemorrhoids [43].

19.8.2.3 Rubber-Band Ligation

The aim is to place a rubber band at the base of the hemorrhoid, which first reduces blood flow by snaring the feeding vessel, secondly removes some of the hemorrhoid's bulk, and thirdly causes fibrosis at the point of banding, to fix the mucosa and impede prolapse. Special instruments for ligation of internal hemorrhoids have been devised. Barron [44] improved the procedure by ligating only the mucosa and submucosa with a rubber band (Fig. 19.4). This method is now universally accepted as the treatment of choice for second-degree hemorrhoids with normal or almost normal perianal skin. Third- and fourth-degree hemorrhoids with venous engorgement are best treated by surgery; nevertheless, good palliation in the form of symptomatic relief can be obtained by ligation.

The instrument comprises two concentric cylinders that move, one inside the other, by using a handle fitted with a trigger device. One or two rubber bands are loaded on the inner drum by means of a cone. Special forceps are inserted through the inner drum and grasp the internal hemorrhoids. Using the trigger, the outer drum pushes the rubber band(s) onto the base of the internal hemorrhoids.

The forceps has been replaced by incorporating an aspirator into the inner drum [45]. The diameter of the inner drum is usually 8–10 mm; larger instruments with a diameter of 14 mm have also been designed [41].

The procedure can be performed as an outpatient procedure by one single operator; it does not usually require anesthesia or preparation, except routine endoscopic examination.

The instrument is inserted onto the most redundant part of the rectal mucosa at the anorectal junction immediately above the internal hemorrhoid. The mucosa is sucked to determine the size of tissue to be strangulated and to ensure that it is painless. Application that is too low, near the dentate line, or too deep, grasping underlying musculature, would induce severe pain.

As a rubber band may break when rolling on the applicator, two bands may be applied; immediate breakage or slippage of one is still possible and would result in incomplete constriction; breakage occurring before scarring would produce bleeding.

The cardinal rule of rubber banding is to ensure that tissue that has tactile sensation is not incorporated. Therefore, the procedure is described as painless in most patients. Nevertheless, some complain of more or less severe discomfort and a sensation of fullness and

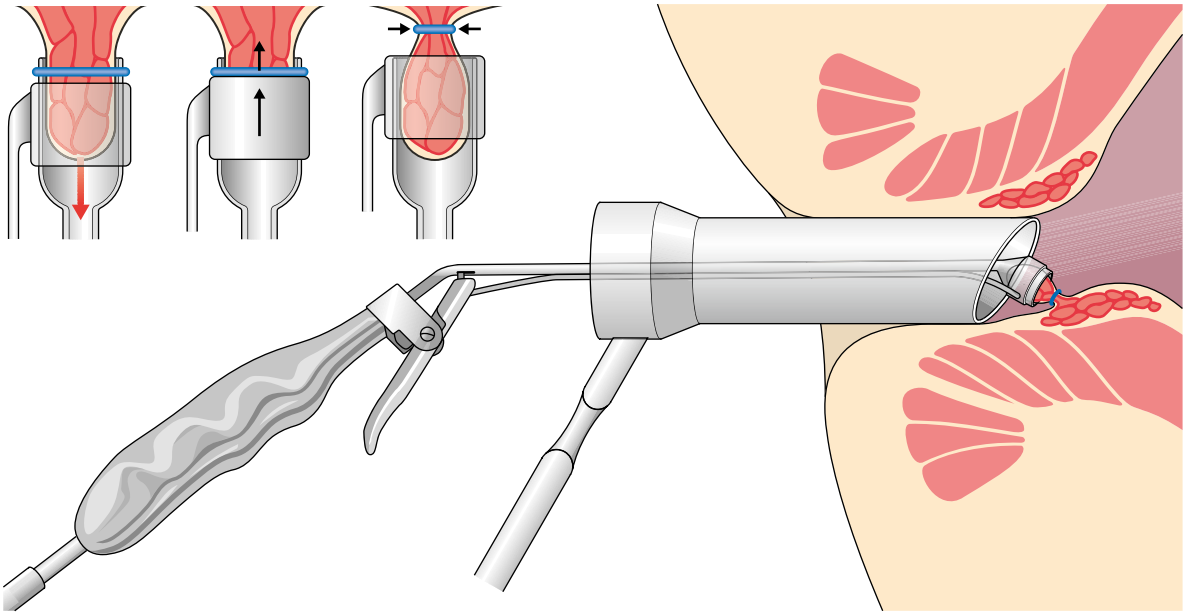


Fig. 19.4 Rubber-band ligation

false bowel movements. This sensation may persist for several days. The patient should be aware of this fact and adequate analgesics prescribed. A local anesthetic (1–2 ml) may then be injected at the base of the strangulated hemorrhoid below the rubber band [46]. If the pain is severe, the band should be removed immediately through a proctoscope, using a fine scalpel.

Strangulated tissue sloughs in 7–14 days, leaving a limited area of inflammation, resulting in a small scar. This scar fixes the mucosa to the deeper layers and prevents prolapse. A small trace of blood will occur during sloughing. Occasionally, bleeding may be more severe and require new banding of the bleeding point, infrared coagulation, or electrocoagulation 7–14 days after the original banding.

Only one or two areas should be banded at a time to prevent severe discomfort. Three bands in one session would result not only in frequent pain, but also in a large area of ulceration with subsequent risk of stenosis. Further treatment can be performed after healing, 3–6 weeks after the first banding. There is a higher incidence of complications, even minor ones, when multiple ligations are performed in a single session [47]. Nevertheless, some surgeons believe that all three hemorrhoid bundles can be ligated in a single session [48].

Banding may precipitate acute thrombosis. In the case of external hemorrhoidal thrombosis alone, simple excision may be performed; a hemorrhoidectomy may be required in acute internal and external hemorrhoidal thrombosis with prolapse.

Good symptomatic relief can be obtained with rubber-band ligation. Results appear to last a long time. Repeated application may be performed. Surgery is still possible later on if there is recurrence, and seems to result in more permanent relief. Rubber-band ligation is considered an excellent alternative for patients with hemorrhoids. A systematic review of randomized trials comparing this method with excisional hemorrhoidectomy showed that the latter has a better long-term efficacy for grade III disease compared with rubber-band ligation, but at the expense of worse postoperative pain, complications, and time off work [49]. Chew and colleagues conducted a retrospective study to assess the long-term results of combined sclerotherapy and rubber-band ligation. They concluded that it is an effective treatment for early hemorrhoids and incomplete mucosal prolapse, with a low rate of recurrence and complications, and that it could easily be repeated [50].

External hemorrhoids are not treated by rubber-band ligation, but may be partially reduced in size. Cosmetic results are not as good as those obtained by surgery. Skin tags may persist and, if unpleasant, should be excised under local anesthesia.

Rubber-band ligation has a low rate of complications, but some severe and even lethal complications have been reported, such as tetanus, liver abscess,

clostridial sepsis, soft-tissue infections, and bacterial sepsis or toxemia [51].

19.8.2.4 Cryosurgery

Hemorrhoids can be treated by freezing to cause necrosis and sloughing, with healing of the wound by secondary intention. The cryoprobe is introduced through the anoscope and placed on the cushion. An ice ball is formed through rapid lowering of the temperature, which delineates the tissue that will slough. The three cushions are destroyed in one session. Of necessity, the mucosa and anoderm between the hemorrhoids should be preserved to avoid strictures [52].

The procedure is time consuming, uncomfortable, and painful. Another disadvantage of cryosurgery is that it results in profuse watery discharge that starts within 3 h and may last for 4 weeks [53]. Large skin tags may result and have to be treated by secondary surgical excision.

From the early days of the technique, when enthusiastic results were reported, very different and even disappointing series have been published [53–55]. Smith et al. compared surgical hemorrhoidectomy and cryodestruction in the same patients. Hemorrhoidectomy is more painful than cryosurgery 2 days after the operation; later on, cryosurgery results in longer-lasting pain. A total of 75% of the patients preferred surgery to cryotherapy [56].

Altogether, this treatment does not offer any advantage over other modalities and is now only rarely used [25, 26].

19.8.2.5 Partial Internal Sphincterotomy

Partial internal sphincterotomy (see Chap. 20) is recognized as a valuable treatment for anal fissures due to hypertonicity of the internal sphincter [57]. This procedure has also been advocated by some surgeons to overcome the hypertonicity of the internal sphincter associated with hemorrhoids. This procedure allows precise division of the internal sphincter and does not result in lesion of the external sphincter, as may occur after anal dilation. The best results are obtained if the procedure is performed under general anesthesia and if the sphincter is visualized, as opposed to a blind lateral submucosal sphincterotomy.

Acute fourth-degree hemorrhoids have been treated successfully with lateral internal sphincterotomy [58]. Incontinence of varying degrees may be observed in as many as 25% of patients.

The addition of lateral internal sphincterotomy to open hemorrhoidectomy seems to have a positive effect on reducing postoperative pain in a few patients, without affecting the postoperative complications rate [59]. In another series, results showed no difference in the perception of pain after hemorrhoidectomy in patients who had an internal sphincterotomy compared with those who did not. Both groups were equally likely to have difficulty with control of gas and soiling [60]. There were no other complications in either group after a mean follow-up of 11 months. Others concluded that the addition of lateral internal sphincterotomy to routine hemorrhoidectomy is unnecessary and carries the added risk of incontinence [61].

Altogether and from our own experience, we do not recommend the combination of systematic internal sphincterotomy and excisional surgery for hemorrhoids.

19.8.2.6 Other Invasive Procedures

Manual Dilation of the Anus

Lord described a treatment for the cure of third-degree hemorrhoids by anal stretching [62]. The rationale is to reduce resting anal canal pressure, which may be raised in hemorrhoids and is considered by some to be a causative factor. The aim of this approach is therefore to lower internal sphincter pressure.

This method has been largely criticized [63]. Endoanal sonography has demonstrated multiple and extensive lesions of the internal sphincter after anal stretching [64]. These lesions cannot be repaired surgically and explain the reduced anal tone at rest and the high incidence of incontinence [65]. For all of these reasons, this method should no longer be advocated.

Proctotherm Therapy

The application of an endoanal plug, heated to 30–41°C, for 15 min twice daily relieves pain and bleeding due to hemorrhoids. The rationale for this treatment is not clearly established [66, 67]. Heat and local compression of the cushions may produce relaxation of the internal sphincter, which results in better venous drainage and regression of the hemorrhoidal congestion. Short-term results are very interesting. Nevertheless, such a treat-

ment takes time: 15–20 min, two or three times per day for at least 1 month.

19.8.3 Operative Treatment

Surgery remains the most efficient treatment to cure hemorrhoidal disease [25], but is often associated with pain and complications. About 5–10% of patients with this condition will require surgical treatment [68, 69]. This group includes patients in whom conservative treatment and invasive procedures have failed, those presenting with grade III–IV mixed hemorrhoidal disease, those with large external hemorrhoids, and those presenting concomitant surgical conditions such as anal fissure or fistula [70]. Surgical hemorrhoidectomy is contraindicated in Crohn's disease, portal hypertension, leukemia, lymphoma, bleeding diathesis, and severe renal failure requiring dialysis.

19.8.3.1 Principles and Preoperative Measures

Preoperative measures before hemorrhoidectomy remain a matter for debate (see Chap. 13). Most of the guidelines are not evidence based [71], leaving the choice to the surgeon's preference and experience. No diet restriction is requested. Antegrade bowel preparation is not necessary. A single disposable phosphate enema is usually performed on the morning of the operation [72]. Shaving is usually not necessary. Blood testing is only required for patients at risk, who are also recommended to undergo short antibiotic prophylaxis [73].

19.8.3.2 Anesthesia and Positioning

General, spinal, or perianal block anesthesia (see Chap. 14) can be considered. Day-care hemorrhoidectomy under perianal block with local anesthetic seems to be the most cost-effective method, with similar tolerance and clinical outcome to general anesthesia [74]. When general or spinal anesthesia are considered, they should be associated with some form of local anesthesia (i. e., lidocaine 1% with epinephrine) to reduce postoperative pain. The acute inflammatory response seems to be similar for both general and spinal anesthesia [75]. Intravenous fluid administration should be restricted.

The anesthetized patient is placed in the lithotomy position. The jackknife position may also be used and is preferred by some authors. The operator and assistant are positioned between the patient's legs, facing the perineum.

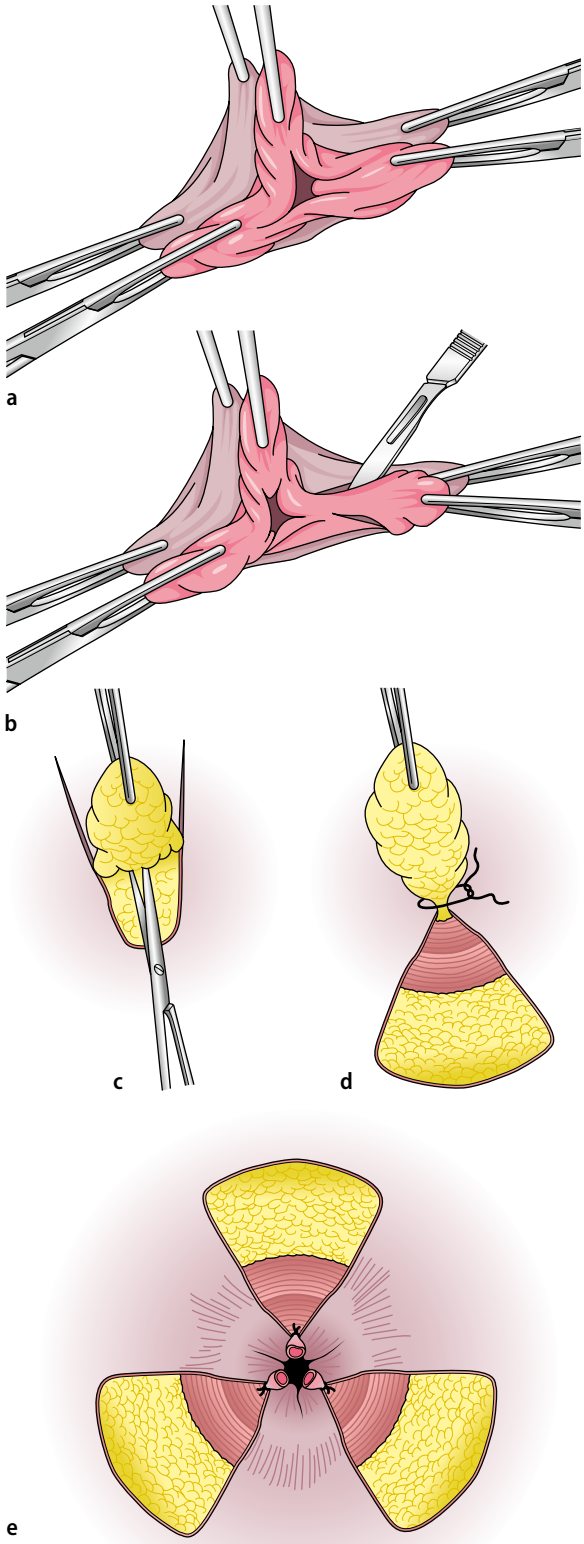
19.8.3.3 Excisional Procedures

Over 100 procedures related to hemorrhoidal disease surgery have been described. For centuries, the surgical rationale was to remove the external and internal components of the hemorrhoidal tissue using various methods. Basically, these procedures may be classified by the method used for dissection and whether or not the wound is closed at the end of the procedure.

Open Hemorrhoidectomy

The open hemorrhoidectomy, also known as ligation and excision hemorrhoidectomy, has been used for centuries. Nevertheless, it is only in 1937 that Milligan and Morgan published the first standardized procedure [76]. In this technique, each cushion's internal and external components are removed and the skin and mucosa left open in a three-leafed clover (if three cushions are removed; Fig. 19.5) [76]. Natural healing occurs within 4–8 weeks.

Artery forceps are placed on the perianal skin opposite each of the three main anal cushions. They are placed at 3, 7, and 11 o' clock. Gentle traction on the forceps allows better examination of the internal hemorrhoids. To ensure preservation of sufficiently large bridges of anoderm after dissection, their limits are determined by small longitudinal incisions. Dissection should start with the largest hemorrhoid. When of comparable size, the 3-o' clock hemorrhoid is excised first. Hemorrhoids are gently pulled using artery forceps. An elliptical incision is made distal to the external component on the perianal skin outside the rima ani and the dissection is then extended proximally, up the anal canal and through the muscle of Treitz, separating the hypertrophied hemorrhoid from the internal sphincter. Dissection should be narrowed toward the apex. Depending on the technique, an absorbable 2.0 suture is usually placed around the tip of the pedicle before excising the hemorrhoid, or it can be simply transected using diathermy. The same procedure is applied to the two other hemorrhoids. Subcutaneous bleeding usually stops spontaneously, but electrocoagulation may be



required. At the end of the operation, wounds are left open and anal dressing is inserted to control bleeding.

Any skin tags should be excised to leave only flat wounds. Accessory hemorrhoids may be present between the three main hemorrhoids. These can be excised by separate longitudinal incision or by undermining the mucocutaneous bridges. If too much skin is excised, there is a significant risk of anal stricture.

Numerous modifications exist, and the technique has been adapted by the use of diathermy [77], laser [78, 79], radiofrequency (LigaSure) [80, 81], and ultrasonic dissectors (Harmonic Scalpel) [82]. Laser excision shows no benefits over the cold scalpel [79]. The LigaSure seems to provide short-term benefits with regard to operative time [83–85] and blood loss, but no difference is shown regarding postoperative pain and length of hospital stay [86]. When the Harmonic Scalpel is compared to diathermy, there seems to be no advantage in complications, blood loss, quality of life, or operation time [82, 87–89]. However, three randomized controlled trials showed that it was associated with less pain [87, 88, 90].

In conclusion, laser equipment offers no advantages over scissors or diathermy. Radiofrequency and ultrasonic dissectors represent promising alternatives, but these need to be evaluated in larger, randomized, controlled trials in terms of complications, length of procedure, cost effectiveness, postoperative pain, and long-term outcome.

Whether or not excised specimens should be sent for histopathological examination remains a matter of debate. Many authors recommend selective rather than routine pathologic examination [91, 92]. Unsuspected malignancy is found in 1–2% of cases [91, 93]. Any suspicious areas, as based on preoperative evaluation, examination under anesthesia, or inspection of excised tissue, should therefore be sent for gross and microscopic evaluation.

Closed Hemorrhoidectomy

Closed hemorrhoidectomy was developed in the United States and reported by Ferguson and Heaton in 1959 (Fig. 19.6) [94]. They were seeking to avoid or mini-

Fig. 19.5a–e Open hemorrhoidectomy. **a** Traction on the three anal cushions with forceps. **b** Limits of skin bridges are determined by small incisions. **c** Dissection. **d** Ligation. **e** Result

mize some of the most common disadvantages of open hemorrhoidectomy and had three principal objectives:

1. To remove as much vascular tissue as possible without sacrificing the anoderm
2. To minimize postoperative serous discharge by prompt healing
3. To prevent the stenosis that may complicate the healing of large raw wounds

This procedure is usually performed on an outpatient basis, under general or spinal anesthesia together with local anesthesia and low-dose epinephrine, thus minimizing blood loss.

Many devices can be used to excise the hypertrophied hemorrhoids and the literature is inconsistent about which technique is associated to fewer complications and less pain. Ferguson's hemorrhoidectomy is basically the same procedure as Milligan–Morgan's, except for the fact that the anoderm and mucosa are closed primarily with an absorbable running suture starting from the apex. Only prolapsing tissue is excised. Mucosa must be sutured to the internal sphincter to prevent further prolapse.

Whitehead's hemorrhoidectomy was first described in 1882 [95]. In this technique, the anal cushions are excised circumferentially and rectal mucosa is anastomosed directly to the anoderm. This procedure was abandoned over time due to its significant complication rate, including excessive blood loss, stricture, loss of sensation, and mucosal ectropion [26]. Today, few surgeons still use this technique with satisfactory long-term results [96].

Many randomized controlled trials have compared the outcomes of open versus closed hemorrhoidectomy [97–101]. The wound seems to heal faster with Ferguson's hemorrhoidectomy compared to the Milligan–Morgan procedure [97, 98, 100]. Results are controversial concerning postoperative pain. The length of the procedure seems to be shorter in the open technique [98]. Risk factors for developing secondary hemorrhage after closed hemorrhoidectomy have also been assessed [102].

Semiopen and Semiclosed Techniques

Many hybrid techniques have been described whereby the wounds are partially closed after hemorrhoidectomy. The rationale for these types of procedure is that partial closure can reduce drainage, soiling, and post-

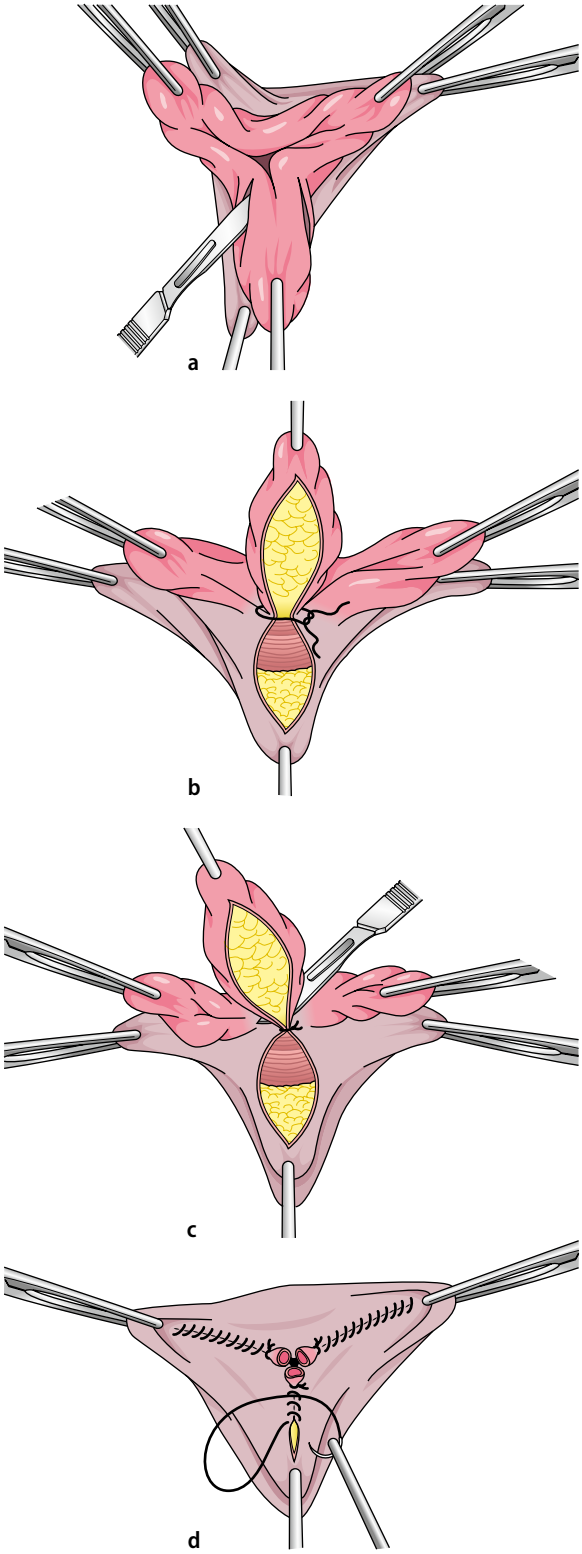


Fig. 19.6a–d Closed hemorrhoidectomy

operative discomfort, and simplify healing, thus leaving minimal scarring of the anal canal. In the semiopen technique, the wound edges left after excision of the hypertrophied hemorrhoid are sutured to the underlying sphincter in an inside-out manner. In the semiclosed technique, the wound edges are sutured together as far as the dentate line, but the external part is left open.

Submucosal Hemorrhoidectomy

Park's submucosal hemorrhoidectomy [103] consists of incising the anal mucosa and removing the internal hemorrhoidal component. The external hemorrhoidal component is grasped with artery forceps and the skin is incised circumferentially around it. The mucosa is incised longitudinally up to the anorectal junction. Submucosal dissection allows for mucosal flap mobilization. All hemorrhoidal tissue is excised and the pedicle ligated. After coagulation hemostasis, the mucocutaneous junction is reconstructed with single stitches fixed to the internal sphincter. Excess mucosa is removed and the skin wounds are left open. This technique was thought to spare somatic nerve bundles [104]. However, it is now rarely performed since it is unsatisfactory for the external hemorrhoidal component and does not remove the excess of mucosa frequently seen in the disease. The results of Park's submucosal hemorrhoidectomy remain controversial, especially when compared to classical open or closed techniques [105, 106].

19.8.3.4 Stapled Hemorrhoidopexy

Stapled hemorrhoidopexy, also called stapled anopexy or procedure for prolapse and hemorrhoids, was introduced by Antonio Longo in 1997. The term "stapled hemorrhoidectomy" should not be used since hemorrhoidal tissue is not necessarily excised [107]. In Longo's procedure, a modified circular stapler is inserted through the anus and a ring of mucosal tissue from above the dentate line is excised. The stapled anastomosis lifts the redundant, prolapsing hemorrhoids back into their original anatomical location (Fig. 19.7f). Attention to details is mandatory, as the technical aspects of the procedure lead to good results and prevent morbid complications.

Stapled hemorrhoidopexy is an alternative to excisional hemorrhoidectomy, and as such the indications should be similar, apart from a few drawbacks [108]. Fourth-degree hemorrhoids may not be good candidates since adequate retraction back into the anal canal may not be achieved. Thrombosed hemorrhoids should be excised since stapled hemorrhoidopexy does not necessarily remove the thrombus. Previous anorectal surgery is a relative contraindication since significant anal canal scarring may interfere with the drawing of anorectal mucosa in the stapling device [109, 110]. Anal abscess or gangrene, full-thickness prolapse, and fecal incontinence with or without sphincter defect represent further potential contraindications.

The patient is positioned in the prone jackknife, lithotomy, or even left lateral position. Based on surgeon's preference, general, spinal, or local (perianal block) [111] anesthesia is used. Careful inspection of the anal canal must be performed and pathology other than hemorrhoids looked for. After anal dilation to three fingers, the dilator is inserted deep into the anal canal (Fig. 19.7a). A semicircular anoscope is inserted through the dilator and will allow placement of the purse-string suture, 2 cm proximal to the hemorrhoidal apex, way above the dentate line (Fig. 19.7b). The height of the suture is crucial in order to avoid recurrence (stapled line too proximal) or pain (stapled line too distal). Only the mucosa and submucosa should be transfixed. This is critical because if the entire rectal wall is sutured and the stapler fired, complications such as rectal perforation or rectovaginal fistula can occur. On the other hand, if the purse-string suture is placed too superficially, anastomotic dehiscence can occur. Once the purse-string suture is in place, the circular stapler is introduced instead of the anoscope and the suture is tight around the shaft, the open head of the stapler being situated proximally to the suture (Fig. 19.7c). Thus, pulling on both threads of the suture places the tissue that must be excised in the stapler's head (Fig. 19.7d). When closed, the stapler is fired (Fig. 19.7e). After 30 s, slight reopening of the stapler facilitates its retraction. The excised mucosal specimen is inspected for completion and the circular stapled line is looked at for bleeding (Fig. 19.7f). Eventual hemostasis is then performed with separated cross-stitches.

A recent meta-analysis [112] based on 29 randomized clinical trials including 2,056 patients compares stapled hemorrhoidopexy with conventional hemorrhoidectomy. Pain is significantly reduced when using a circular stapler. Longo's procedure favors a shorter operative time, a shorter hospital stay, and a quicker return to daily life activities. There is no difference in complication rates. Recurrences are seen significantly

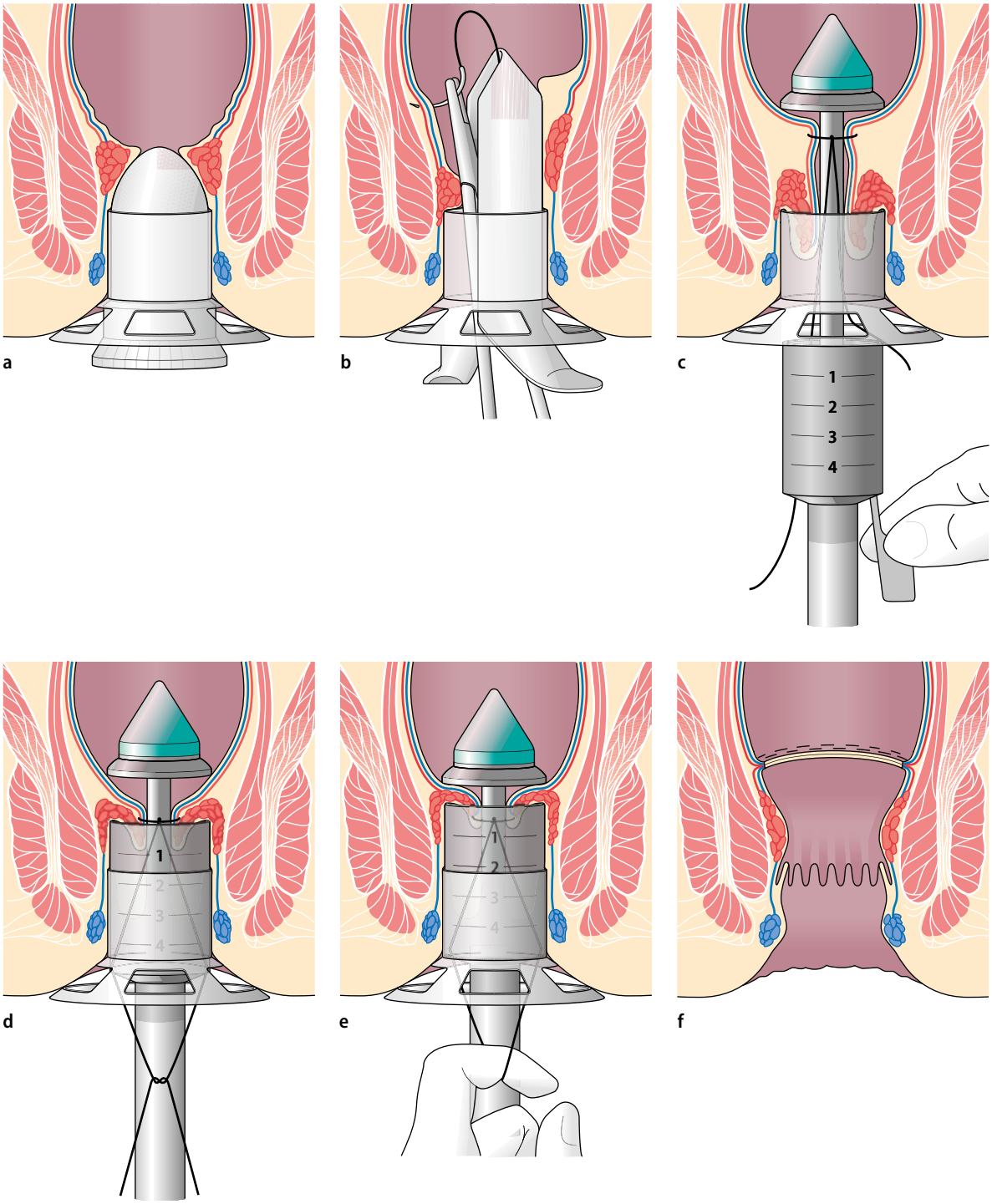


Fig. 19.7a–f Stapled hemorrhoidopexy

more often with stapled hemorrhoidopexy. It seems that long-term results are less satisfactory than with hemorrhoidectomy. After a minimum of 5 years follow-up, only 65% of patients were symptom free, 18% presenting a recurrence [113].

A monocentric retrospective review of 3,711 cases of stapled hemorrhoidopexy reported a 12.3% minor complication rate, including urinary retention (4.9%), bleeding (4.3%), postoperative pain requiring readmission (1.6%), anorectal stricture (1.4%), perianal hematoma (0.05%), and significant residual skin tags (0.05%). Anastomotic dehiscence occurred in three patients (0.08%). Twelve patients (0.3%) had a recurrence after 5–45 months [114]. Other rare postoperative complications have been reported [115, 116], including rectal perforation [117], obstruction [118], retroperitoneal sepsis [119, 120], pneumoperitoneum [121], severe bleeding necessitating low anterior resection of the rectum [122], and rectovaginal fistula [123–125]. Mortality is extremely rare [119].

19.8.3.5 Doppler-Guided Hemorrhoid Artery Ligation

With the trend toward minimally invasive surgery, much effort has been made to replace the well-established gold-standard excisional procedures by less-invasive outpatient techniques. In 1995, Morinaga et al. first reported their experience with hemorrhoidal artery ligation (HAL). They used a specifically designed anoscope coupled to a Doppler flowmeter [126].

The patient is placed in the lithotomy position. The technique starts with identification of the hemorrhoidal artery branches. Ligation can then be performed through a lateral window located above the Doppler transducer. Eight-shaped, absorbable, 2–0 sutures are tied around each artery. When the suture is appropriately placed, the Doppler echo distal to the knot fades off.

Encouraging preliminary observations have since resulted in several trials [127–132]; only one of them was randomized between HAL and closed-scissors hemorrhoidectomy [127]. All concluded that HAL is a safe and effective procedure and should be considered as an alternative treatment for grade II–III hemorrhoids.

Due to its minimally invasive aspect, HAL-related complications are rare. Faucheron and Gangner reviewed complications and recurrence rates in all published studies [132]: pain occurs in 1.5–8% of the patients, and bleeding in 4–18%. Thrombosis is infrequent (3–7%). HAL results in a fissure in 1.5–3% of the cases. Recurrence rates vary between 3 and 22% at 12 months. The longest follow-up period was 36 months, with a recurrence rate of 12%.

Dal Monte et al. developed a modified HAL technique, called transanal hemorrhoidal dearterialization. They combined ligation of arteries with a lifting and anchoring of the slipped cushions to the deep layers, reducing the mucosal prolapse by anopexy [133].

In conclusion, HAL seems to be an attractive alternative to classical excision procedures, but longer follow-up and well-designed, randomized controlled trials are needed to draw more precise conclusions. Even though the recurrence rate is high, HAL can be redone and other procedures are always possible.

19.8.3.6 Postoperative Care

All interventional procedures for hemorrhoids may be performed in an outpatient setting. Surgical hemorrhoidectomy is painful, whatever the technique. Patients should be informed that an early increase in pain after surgery is part of the process, which is exacerbated by the passage of stools and lasts 3–5 days and then usually decreases. Pain can be reduced by using per-operative local anesthetic infiltration (perineal block with 20 ml bupivacaine 0.5%). Nonsteroidal anti-inflammatory drugs are usually sufficient to relieve the patient of pain. Opiates should not be prescribed systematically because of their constipatory side effect. Lactulose [134] and oral [135] or topical [136] metronidazole have proven efficient in controlling postoperative pain. Nitroglycerine derivatives may help by creating a reversible chemical sphincterotomy. Unfortunately, frequent headache limits the use of this drug.

The first bowel movement occurs within 24–48 h after surgery, and may be facilitated by the use of paraffin oil. If constipation occurs, mucilage, bran, or laxatives may be prescribed. When compared to laxatives, bran seems to reduce hospital stay [137]. Betadine or chamomile sitz baths are recommended. These help to maintain anal hygiene and relax muscle contractions, and should be performed two to three times a day and after each bowel movement.

When no complication occurs, patients can leave the hospital on the day of surgery. They should be informed of any possible complications and on what to do if they occur. An outpatient control should be planned within 10–12 days.

19.8.3.7 Postoperative Complications

Hemorrhoidectomy is not a minor procedure as it may end in major complications if not performed correctly. This topic is extensively covered in Chap. 29 and will therefore not be treated here.

19.9 Hemorrhoids Occurring in Special Situations

19.9.1 Fistula and Scar

Any previous anal surgery or radiotherapy can result in scarring. For example, excision of a fistulous track may give raise to a depressed scar. The anal cushion opposite to the defect becomes hypertrophied, obstructing the anal canal. To avoid postoperative incontinence, such hypertrophied tissue should not be excised.

19.9.2 Pregnancy

Hemorrhoidal disease is the most frequent anorectal complaint during pregnancy. It results mainly from a transient engorgement of the perianal venous plexus. Moreover, constipation, a known risk factor for hemorrhoids, is frequently associated with pregnancy, thus favoring the pathogenesis of hemorrhoidal disease. Symptoms are usually mild and resolve spontaneously in the postpartum period. Treatment should be considered when bleeding and/or pain interfere with the patient's daily activities, and consists mainly of conservative measures, such as dietary changes, laxatives, or local treatment. A 2005 systematic review evaluated the efficacy of oral rutosides, vasotopic drugs, in relieving symptoms in pregnancy. Even if efficiency was shown, the few women enrolled in the studies did not allow for safety profile conclusions and the authors advised not to expose pregnant ladies to this drug as long as such evidence is not available [138]. If needed, surgical treatment should be postponed to after delivery. A more aggressive approach should be restricted to hemorrhoidal complications, such as thrombosis or perianal hematoma.

19.9.3 Inflammatory Bowel Disease

Hemorrhoidal disease may be associated with inflammatory bowel diseases. Although in Crohn's disease it is relatively uncommon [139, 140], some authors report an incidence of up to 7% [141]. Its course is usually asymptomatic, but can be worsened by diarrhea. The treatment should be conservative and aimed to reduce diarrhea. Surgical treatment should be avoided, since delayed healing is frequent and major complications may occur. In ulcerative colitis, however, Jeffery et al. showed that the complication rate associated with hemorrhoidectomy is low [142].

19.9.4 Portal Hypertension

Changes in the rectal venous system due to portal hypertension have been reported. The terms "rectal varices" and "congestive rectopathy" are often used [143]. These entities should be differentiated from hemorrhoids, since varicose veins may develop far above the anal cushion. If acute bleeding from one of these structures occurs, emergency banding and sclerosis can be used, as for esophageal varices.

The prevalence of hemorrhoidal disease in patients with portal hypertension remains controversial but does not seem to be increased, compared to healthy subjects [144]. In the absence of coagulopathy, surgery can be safely performed and closed procedures should be chosen.

19.9.5 Immunodeficiency

Patients with altered immunity (i. e., with leukemia, lymphoma, or human immunodeficiency virus) presenting with symptomatic hemorrhoids are at an increased risk of sepsis, local infection, gangrene, and necrosis. Surgery should only be performed once coagulation disorders have been ruled out, and under antibiotic prophylaxis. Even under these conditions, wound healing is usually delayed, exposing the patient to a greater risk of infection [145]. In patients with acquired immunodeficiency syndrome, wound healing seems to be particularly delayed, especially for those with CD4 levels under 50/μl [146]. In lymphoma, rectal irradiation of tumoral infiltration and consequent scarring may preclude surgery. Patients presenting with leukemia and concomitant hemorrhoids usually respond well to conservative treatment [147]. As a rule, conservative treatment is preferred in immunocompromised patients presenting with symptomatic hemorrhoids.

19.10 Thrombosed External Hemorrhoids

Thrombosed external hemorrhoids are common and result from the engorgement and swelling of distended external hemorrhoidal vessels, predisposing to pooling of blood and subsequent intravascular clotting. The term "perianal hematoma" refers to a different condition that is attributable to the rupture of a blood vessel.

Acute thrombosis is usually associated with severe persistent pain and swelling with a lump. It often follows exercise or straining at stool and is worsened by defecation. Pain may be considerable as the clot enlarges, inducing a local inflammatory reaction. Inspection and gentle palpation confirm the diagnosis by showing a perianal lesion that does not prolapse from within the anal canal. Further investigation such as rectal digital examination and sigmoidoscopy should not be performed in the acute stage.

The lesion usually resolves spontaneously within a few weeks, although it might leave a residual fibrous nodule. If the patient is seen when pain is at its greatest (within the first 48 h), evacuation of the clot gives immediate relief. Local excision represents an alternative to this technique. Its advantage is that hemostasis is then assured by primary suture.

When pain is settling, treatment is mostly symptomatic. Local application of lead lotion, laxatives, sitz baths, and analgesia are all that is necessary.

Greenspon et al. [148] compared outcome after conservative or surgical management for thrombosed external hemorrhoids. Of the 231 patients followed for a mean duration of 7.6 months, 48.5% were treated surgically, mostly by excision. Recurrence rate was 25.4% in the conservative group and 6.3% among surgical patients. The mean time to recurrence was 7.1 months in the conservative group versus 25 months in the surgical group.

In most series, surgically treated patients have a lower frequency of recurrence [149] and a longer time interval to recurrence than conservatively treated patients. Nevertheless, patients presenting with a first acute episode may initially be managed conservatively. Those who return with recurrent disease should be considered for early surgery because of their increased risk of further episodes.

19.11 Conclusion

Hemorrhoids represent the most frequent anal disease. Patients belong to a heterogeneous group and diagnosis and treatment are based on symptoms rather than appearance. There are many ways to treat hemorrhoids, but no single treatment is suitable for all degrees of the disease.

Patients should be advised to take a high-fiber diet and to avoid straining during defecation. For those initially presenting with bleeding and first- to second-degree hemorrhoids, treatment should start medically. Rubber-band ligation or infrared coagulation is preferred if the symptoms recur. When prolapse is the main symptom, rubber-band ligation should be considered first. Hemorrhoidectomy, either closed or open, as well as stapled hemorrhoidopexy, which offers a less painful alternative to excisional surgery, should only be considered when conservative measures have failed. Newer, less invasive techniques such as HAL are still in their early days and further experience is mandatory before they demonstrate their real value and indication.

There remain several unanswered questions concerning the etiology and treatment of hemorrhoids. The literature is often based on limited series, with poorly defined outcome measures. The need to evaluate new treatments by proper prospective randomized trials is therefore strongly requested.

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Self-Assessment Quiz

Question 1

Which of the following mechanisms does not play a role in the pathophysiology of hemorrhoids?

a. Insufficient blood return through the superior rectal veins
b. Increased intra-abdominal pressure
c. High anal resting pressure
d. Incomplete relaxation
e. Portal hypertension

Question 2

Which of the following characteristics of bleeding in hemorrhoids is wrong? Bleeding…

a. Is usually the earliest symptom of the disease
b. Is mostly associated to defecation
c. May be occult
d. May be the cause of chronic iron deficiency
e. Is often associated to pain

Question 3

Among the goals of treatment modalities of hemorrhoids listed below, which of the following is correct?

a. To stimulate regular production of large and soft stools
b. To diminish the swelling of the submucosa and corpus cavernosum recti
c. To stimulate adhesion between the mucosa and muscular coats
d. To surgically remove all visible lesions
e. To treat any concomitant lesion

Question 4

A healthy, stable 45-year-old male complains about recurrent rectal bleeding as a single symptom. Perineal inspection is not contributive. Digital rectal examination reveals bright blood. Which complementary investigation should be performed ?

a. Endoanal ultrasound
b. Magnetic resonance imaging
c. Endoscopy
d. Barium enema
e. Blood tests

Question 5

Stapled hemorrhoidopexy:

a. Has similar indications to excisional hemorrhoidectomy
b. Is indicated above all for fourth-degree hemorrhoids
c. Excises most of the hemorrhoidal tissue
d. Is contraindicated in the presence of thrombosed hemorrhoids
e. Does not require specific training

1. Answer: e
Comments: The first four of these mechanisms have been shown to play a role in the pathophysiology of hemorrhoids. Portal hypertension does not seem to increase the risk of hemorrhoidal disease, but is responsible for the development of rectal varicose veins
2. Answer: e
Comments: Painless bleeding is usually the earliest and most frequent symptom of the disease. Conversely, pain is a marked feature of advanced disease, thrombosis or other coexisting anal lesion.
3. Answer: d
Comments: Not all patients with hemorrhoidal disease require active treatment. Furthermore, the aim of treatment is not that all lesions should disappear. Therefore, normal structures with minimal symptoms should not be overtreated.
4. Answer: c
Comments: Local examination is necessary to ensure the diagnosis and exclude other associated disease or coincidental lesions. After digital examination, proctoscopy should be performed.
5. Answer: d
Comments: Thrombosed hemorrhoids should be excised since stapled hemorrhoidopexy does not necessarily remove the thrombus.

20 Anal Fissure

Ian Lindsey

CONTENTS

20.1 Introduction

Anal fissure is a painful tear or split in the distal anal canal. Most acute fissures heal spontaneously, but a proportion becomes chronic. This review article is restricted to the management of patients with chronic fissure. Chronicity is defined both chronologically and morphologically. The chronological definition is rather loose, but most surgeons would regard persistence beyond 6 weeks as a reasonable point when an acute fissure, now unlikely to heal with conservative treatment, may be considered chronic. Morphologically, the presence of visible transverse internal anal sphincter fibres at the base of a chronic anal fissure provides a more clear-cut morphological definition. Associated features exclusive to but by no means universally seen in chronic fissure include indurated edges, a sentinel pile and a hypertrophied anal papilla.

Because of widely disparate healing rates, it is of major importance that chronic fissures are defined, and the defining criteria reported in published studies. Some studies have used a mix of the chronological and morphological definitions noted above, but it would be useful if a universal definition for trial entry could be agreed upon and used. A reasonable definition might be: "the presence of visible transverse internal anal sphincter fibres at the base of an anal fissure of duration not less than 6 weeks".

Chronic fissure is usually associated with internal-anal-sphincter spasm, relief of which is central to promoting fissure healing. The treatment of chronic anal fissure has undergone a transformation in recent years from surgical to medical [1], both approaches sharing the common goal of reducing this spasm. There is both anatomical [2] and physiological evidence [3] that the anal canal is relatively poorly perfused, especially in the posterior midline, and this relative ischaemia is rendered critical when compounded by the internal-anal-sphincter spasm that has long been recognised as being associated with fissures [4].

This chapter examines some of the evidence for concern about the surgical treatment of chronic fissures, outlines the physiological basis for the pharmacological manipulation of internal-anal-sphincter tone, and proposes sphincter-saving approaches to the patient with chronic anal fissure.

20.2 The Physiology of Regulation of Internal-Sphincter Tone

There are three main influences on internal-sphincter tone and function, which reflect the sphincter specialisation of this muscle [5]. The first influence is intrinsic myogenic tone. This is spontaneous, poorly understood and depends on extracellular calcium levels entering via L-type calcium channels [6]. The second influence is the enteric nervous system, often referred to as the "third division" of the autonomic nervous system [7]. These neural pathways are located in Auerbach's and Meissner's plexi in the wall of the gut, and are responsible for peristalsis as well as local reflexes such as the rectoanal inhibitory reflex. These nerves are known to be non-adrenergic and non-cholinergic because neither guanethidine nor atropine blocks their activity, yet tetrodotoxin does [8]. The neurotransmitter identified was nitric oxide, and it relaxes the internal sphincter [8]. This action is blocked by LG-nitro-L-arginine (a nitric oxide synthase (NOS) inhibitor) and enhanced by L-arginine (a nitric oxide precursor). Their presence has been confirmed by the finding of NOS-positive immunohistochemically stained neurones in the rectal myenteric plexus and anal canal [9].

Thirdly, the autonomic nervous system exhibits contractile and relaxing influences on the internal sphincter via sympathetic and parasympathetic postganglionic fibres, respectively. It is not entirely clear precisely how they do this, but they may act directly on the smooth muscle, indirectly on the nerves of the enteric nervous system, or both. There is a relative dominance of sympathetic over parasympathetic neural input, leading to a background tonic state of the internal sphincter. The parasympathetic agent carbachol (equivalent to the neurotransmitter acetylcholine) relaxes the internal sphincter via its action on muscarinic receptors, which is blocked by the muscarinic antagonist atropine. The sympathetic neurotransmitter noradrenaline contracts the internal sphincter via its action on alpha-receptors, which is blocked by the alpha-antagonist phentolamine.

20.3 Medical Therapies

Conservative non-surgical measures, including topical steroids, local anaesthetics and bulk laxatives, successfully heal acute anal fissures in about 90% of cases [10]. Although employed alongside specific medical and surgical therapies to minimise relapse, these measures alone heal less than 40% of chronic fissures [10]. One study showed a poor response to conservative therapy in fissures demonstrating features of chronicity, such as sentinel tags or hypertrophied anal papillae [11].

There have been two forces behind the development of pharmacological treatments for chronic anal fissures. Not only is there concern over rates of incontinence after surgery, but also the deeper understanding of the pharmacology and physiology of the anal sphincter has allowed a reasoned approach to the manipulation of sphincter tone [8].

20.3.1 Nitric Oxide Donors – Glyceryl Trinitrate

Against the backdrop of an increasing grasp of the physiology of the internal sphincter, the first pharmacological treatments developed were the nitric oxide donors, principally glyceryl trinitrate (GTN). The usual course is 0.2%, applied topically two or three times daily for 8 weeks.

There have been several published randomised, controlled trials of GTN. The first well-constructed trial originated in Nottingham (UK), and in it, 80 patients were randomised to 0.2% GTN (twice daily for 8 weeks) versus placebo paste [12]. Healing rates were significantly higher in the GTN than the placebo arm (68% vs 8%, $p<0.0001$), but headaches were very common (58% vs 18%). GTN caused a relaxation of the internal sphincter of the order of 35%.

A trial from Kennedy and Lubowski in Sydney (Australia) was less successful, with more modest healing in the GTN arm (three times daily for 4 weeks), although it was superior to placebo (46% vs 16%) [13]. In the longer term, 35% of patients submitted to internal sphincterotomy. Carapeti et al. from St Marks Hospital (Harrow, UK) attempted to determine whether healing could be improved by increasing the dose of GTN (three times daily for 8 weeks) [14]. Higher doses were not more effective, and interestingly, neither were headaches more common. A fourth multicentre trial from Italy was notable for its failure to demonstrate the

superiority of GTN (twice daily for 4 weeks) over placebo (49% vs 52%) [15]. Improvements in pain and anodermal blood flow as well as reduction in maximum resting pressure (MRP) were demonstrated. However, the very high placebo response rate suggests the inclusion of acute as well as chronic fissures.

The role of GTN paste in the treatment of chronic anal fissure remains uncertain. Although GTN paste showed early promise in healing fissures, initial enthusiasm has been tempered somewhat by concerns over medium-term relapse, headache and tachyphylaxis [14]. As a topical preparation, there are inevitable difficulties with regulating the dose, and non-compliance may be common. The impressive results of early trials have been countered by reports suggesting that healing rates and patient satisfaction with GTN are low [16]. The poor side-effect profile may improve with more sophisticated and precise drug-delivery systems [17].

Direct comparison of trials is complicated by the different dosages of GTN used, the criteria used for distinguishing chronic and acute fissures, and the duration of symptoms prior to treatment. However, GTN is still considered first-line therapy in many centres. It is readily available and its safety is undisputed. However, given that between 20 [18] and 70% [19] of patients with chronic anal fissure will fail on a single course of GTN, the problem of how to treat these GTN-resistant chronic fissure is becoming increasingly common. There are few data on whether these patients should be scheduled for surgery after treatment failure or whether further medical therapy confers any benefit.

Recent data have suggested additional explanations for the shortfall in healing rates with GTN. In a study from Nottingham (UK), continuous anal manometry was performed on 15 normal volunteers for 10 min before and 120 min after treatment with 0.2% GTN [20]. A significant reduction in MRP was noted at between 15 and 90 min, suggesting a limited duration of action of one application of GTN. This means that with twice- or three-times daily topical application, the internal sphincter still spends most of its time in a hypertonic state. Furthermore, there is a subgroup of patients with chronic fissure that fails to exhibit reductions in MRP in response to topical GTN, and healing seems unlikely in these patients [21].

In a retrospective review of 64 patients treated with 0.2% GTN, healing was achieved in only 41%, and half of these subsequently relapsed [22]. Two independent risk factors for failure to heal were the presence of a sentinel pile ($p<0.035$) and a history of a fissure longer than 6 months ($p<0.019$). This suggests an inability of medical therapy to heal fissures at the truly chronically established end of the spectrum.

20.3.2 Calcium Channel Blockers

There are alternatives to GTN, including the calcium-channel-blocking drugs (oral or topical). Oral nifedipine (20 mg retard twice daily) produced a 36% fall in MRP in a small open-label study; healing rates were equivalent to those for GTN (60%), and headaches (33%) and flushing (66%) were very common [6]. In a similar study, the reduction in MRP was of a similar order (30%) [23]. Topical nifedipine reduced the mean MRP by 11%, healed significantly more chronic fissures at 6 weeks (95%) than control (16%, $p<0.001$) [24], and produced no side effects.

Topical diltiazem shows promise as an effective therapy with minimal side effects. In a randomised trial of 50 patients, topical 2% diltiazem demonstrated a more profound reduction in MRP (23% vs 15%), better healing (65% vs 38%) and fewer side effects (0% vs 33%) than oral diltiazem [25]. Topical diltiazem appears to produce similar fissure healing with fewer side effects compared to GTN [26, 27]. It also appears to successfully heal between 48 and 75% of fissures that fail GTN treatment [28, 29]. This agent may ultimately supersede GTN because of its superior side-effect profile, although the long-term efficacy of diltiazem remains open to question [30].

20.3.3 Bethanocol, Alpha-Antagonists and Phosphodiesterase Inhibitors

There are other alternative potential medical therapies, including alpha-1 adrenoceptor antagonists (indoramin) [31, 32], cholinergic agonists (bethanechol) [33], exogenous (isosorbide dinitrate – ISDN) [34] and endogenous (l-arginine) [35] nitric-oxide donors, and phosphodiesterase inhibitors [36, 37], although these remain incompletely evaluated.

20.3.4 Botulinum Toxin A

Botulinum toxin A (BTX) is an exotoxin produced by the bacterium *Clostridium botulinum* and is a potent

neurotoxin that causes botulism in humans. For several reasons, BTX injection represents an exciting new development in the treatment of chronic anal fissure. It has distinct advantages over other current medical therapies, overcoming many of their shortcomings. BTX is administered by one-off injection, which seems to be well tolerated [38], thus eliminating non-compliance issues. A single injection into the internal sphincter produces a reduction in MRP of a similar order to that obtained with GTN (25–30%) [39]. However, BTX produces a constant reduction in MRP that is sustained over a 2- to 3-month period, which should translate to improved healing. Side effects such as temporary minor incontinence and urgency are infrequent and not sustained. Its major disadvantage is its cost, although this can be set against the cost of surgical therapy.

BTX has been shown to be efficacious in the treatment of chronic anal fissure [40, 41]. A recent randomised, double-blind, placebo-controlled trial comparing BTX and GTN paste has suggested that BTX should be considered first-line therapy for the treatment of chronic fissure [42]. In the short and medium term it is a safe drug with transient flatus incontinence and perianal haematoma only occasionally reported [43]. No data exist on the long-term effects of BTX on the sphincter mechanism.

There is speculation about the mechanism of action of BTX and its optimal injection site. It was first injected into the external sphincter for anal fissure [40], but more recently an intersphincteric injection or injection into the internal sphincter has been suggested [38, 42]. BTX classically causes paralysis of skeletal muscle by binding to the presynaptic nerve terminal at the neuromuscular junction and preventing the presynaptic release of acetylcholine. A similar action on the internal sphincter would argue against its use in chronic anal fissure, because inhibition of acetylcholine release would lead to contraction of the internal-sphincter smooth muscle.

A recent animal study has shed light on the mechanism of action of BTX in anal fissure. Jones et al. injected BTX into the internal sphincter in half of pigs kept in identical conditions, the other half acting as controls [44]. Strips of their internal sphincters were cut and mounted in a superfusion organ bath, and comparisons made between BTX and control sphincters in response to electrical-field stimulation and various agonists. BTX-treated sphincter strips developed less myogenic tone than controls and showed a marked reduction in field-stimulation-induced contraction. This was secondary to an effect of the toxin on sympathetic input, because it was profoundly inhibited by guanethidine. There was no evidence that BTX affects the release of nitric oxide. These findings suggest that BTX does have an action on the internal sphincter, reducing myogenic tone and the contractile response to sympathetic stimulation either by direct action on smooth muscle or indirectly on the nerves, perhaps through acetylcholine at the ganglionic level.

20.4 Surgical Therapies

The goal of treatment is to cure the fissure by reducing the associated abnormally elevated resting anal pressure. Traditionally, surgery has been the mainstay of treatment, producing a permanent reduction in MRP by manual dilatation or internal sphincterotomy.

20.4.1 Manual Dilatation of the Anus

For many years manual dilatation of the anus was the primary treatment for chronic anal fissure. Its goal was to reduce sphincter tone by controlled manual stretching of the internal sphincter. After insertion of a Park's speculum, two and eventually four fingers were inserted into the anal canal, and lateral distension was exerted on the anal sphincters and sustained for a period. In practice, this procedure frequently produced uncontrolled "tearing" of the sphincter muscles, resulting in symptoms of incontinence, with characteristic findings on anal endosonography [45–47].

Speakman et al. evaluated 12 men with faecal incontinence after manual dilatation and found that 11 had gross internal-sphincter disruption (mean 153° of circumference), 3 of which were associated with external-sphincter damage [45]. Nielsen et al. followed up 32 consecutive patients undergoing manual dilatation of the anus by anal ultrasound and questionnaire [46]. Four patients (13%) developed minor anal incontinence. Of 20 patients agreeing to anal ultrasound, 13 (65%) were found to have sphincter defects, 2 with and 11 without incontinence. Nine (45%) sphincter injuries were internal, 1 (10%) external and 1 (10%) combined.

The risk of incontinence after manual dilatation of the anus has been documented by both prospective [47–50] and retrospective [51–54] studies. Incontinence to flatus is in the order of 0–25% (prospective) and 18–27% (retrospective). There may be problems

standardising the interpretation and gradation of incontinence symptoms, but a 20–25% risk is a reasonable estimate.

In a study on incontinence after minor anal surgical procedures evaluated by anal manometry and ultrasound, Lindsey et al. found characteristic patterns of anal sphincter damage after manual dilatation in 27 incontinent patients [55]. Incontinence grade was severe, with 63% of patients complaining of incontinence to solid stool. All 27 (100%) patients demonstrated internal-sphincter injury. Ten (37%) had thinning of the posterior half of the internal sphincter, 12 (44%) a posterior defect in the internal sphincter and 5 (19%) internal-sphincter fragmentation. Eight patients (30%) also had associated surgical damage to the external sphincter (seven fragmented, one gap).

20.4.2 Lateral Internal Sphincterotomy

Eisenhammer introduced internal sphincterotomy into surgical practice in 1951 [56]; it was originally performed in the posterior midline location, but this often led to so-called "keyhole" deformities. For lateral subcutaneous sphincterotomy, popularised by Notaras (first reported in 1969) [57], the caudal part of the internal sphincter is divided for a variable distance cranially, usually to the dentate line.

The suggested advantage of lateral sphincterotomy over manual dilatation of the anus is that it represents a surgically controlled partial internal-sphincter division. Yet despite this, it carries a significant risk of minor, persistent disturbances in anal continence. This incidence has been poorly documented, but varies between 0 and 36% for flatus incontinence, 0 and 21% for incontinence to liquid stool, and 0 and 5% for solid-stool incontinence [58–65].

20.4.2.1 Reasons for Incontinence After Sphincterotomy

Several groups have explored why internal sphincterotomy leads to incontinence in a significant number of patients. The procedure is seemingly controlled and standardised and only partially divides the internal sphincter, with a consequent limited reduction in MRP in the order of 25–35% [66].

Ultrasound studies have revealed that like manual dilatation of the anus, internal sphincterotomy appears to be difficult to standardise. Sultan evaluated the extent of sphincterotomy using anal ultrasound [61]. Fifteen patients were examined pre- and post-operatively with anal ultrasound. Nine females (90%) and one male (20%) had inadvertently undergone full-length division of the internal sphincter, and three females (30%) complained of flatus incontinence. They concluded that the length of internal-sphincter division in women is frequently greater than anticipated, partly due to the shorter anal sphincter anatomy, and questioned the reproducibility of the procedure.

Farouk et al. noted that sphincterotomy sometimes extends into the external sphincter [67]. Follow-up of patients with persistent fissures after internal sphincterotomy by anal ultrasound found that over 70% of patients had no internal-sphincter defect, and several patients had incurred external-sphincter defects.

Lindsey reported on 17 patients complaining of incontinence after lateral sphincterotomy who were evaluated by anal manometry and ultrasound [55]. Fifteen patients (88%) demonstrated an overextensive lateral internal sphincterotomy, of which 8 (53%) were female and 7 male. The sphincterotomy in 11 (64%) extended two-thirds of the length, and in 4 (24%) the complete length of the internal sphincter. Only two incontinent patients (12%) had a normal-length sphincterotomy (both had an external-sphincter injury). In addition, four patients (24%) had a sphincterotomy extending into the external sphincter, and 90% of incontinent women had an underlying obstetric external-sphincter injury.

Overzealous or inaccurate sphincterotomy can result in incontinence, and female patients are particularly at risk. In women, because shorter anal sphincters and occult obstetric sphincter defects may compound the effects of surgery [68, 69], special caution must be exercised when contemplating internal sphincterotomy.

Some chronic fissures are not associated with spasm, making therapeutic reduction in resting pressure not only illogical, but also a potential threat to continence. Corby et al. examined MRP in women with postpartum chronic fissure and found that median antenatal and post-natal MRPs were 58 and 49 mmHg, respectively, similar to control patients without anal fissure [70]. Jones et al. performed manometry on 40 consecutive patients presenting with chronic fissure and found that 19% of men and 42% of women had low or low–normal resting pressures [71], placing them at potential risk of incontinence with a surgical reduction in

MRP of 25%. They also found that surgeons were poor at clinically identifying this at-risk group.

20.4.2.2 Techniques to Make Sphincterotomy Safer

Several surgeons have examined ways of reducing the risks associated with lateral sphincterotomy. Littlejohn and Newstead reported experience of tailored lateral sphincterotomy in 287 patients [72]. This procedure differs from standard internal sphincterotomy in that the sphincterotomy is more conservative and is carried cranially for the length of the fissure rather than to the dentate line. Flatus, liquid and solid incontinence rates of 1.4, 0.4 and 0%, respectively, and a recurrence rate of 1.7% were noted. This procedure appears to be safe and efficacious, but has not become common practice.

In an evaluation of ultrasound-guided internal sphincterotomy, Mylonakis et al. [73] randomised 50 patients to either standard or ultrasound-guided surgery. There were more complete internal-sphincter defects and a greater reduction in MRP with ultrasound guidance, but healing and incontinence were similar in both groups.

Pescatori et al. selected patients for internal sphincterotomy on the basis of their MRP results [74]. Forty patients were randomised to either standard internal sphincterotomy to the dentate line or internal sphincterotomy, with sphincterotomy extent proportional to the MRP. Post-operative soiling and recurrence were less in the manometry-guided group compared with the standard group (20 and 10% versus 5 and 0%, respectively). However, the benefits of routine anal manometry were not demonstrated in a study of pre- and post-operative manometry in 177 patients with chronic fissure [75].

The emergence of medical therapies has certainly re-focussed attention on the efficacy and safety of internal sphincterotomy in comparison. While undoubtedly effective, recent studies of internal sphincterotomy promising minimal incontinence with limited follow-up are not entirely reassuring [76, 77]. We believe the key to making internal sphincterotomy safer is to minimize the size of the cohort exposed to its inherent long-term risk by using a "medical therapy first" approach, and reserving it for patients assessed and stratified to a low-incontinence-risk category.

20.5 The Approach to a Primary Chronic Fissure

20.5.1 Medical or Surgical Therapy?

There are several published randomised controlled trials comparing medical versus surgical therapy in a total of 347 patients (4 GTN vs internal sphincterotomy, 1 BTX vs internal sphincterotomy). A trial from South Africa [78] randomised 24 patients to internal sphincterotomy, GTN (0.5-mg tablet crushed in 10 ml lubricating jelly, three times daily for 4 weeks). Healing rates were high in both arms, with no recurrence and no incontinence in either arm. A multicentre trial from Canada [19] randomised 82 patients to internal sphincterotomy or 0.25% GTN (three times daily for 6 weeks); healing rates were higher in the surgery arm (90% vs 30%) and there was no incontinence in the surgical arm at the 6-month follow-up. A trial from Australia [79] randomised 60 patients to internal sphincterotomy or 0.2% GTN (three times daily for 8 weeks). Healing rates were higher in the surgery arm (97% vs 61%) and there was no surgical incontinence. A multicentre trial from the UK [80] randomised 70 patients to internal sphincterotomy or 0.2% GTN. Short-term healing rates were higher in the surgery arm (100% vs 54%) and remained higher at 2-year follow-up (97% vs 46%). A recent Turkish trial [81] randomised 111 patients to internal sphincterotomy or 20–30 units of BTX (Botox). At 12 months, healing rates were higher in the surgery arm (94% vs 75%). However, faecal incontinence was higher (16% vs 0%, $p<0.001$) and return to normal activity slower (15 days vs 6 days, $p<0.0001$) in patients undergoing internal sphincterotomy.

The conclusion from the Canadian and Australian trials was that internal sphincterotomy was superior to medical therapy because of better healing and no incontinence. However, the results of these trials should be interpreted with caution. Firstly, the studies were not powered to detect differences in continence between the two groups. Secondly, follow-up was generally too short in these trials to detect the true long-term incidence of incontinence after internal sphincterotomy, which is higher in studies with longer follow-up [58, 60, 65]. The safety of internal sphincterotomy in the Canadian trial was sustained at the 6-year follow-up, but only 62% of the original surgical cohort was reassessed [82]. The Turkish trial, despite demonstrating significantly higher incontinence for sphincterotomy at 12 months, still concluded that surgery was superior to

BTX, and the UK study concluded that surgery should be reserved for patients failing to respond to medical therapy. Thirdly, a study of the economic impact of GTN employing economic modelling showed a reduction in health-care costs using GTN (£616 per patient) compared to internal sphincterotomy (£840 per patient), a cost saving of about 25% [83], although first-line use of BTX would erode some of these savings.

The approach to primary therapy, be it surgical or medical, remains a matter of philosophy. Internal sphincterotomy remains a good operation in that it brings rapid pain relief and a high degree of patient satisfaction. However, there is still concern about the lack of standardisation of the procedure, exposing some patients to a longer-term risk of permanent disturbances in anal continence [58, 60, 65], particularly in inexperienced hands. These concerns are not shared with a medical approach.

Until better results can be demonstrated with modification of technique, such as tailored sphincterotomy, or accurate identification of high-risk patients, many will continue to take the "safety first" approach and treat all patients primarily medically. The one-third to one-half of patients with chronic fissures resistant to medical therapy can subsequently be offered internal sphincterotomy, and higher-risk patients can be better targeted by anorectal manometric and ultrasonographic evaluation prior to surgery, with better informed consent. Some of these patients may indeed wish to avoid internal sphincterotomy altogether and persist with an alternative medical therapy.

A recent Cochrane analysis of trials of medical versus surgical therapy for fissure concluded that medical therapy is only marginally better than placebo, and significantly less effective than surgery [84]. Yet most of the trials were not powered, nor was follow-up long enough to detect differences in incontinence between medical and surgical treatments. In addition, several small, well-designed trials of GTN versus placebo were discarded from analysis for the strange reason that their placebo-arm healing rates were considered too low, yet a trial from Italy [15] with an unusually high placebo healing rate of 52% (perhaps suggesting the treatment of acute as well as chronic fissures) was included. This, along with false assumptions about high healing rates with placebo in chronic fissure, may have skewed the analysis and produced potentially misleading conclusions.

20.5.2 GTN versus BTX

GTN has been evaluated against BTX for primary chronic fissure treatment in a small, well-designed controlled trial from Italy [42]. Fifty patients were randomised to either 20 units of BTX (Botox) or 0.2% GTN. At the 8-week follow-up, healing rates were higher in the BTX arm (96% vs 60%), and 100% of GTN failures healed when crossed over to BTX. These results were confirmed recently in a similar study by the same group [85]. A Swiss randomised, controlled trial of GTN versus BTX demonstrated superior healing with GTN, but unusually, healing was assessed at 2 weeks [86].

While BTX overcomes many of the disadvantages of GTN, the cost and inconvenience of BTX argue for its second-line use for GTN failures. For many, GTN remains ideal first-line treatment: it is cheap, convenient and widely available, although topical diltiazem may challenge that role in the future.

20.5.3 GTN Versus Diltiazem

Topical diltiazem shows promise as an effective therapy with minimal side effects. In a randomised trial comparing 2% topical diltiazem with 0.2% GTN in 50 patients, fissure healing was equivalent (77% vs 86%) and side effects fewer (42% vs 72%) for diltiazem [26]. A further randomised trial of 43 patients, comparing 2% topical diltiazem with 0.5% GTN, showed similar healing (86% vs 86%) with fewer side effects (0% vs 33%) with diltiazem [27]. This agent may supersede GTN because of its apparent superior side-effect profile. However, in one study, about 60% of patients required further treatment (either surgical or medical) in the 2 years following initial treatment [30].

20.6 The Approach to a Medically Recalcitrant Chronic Fissure

20.6.1 Further Medical Therapy or Surgery?

The optimum approach to GTN-resistant fissures, further medical therapy or surgery, remains open to debate. There are no trials directly comparing these approaches and treatment will largely depend on the choice of the fully informed patient.

20.6.2 Repeat GTN

Seven trials reporting the use of primary GTN describe a further treatment course of GTN in a total of 60 relapsing patients, with short-term healing in 77% of patients [32, 87]. However, underlying issues of tachyphylaxis and side effects would suggest changing to an alternative treatment unless the primary course of treatment was insufficient.

20.6.3 Diltiazem After Failed GTN

In two case series of treatment with topical 2% diltiazem not responding to GTN, diltiazem successfully healed between 48 and 75% of those chronic fissures [28, 29].

20.6.4 BTX After Failed GTN

One trial of BTX for GTN-resistant fissures reported rather modest results. In an open-label study of 40 patients using 20 units of BTX (Botox), Lindsey et al. noted healing in 43% of patients at 8 weeks, although 73% were asymptomatic or symptomatically much improved and avoided surgery [88]. Although transient flatus incontinence was noted in 18%, patients preferred delivery of BTX to initial GTN (71% vs 20%, 9% equivocal) if outcome was ignored. The conclusion was that although BTX appears to be very successful in healing primary chronic fissures, healing rates are lower for GTN-resistant fissures. They speculated that the chronic fibrotic nature of the fissure was not treated by BTX, and that this prevented better fissure healing, a concept supported by others [89].

A recent randomised trial of BTX after failed GTN suggests some improved outcomes if BTX is combined with GTN [90]. There was a non-significant trend towards better healing (47% vs 27%), symptomatic improvement (87% vs 67%) and less resort to surgery with BTX plus GTN. Somewhat superior results were reported using BTX [91] after failed treatment with the nitric-oxide donor ISDN, with 75% healing at a median follow-up of 14 months. A large study from Israel using BTX after failed initial ISDN or nifedipine showed relatively good overall healing of fissures, although longer-term relapses were common and 29% of patients were ultimately referred for internal sphincterotomy [92].

20.6.5 Combined Surgical-Medical Therapy (Fissurectomy-BTX) After Failed GTN

With this in mind, Lindsey et al. took 30 patients with both GTN-and BTX-resistant chronic fissures and treated them with a novel surgical procedure [93]. Fissurectomy was combined with 25 units of BTX (Botox), thus addressing both internal-sphincter spasm and chronic-fissure fibrosis. Twenty-eight fissures (93%) were healed at a median follow-up of 16 weeks; 2 (7%) experienced transient flatus incontinence, and no patient required internal sphincterotomy.

Of particular note, the fissures took longer to heal than usual; although they were smaller and more superficial, few fissures had healed by 8 weeks. By this time patients were generally much more comfortable, having typically experienced initial, short-lived worsening of pain in the first 1–2 weeks after surgery. The results of this trial have been confirmed at longer-term follow-up, with similar rates of healing at 12 months in a series of 40 patients undergoing fissurectomy combined with 10 units of BTX (Botox) [94].

A similar approach was adopted by a Dutch group, who treated patients with ISDN-resistant chronic fissures with fissurectomy plus further ISDN therapy [95]. All 17 patients healed (100%) at 10 weeks, with no recurrence at 29 months follow-up.

Fissurectomy alone has been employed to treat fissures in children, the aim being to avoid permanent disruption of the internal sphincter in this age group [96]. Fissurectomy combined with a sphincterotomy at the base of the fissure was used commonly in the 1980s [97–100]. While fissure healing was variable, problems occurred with keyhole deformity and minor post-operative faecal incontinence, and it was generally superseded by lateral internal sphincterotomy. There is no publication in the literature on fissurectomy alone for chronic anal fissure in adults.

20.7 Conclusion

Although debate regarding the optimum first-line therapy for chronic fissure continues, treatment is increasingly medical, particularly the use of GTN. This has evolved mainly because of the greater understanding of the pharmacology and physiology of the anal sphincter, allowing a reasoned approach to the manipulation of sphincter tone, but also because of concerns over the longer-term threat to anal continence posed by lateral sphincterotomy.

First-line use of medical therapy cures most chronic anal fissures cheaply and conveniently without resorting to traditional surgery and risking incontinence. The residual smaller cohort of medical failures can then be better targeted for sphincter assessment prior to traditional surgery. If the good results of newer sphincter-sparing surgery are borne out, it may be surgically possible to avoid the risk of incontinence altogether, while maintaining high rates of fissure healing.

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Self-Assessment Quiz

Question 1

Glyceryl trinitrate acts on the internal sphincter by:

a. Calcium channel blockade
b. Blocking acetylcholine release in the sympathetic relay ganglion
c. Phosphodiesterase-5 inhibition
d. Acting as a nitric oxide donor
e. Reducing sympathetic tone

Question 2

The most common site for a chronic anal fissure is:

a. Anterior
b. Left lateral
c. Right lateral
d. Anterior/posterior
e. Posterior

Question 3

The procedure with the highest risk of faecal incontinence is:

a. Manual anal dilatation
b. Tailored internal sphincterotomy
c. Internal sphincterotomy to the dentate line
d. Fissurectomy-botulinum toxin
e. Cutaneous advancement flap

Question 4

Which is not a sign of fissure chronicity and predictor of failure of medical treatment?

a. Sentinel tag
b. Anal spasm
c. Fissure fibrosis
d. Visible internal-sphincter fibres in the fissure base
e. Long history

Question 5

Which is not a symptom in the history of chronic anal fissure?

a. Anal pain
b. Anorectal bleeding
c. Anal prolapse
d. Constipation
e. Diarrhoea

1. Answer: d
2. Answer: e
3. Answer: a
4. Answer: b
5. Answer: c

21 Anorectal Abscesses and Fistulas

Peter Buchmann and Marc-Claude Marti †

CONTENTS

21.1 Introduction

Anorectal abscesses and fistulas are among the most frequently observed anorectal lesions. As anorectal abscesses frequently result in more or less complex and extensive fistulous tracts, the two pathologies should be regarded as the same condition. Abscesses and fistulas are two phases of the same disease, fistulous abscess [21]. However, for practical and therapeutic reasons, they should be considered separately, except regarding aetiology and spread of infection.

21.2 Aetiology

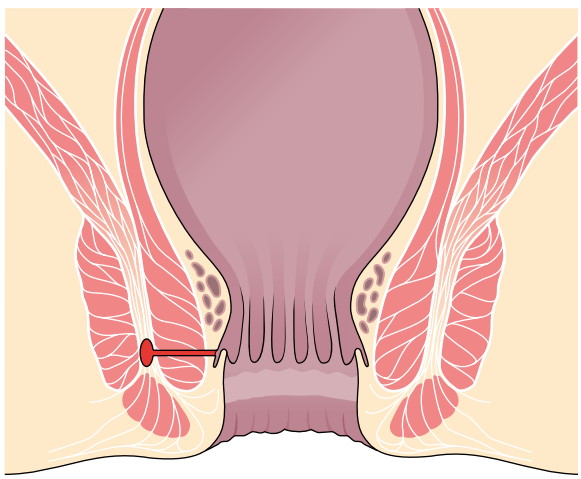
Perianal septic lesions may be the result of several aetiologies [11, 84]. A distinction may be made between primary septic lesions of cryptoglandular origin and secondary septic lesions (Table 21.1). Primary septic lesions are the most common. Perianal abscesses have a cryptoglandular origin [28].

The anal glands, described in 1844 by Hermann and Desfosses [38], are located in the intersphincteric space and empty through a duct crossing the internal

Table 21.1 Frequency (%) of various types of anorectal abscess

Reference	*n*	Type of abscess				
	Total	Perianal	Inter-sphincteric	Ischiorectal	Supra-levatoric	Submucosal, high intramuscular
Goldberg et al. [27]	50	26	16	54	4	–
Ramanujam et al. [76]	1023	42.7	21.4	22.8	7.3	5.8
Abcarian et al. [1]	1732	44.6	22.9	22.4	6.2	3.9

sphincter into the base of an anal crypt at the level of the pectineal line (Fig. 21.1). Not all crypts contain anal glands, and two glands may open into one crypt. The posterior half of the anus has a higher density of anal glands. Cystic formation may be present. Increased back pressure due to occlusion of a duct and secondary to faecal material, foreign bodies or trauma results in stasis and secondary infection with abscess formation in the intersphincteric space. The isolation of gut-specific organisms such as colonic aerobes and *Bacteroides fragilis* in the culture of pus tends to confirm the cryptoglandular origin of anal fistulas [23, 30].



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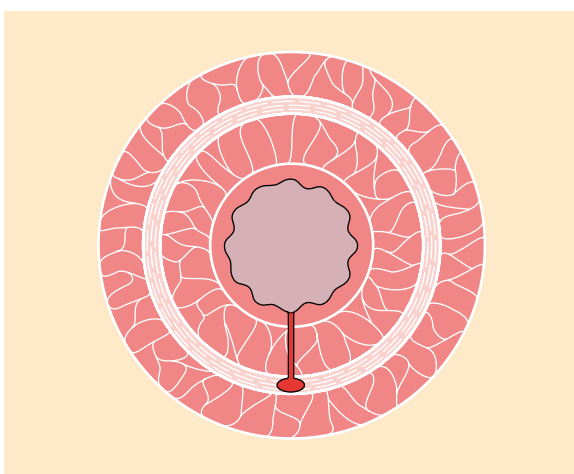


b

Fig. 21.1a,b Position of the intersphincteric anal gland (*red*) in a frontal (**a**) and horizontal (**b**) section

Only 10% of anal fistulas are due to a specific aetiology (Table 21.2); 90% of cases have a cryptoglandular origin [1, 84]. A previous history of abscesses may not be recorded in nearly one-third of the patients; in these cases, discharge is the first indication of trouble [37, 69, 77]. In a study of 562 consecutive fistulous abscesses (unpublished data), 190 fistulous tracts were evident at the first examination, while 101 were discovered at the second stage. In 143 cases of a fistulous tract, no abscesses were recorded; 209 abscesses were incised and no fistulous tract was evident at the first stage or later over a period of 5 years.

A specific aetiology of anal fistulas must be recognised as early as possible to avoid the risk of inadequate treatment. Pilonidal sinus with an extension inside the anal canal is a rare condition [3]. In cases of Crohn's disease in particular, more or less extensive lesions may be recognised in the distal colon. One-third of those initially free from intestinal Crohn's disease will develop the disease within 5 years (see Chap. 30).

21.3 Spread of Infection

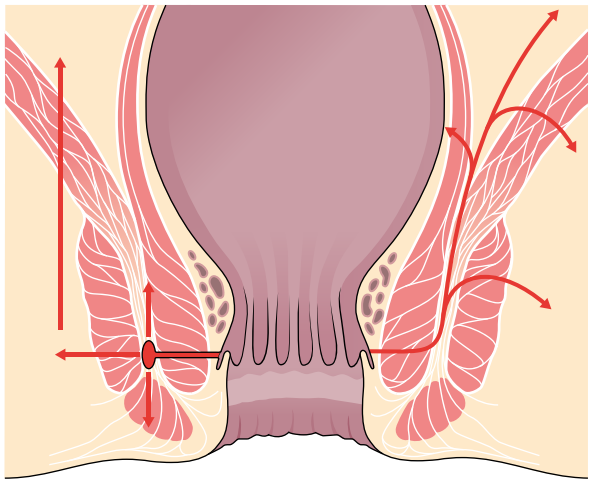
Infection may spread and seek the path of least resistance (Fig. 21.2). It may extend downwards into the intersphincteric space resulting in a perianal abscess, upwards inside the longitudinal muscle layer within the gut walls causing an intermuscular abscess, or upwards outside the gut walls resulting in a supralevator abscess. It may spread across the external sphincter at any level, resulting in an ischiorectal abscess, which may also extend upwards or downwards. Furthermore,

Table 21.2 Aetiology and differential diagnoses of specific anorectal abscesses and fistulas (10% out of all)

General aetiology	Specific aetiology	Microbiology
Anorectal disease	Crohn's disease (ulcerative colitis)	Colonic flora
Colonic	Diverticular disease	Colonic flora
Skin disease	Pilonidal sinus	Skin flora
	Hidradenitis suppurativa	
	Sebaceous cyst	
	Furunculosis	
	Pyoderma (localised)	
Infection	Tuberculosis	*Mycobacterium tuberculosis*
	Actinomycosis	*Actinomyces*
	Lymphogranuloma venerum	*Chlamydia*
	Chancroid	*Haemophilus ducreyi*
	Gonorrhoea	*Neisseria gonorrhoea*
	Bursitis ischiadica	
	Prostatitis	
	Bartholinitis	
Trauma	Penetrating injuries	
	Episiotomy	
	Sclerotherapy of haemorrhoids	
	Surgery of the prostata	
	Ingested foreign bodies	
	Impalement	
	Injuries due to enema	
Malignancy	Anal carcinoma	
	Low rectal carcinoma	
	Post-irradiation	
	Dermoid	
	Teratoma	
	Chordoma	
	Acute leukaemia	
Generalised or systemic disease	AIDS	
	Diabetes	
	Pancytopenia	

circumferential spread is possible at any level within the intersphincteric space, the ischiorectal space, or the supralevator space. It may extend from one ischiorectal fossa to the contralateral one via the intersphincteric space of Courtney or deep post-anal space (Fig. 21.3) [32], resulting in a so-called horseshoe abscess.

A pelvirectal supralevatoric abscess resulting from a cryptoglandular infection extending above the levator ani in close contact with the rectal wall and below the peritoneum is rare; a pelvirectal abscess originates more frequently in pelvic pathology.



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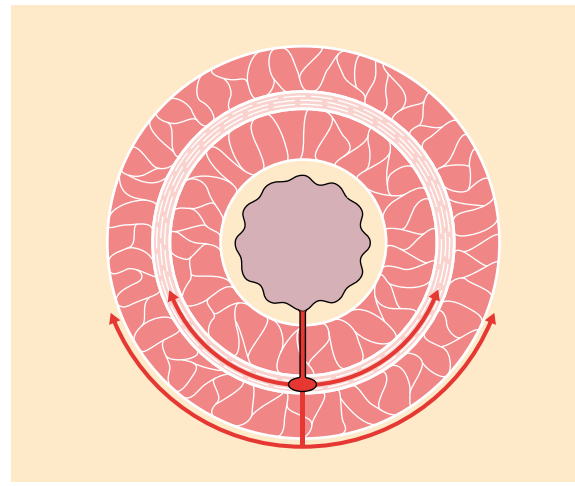

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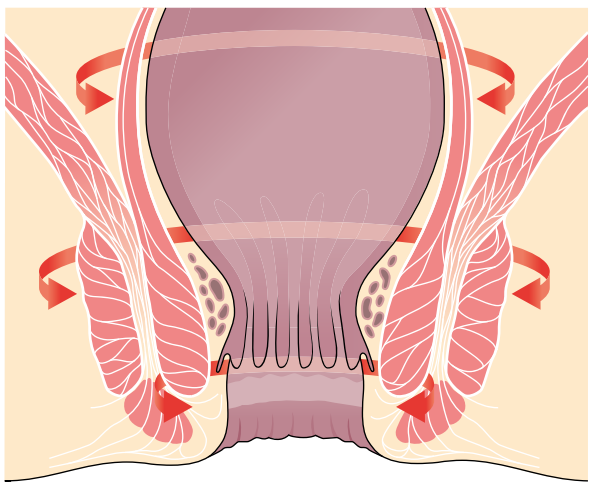


c

Fig. 21.2a–c Possible ways to extend an anal abscess downwards, upwards, and along the various planes and fatty spaces of the perineum

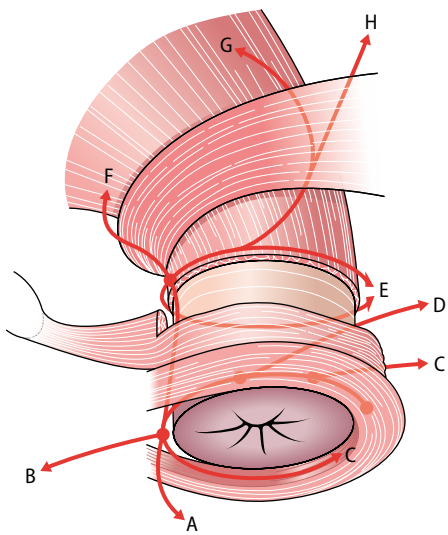


Fig. 21.3 Various extensions of anal abscesses: *A* intersphincteric; *B* para-anal; *C* horseshoe, superficial; *D* horseshoe, superficial; *E* horseshoe, deep; *F* ischiorectal; *G* pelvirectal; *H* supralevator

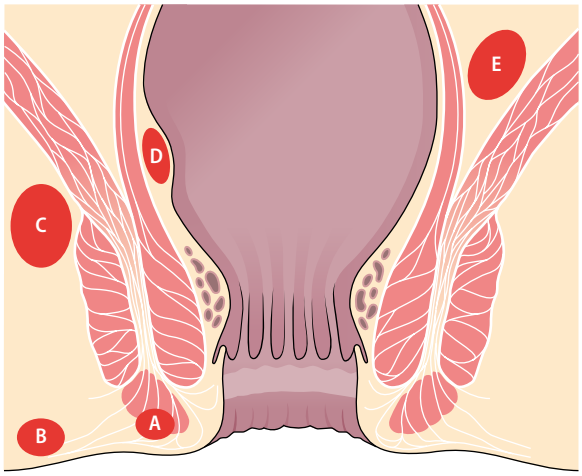


Fig. 21.4 Classification of anal abscesses: *A* perianal; *B* perineal; *C* ischiorectal; *D* submucosal; *E* pelvirectal = supralevatoric

The location of anorectal abscesses may be classified as shown in Fig. 21.4. The reported incidence of the various sites of anorectal abscesses (Table 21.1) differs among the published series for several reasons, including the fact that classification and patient recruitment are different from one institution to another. Anal abscesses may be complicated by extensive perineal gangrene due to streptococci, *Pseudomonas aeruginosa*, mixed aerobic and anaerobic infections, and purely clostridial germs [13, 63, 81, 85]. Such a condition may be life-threatening [10]. Fournier's disease is an uncommon form of gangrene involving the scrotum and the perineum (see Chap. 49); this necrotising infection, which requires extensive skin excision, may be secondary to an anal abscess or fistulous abscess [19, 25, 78]. Tetanus as a complication of anorectal surgery and anal abscess has also been reported [59]. Delay in treatment, inadequate examination and initial drainage may result in extensive infection with a fatal outcome [10, 12, 54].

21.4 Abscesses

21.4.1 Signs, Symptoms and Diagnosis

The main symptoms of an abscess are discomfort, perianal pain and swelling. The symptoms develop more or less rapidly within hours or days. They are aggravated by sitting, walking and defaecation. Minor anal bleeding and discharge of a small amount of pus may occur if the abscess opens into the anal canal. This is different from patients with Crohn's disease, who are often oligosymptomatic and therefore often not referred to a surgeon for a long time (see Chap. 30). An obvious cause of the pain is usually detected (e. g. swelling, tenderness and induration at palpation, asymmetry of the buttocks, redness, superficial cellulitis, or even gangrenous skin). However, fluctuation is nearly always missed. The inguinal lymph nodes may be enlarged. Systemic symptoms such as fever, chills, malaise and tachycardia occur more frequently with high abscesses than with more superficial ones. In the most severe cases, patients may be hospitalised for severe fever of unknown origin or acute urinary retention. Only a careful rectal examination reveals the development of a high anorectal abscess.

Bidigital examination allows an appreciation of an induration in the deep post-anal space and in the ischio- and/or pelvirectal spaces. A small intersphincteric abscess may be very painful and is sometimes confused with an acute anal fissure. Examination under general anaesthesia may be required to allow palpation of a small nodule, no bigger than a grain of rice, within the intersphincteric space at the level of the dentate line [67]. An anorectal examination with a rigid instrument must be performed at some stage for three main reasons:

1. To identify the anal crypt responsible for the infection
2. To determine the presence of underlying septic or inflammatory proctitis
3. To look for a perforated anorectal cancer

In men, an abscess situated anterior to the anus should be distinguished from a periurethral abscess and, in women, from infections of Bartholin's glands.

An internal fistulous opening can be identified on careful examination in about 30–40% of patients undergoing drainage of an abscess [58, 76]. It may be missed at the time of the initial drainage of the abscess, as the tissues are distorted and inflamed by the septic conditions, and also may not be recognised as a result of spontaneous closure [21]. One-third of patients have a history of anorectal abscess that had ruptured spontaneously, had been drained surgically or had undergone spontaneous remission [77].

The exact location and extent of the suppurative process may be analysed by endoanal ultrasonography (see Chap. 9). Septic diverticula, which should not be overlooked during surgical treatment, are best identified with preoperative computed tomography (CT) [6]. The differential diagnoses are listed in Table 21.2.

21.4.2 Treatment of Anorectal Suppuration

To treat anorectal abscesses, some guidelines must be followed:

1. Spontaneous healing and complete resolution without suppuration of perianal cellulitis is very rare and should not be expected.
2. Broad-spectrum antibiotics without drainage delay the need for surgery and create more complex lesions.
3. Microbiological investigations may be useful to confirm or rule out the presence of a fistulous tract and to obtain evidence of some specific infection or of a venereal anal disease (see Table 21.2).
4. Incision should not be delayed.
5. Incision should allow optimal drainage without pocketing; deroofing of the abscess is thus optimal.
6. On the occasion of an abscess incision, a fistular duct must not be perceived, as the perifocal tissue is inflamed and the risk of forming a *via falsa* is very high. Hence, the patient has to be informed preoperatively about future sonographic fistula detection and potential additional operations.

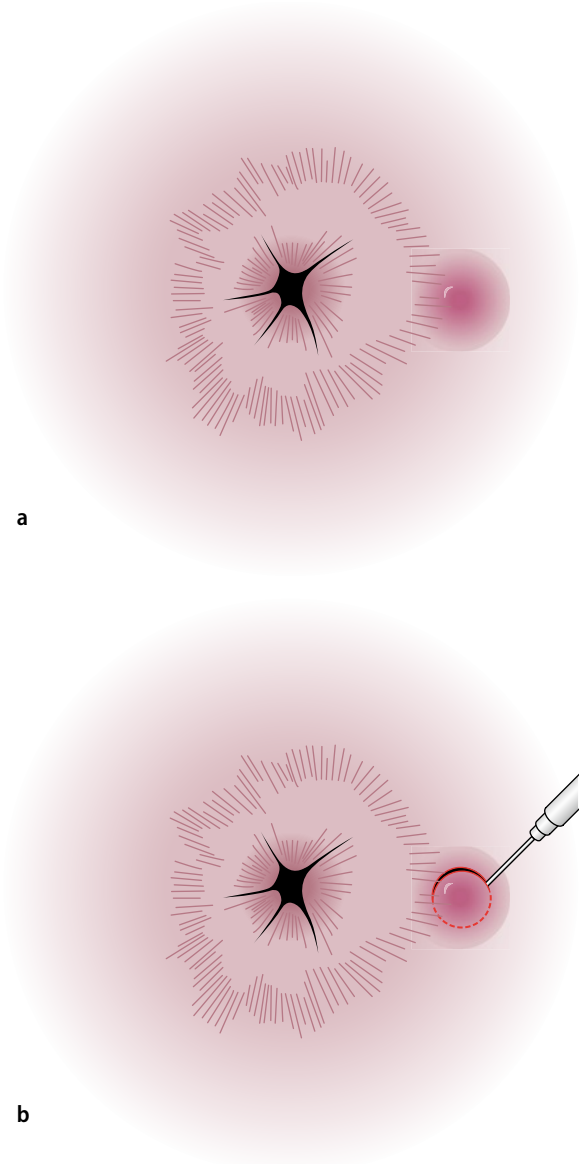


Fig. 21.5a,b Incision and drainage of anal abscess

21.4.3 Surgical Treatment

21.4.3.1 Perianal Abscesses

A perianal abscess can almost always be drained under local anaesthesia in the office. The skin must be shaved and prepared with antiseptics; 2 ml of 1% lidocaine is injected into the skin at the level of the most tender point. A diamond-shaped or round skin flap may be excised to prevent early closure with subsequent recurrence of the abscess (Fig. 21.5). Packing to control bleeding should be reduced to a minimum as it would interfere with drainage. If the operation is performed under local anaesthesia, any curettage or deep excision should be avoided to prevent the risk of bacteraemia and septic shock. If a more extensive procedure is planned, preoperative broad-spectrum antibiotics should be injected intravenously and general anaesthesia should be considered.

21.4.3.2 Intersphincteric Abscesses

Locoregional or general anaesthesia is required to allow examination and adequate exposure. Incision starts at the level of the intersphincteric groove, just beyond the lower edge of the internal sphincter (Fig. 21.6). The anoderm is incised, or a strip of it is excised up to the level of the dentate line. The internal-sphincter fibres are divided from the lower end up to the level of the highest cavity. The intersphincteric space is cleaned, and curettage is performed to remove any trace of the infected anal gland.

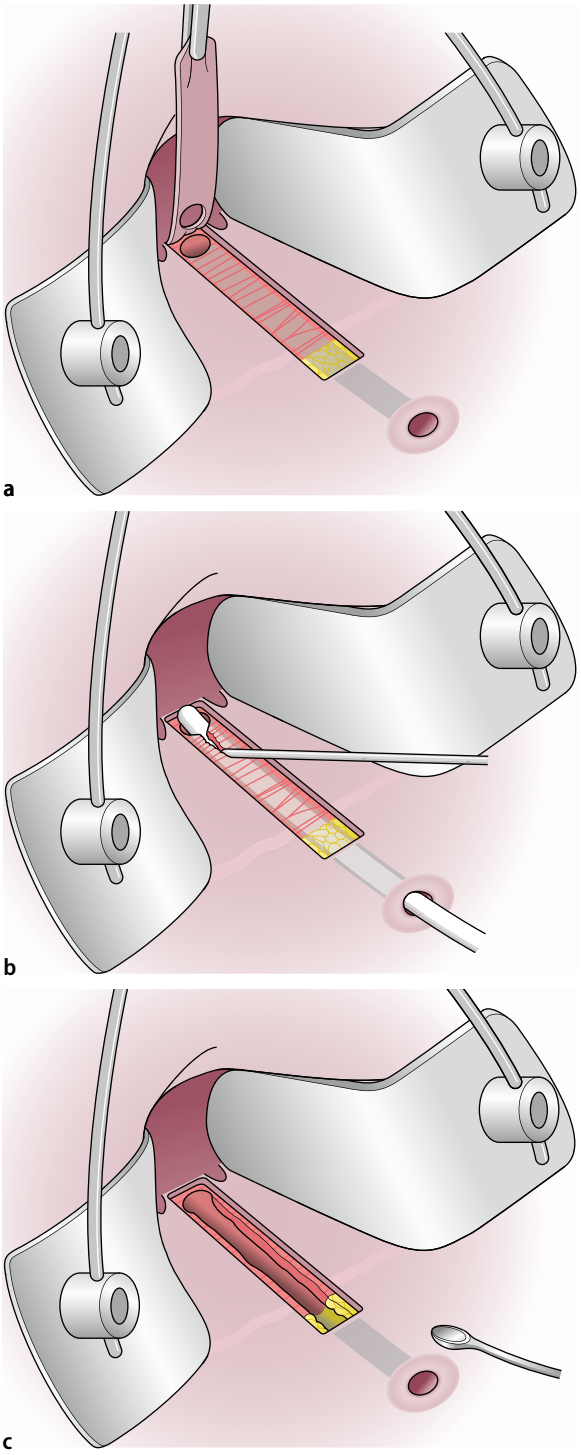


Fig. 21.6a–c Treatment of an intersphincteric abscess: excision of a flap of anoderm (**a**), division of the internal sphincter (**b**) and curettage of the intersphincteric space (**c**). If a fistulous tract is identified, curettage may be performed

21.4.3.3 Ischiorectal Abscesses and Pelvirectal Abscesses

These lesions are too deep to be treated under local anaesthesia; caudal, locoregional or general anaesthesia is required. After proctoscopy to identify the anal crypt involved in the process, a round incision is made in the perianal tissue and continued into the ischiorectal space.

If the internal opening is clearly identified and if the underlying fistulous tract can be catheterised easily, a seton drainage should be placed. A probe should never be pushed forcefully, as this may lead to the creation of a false tract. If preoperative ultrasonography or bidigital examination confirms extension into the pelvirectal supralevatoric space, the levator muscle fibres are separated to allow drainage of the highest septic cavities (Fig. 21.7). A rubber tube, a mushroom or a corrugated drainage sheet made of soft rubber drain is inserted and fixed to the skin with a stitch (Fig. 21.8). After gentle curettage, the wounds are loosely packed with a mesh dressing for 24–48 h. A second stage will be required to treat the transsphincteric fistulous tract.

A perianal fistula with a pelvic abscess extending from the anal canal should never be drained into the rectum as this would result in an extrasphincteric fistula, which is a much more complex problem to treat. If the pelvic abscess is caused by a pelvic disease such as complicated diverticulitis, Crohn's disease or appendicitis, it should be drained through the abdominal wall or as a Douglas abscess, through the rectal lumen.

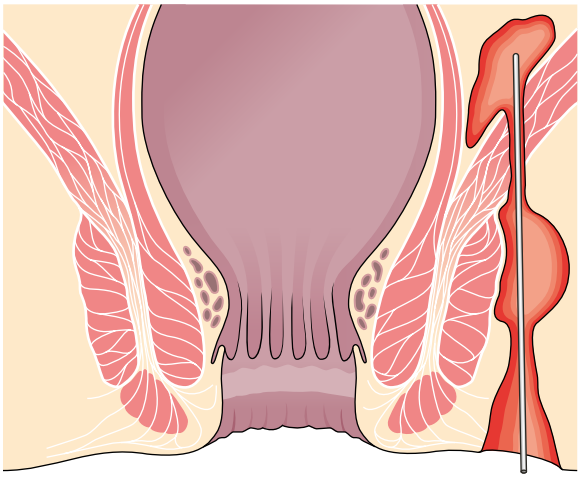


Fig. 21.7 Drainage of a pelvirectal abscess through the ischiorectal space

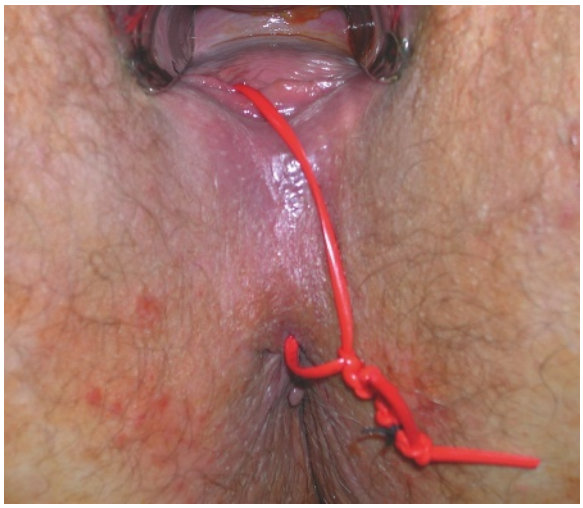


Fig. 21.8 Seton drainage of a perianal abscess

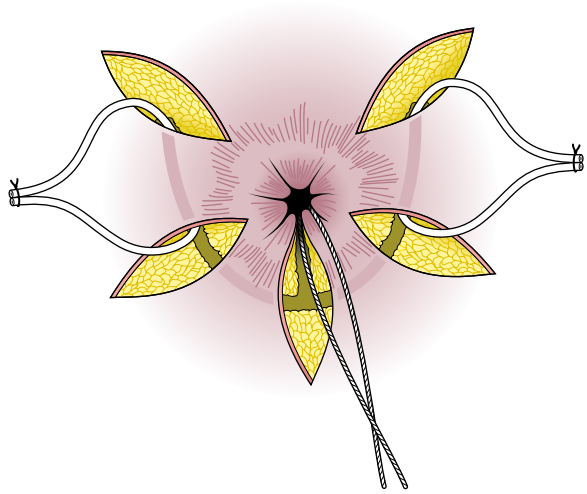


Fig. 21.9 Horseshoe abscess. The postnatal space is opened and a seton drainage is placed through the posterior tract. Lateral and anterior extensions of the abscess are drained through several round incisions

21.4.3.4 Post-anal Abscesses and Horseshoe Abscesses

A deep post-anal abscess should be drained by a posterior radial incision on the midline [35, 36]. The primary opening is usually located in a crypt in the posterior midline; it is easy to identify, as pus can be seen draining from it. A probe is inserted into the tract and passed into the deep post-anal space. The round incision is performed on the tip of the probe. The post-anal space is opened to allow free drainage of the pus-filled space (Fig. 21.9). The fistulous tract should not be submitted to immediate fistulotomy in order to prevent excessive sphincter damage. Seton drainage, consisting of a vessel loop (Fig. 21.8), is placed to allow easy identification of the tract at a later stage and to allow better drainage. In the case of a horseshoe abscess, the lateral and anterior extensions of the abscess are drained by one or more separate round incisions on each side. Curettage is performed in the lateral limbs of the abscess, which are then drained and packed separately.

21.4.3.5 Primary Suture Under Systematic Antibiotic Coverage

An abscess evacuation with direct closure and a concomitant high-dose antibiotic therapy has frequently been attempted. This method is not recommended, however, as the cryptoglandular origin of the abscess stays intact and the risk of relapse is thus high.

Are Antibiotics Necessary?

As antibiotics do not remove the cause of anorectal infection, they have very little place in the management of anorectal abscesses. They are useful in cases of extensive cellulitis to prevent bacteriological dissemination due to the surgical procedure. They must be given if the patient is diabetic, immunosuppressed, suffering from valvular lesions of the heart, or wearing prosthetic material. They should also be administered in the case of a specific infection.

21.4.3.6 One- and Two-Stage Operations and the Value of Seton Drainage

The primary opening in a crypt may be identified when treating an acute abscess. A one-stage or a two-stage operation may be considered. A one-stage operation is possible in the case of an intersphincteric abscess or a low transsphincteric fistulous tract. The lay-open technique should only be performed by an experienced proctologist and if it results in minimal sphincteric

division. In all other instances, a two-stage operation should be planned. The abscess is incised and drained as described previously, and the fistulous tract should be drained using seton drainage [75].

A vessel loop is placed from the incision of the abscess along the tract to the primary crypt or in the opposite direction. It is tied loosely without tension, or the strands are tied with a non-resorbable suture. The seton will allow drainage and promote fibrosis around the fistulous tract.

21.4.4 Post-operative Care After Abscess Drainage

The wounds are dressed with dry gauze, and not with gauze impregnated with petroleum jelly, to prevent small collections of remaining pus and to facilitate further changes of dressing. The patient should have a bath or a shower after each bowel action and clean the wound at least three times a day. After a short hospital stay, the wound must be supervised weekly until complete healing occurs. A possible initially unrecognised fistulous tract must be looked for carefully after 2–3 weeks. A second-stage operation can be planned as soon as sufficient wound healing has been achieved, usually after 3–6 weeks. A preoperative sonographic imaging is indispensable to obtain information concerning:

1. Fistular penetration level in relation to the sphincteric muscle
2. Fistular course through the sphincter apparatus
3. Possible side branches

The knowledge of these details provides a basis for choosing the appropriate method.

21.5 Anal Fistula

21.5.1 Signs and Symptoms

Anorectal fistula causes chronic purulent, faecal or serosanguineous discharge with skin irritation. Intermittent swelling, pain and even fever are due to faecal stasis in the tract; spontaneous rupture and drainage will result in improvement. More frequently, in the absence of acute suppuration, a fistula is seen as a draining sinus in the perineal area. A long history may result in the formation of several lateral secondary openings with a "watering-can" appearance.

21.5.2 Examination

If there is no abscess, palpation is painless and the examining physician can appreciate a torte-like indurated structure stretching more or less radially from the draining sinus towards the anal canal. If the fistulous tract is in a high location, perineal palpation near the external sphincter is insufficient. Bidigital examination is then useful to appreciate the fibrous tract crossing the external sphincter and to palpate a retraction at the level of an anal crypt. A primary opening should be identified if this has not already been done when draining an abscess.

Goodsall's rule is still very useful (Fig. 21.10) [29]. Fistulas opening in front of an imaginary line dividing the anus transversely have a direct course to the anus, while those with an external opening behind this line have a curved course and usually reach the anal canal in the midline. Anterior openings, located more than 3 cm from the anal verge, also have a posterior curved course. However, Goodsall's rule is only appropriate in about two-thirds of our patients [90].

Identification of the fistulous tract is best performed with a curved, blunt-tipped probe introduced through the secondary opening. It is a very painful procedure

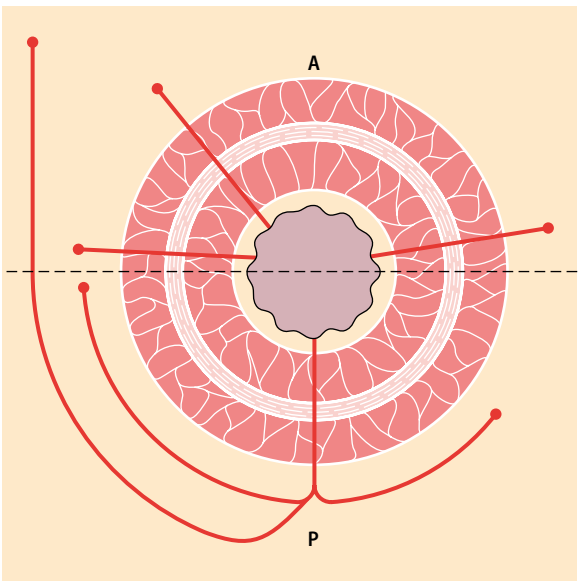


Fig. 21.10 Goodsall's rule: anterior (*A*) fistulous tracts are linear, whereas posterior (*P*) tracts are curved. Anterior secondary openings located more than 3 cm from the anal margin communicate through a curved tract with a posteriorly located anal gland

that traumatises the tract and may create a false passage into the anal canal. This examination therefore requires anaesthesia. The primary opening at the depth of an anal crypt can be identified according to Goodsall's rule by using a blunt crypt hook.

Injection of air into the secondary opening helps in the identification of the primary opening and to some extent distends the fistulous tract. The passage of air into the anal lumen is confirmed by digital perception of air bubbles or by anoscopy. Air is far more useful than saline or any dye solution, as it does not stain the various structures. Hydrogen peroxide may be useful not only for digital probing, but also if endoanal ultrasonography is performed, as it enhances the contrast [14]. As this examination is painless, unlike the use of metallic probes, it can be performed without anaesthesia.

Fistulography may be useful to identify the various tracts in selected cases of complicated and/or recurrent fistulas. Radiographs in the supine and lateral decubitus positions should be obtained with a probe in the anal canal; labelling of the secondary fistular orifice and of the linea anocutanea is essential for an exact orientation Nevertheless, results may be inaccurate and are unreliable [45, 74].

Endoanal ultrasonography, performed by the surgeon, is a helpful examination to allow precise identification of any fistulous tracts and septic diverticula that may not be palpated (see Chap. 9) [14–16, 28, 46].

CT and magnetic resonance imaging have been advocated to determine the position of fistulous tracts. They give precise information on high tracts with or without extension to adjacent organs. The use of an intra-anal coil and contrast enhancement was previously recommended, but it turned out to be inappropriate for the exploration of fistulas, so that nowadays this technique is more established in anorectal carcinoma and examination of the prostate [34, 50, 60, 87].

21.5.3 Classification

A fistulous tract of cryptoglandular origin crosses the sphincters or extends in the same way as abscesses [21, 49] (i. e. upwards, downwards and around the anal canal along the various spaces), resulting in more complex lesions (see Figs. 21.2 and 21.3). The various tracts must be recognised so that they can be treated optimally.

Various classifications of anal fistulas have been described. The most useful is that of Parks et al. [68]:

1. Intersphincteric:
   a. Simple low tract
   b. High blind tract
   c. High tract with rectal opening
   d. Rectal opening without a perineal opening
   e. Extrarectal extension
   f. Secondary to pelvic disease
2. Transsphincteric:
   a. Uncomplicated
   b. High blind tract
3. Suprasphincteric:
   a. Uncomplicated
   b. High blind tract
4. Extrasphincteric:
   a. Secondary to anal fistula
   b. Secondary to trauma
   c. Secondary to anorectal disease
   d. Secondary to pelvic inflammation

This classification has optimal correlations with the anatomical structures and helps in the planning of surgical treatment (Fig. 21.11). Intersphincteric and transsphincteric fistulas are observed more frequently than extrasphincteric and complex ones (Table 21.3).

Table 21.3 Frequency of various anal fistulas

Reference	*n*	Type of fistula					
	Total	Superficial (%)	Inter-sphincteric (%)	Trans-sphincteric (%)	Supra-sphincteric (%)	Extra-sphincteric (%)	Multiple and complex (%)
Parks et al. [68]	397	–	45	30	20	5	–
Marks and Ritchie [53]	1190	16	54	21	3	3	3
Rosa et al. [80]	844	15	24	58	3	21	–

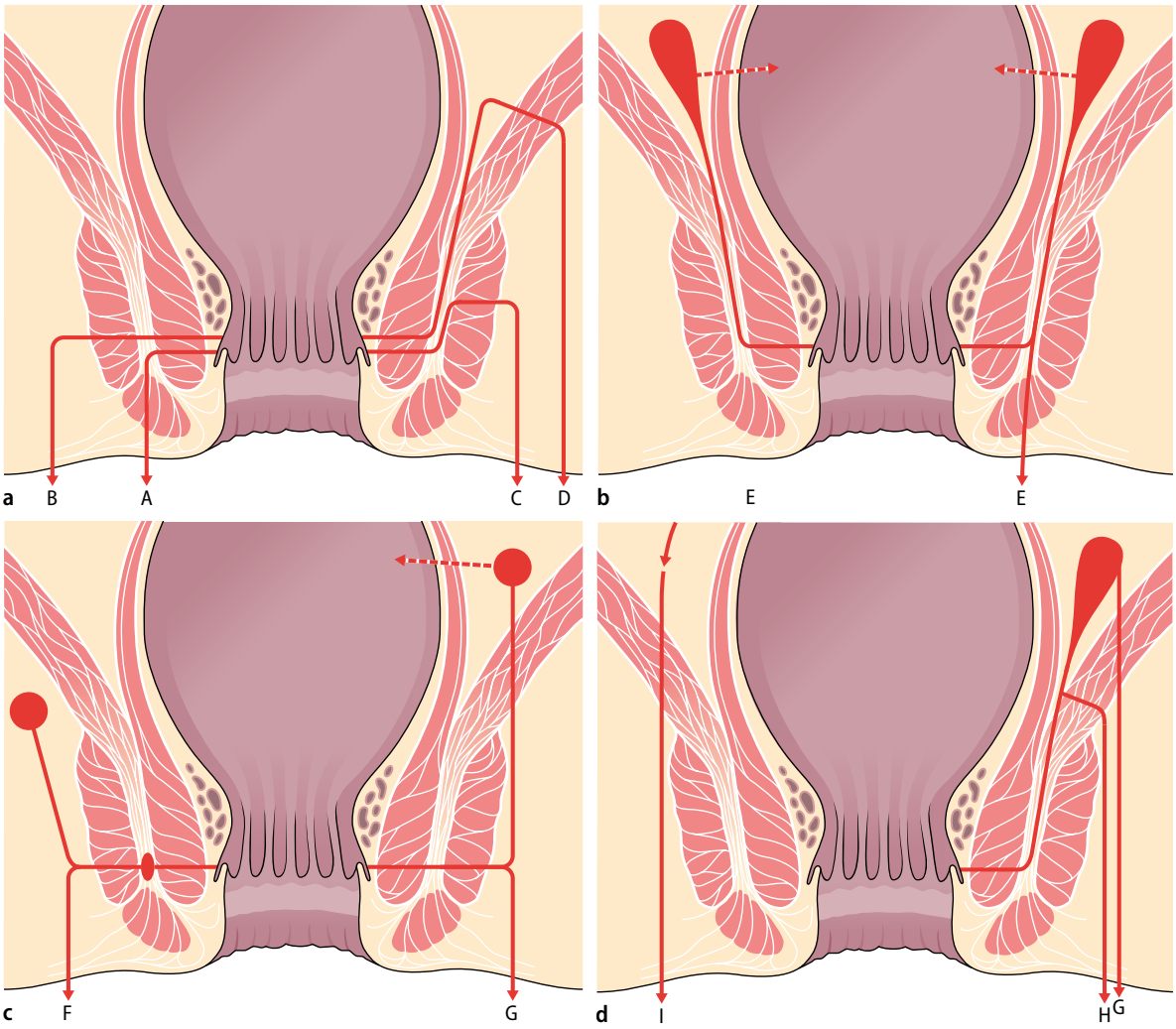


Fig. 21.11a–d Classification of anal fistulas according Parks et al. [68]: *A* intersphincteric fistula; *B* low transsphincteric fistula; *C* high transsphincteric fistula; *D* suprasphincteric fistula, *E* intersphincteric fistula with high tract extension and possible rectal opening; *F* transsphincteric fistula with high blind tract; *G* extrasphincteric fistula secondary to anal fistula; *H* suprasphincteric fistula; *I* extrasphincteric fistula

21.5.4 Surgical Treatment

Anal fistulas do not heal spontaneously without surgery. As anal fistulas are the result of infection of the anal glands, in 90% of cases the "infecting source" (i. e. the anal gland and duct) must be removed to allow healing of the tract. A precise definition of the anatomy of the fistula should be obtained before treatment. An approved method is sonography. Surgery must achieve the following goals:

1. Preservation of continence
2. As little cicatrisation as possible

Various methods have been described. The choice must be adapted to the course of the tract in relation to the sphincter. In order to avoid subsequent incontinence, it is crucial to know if there has been any sphincter damage, particularly in women; therefore, preoperative sonography is necessary. Even if there is total continence at the time of fistula operation, aging of the muscular system can result in incontinence.

21.5.4.1 One-Stage Fistulotomy and Fistulectomy

Fistulotomy involves the deroofing or laying open of a fistulous tract along a probe. Fistulectomy consists of the excision of all of the fistulous tract, granulation and dense fibrous tissues. Fistulectomy creates larger wounds and a greater separation of the ends of the sphincter, resulting in a longer healing time and increased risk of incontinence.

Fistulectomy and fistulotomy are easy to perform in cases of perineal, intersphincteric and low transsphincteric fistulas. If the fistulous tract crosses the external sphincter, a lay-open technique or fistulotomy results in some sphincter damage, depending on the amount of sphincter that is divided [82, 88].

21.5.4.2 Healing by Second Intention

After excision or incision of a fistulous tract, with more or less extensive excision of the skin, and after removing the intersphincteric anal gland, the wound is left open for healing by second intention (Fig. 21.12). Wounds are irrigated or washed several times a day and dressed by a nurse during the hospital stay or by the patients themselves. The application of petrolated gauze or dressings impregnated with antibiotics or wound-healing medium is not needed.

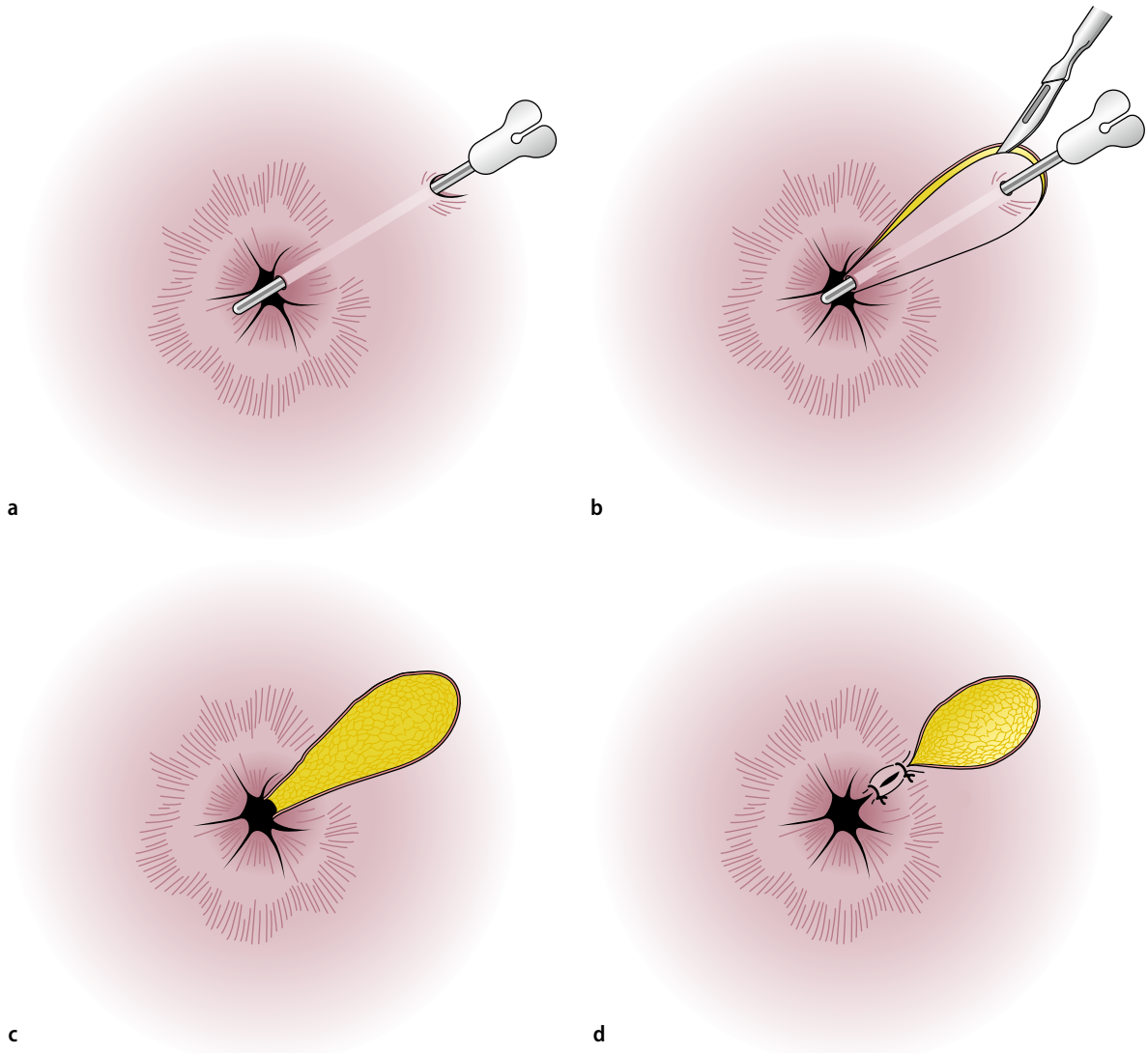


Fig. 21.12a–d Management of fistulectomy wounds: excision may be left open for healing by second intention (**c**); partially closed (**d**)

21.5.4.3 Primary Suture

There are several reasons why primary suture of wounds resulting from fistulectomy (Fig. 21.12) is unsound:

1. A contaminated haematoma may develop and lead to infection and recurrence of a fistula.
2. Exploration of any secondary or deep tract may be difficult.
3. If skin is excised, the suture will be under tension, with a risk of becoming loose.

After excision of the internal opening, partial suture at the level of the pectineal line and anoderm may nevertheless achieve haemostasis, speed up healing time and prevent an anal keyhole deformity. The outer part of the excision is left open to ensure drainage.

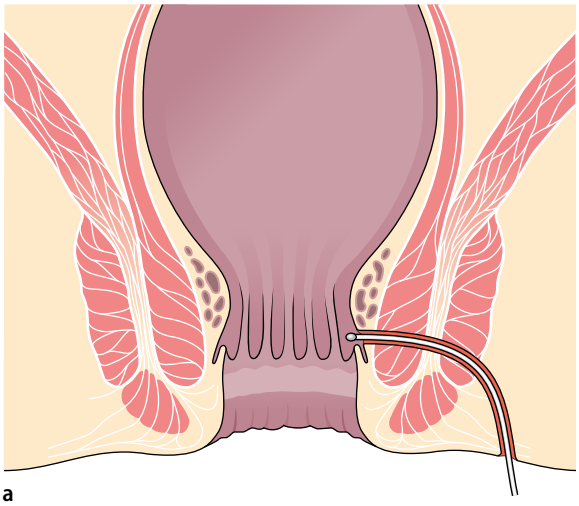
21.5.4.4 Two-Stage Fistulectomy

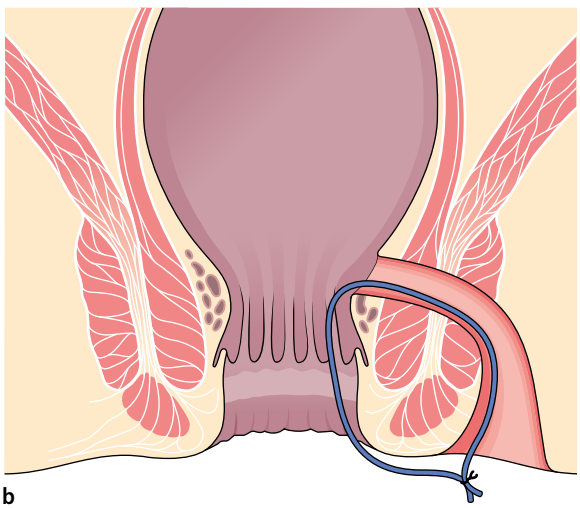
For transsphincteric fistulas in a low or a high location and for suprasphincteric fistulas, a two-stage procedure should usually be planned. In the first stage, the original abscess is exposed within the intersphincteric space, as described earlier (see Sect. 21.4.3.6). The relationship between the primary tract and the external sphincter and the puborectalis muscle must be determined. If the tract is low and if a sufficient amount of external sphincter is left above, a fistulotomy may be performed in the same session; the fistulous tract may be curetted or cored out. This tract may close spontaneously.

If there are doubts about the amount of sphincter left, the external tract outside the sphincter and within the ischiorectal space is excised widely to allow good drainage (Fig. 21.13). The external sphincter is denuded for 1–2 cm. Seton drainage made of a vessel loop (see Fig. 21.8) is passed through the tract across the external sphincter and tied loosely. No bridge of skin or anoderm should be left between the anal excision and the ischiorectal incision. The wounds are drained and dressed. The amount of functioning muscle enclosed by the seton is estimated later when the patient is conscious.

21.5.4.5 Long-Term Seton Drainage

Seton drainage can be left in place for many months. It can represent a definitive treatment in case of Crohn's disease, preventing recurrent abscess formation. Long-term seton drainage has proved helpful in managing anorectal sepsis secondary to AIDS [56].





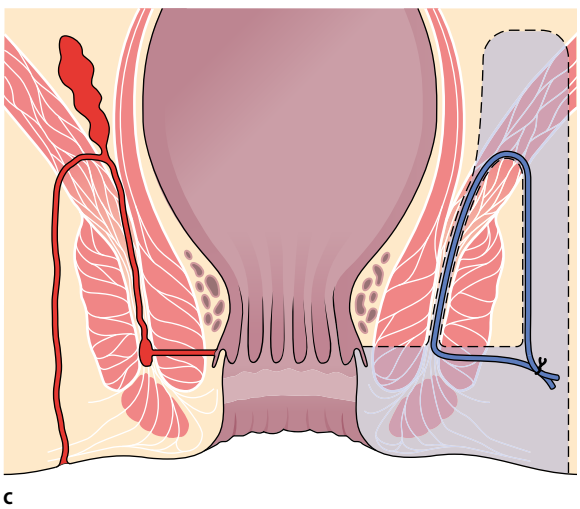


Fig. 21.13a–c Seton drainage in cases of: transsphincteric fistula (**b**) and suprasphincteric fistula (**c**)

21.5.4.6 Seton Drainage and Secondary Fistulotomy or Staged Fistulotomy

Seton drainage allows healing of the external wound with fibrous tissue bridging the external sphincter outside the fistulous tract. When complete healing of the external wound is achieved (from several weeks to 6 months later), a fistulotomy may be performed; the muscle may be divided even at the level of the puborectalis sling, preventing the sphincter edges from retracting and minimising the risk of post-operative incontinence [66, 89, 93]. Special attention is required for female patients (see above).

21.5.4.7 Cutting Seton

Different techniques have been proposed [56]:

1. A no. 1 nylon seton suture is fixed to a rubber band anchored to the posteromedial thigh via a safety pin and adhesive tape. The tension on the seton is adjusted for minimal discomfort and maximal effectiveness.
2. The monofilament seton is replaced by a rubber band. This band is tied progressively every 2–3 weeks to slowly cut the external sphincter and puborectal sling.
3. The monofilament seton, replaced by a rubber band, is tied every 2–4 weeks using a Barron band ligator.

The aim of such a treatment is to cut the muscular mass surrounded by the seton slowly in a similar way to a wire cutting slowly through an ice cube [7, 56, 57, 71, 93]. By reason of a very high incontinence rate, the cutting seton is inadvisable [80]. Furthermore, this method is very displeasing for the patients.

21.5.4.8 Fistulotomy and Primary Occlusion of the Internal Ostium with Mucosal Flap Advancement

This procedure consists of a conventional fistulectomy, an opening of the intersphincteric space through a partial excision of the internal sphincter, and occlusion of the former primary orifice of the fistula with mucosal flap advancement (Fig. 21.14) [8, 9]. This technique has been used for transsphincteric and for suprasphincteric fistulas. The complication rate is still high: suture dehiscence of the flap occurs in 9–20%, the recurrence rate varies from 8 to 17%, and significant impairment of continence develops in 21–43% of patients. Continence disorders result from the opening of the intersphincteric space and partial resection of the internal sphincter.

21.5.4.9 Sliding Flap Advancement

The prevalent procedure for transsphincteric and supralevatoric fistulas is the sliding flap advancement technique. The perianal fistular tract has to be excised funnel-shaped up to the external sphincter. A transanal incision has to be applied distal to the primary orifice and a flap is formed that ideally contains muscular mucosa. The primary orifice is excised (Fig. 21.14) [4, 5, 18, 41, 47, 52, 63, 65, 91]. The intersphincteric space is curetted. The gap through the external and internal sphincters is closed by separate stitches of absorbable material starting from the anal lumen. The size of the flap varies according to different authors. It must have a base twice the width of the apex, but the length should be as short as possible to reduce the risk of ischaemia. The flap is sutured to the lower edge of the mucosa. The suture line must lie distal to the previous muscle closure. The external wound is left open. If the wound below the pectineal line cannot be completely closed, the flap is sutured to the muscles below the previous opening [26]. No stoma is necessary, but a medical treatment with the aim of soft, formed faeces is administrable. The external wound should be cleaned at least twice daily with saline and disinfectant solution. This technique preserves a greater amount of sphincter than any other; it minimises star formation, avoids anatomic deformities such as keyhole deformity, and does not require any intestinal diversion. The success rate is very high (Table 21.4), and if the fistula recurs, the procedure should not be repeated within 3–6 months.

Functional results confirm that this technique does not change the median maximal resting pressure or the resting-pressure profile of the anal canal, because the external sphincter is preserved and no keyhole deformity is created [24]. The technique is used for chronic fistula; it can also be performed as the second stage after incision and drainage of a fistulous abscess with a seton. We have used it as the first and therefore the only stage in some selected cases of localised and small ischiorectal abscesses.

This technique has also been advocated in cases of fistula occurring in patients suffering from Crohn's disease; if anorectal mucosa is only minimally inflamed and if Crohn's disease is under control with or without

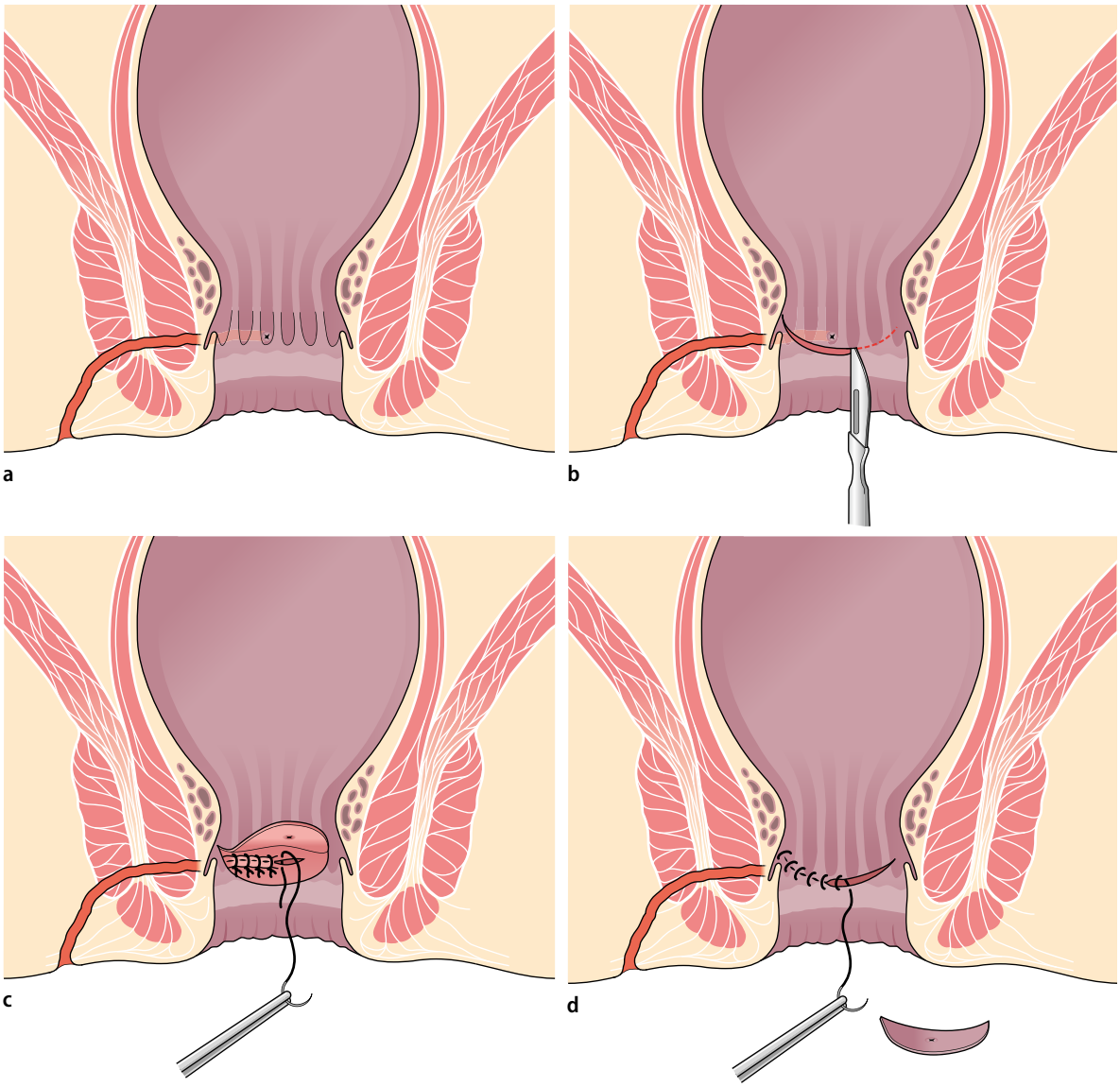


Fig. 21.14a–d Sliding flap. **a** Fistulous tract. **b** Coring out of all of the fistulous tract and mobilisation of a mucosal flap. **c** Closure of the muscular gap. **d** Suture of the mucosa

Table 21.4 Results of sliding flaps in the treatment of anal fistulas

Reference	Year	Treated (*n*)	Success rate (%)
Oh [62]	1983	15	87
Wedell et al. [91]	1987	30	96
Jones et al. [41]	1987	39	69.2
Koscinski and Marti [44]	1992	69	97
Oritz and Marzo [64]	2000	103	93

reduced amount of steroids, success rates of over 60% can be expected [41, 52, 65].

21.5.4.10 Anocutaneous Advancement Flap Repair

According to the sliding flap advancement procedure, the concept arose of sliding the flap from the perianal region orally instead of moving it from the rectum downwards. After excision of the inner fistula orifice,

the intersphincteric part has to be ablated. The external fistular tract has to be excised up to the external sphincter ani. A U-shaped flap of perianal skin and adjacent subcutaneous fat is designed for prevention of flap ischaemia. The gap in the sphincteric apparatus is closed by resorbable suture material and the flap is inserted into the defect. The perianal skin heals by second intent. Although the recurrence rate is quite high (20–25%) and incontinence occurs in 30% of cases [79, 94], this method remains accepted as therapy for recurrent fistulas when a rectal flap cannot be implemented.

21.5.4.11 Fistulotomy and Primary Sphincteral Reconstruction

In the case of refractory recurrent fistulas that cannot be incised due to their relationship with the sphincteric apparatus, it is a moot point whether another surgery with a diverting stoma will work out or a fistulotomy and simultaneous sphincteral reconstruction should be performed. If such a recurrent fistula is treated for a long time with a seton and retention of pus can be prevented, epithelialisation of the fistular duct can be expected and the local inflammation is healed. In this situation, a fistulotomy and primary sphincteral reconstruction is the proper option.

Our Technique

The fistula is incised and the adjacent sphincter has to be transected. The epithelial lining of the open fistular tract must be precisely dissected up to the anal canal for the preparation of a flap. The transected sphincteric muscle is reconstructed and adapted by resorbable single-knot suture. The flap that is sewn into the anoderm covers the reconstructed sphincter in the early phase, so that even in the case of flap necrosis the reconstructed area is adhered in the primary healing phase and a relapse is less likely. The external sphincteric orifice and a remnant of the fistula tract to the external sphincter ani are excised and the wound is left open.

In a small study, a fistulotomy with subsequent fistulectomy was performed. The muscle endings, which were marked by threads, were readapted in an overlapping manner and the wound was closed thoroughly. The patients were treated with orthograde intestinal lavage and antibiotic prophylaxis. Of 16 patients, 1 experienced a recurrence. The incidence of post-operative incontinence depends on the preoperative condition of the patient. Two out of eight continent patients were afflicted with incontinence of gas and soiling, The Wexner score for all incontinent patients improved from 8.5 to 1.875 [72].

21.5.4.12 Technique for Intramural or Intermuscular Fistula

Intramural or intermuscular fistulas may extend from the pectineal line high up into the rectum. If the tract below the anorectal ring is adequately opened and destroyed, the remaining tract above the ring will close spontaneously. If an abscess is present, a seton drainage may be applied for several days or weeks before the tract is opened. If the intramural abscess constitutes a diverticular extension of a transsphincteric fistula, it must be opened in the first stage of a two-stage fistulectomy [17].

21.5.4.13 Extrasphincteric Fistula

These fistulas may have a cryptoglandular origin, but occur more frequently as a result of Crohn's disease and as a complication of probing too deeply and surgical drainage of an abscess. In the case of Crohn's disease, a permanent seton should be kept in place for several months to prevent the formation of an abscess and to promote the growth of an epithelial lining. If the patient does not respond to this treatment or to metronidazole and 6-mercaptopurine, proctectomy must be considered (see Chap. 31). If the extrasphincteric fistula has a traumatic origin, a sliding flap advancement, as described earlier, or a low anterior resection with coloanal anastomosis must be considered.

21.5.4.14 Horseshoe Fistula

Horseshoe fistula is one of the most difficult conditions that an anorectal surgeon has to face [32, 69, 73, 86]. The primary fistulous opening is usually in a posterior midline crypt. If not previously drained by a seton, the primary tract is deroofed through a sagittal incision at the tip of the coccyx. The posterior anal space is opened. The Y-shaped portion of the tract in the postanal space, below the anococcygeal raphe, is excised. The remaining transsphincteric tract is drained with a seton (Fig. 21.9). The secondary openings are excised through radial incisions. The tracts are excised or cu-

retted but not deroofed in order to prevent large scars. As soon as the lateral wounds have closed, the primary tract may be excised or cored out, as described earlier. In our experience, this constitutes one of the best indications for a sliding flap in order to prevent any iatrogenic sphincter damage in the posterior midline and any keyhole deformity.

21.5.5 Post-operative Care After Fistulectomy

At the end of an operation for fistula, the wounds are kept apart with a gauze dressing soaked in antiseptic. Baths, showers or wound irrigations are recommended three to four times daily. In order to promote the healing from the depth of the wound, the skin edges should not have made contact so that new fistula formation is avoided. The wound must be kept clean.

Application of antibiotics to improve the prognosis is discussed. Better results are expected if the patient was pretreated 5 days preoperatively. A post-operative antibiotic treatment may be reasonable under unclean conditions, although the total duration of this therapy remains unclear.

Weekly inspection should be carried out by the surgeon. Pocketing and early bridging of the wounds must be avoided. Silver nitrate may be applied to prevent overgranulation and early bridging. Sphincter function must be evaluated soon after surgery, especially if seton drainage is in place. Bowel action should only be delayed in the case of a sliding flap. Bulky laxatives must be given to allow passage of stools without straining and to reduce pain. Non-steroidal anti-inflammatory drugs are useful to reduce local pain.

21.5.6 Results and Complications After Treatment

Satisfactory results may be achieved in the treatment of anal fistula. Results depend on the type of fistula. The healing time varies from 6 weeks for the low type to 16 weeks or more for the complex variety. Fistula surgery should be reserved for experienced surgeons in order to reduce as much as possible the high incidence of recurrence and prevent continence. Three main post-operative complications may occur after treatment of an anal fistula: recurrence, incontinence and mucorectal prolapse. The incidences of these complications are listed in Table 21.5.

21.5.6.1 Recurrence

Recurrence of anal fistula in cases of cryptoglandular origin is essentially due to failure to remove the correct anal gland. The internal opening may not be found and part of the tract may be buried under the granulation tissue, including the epithelial remnants [51, 83]. A recurrence rate of up to 10% is observed. It is also difficult to assess the adequacy of the initial manage-

Table 21.5 Results and complications after surgical treatment of fistula-in-ano

Reference	Patients (*n*)	Recurrence (%)	Incontinence (%)
Aguilar et al. [5]	189	0.01	0
Bennett [11]	108	2	36
Hill [39]	626	1	4
Koscinski and Marti [44]	55	6	0
Kubchandani [42]	137	5.8	–
Lilius [49]	150	5.5	13.5
Marks and Ritchie [53]	793	–	17–31
Mazier [55]	1000	3.9	0.01
McElwain et al. [58]	1000	3.6	7.0–3.2
Ortiz and Marzio [64]	103	7	8
Parks and Stitz [66]	400	9	–
Pearl et al. [70]	1732	1.8	–

ment from reports in the literature. If a fistula has been adequately treated and still recurs, the possibility of Crohn's disease must be considered.

21.5.6.2 Incontinence

Partial early post-operative incontinence is frequent after surgery of any fistulous tract and is the result of inflammation, tissue deformity, pain and the dressing [2, 88]. If the sphincter has been divided, the initial weakness regresses, and continence has proved to be adequate within 2–3 weeks. As many as one-third of the patients have some permanent disturbance in anal continence, varying from loss of flatus control to severe faecal incontinence. To prevent incontinence, there must be a sufficient time interval between the two operative sessions in a two-stage procedure. Division of the sphincter muscle must be kept to a minimum. In cases of transsphincteric fistula, a sliding flap is preferable to long and high fistulotomies. The sliding flap procedure reduces the risk of alteration of sphincter function, as proven by clinical and manometric studies [48]. If sphincter division results in persistent incontinence, sphincter repair must be considered.

21.5.6.3 Prolapse of the Rectum

Mucosal prolapse frequently occurs after sphincter division below the anorectal ring. The hypertrophic mucosa tends to obliterate the post-operative deformity. This prolapse is usually asymptomatic and should not be excised. If the anorectal ring has been divided, rectal prolapse with incontinence may occur. An abdominal rectopexy with suture of the levator ani must be considered.

21.5.7 New and Alternative Procedures

The surgery of anal fistulas is challenging and the results depend on the fistular course in relation to the sphincteric apparatus, the side tracts of the fistulas, the possible underlying disease (Crohn's disease) and last but not least on the surgeon's skill. Laying open of fistulas with a transsphincteric course involving a large amount of sphincter muscles is rejected at the expense of better results due to the risk of post-operative incontinence. Therefore, again and again new techniques are proposed.

21.5.7.1 Local Antibiotic Collagen Treatment

As a fistula before epithelialisation is a chronic inflamed duct, it seems evident that antibiotic treatment will improve the results. In a randomised study with 83 patients, 42 were treated with a gentamycin-collagen sponge placed under the flap and the fistular tract, respectively. No benefit was shown by this treatment compared with the solely surgically treated group [31].

21.5.7.2 Fibrin Glue

The idea of duct closure by glue is appealing. However, a precondition of definite healing is the absence of epithelialisation, as is seen in the early stages of anovaginal or rectovaginal fistulas. Furthermore, the inflammation with its proteolytic processes must not dissolve the glue before time. This method is technically very simple. A fine thread is pulled through the fistular tract and a plastic cannula is placed close to the internal orificium. After removal of the thread, the fibrin is injected into the duct by the cannula as it is pulled back slowly. The results of this method are not persuasive; although in particular cases a 100% success rate is reported, other authors report 0% success, a result that is consistent with our own experience [33]. Nevertheless, an attempt using glue therapy can be made as there is no morbidity and the option of subsequent surgery is not affected.

The attempt was made to apply fibrin glue as an adjunct to flap repair. A randomised study showed no advantage of this technique [22].

21.5.7.3 Fistular Plug

A further very new development is the use of a lyophilised pork submucosa plug (Surgisis AnoFistula Plug). The bioabsorbable xenograft has inherent resistance to infection, evokes no foreign-body or giant-cell reaction and is repopulated with host cell tissue within 3–6 months [59]. United States Food and Drug Administration approval was given in April 2005. The fistular duct is purified with a disinfectant solution without being enlarged. A thread is pulled through the fistular tract and attached to the tip of the cone-shaped plug. The plug is pulled through the anal canal into the fistula so that the large base is positioned under the internal fistular orifice. This has to be fixed so that the mucosa seals over the plug. Protruding parts have to be

cut at the level of the skin. The wound is left open on the external surface.

First results show a promising success rate of 87%. In a randomised study the healing rate was found to be significantly higher than with the fibrin glue procedure [40]. Even in cases of Crohn's disease, very good results of 80% healing were reported [61]. Unfortunately, recent studies do not indicate as good results.

21.6 Carcinoma

The occasional development of a carcinoma in a fistulous tract has been reported. The tumour is situated in the perianal and perirectal tissues and is of the mucoid adenocarcinoma type [20, 92]. Furthermore, free viable cancer cells from an upper rectal tumour may be grafted onto the granulation surface of a perianal fistula [43].

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Self-Assessment Quiz

Question 1

The optimal therapy for anorectal suppuration is:

a. Administration of broad-spectrum antibiotics
b. Wait for spontaneous drainage
c. Sitz baths
d. Deroofing the abscess
e. Short incision of indurated skin

Question 2

Timing and procedure for the treatment of perianal sepsis:

a. Wait for fluctuation in the area of suppuration.
b. Give an initial dose of broad-spectrum antibiotics.
c. Operation is mandatory, as soon as possible.
d. During emergency operation, fistula track probing is performed to place a seton.
e. Fistula therapy during emergency treatment is desirable.

Question 3

Post-operative care after abscess deroofing consists of:

a. Sitz baths and endosonography after a period of about 6 weeks
b. Vacuum-assisted closure therapy
c. Broad-spectrum antibiotics and endosonography after a period of about 6 weeks
d. No further care if properly operated
e. Always a second go for fistula treatment

Question 4

For fistula therapy, which of the following statements is true?

a. The advancement flap procedure provides the best results in all types of fistula.
b. Incontinence due to surgery is the greatest concern in fistula therapy.
c. A cutting seton results in healing with a very low rate of incontinence.
d. The classification of the fistula has no major influence on the choice of treatment.
e. None of the answers is correct.

Question 5

Extrasphincteric fistulas:

a. Are caused by *Neisseria gonorrhoea*
b. Are most often caused by a rectal cancer
c. Are related to immune deficiency
d. Need a search for Crohn's disease
e. Are the second most frequent type of fistula

1. Answer: d
2. Answer: c
3. Answer: a
4. Answer: b
5. Answer: d
   Comments: Gonorrhoea causes an inflammation of the anal canal and proctitis. Perineal fistulas originate from the urethra and not the intestinal tract.

22 Malignant Tumours of the Anal Canal and Margin

Syed A. Hyder and Christopher Cunningham

CONTENTS

22.1 Incidence of Anal Cancer

Cancer of the anal canal is an uncommon malignancy and accounts for less than 4% of large bowel cancers. It affects around 800 people in the UK and 3,400 in the USA per annum. The incidence is rising worldwide, but particularly in the USA, with San Francisco having the highest incidence, attributed to a large homosexual male population [1].

22.2 Anatomy

The palpable upper edge of the junction of the puborectalis and anal sphincter marks the start of the anal canal, which ends at the intersphincteric groove 2 cm distal to the dentate line (Fig. 22.1). The anal margin accounts for the area of 5 cm circumferentially from the intersphincteric groove.

22.3 Aetiology and Pathogenesis

There is a strong association between the human papilloma virus (HPV) and anal cancer. HPV type 16 is most commonly implicated, but HPV types 18, 31 and 33 are also associated [2]. Human immunodeficiency virus (HIV)-positive homosexual men have a 30- to 80-fold increased rate of anal carcinoma compared with the general population. Various additional factors have been associated with an increased risk of anal cancer. Frisch et al. [3] reported that all risk factors for

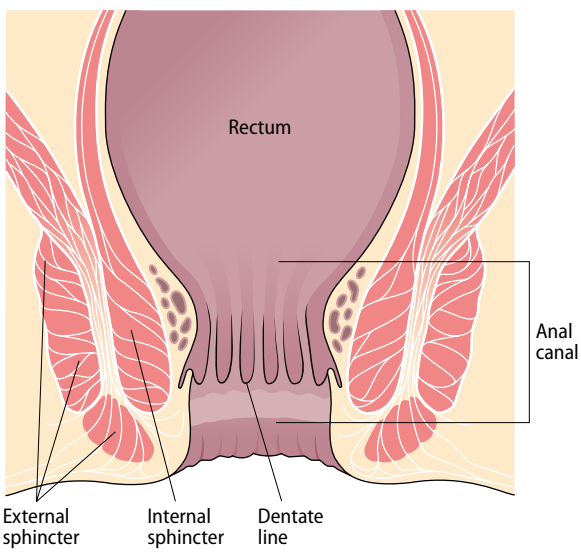

Fig. 22.1 Anatomy of the anal canal

anal cancer were consistent with sexual transmission, and include high number of sexual partners, receptive anal intercourse, unmarried status and history of sexually transmitted disease. Other important causes include homosexuality, anal condylomata, chronic irritation, smoking, increasing age and immunosuppression. Penn [4] reported an analysis of 65 patients with renal transplant, and found a 200-fold increased risk of anal cancer in those patients who were maintained on immunosuppressive drugs, a finding that is supported by Adami et al. [5]. It has been reported that smoking alone is associated with a two- to five-fold increase in the incidence of anal cancer [6].

Chronic anal irritation has also been suggested as a possible predisposing factor for anal cancer. The development of anal cancer in chronic benign conditions has been reported, including anal fistula, condylomata acuminata and leucoplakia. Patients with longstanding Crohn's disease have also been reported to have a higher risk of developing anal carcinoma [7, 8].

22.4 Classification of Anal Cancer

On the basis of their anatomy, tumours can be divided into anal canal tumours and tumours of the anal margin. The World Health Organisation (WHO) classification of anal cancer is provided in Table 22.1.

Table 22.1 World Health Organisation classification of carcinoma of the anal canal and anal margin

Intraepithelial neoplasia	Squamous transitional epithelium Glandular Anal cancer
Carcinoma	Squamous cell carcinoma Adenocarcinoma Mucinous adenocarcinoma Small cell carcinoma Undifferentiated carcinoma Others
Anal margin tumours	Squamous cell carcinoma Basal cell carcinoma Bowen's disease Paget's disease Kaposi sarcoma

22.5 Squamous Cell Carcinoma

This is the commonest form of anal cancer, accounting for 70%. It is marginally more common in women, with a maximum incidence in the sixth and seventh decades of life. Traditionally, squamous cell carcinoma of the anal canal has been divided into large non-keratinising, large keratinising and basiloid types. However, the revised WHO classification recommends that squamous cell carcinoma should be used for all histological variants [9] as no significant prognostic difference has been shown between the different morphological types [10, 11].

22.6 Symptoms

Pain and bright red rectal bleeding are presenting features in almost 50% of patients. Bleeding is usually more constant than that associated with the haemorrhoids. Less common presentations include itch, discharge, tenesmus and an anal lump. Faecal incontinence and pain may be present depending on the extent of local invasion of the sphincter. Delay in diagnosis is common, as many of these symptoms are non-specific, with most (70–80%) being initially diagnosed as benign anorectal conditions [12].

22.7 Clinical Findings and Diagnosis

Careful inspection of the perianal area can often permit diagnosis. Pain is a common feature of advanced disease, and a thorough assessment of the site and degree of tumour invasion benefits from formal examination under anaesthesia. Routine clinical examination for groin lymphadenopathy is performed. The primary tumour is biopsied for histological confirmation, and suspicious groin lymph nodes may be sampled by fine-needle aspiration. Traditional teaching emphasises the spread of anal cancer to the ipsilateral groin nodes, which is seen in 36% of patients at presentation. However, lymphatic spread to the superior rectal nodes is an earlier event that is present in 43% of patients. Tumour size, depth of invasion and lymph-node involvement have an adverse effect on prognosis. Distant metastases are most often found in the liver and lung, and less frequently bones and subcutaneous tissues; 10–30% of patients develop distant disease [13, 14], and the 5-year survival in this group is 18% [13].

22.8 Staging

Local disease is staged by ultrasound, magnetic resonance imaging (MRI) and careful clinical examination usually performed under anaesthesia. At presentation, 30–50% of patients have locally advanced disease, with a mean tumour size of 3–4 cm (Fig. 22.2) [15]. Lymphatic spread to the groin may be detected by clinical examination, but this is unreliable as 14% of involved nodes are less than 5 mm in size [16]. This area is best assessed by MRI.

The most common sites of distant disease are the liver and lung, and these are assessed primarily by computed tomography (CT) scan of the abdomen and chest. Equivocal abnormalities on CT may be further investigated by MRI or positron emission tomography scanning. Visceral metastases are present in 10% of patients at the time of diagnosis [17]. Some success in lymphatic mapping and sentinel lymph-node biopsy has been reported in squamous cell carcinoma of the anal canal; however, these are not widely employed.

The most commonly employed staging system was introduced in 1997 by the American Joint Committee on Cancer (Table 22.2) to determine the local extent of the disease, lymphatic spread and distant metastases. This pathological staging system was devised when surgery was considered the primary treatment. Most resections now follow combined modality treatment (CMT), and a new pathological staging system has been proposed for classifying residual or recurrent disease after this treatment with a view to offering prognosis in this group [18].

22.9 Treatment

Small anal-margin lesions can be treated safely by local excision alone with excellent results, avoiding the need for non-surgical therapy. Larger tumours, or those in the anal canal, were treated by abdominoperineal resection (APR) with a wide perineal resection [19]. The reported local failure rate varied between 30 and 50%, with 5-year survival was in the range of 40–70%. CMT is now the mainstay of treatment in squamous cell cancer of the anus, and for historical interest the evolution of this approach will be considered.

22.9.1 Radiotherapy

Anal cancer is a radiosensitive tumour and experience in primary treatment with radiotherapy was initially described in the 1920s [20]. It offered the potential to preserve sphincter function and avoid the high morbidity and mortality associated with APR. Treatment is based on two methods, external beam radiation therapy (EBRT) and interstitial radiotherapy, either alone or in combination. James et al. [21] reported local tumour control of 47% using interstitial irradiation alone. High-dose EBRT showed a 5-year survival rate of 75% at 3 years [22]. EBRT combined with interstitial therapy was associated with a 5-year survival of 50–94%, which is comparable to CMT, but was associated with a high complication rate [23–25].

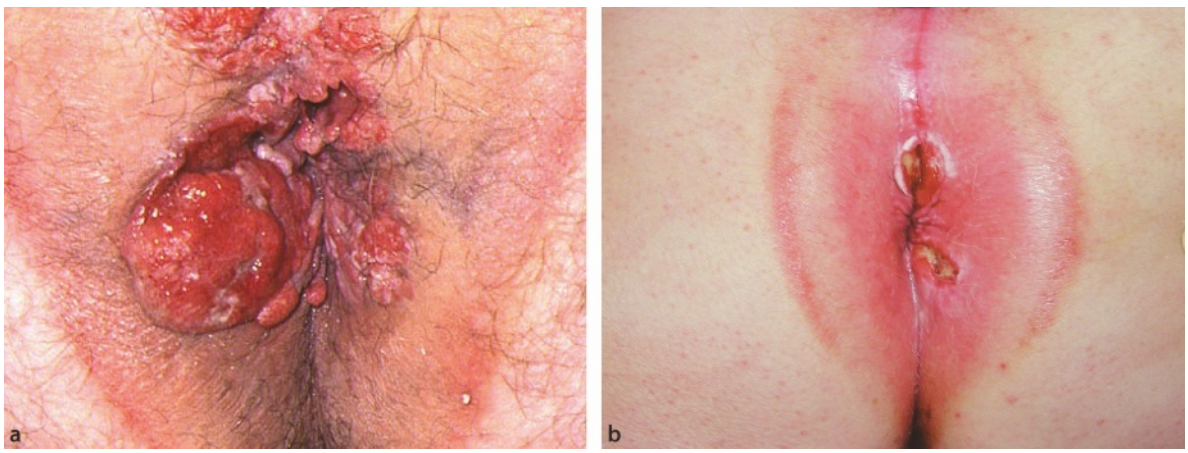

Fig. 22.2 Anal cancer. **a** Locally advanced fungating anal cancer. **b** Synchronous squamous cell cancer in a human-immunodeficiency-virus-positive patient

Table 22.2 Staging method devised by the American Joint Committee on Cancer

T	Primary tumour		
	TX	Primary tumour cannot be assessed	
	T0	No evidence of primary tumour	
	Tis	Carcinoma in situ	
	T1	Tumour 2 cm or less in greater dimension	
	T2	Tumour more than 2 cm but not more than 5 cm in greater dimension	
	T3	Tumour more than 5 cm in greater dimension	
	T4	Tumour of any size invades adjacent organ(s) (e.g. vagina, urethra, bladder, involvement of sphincter alone is not classified as T4)	
N	Regional lymph nodes		
	NX	Regional lymph nodes cannot be assessed	
	N0	No regional lymph-node metastasis	
	N1	Metastasis in perirectal lymph node(s)	
	N2	Metastasis in unilateral internal iliac and/or inguinal lymph node(s)	
	N3	Metastasis in perirectal and inguinal lymph nodes and/or bilateral internal iliac and/or inguinal lymph nodes	
M	Distant metastasis		
	MX	Distant metastasis cannot be assessed	
	M0	No distant metastasis	
	M1	Distant metastasis	
Stage 0	Tis	N0	M0
Stage I	T1	N0	M0
Stage II	T2	N0	M0
	T3	N0	M0
Stage IIIA	T1	N1	M0
	T2	N1	M0
	T3	N1	M0
	T4	N0	M0
Stage IIIB	T4	N1	M0
	Any T	N2, N3	M0
Stage IV	Any T	Any N	M1

22.9.2 Combined Modality Therapy

Nigro's report of CMT for anal cancer, published in the 1970s [26], revolutionised our approach to the treatment of anal cancer. CMT resulted in complete pathological response in a proportion of patients who underwent APR as planned. Subsequently, some patients with complete clinical response avoided surgery and it became clear that this approach could offer a cure. Ten years later [27], Nigro reported on a follow-up in 104 patients who received CMT. Complete response was achieved in 97 of these patients, with an overall survival of 88%, avoiding permanent colostomy and preserving sphincter function.

The work of Nigro has been confirmed by other studies. There have been three large randomised trials by the European Organisation for Research and Treatment of Cancer (EORTC), the UK Coordinating Committee on Cancer Research (UKCCCR) and the Radiation Therapy Oncology Group (RTOG)/Eastern

Cooperative Oncology Group (ECOG), which clearly define the benefit and protocols of CMT.

The UKCCCR is responsible for the largest multicentre anal cancer trial [28] in which outcomes using radiotherapy alone versus radiotherapy, 5-fluorouracil (5-FU) and mitomycin C were assessed. A total of 585 patients were randomised to receive 45 Gy radiation in 20–25 fractions over 4–5 weeks alone or combined with 5-FU (1,000 mg/m² for 4 days or 750 mg/m² for 5 days) by continuous infusion in the first and final weeks of radiotherapy, with mitomycin C on day 1 of the first course. The clinical response was determined 6 weeks after initial treatment. Good responders (> 50% tumour regression) were recommended for boost radiotherapy and poor responders (< 50% tumour regression) for salvage surgery. After a median follow-up of 42 months, 59% of patients receiving radiotherapy alone suffered local failure, compared with 36% of CMT patients. This gave a 46% reduction in the risk of local failure in the CMT group. There was more significant early morbidity in the CMT group, but late morbidity occurred at a similar rate in both arms. There was no overall survival advantage. The same CMT protocols were used by an EORTC study [29] in which a total of 110 patients was recruited. Treatment comprised 45 Gy in 25 fractions over 5 weeks and results were evaluated at 6 weeks. A further 15 or 20 Gy was given to patients with complete and partial response, respectively. In the CMT group 5-FU (750 mg/m²/day for 5 days) was delivered as a continuous infusion in the 1st and 5th weeks of radiation and a single bolus dose of mitomycin C on day 1. CMT showed a higher complete response rate of 80%, as compared to 54% in the radiation-alone arm. The overall survival was similar in both groups.

An RTOG/ECOG trial randomised 310 patients [30]. The radiation dose was 45–50.4 Gy in 25–28 fractions over a period of 5 weeks. Continuous intravenous infusion of 5-FU (1,000 mg/m²/day for 4 days) alone was given in the 1st and 5th weeks or with a single dose of mitomycin C (10 mg/m²) on day 1. Biopsies of the primary tumour site were performed after 6 weeks. These were positive in 14% of the patients who received 5-FU alone versus 8% in group who had 5-FU and mitomycin C. Again, overall survival was similar in both groups; however, disease-free survival was improved (65% versus 50%) in those receiving radiation along with 5-FU and mitomycin C. Fatal toxicity was noticed in four patients treated with radiation and both drugs, compared to single fatality in the group who had radiation and 5-FU alone.

In non-randomised studies, Beck and Karulf [31] reported 35 patients with squamous cell cancer treated with a combination of chemotherapy and radiotherapy using 5-FU and mitomycin C. Only one patient required APR for persistent tumour, and the 5-year survival rate using life-table analysis was 89%. Similar results were reported by Grabenbauer et al. [32]. Sphincter function was preserved in 91% of the patients and APR was reserved as a salvage procedure in those with persistent cancer after CMT or those who developed recurrent disease.

These trials show CMT to be superior to any single-modality treatment, and this approach offers a reduction in local failure while avoiding major surgery and permanent colostomy in the majority of patients.

The management of anal cancer in HIV-infected individuals presents a challenge. These patients are intolerant to CMT and show an inferior response to treatment. Kim et al. [33] compared the treatment of anal cancer in patients between HIV-positive and HIV-negative patients. HIV-positive patients were less likely to have a complete clinical response (65% vs 85%), more likely to have grade 3 or 4 acute toxicity (80% vs 30%) and more likely to die from the cancer (38% vs 27%).

22.9.3 Optimum Chemotherapy Drugs

Various chemotherapy drugs have been studied to identify the optimum cytotoxic for use alone or in combination. In addition to 5-FU and mitomycin C, these drugs include cisplatin, carboplatin and bleomycin. Among these, cisplatin has gained most popularity. Cisplastin has been shown to enhance the effect of radiation and was also found to be less toxic. A few studies have assessed the use of chemoradiation with 5-FU and cisplatin with promising results [34–36]. Radiotherapy combined with mitomycin C and cisplatin or 5-FU in locally advanced anal cancer is currently the subject of a randomised study by the EORTC.

22.9.4 Treatment Response and Surveillance

There is no agreed surveillance guideline for patients with anal cancer, but careful follow-up is mandatory. A typical programme would involve an initial assessment 6 weeks after treatment, with 3-monthly clinical examinations including proctoscopy for the 1st year and 6-monthly for another 2 years. If residual disease after treatment is suspected, care should be taken to

avoid early biopsy as this can result in ulceration or fistulation. It can be difficult to differentiate between malignancy and an inflammatory response, but biopsy should be deferred for a few months after the treatment if the suspicion persists. CT scan for distant disease and MRI for assessing the primary site and draining lymph nodes should performed at 12 and 24 months.

22.9.5 Treatment of Nodal Disease

Inguinal lymph-node metastases occur in 15–60% [17] of patients with anal cancer at some stage during their disease. Histological confirmation by fine-needle aspiration cytology or biopsy is preferred. Inguinal regions are usually included in the initial radiation field for anal cancer. A high rate of morbidity is associated with dissection of the irradiated inguinal region. In synchronous nodal disease, radiation treatment to the nodes provides disease control rates of 65%, and with CMT this increases to 90% [37]. In metachronous or recurrent inguinal disease, dissection of the lymph nodes can provide good long-term control, with a 5-year survival of over 50% [38, 39].

22.9.6 Management of Residual and Recurrent Disease in the Anus

Anal disease arising within 6 months of treatment is considered residual, and that identified after 6 months is considered recurrent [40]. Renehan et al. [41] reported the results of 254 patients treated with radiation or chemoradiation and evaluated local disease failure and outcome of salvage surgery. Further chemoradiotherapy alone for recurrent or residual disease is noncurative. APR as salvage for locally recurrent or residual disease, with posterior vaginectomy as part of the procedure in women, has been suggested as the preferred approach. The overall 5-year survival for salvage surgery after CMT is 24–47% [40, 42–45]. The major morbidity associated with salvage surgery is perineal wound breakdown, poor healing and infection, reported in 30–60% cases and attributed to the effects of irradiation and the presence of a large skin defect [45, 46]. This can be improved with the use of myocutaneous flap reconstruction, most often from the rectus abdominus muscle [47]. Salvage surgery is more effective for recurrent rather than persistent disease after CMT [40, 48].

22.10 Adenocarcinoma of the Anal Canal

Adenocarcinoma of the anal canal is rare and there is often diagnostic doubt between true anal canal cancer, most likely arising from anal glandular tissue, and direct invasion from very low rectal cancers. These account for around 5% of all anal cancers [49] and there is a lack of clarity in the literature regarding the precise incidence, aetiology, treatment options and prognosis. Reports are usually based on small retrospective series or case reports. Chronic anal irritation or inflammatory conditions have been suggested as possible causes, and several cases have been described arising in chronic fistulae of Crohn's disease. The disease is regarded as aggressive, with a higher risk for local and distant recurrence than for squamous cell carcinoma of the anus [50]. Historically, APR was the treatment of choice; now, however, CMT regimens similar to those used to treat squamous cancer are employed, but these are usually followed by APR providing patient fitness allows. Myerson et al. [14] reported in 1993 that surgery alone was performed in 36.8% of 230 patients identified with anal adenocarcinoma. Chemoradiotherapy was given to only 9% of these patients. The overall resection rate with or without adjuvant therapy was 77.4%. A similar high rate of surgical treatment was observed in a survey of the American Society of Colon and Rectal Surgeons [51], which showed that 77% of 52 patients underwent initial surgery. In another retrospective analysis by Klas et al. [12], 61% of 36 patients in their series underwent surgery as a primary treatment. Of note, at the time of presentation 9.8% of patients with adenocarcinoma had stage IV disease, compared with 5% of those with squamous carcinoma.

Belkacemi et al. [50] reported a large study on 82 patients with primary adenocarcinoma of the anal canal showing that combined chemoradiotherapy increased survival with low risk of toxicity compared to other modalities. They also suggested that APR should be reserved as the treatment of choice for salvage treatment for residual tumour and recurrent disease. A smaller study [52] demonstrated a higher rate of recurrence at the primary site compared to squamous cancer of anus after CMT. This group recommends preoperative chemoradiation followed by APR to maximise pelvic disease control. The use of CMT and APR has also been reported as a favourable approach, with a 2-year survival of 62% [53]. However, this study included only 13 patients, underlining the difficulties of determining optimum treatment in this rare cancer.

22.11 Bowen's Disease

Bowen first described this disease in 1912 as a precancerous dermatosis [54]. The disease in the perianal region was first described by Vickers et al. [55]. Bowen's disease is an intraepithelial squamous cell carcinoma. There is a female predominance to the disease, with the highest incidence occurring in the fifth decade of life. Progression to invasive carcinoma occurs in 2–6% of cases [56–58]. Associated malignancy has been reported in 4.7% of these patients [57]. Common presentations are anal discharge, perianal burning, bleeding, sensation of lump in the anal canal and pruritus, or the disease may be asymptomatic. Twenty five to 40% of cases are discovered incidentally on histological examination of haemorrhoidectomy specimens [59]. These lesions appear as well-defined, scaly or crusting plaques, usually erythematous with sharp borders. Diagnosis should be confirmed by histology. Microscopic findings are similar to the Bowen's disease found in other sites. Dyskeratotic and mitotically active cells with large, atypical nuclei are seen with in acanthotic epithelium, sometimes showing hyperkeratosis and parakeratosis.

Various treatment options have been reported including argon laser therapy, 5-FU cream and cryosurgery. Graham et al. [60] showed good results with 16 weeks of topical 5% 5-FU, used on eight patients, seven of whom were free of Bowen's disease 1 year after completion of therapy. Wide local surgical excision is considered as the therapy of choice, and closure can be achieved by primary closure, split-thickness skin graft and advancement flaps. Although some controversy exists regarding the extent of the surgical disease-free margin required, this can be assessed intraoperatively by frozen section of four quadrants.

Recurrence of Bowen's disease after therapy depends on poorly defined areas of involvement, a poor immune response, follicular involvement, dense scar tissue, persistent or recurrent HPV infection and poor compliance with topical therapy [60]. Long-term follow-up is recommended with repeat biopsy and colonoscopy.

22.12 Paget's Disease

Sir James Paget [61] first described this disease in the breast in 1874 and suggested that it might also be found in other areas. Darier et al. [62] reported the first case of perianal Paget's disease in 1893. Paget's disease is an intraepithelial adenocarcinoma arising from the dermal apocrine sweat glands. It is a rare condition, usually presenting in the sixth and seventh decades of life and is more common in women. The progression of Paget's disease into an invasive carcinoma in untreated cases is as high as 40%. There is also a 52–73% incidence of associated malignancies in these patients [63]. Patients usually present with a long history of intractable pruritus ani, bleeding and discharge, perhaps with an anal lump. These lesions are raised, scaly and erythematous, and biopsy of the lesion is necessary to confirm the diagnosis and exclude carcinoma. Four-quadrant or multiple-punch biopsies are recommended for mapping, as Paget's cells may extend beyond the gross margins of the lesion [64]. Microscopic findings are characteristic, with large, pale, vacuolated cells and hyperchromatic eccentric nuclei. Differentiation from Bowen's disease can be made by the presence of mucoproteins that stain with Alcian blue. Treatment is usually wide local excision and may require a skin graft or flap closure. There is a high incidence of local recurrence in up to two-thirds of patients, and it may carry significant morbidity [65, 66]. Other treatment modalities are available, such as radiotherapy and photodynamic therapy, which can be used in selected cases. Shieh et al. [67] used photodynamic therapy to achieve a complete clinical and functional response in 50% of 16 treatment sites in 5 patients. Long-term follow-up is required for these patients. Thorough clinical examination, along with biopsy of any suspicious area is mandatory. Paget's disease has a high incidence of associated cancer, and colonoscopy should be performed at 3-yearly intervals to rule out any colorectal malignancies.

22.13 Malignant Melanoma

Malignant melanoma is a very rare tumour comprising less than 1% of all anal cancers. It arises from melanocytes found in the mucosa of the anal transitional zone above the dentate line or the non-keratinising squamous mucosa below the dentate line [68]. It typically presents with bleeding, pain or a mass, and may mimic a thrombosed haemorrhoid. One-quarter of lesions are amelanotic. The incidence of regional lymph-node or distant metastases at presentation ranges between 28 and 63% [69–72]. Goldman et al. [72] reported 49 cases of anal malignant melanoma, with female predominance and tumour ranging between 2 and 5 cm in diameter. Local excision was compared with APR. Most patients

died from distant disease and APR offered no benefit in disease control or survival. However, this was challenged by a more recent series in which all long-term survivors had undergone APR [73]. Tumour thickness may be prognostic for anal melanoma, but this appears to be less reliable than at other sites. Wanebo et al. [74] reported three patients with a tumour thickness less than 2 mm who survived disease-free for 10 years, but all patients with tumours >2 mm thick died within 5 years. However, long-term survival has been reported in a later series from the same centre in patients with melanomas 2.5- to 6-mm thick treated by APR [73]. In contrast, early melanoma can be associated with poor prognosis, as seen in one series where a patient with a 0.9-mm tumour had diffuse metastases at presentation [75].

22.14 Anal Intraepithelial Neoplasia

Anal intraepithelial neoplasia (AIN) is a precursor to squamous cell carcinoma of the anal canal and was first described by McCance et al. in 1985 [76]. The presence of HIV and genital warts are risk factors for the development of AIN and the incidence is equal in the two genders. Patients with AIN may be asymptomatic or present with a variety of symptoms including bleeding, discharge, pruritus ani, erythematous scaly lesions or condyloma. The disease is confirmed on biopsy and the degree of dysplasia assessed from I to III on the basis of the extent of dysplastic involvement of the epidermis. Histologically, this appears as a thickened epithelium in which undifferentiated cells with a high nucleocytoplasmic ratio extend from their usual basal position towards the mucosal surface. The natural history of AIN is uncertain and poorly understood. Most data available to assess the progression of AIN are gained from the experience of gynaecological intraepithelial neoplasia: malignant progression of cervical intraepithelial neoplasia III to invasive cancer over a period of 20 years is approximately 35%. AIN III is a high-grade lesion and has a significantly higher potential for malignancy. Schofield et al. reported 32 patients with AIN III, 5 of who developed cancer at median follow-up of 18 months [77]. Patients with multifocal AIN III and systemic immunosuppression display an increased risk of malignant progression [78]. AIN I and AIN II are low-grade lesions that are unlikely to become malignant, but over time may progress to AIN III [79].

AIN I and AIN II are managed conservatively with close surveillance at an interval of 6–12 months, depending on the extent of the disease. Any change in symptoms or extent of the disease warrants further biopsy. Surgery is often the treatment of choice for patients with symptomatic AIN III. There is a significant morbidity associated with the excision of these lesions, which may involve a larger circumferential area. Wide local excision with or without skin graft or advancement flaps is usually advocated depending on the size of the defect. Various other treatment modalities are available, although less favourable (e. g. cryotherapy and laser treatment). These treatment options are associated with significant tissue damage that can make subsequent histological assessment difficult.

22.15 Conclusion

Anal cancer is a rare condition and it is apparent that advances have arisen from work in specialist high-volume centres supported by multicentre randomised trials. This is demonstrated in anal squamous cell cancer in which treatment strategies have changed dramatically in the last 30 years with subsequent improvement in outcomes. Further advances in squamous cancer treatment are likely to come from the use of novel chemotherapies, with the role of surgery remaining for salvage of residual or recurrent disease. Our understanding of rarer diseases such as adenocarcinoma and malignant melanoma is poor, largely as a result of limited experience in treating these cancers. This certainly supports the concept of centralisation of treatment to specialist centres and encouraging inclusion in multicentre trials. The management of AIN continues to pose challenges, particularly in the immunocompromised population. Again it is likely that the concentration of expertise in this area will be more likely to result in meaningful developments and rationalisation of treatment protocols.

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Self-Assessment Quiz

Question 1

Anal squamous cell carcinoma:

a. Chemoradiation is the primary treatment of choice.
b. It is a radioresistant tumour.
c. Its incidence does not increase in patients with human papilloma virus or human immunodeficiency virus.
d. It accounts for almost 50% of all anal cancers.
e. Nearly 75% of these cancers are locally advanced at the time of presentation.

Question 2

Lymph-node and distant metastasis in anal cancer:

a. Almost 5% of patients with anal cancer have lymph-node involvement on presentation.
b. Sentinel lymph-node biopsy is the gold standard to assess nodal involvement in anal cancer.
c. Superior rectal nodes are usually the lymph nodes to metastasise.
d. Lymph-node involvement does not depend on the size of the tumour.
e. Visceral involvement is seen in 30% of patients on diagnosis.

Question 3

Paget's disease of the anus:

a. Is an intraepithelial adenocarcinoma arising from dermal apocrine sweat glands
b. Has a very low incidence of associated malignancy
c. Has a higher incidence in females
d. Is rarely associated with local recurrence
e. Progresses to an invasive carcinoma in more than 95% of untreated lesions

Question 4

Bowen's disease of the anal margin:

a. Has a male preponderance
b. Has its highest incidence in the seventh decade of life
c. Progresses to invasive cancer in approximately 50% of cases
d. Is an intraepithelial squamous cell carcinoma
e. Is associated with an extremely high incidence malignancy

Question 5

Anal intraepithelial neoplasia (AIN):

a. AIN I and AIN II can progress to AIN III.
b. Surgical excision is first-line treatment for AIN I and AIN II.
c. AIN is more common in females.
d. AIN is unrelated to intraepithelial neoplasia of the cervix and vulva.
e. It can be considered as carcinoma-in-situ of the anus.

1. Answer: a
   Comments: Over 70% of anal cancers are squamous in origin. The first-line treatment for these cancers is chemoradiation, similar to what is described by Nigro et al. [26].
2. Answer: c
   Comments: The first group of lymph nodes that metastasise is the superior rectal, followed by the inguinal and lateral pelvic nodes. Lymph-node spread is seen in around 30% of patients.
3. Answer: a
   Comments: Sir James Paget described this lesion in breast tissue in 1874; it is an intraepithelial adenocarcinoma arising from dermal apocrine sweat glands. The incidence of associated malignancy is very high, in the region of 50–73%. It has an equal gender distribution.
4. Answer: d.
   Comments: Bowen's disease is an intraepithelial squamous cell carcinoma with female preponderance and has its highest incidence in the fifth decade of life. The incidence of associated malignancy is 4.7%.
5. Answer: a
   Comments: AIN is a precursor to squamous cell carcinoma of the anal canal. AIN is graded on the basis of dysplastic involvement into low-grade AIN I and AIN II, and high-grade AIN III; hence, AIN III has a higher potential for malignancy. AIN I and AIN II can progress into AIN III. AIN has an equal gender distribution.

23 Pilonidal Sinus Disease

Michael R. Thompson, Asha Senapati and Paul R. B. Kitchen

CONTENTS

23.1 Introduction

A clear understanding of the changes in the theories on the aetiology of pilonidal sinus disease is essential to understand how these have influenced the evolution of its treatment and to select appropriate modes of treatment in the future. This condition may be self-limiting, and successful non-surgical treatments have been reported using simple removal of hairs, careful natal-cleft hygiene and injections with phenol. For patients with minor symptoms, this could be the correct initial approach.

It is important to understand that for this relatively minor condition surgery can do more harm than good, particularly if the end result is an unhealed midline wound. In the majority of cases, surgery for pilonidal sinus disease must therefore be simple and its complications should never be worse than the original disease! Even for patients with more extensive disease and those needing second operations, radical surgery can now be avoided and many can be managed as day-cases under local anaesthetic. Whenever possible, patients should be self-caring post-operatively and have an early return to work. Reports over the last 60 years from Patey and Scarff in 1946 to Peterson in 2002 arguing against wide en-bloc excisional surgery [2, 13, 14, 21, 39, 42, 60, 62, 63, 66, 68] are still frequently ignored, with considerable adverse clinical and economic consequences.

23.2 Presentation of Pilonidal Sinus Disease

This ranges from small, asymptomatic, midline nodules and pits to extensive disease with large acute and chronic abscesses and long lateral sinuses. The nature of its presentation should determine the mode of treatment, whether it be no treatment for asymptomatic nodules and pits, non-surgical treatment [5, 15, 23, 35, 51, 70, 71], a minimal surgical approach [9, 10, 25, 39, 43, 56, 64, 68] or more extensive surgical procedures [4, 6, 8, 11, 16, 31–33, 37, 38, 48, 49, 54, 55, 59, 72, 74].

23.3 Aetiology of Pilonidal Sinus Disease

Key points:

1. This disease is acquired not congenital.
2. old theories of a congenital cause led to excessive surgery with high morbidity and high recurrence rates.
3. current theories on its aetiology developed over the last 50 years strongly encourage minimal surgery for primary disease.
4. There is an increased incidence in patients who:
   i. are aged 18–30 years
   ii. are male and hirsute
   iii. have a deep natal cleft and practise poor hygiene

5. Loose natal cleft hairs are an important secondary, factor but it is unlikely that they are the primary cause.
6. This is a self-limiting disease and can burn itself out.
7. Sequence of pathological events:
   i. widening and lengthening of midline hair follicles in adolescence
   ii. blockage of hair follicles and acne-type folliculitis
   iii. follicle sheds its own hair
   iv. collection of loose hairs and skin debris in the natal cleft pushed or sucked into the enlarged hair follicles
   v. development of midline abscesses and lateral sinuses

23.3.1 Congenital

The theory of a congenital cause from a pilonidal cyst developed soon after the earliest descriptions of pilonidal sinus disease [3, 27, 52, 75] and resulted in radical excisions [39]. The current versions of en-bloc excisional surgery [1, 7, 28] are probably the residual reflections of these early theories.

23.3.2 Acquired

The current view that pilonidal sinus is an acquired condition was originally suggested by Patey and Scarff in 1946 [60] and re-enforced by Klass in 1956 [39]. In 1969, Patey [61] put forward a convincing summary of its pathogenesis, which was reiterated by Bascom in 1983 [10] and 1994 [13]. It has been suggested that midline pits are always present in this condition [9, 10, 61, 71] and Patey [61], King [36] and Palmer [58] suggested that these develop from midline hair follicles, which enlarge and develop a folliculitis around puberty. This can lead to a central abscess, which may discharge through lateral sinuses. This theory is supported by the fact that the direction of hair growth in follicles around the pilonidal sinus pit is always in the same direction as the pit [45, 53]. The role of the hair in the further development of pilonidal sinus disease is likely to be a secondary phenomenon. Loose hairs gather in the cleft from elsewhere (back of the head, neck, buttock) and orientate vertically, entering by their roots. The distally directed microscopic scales on the hairs encourage their entry and retention in the midline pits [57], and Lord [44] has shown that the hair may occasionally not come from the patient. There is one report in which a pilonidal sinus contained a small bird feather, probably from feather bedding [26]. Entry of hairs and other skin debris into the enlarged hair follicles and skin pits may be facilitated by movement of the buttocks causing negative pressure in the inter-natal cleft, hair follicle and/or abscess, "a cigarette-rolling effect" [17]. This debris exacerbates the folliculitis and causes the primary abscess. It is also likely that the depth, hairiness and anaerobic environment of the natal cleft [13, 32, 33, 39, 50, 61, 65] are important factors in the perpetuation of the disease, and may also be the cause of enlargement of midline hair follicles [9, 13, 36, 58]. Bascom suggested that it is the heavy buttocks dragging on the sacral attachments that elongates and enlarges the midline hair follicles. Pilonidal sinuses are rare in children, in people with curly hair and in the elderly, whose hairs are more likely to be devoid of scales. In spite of the fact that hairs have long been recognised as being associated with pilonidal disease [36, 39, 60], it is less convincing that the hairs are the primary cause of the pits by puncturing the intact skin through a drilling action, as was suggested by Karydakis [32, 33]. This theory is weakened by the fact that many patients do not have any hairs in the abscesses [40, 61] and the disease can occur in relatively hairless young women.

23.4 Economic and Clinical Consequences of En-Bloc Excisional Surgical Treatment

The initial theories of a congenital cause for pilonidal sinus disease led to wide en-bloc excisional surgical treatment, which resulted in considerable morbidity and use of hospital resources.

During World War II (1942–1945), 78,924 soldiers were admitted to USA Army hospitals for pilonidal sinus disease, and remained an average of 55 days [19]. Over a 2-year period in one Army centre in the USA in the 1990s, 240 excisional operations were performed in a group of 229 patients, who required 4,760 occupied-bed days, or an average of 21 occupied bed-days per patient [5]. Karydakis [34] reported examination of 4,670 Army candidates operated on previously for pilonidal sinus disease by various methods in whom there were 2,288 (49%) recurrences. In 1985, 7,000 patients were admitted for an average stay of 5 days to hospitals in England (unpublished data from the London Office of Population and Surveys (1985) http://www.doh.gov.uk/hes/standard_data/available_tables_operations/tb02100e.xls), and 11,534 admissions were recorded in

2000/2001 for pilonidal sinus disease, with a mean 4.3-day length of hospital stay (17,084 bed days) [22].

As pointed out by Bascom [11, 13], failure after pilonidal sinus operations can be pernicious, requiring multiple operations with reconstructive surgery, at times using radiotherapy and gluteal muscle flaps, with some patients having wounds packed for up to 15 months.

In spite of the pleas since 1947 to avoid wide en-bloc excisional surgery and for the adoption of day-case surgical treatment [2, 13, 14, 21, 39, 42, 60, 62, 63, 66, 68], many surgeons continue to use radical techniques that need in-patient care [1, 7, 28], with the significant economic consequences for the health-care system.

"Pilonidal suppuration is a self-limiting disease… Such dismal statistics after surgical treatment naturally pose the question: Is it possible that our treatment may, in part, be responsible for such poor results …prolonged disability may be partly iatrogenic?" Klass 1956 [39].

23.5 Management of Pilonidal Sinus Disease

23.5.1 Non-surgical Treatment

Key points:
1. No treatment for asymptomatic nodules and pits.
2. Consider shaving and cleft hygiene for mild-to-moderate disease with or without phenol injections.

It is quite reasonable for some patients with minimal pathology and no symptoms that a "no-treatment, watch-and-wait" policy is adopted. This is particularly true in relatively soft-haired or hairless young women with flat natal clefts. In patients with minimal symptoms such as a single acute abscess with minimal pathology on clinical examination, it may be worth first trying a non-surgical treatment after drainage of an acute abscess, with shaving and greater attention to natal cleft hygiene with or without injection with phenol [5, 15, 23, 35, 51, 70, 71]. This is particularly appropriate if the theory that the disease can be self-limiting [20, 30, 39] or burns itself out [29] is correct. However, more studies on non-surgical methods of treatment [5, 15, 23, 35, 51, 70, 71] are needed to establish the true value of this approach, particularly in view of the newer minimal surgical methods [9, 10, 25, 43, 56, 67] of treating pilonidal sinus disease that have more reliable outcomes with little morbidity.

23.5.2 Surgical Treatment

Key points:
1. Surgical treatment should do no harm and never result in an unhealed midline wound.
2. Lateral incisions and wounds heal better.
3. In most patients, surgery should be minimal and done as a day-case under local anaesthetic.
4. Patients should be self-caring post-operatively and have early return to work.
5. Recurrence rates should be low.
6. Wide en-bloc excisional surgery should be abandoned.

It is important to differentiate between primary and recurrent pilonidal sinus disease in assessing the results of its treatment. It is common for reviewers [2, 62] not to differentiate between Bascom's first-described simple operation, sometimes called Bascom I [9, 10] and the operation he advocates for recurrent disease with an unhealed midline wound, which he describes as a modification of the Karydakis procedure [32, 33], Bascom's II or cleft closure, now known as the "cleft-lift operation" [11, 13].

The Bascom I procedure [9, 10], a development of the Millar/Lord procedure [25, 43], and the Kitchen [37, 38] and Bascom II [11, 13] modifications of the Karydakis technique for more extensive disease, demonstrate many of the clinical and economic benefits of conservative surgery, which have few complications and rarely if ever lead to unhealed midline wounds.

23.6 Bascom I and the Lord/Millar Procedure for Minor to Moderate Disease

Key points:
1. Minimal midline wounds; "pick the pits, stay out of the ditch".
2. Lateral wound left unsutured for drainage of the chronic abscess.
3. Day-case surgery is done under a local anaesthesia with sedation.
4. Patient self-caring post-operatively.
5. Has a <10% recurrence rate.

This procedure may be seen as a development from Rickles' [64] and Patey's [60] plea for minimal surgery. Lord's paper in 1975 [45] shows, in its Fig. 3, some of the basic principles adopted by Bascom's I procedure,

and the Lord/Millar technique produced satisfactory results in 76% of patients [24, 43]. Bascom I and the Lord/Millar procedures [9, 10, 25, 43] are based on the theory that as long as the midline pits are removed and the midline wounds heal, the patient will be cured of their disease, and that this can be achieved by keeping the incisions to a minimum, particularly in the midline. The technique eliminates the risk of an unhealed midline wound.

Bascom [9, 10] emphasises that midline wounds should be less than 7 mm in length, which is all that is required to remove the pits, most of which do not have long extensions of squamous epithelium below the skin surface; "pick the pits, keep out of the ditch" (Figs. 23.1 and 23.2).

The volume of tissue removed for each pit should be no greater than a "grain of rice" (Fig. 23.3) [12]. It is important to remove all of the pits, as a missed pit can be the cause of recurrent disease. Excision of the pit should not be attempted until an acute abscess has completely settled after its drainage, as pits can disappear with the associated oedema of the abscess. Drainage of the abscess can often be done in the outpatient clinic with a simple stab incision after spraying the skin with ethyl chloride spray. This should be away from the midline and should not be a de-roofing procedure; definitive surgery can be done 3 weeks thereafter. The number of midline pits that need to be excised usually ranges from one to four, but in exceptional cases can be up to seven. If there are as many as this, a Bascom II operation would be a more appropriate procedure as it is quite difficult to avoid merging multiple incisions into longer wounds of up to 1–2 cm. The midline pits are closed with a 4/0 non-absorbable suture that is removed after 1 week. After removal of the sutures there may be some gaping of the midline wounds, which heal quickly if kept clean with shaving and daily showering. Small midline wounds left unsutured still heal well, as shown by the Lord/Millar technique [25, 43]. The lateral incision, which should be placed at the site of the original drainage procedure for the acute abscess and allows egress of blood and serum in the early post-operative period, always heals (Fig. 23.4). It may also prevent distraction of the midline wounds and help healing, which is crucial to the success of this operation.

Initially, Bascom [9, 10] recommended the raising of a fat flap to support the midline closures. He now believes this is unnecessary [63] and there is no evidence that this increases the success of the procedure. However, this technique has been used in all reports of this technique so far [9, 10, 56, 67].

The posterior wall of the abscess cavity is mobilised off the sacral fascia, and after removal of all its debris from the abscess cavity, a "flap" consisting of fat and the posterior wall of the abscess cavity is sutured to its anterior wall and the skin just 1 cm from the midline, closing the abscess cavity completely (Figs. 23.5–23.7).

One of the economic advantages [67] of this procedure is that it can be done under sedation and local anaesthesia as a day-case, and the patient is self-caring post-operatively with daily showers and a pad. It is important that the area around the wounds is kept shaved until complete healing has been obtained. In the USA, patients are encouraged to go back to work the day after surgery [9, 10], although this is not usually achieved in the UK [67]. The only immediate major post-operative

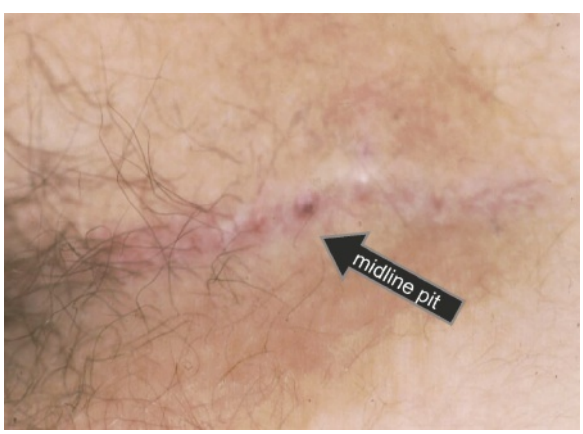

Fig. 23.1 A midline pit

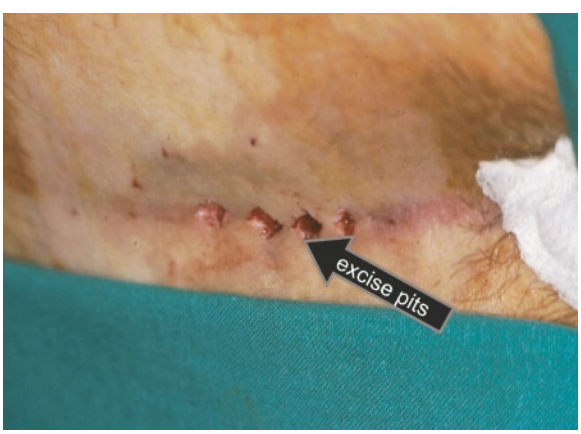

Fig. 23.2 Four excisions of midline pits through small incisions; all less than 7 mm in length

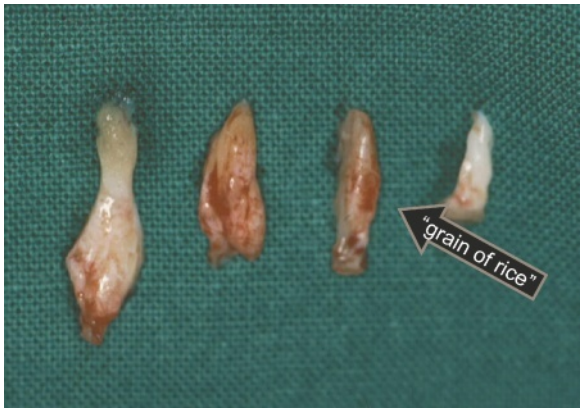

Fig. 23.3 Volume of tissue removed after the four excisions of midline pits shown in Fig. 23.2, each measuring less than 1 cm in length; "a grain of rice"

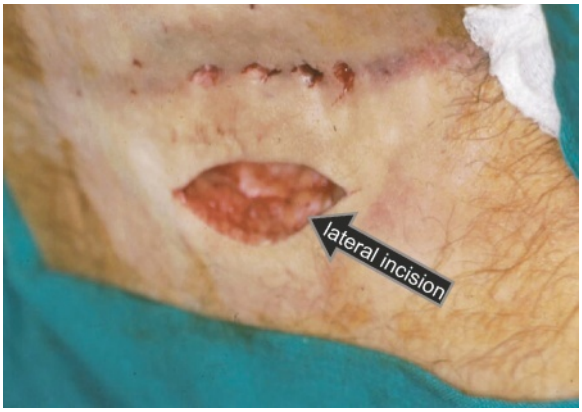

Fig. 23.4 A lateral incision placed 1–2 cm from the midline to allow egress of blood and serum in the early post-operative period

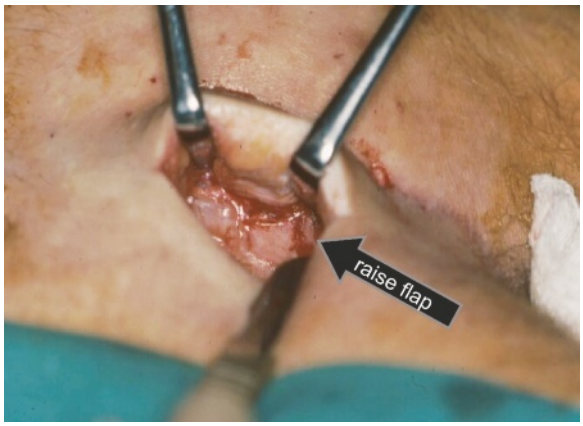

Fig. 23.5 Raising of a fat flap through the lateral incision, which is sutured to the flap of skin between the midline incisions and the lateral incision

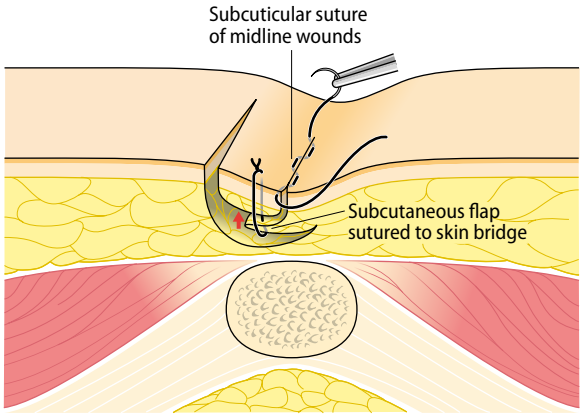

Fig. 23.6 Diagrammatic representation of Fig. 23.5

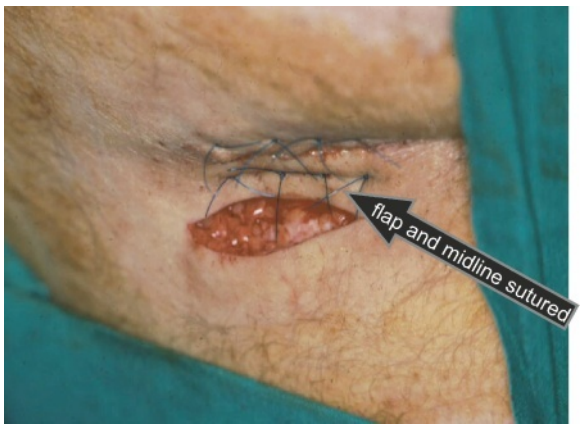

Fig. 23.7 This photograph shows the four sutures securing the fat flap as well as the four sutures in the midline

complications are bleeding, which usually stops spontaneously with local pressure, and an abscess if the lateral wound heals too quickly. This can often be treated by digitation of the wound in the outpatient clinic. There are no reports of unhealed midline wounds after the Bascom I procedure [9, 10, 56, 67]. The disadvantages of this procedure are the open lateral wound, which can take 3–4 weeks to heal, and the associated 10% recurrence rate [67]. However, as the lateral wound is simply self-managed by the patient with daily showers and a pad, this is not usually a major problem and should not prevent an early return to work. Recurrences can be treated successfully by a second Bascom I procedure, usually simpler than the first.

23.7 The Karydakis Procedure and its Kitchen and Bascom II Modifications

Key points:

1. excision of the midline pits and lateral sinuses
2. development of a flap consisting of skin and a little fat
3. asymmetric closure to avoid a midline wound and to flatten the inter-natal cleft
4. can be done under local anaesthetic as a day-case
5. wound drain removed at 24 h
6. complete closure (no open wounds)
7. < 10% wound complications (haematoma and skin infections)
8. Recurrence rate <4%

First described by Karydakis in 1973 [32], with a further report in 1992 [33], of 7,471 patients treated over the period 1966–1990, with 95% of cases being followed up for 2–20 years. The large numbers accrued by Karydakis may be due to the fact that there is a high prevalence of this disease in the Greek Army and he may have operated on asymptomatic cases because of the risk of sepsis incapacitating soldiers on active duty (see Appendix; G.E. Karydakis, personal communication). He reported that he did 13 cases/day on 3 days/week and continued to work after his retirement without receiving payment, sometimes having to pay the anaesthetist himself (see Appendix; G.E. Karydakis, personal communication). When asked how he had thought up the "lateral flap operation", he records he used to do a Munro Z-plasty, but many of them had a recurrence at the lower end of the wound and this was nearly always in the midline. He had therefore begun to think of ways of keeping the wound off the midline. Soon after World War II he started to get a reputation in the military hospital as a "communist", because his patients were leaving with a Z (from the Munro Z-plasty) on their buttocks. The sign "Z" was interpreted as a symbol of insurrection against dictatorship, and this increased the need to develop another way of treating pilonidal sinus disease, hence the Karydakis procedure [32]. He preferred general anaesthesia, but said that it was possible to do it with a local anaesthetic. Kitchen's [38] and Bascom's modification [11] of the Karydakis technique are done under local or general anaesthestic. Karydakis said that he could do the procedure in 15 minutes! He did not use methylene blue to identify the tracts, and the assistant had to press hard on the edge of the wound to gain haemostasis. He started his deep-layer closure at the bottom end. He used continuous chromic catgut for fat sutures and placed a Penrose drain at the top end for 2–3 days, being unconcerned about leaving a hole, as recurrences do not occur at the top of a lateralised wound. He shaved around the wound until the wound was healed. He instructed patients to report early any new symptoms and said that if recurrences were treated early, by pulling out hairs and covering the new pit (he used Leucoplast), a true recurrence could be avoided. He said that recurrence was never a problem and he never had to operate on them! He used the technique for all cases including early disease, especially if a patient was less than 30 years of age. He was still concerned about teenagers in whom the new midline could assume features of the old raphe with wide pores where recurrences could form. He claimed to be able to lateralise a wound only 2 cm long (see Appendix; G.E. Karydakis, personal communication).

After excision of the pits and lateral sinuses (Fig. 23.8), the technique consists of mobilisation of an elliptical flap (Fig. 23.9). The original Karydakis procedure recommended the development of a thick flap, but both Kitchen [37] and Bascom [11, 13] have modified this to produce a thinner flap. The end result of this flap

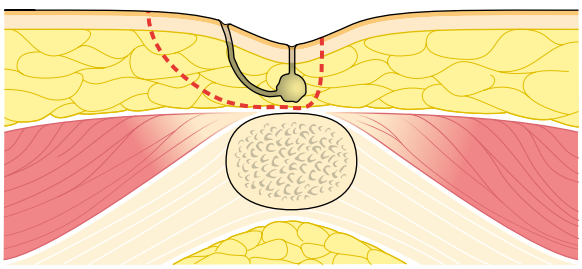

Fig. 23.8 Diagrammatic representation of the area excised in the Karydakis operation

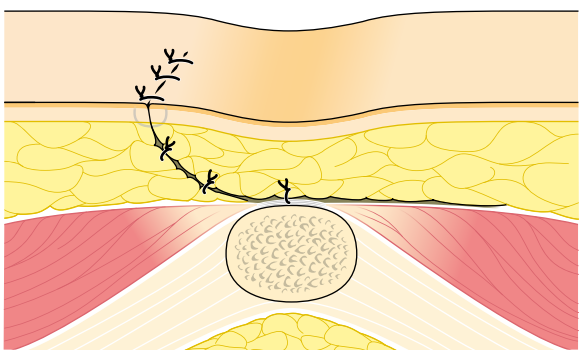

Fig. 23.9 Shows the Karydakis flap sutured away from the midline with three deep sutures securing the fat to the sacral fascia and to the opposite buttock fat

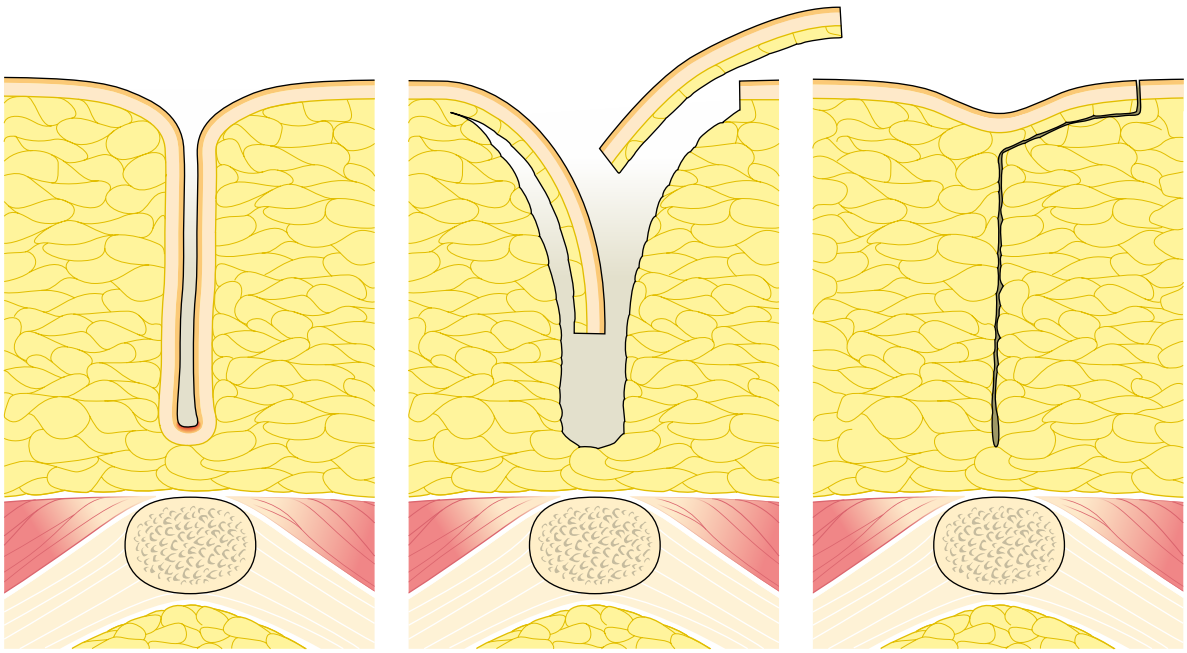

Fig. 23.10a–c Diagram of the principles of the Bascom cleft-lift operation with elevation of skin from the inter-natal cleft, excision of a proportion of the skin and suture of a flap off the midline after partial closure of the denuded fat in the cleft

thinning is the Bascom II, "cleft-lift" operation, which raises virtually only skin and a thin layer of fat and aims to flatten or make the cleft shallow by allowing the fat of the buttocks to be sutured together beneath the skin closure, which remains "asymmetrically" off the midline (Figs. 23.10 and 23.11). The abscess cavities are scraped clean or excised. Karydakis [32, 33] and Kitchen [37, 38] recommend fixation of the base of the typical Karydakis flap to the sacrococcygeal fascia, and skin closure by suturing the edge of the flap to the lateral incision at least 1 cm from the midline (Fig. 23.9). Bascom fashions the flap first and tests it before completing the excision, and he tries to preserve as much fat as possible to help elevate the cleft [11].

Antibiotics and analgesia were initially used in a very few cases, although this is now more often used in the modifications of the Karydakis procedure [11, 38]. Karydakis [33] reported that the mean stay in hospital was 3 days, but was starting to move towards day-case surgery, and Kitchen's modification [38] and Bascom's II cleft lift [11] can now be done as day-cases. Karydakis [32] reported an average absence from work of 9 days. Karydakis [33], Bascom [11] and Kitchen [38] have reported up to 10% of patients having complications in their wounds, although the majority of these heal completely. Karydakis [33] reported 55 recurrences in the first 6,545 cases, a recurrence rate of less than 1%. In each case, "re-insertion" of the hair was observed, once again stressing the importance of shaving until all wounds are completely healed. He felt that recurrence could have been prevented as most were early cases in the series and the hair reinsertion occurred because the

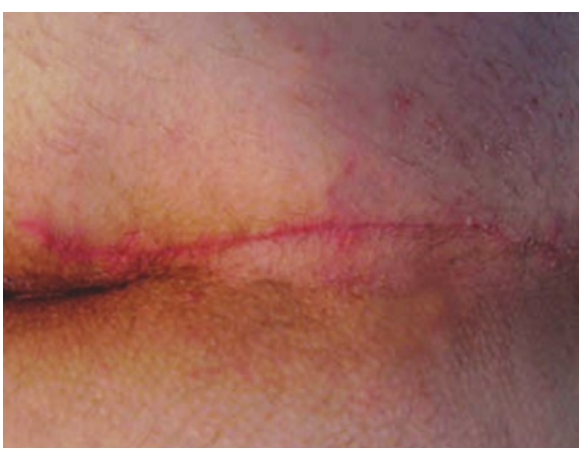

Fig. 23.11 The sutured skin off the midline after the cleft-lift operation

objective of "no raphe, no wound at the depth" had not been totally successful [33]. A stitch from the lateral wound penetrated the depth of the midline, permitting hair insertion in four cases [33]. Karydakis noted that as young people developed the adult body form, there is a change in the skin of the midline, and the skin in the depth of the "new" natal cleft after the Karydakis procedure can develop the characteristics of a vulnerable raphe with wide pores and maceration, and these form a high-risk group for recurrence. He also noted that there had been an increased incidence of pilonidal disease in Greece in the very young, down to 11 years of age, especially in girls [33]. In this group, the recurrence rate of 3% after surgery was higher than for the whole series [33]. Karydakis [33] commented that other surgeons had applied this method with the same or better results. Kitchen [37, 38], Anyanwu et al. [4] and Patel et al. [59] have obtained good results with the Karydakis technique, and it was Kitchen who suggested that it should be called the Karydakis operation. Kitchen has described using a thinner flap, particularly in obese individuals [38], moving towards the idea of a Bascom II operation [11]. He initially recorded a mean hospital stay of 4 days [38]. All patients had a general anaesthetic [27, 28]; wound infections and haematomas occurred in <10% [38], some wound numbness in 12%, slow healing in 3%, and there was a 4% recurrence rate, mostly occurring from 9 to 18 months after surgery and all in the midline. Anyanwu et al. [4] reported no recurrences, but did report that 10% of patients had complications requiring surgical intervention. Patel et al. [59] reported a mean hospital stay of 7 days. Mann and Springall [48] reported a success rate of 88% in patients having primary surgery, and 69% in those patients having had previous surgery; 20% of patients required intervention to obtain permanent healing.

Bascom reported the results of his modification of the Karydakis techniques in 30 patients [11], with complete wound healing in all patients, who were mostly treated as day-cases under local anaesthetic. One patient was hospitalised overnight and the median number of office visits required for follow-up was two. The median number of disability days until return to school or work was four. All patients were followed for 99% of the patient months after operation (629 of 632 months). Complications were infrequent and correctable. Senapati and Cripps [66] used this technique in 26 patients, mainly for unhealed midline wounds. Although only 30–40% healed primarily, all eventually healed within a short period of time, and there have been no recurrent problems.

23.8 Z-plasty, Rhomboid Flaps and the Limberg Flap

Z-plasties [49, 57, 74], rhomboid "flaps" [6, 8, 31, 54] and the Limberg flap [16, 72] appear to involve more extensive surgery with little extra benefit [62, 66]. All use general anaesthesia and are associated with hospital stays of not less than 4 days, and all have recurrence rates not less than the Karydakis technique. There seems to be very little benefit over the Kitchen [37, 38] and Bascom II [11, 13] modifications of the Karydakis procedure, which have the advantage of being done often as day-cases under local anaesthetic, with the patient largely self-caring post-operatively, and are probably less destructive to the tissues with a better cosmetic result [66].

23.9 Unhealed Midline Wounds

Unhealed midline wounds are almost entirely iatrogenic and even if they do not occur very frequently, can result in very prolonged disabling and distressing morbidity [66]. In most reports of treatment of pilonidal

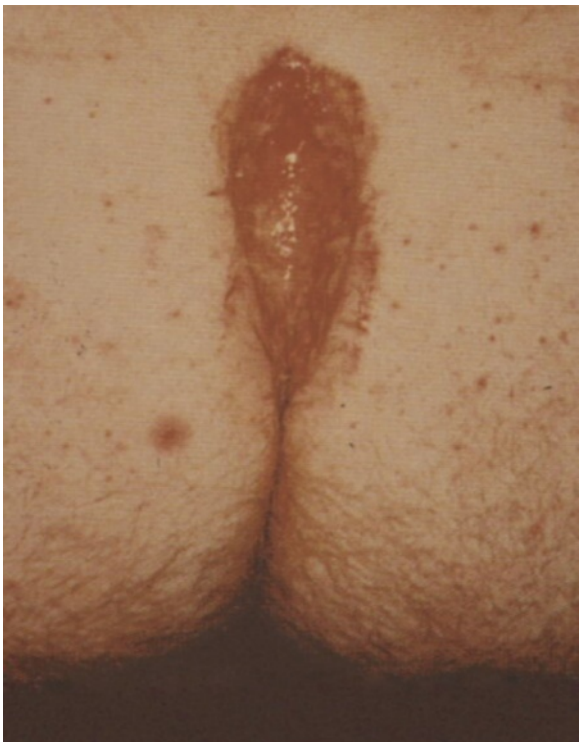

Fig. 23.12 An unhealed wound after wide excisional surgery with a long midline incision

sinus disease, it is unclear how often this happens, but all surgeons are aware that when it does it is a difficult condition to cure (Fig. 23.12). It is not recorded as occurring after the Bascom I, and Kitchen and Bascom II modifications of the Karydakis technique.

23.10 Conclusion

As the range in severity of the pathology of pilonidal sinus disease is considerable, it is appropriate to vary the treatment and not assume that one treatment should cover all clinical situations.

"Many surgeons develop or adopt favourite surgical schemes, which they tend to apply to all types and varieties of a certain pathologic condition. There is room for utilization of several types of surgical procedure in the treatment of pilonidal disease. Probably no single operation has been, or can be devised, that will fit all cases….." Buie and Curtiss (1952) [18].

Disease without symptoms needs no treatment at all. In patients with minimal disease and after incision and drainage of a single abscess, it may be worth trying the Armstrong Barcia approach [5] with or without injection with phenol [15, 23, 35, 51, 70, 71]. However, there is accumulating evidence that patients with mild-to-moderate disease can be managed by simple techniques such as the Bascom I procedure done under sedation and local anaesthetic as a day-case, with the patient self-caring post-operatively, and have as little morbidity as non-surgical treatment. Conservative surgical procedures have as good clinical results as wide en-bloc excisions, which need inpatient care, prolonged periods off work and have greater morbidity. Surgery should be limited to minimal excision of the midline pits and sinuses, and sufficient skin to simply achieve an asymmetric skin closure with flattening of the inter-natal cleft, even in patients with recurrent or more extensive disease.

The plea for conservative surgical treatment of pilonidal sinus disease was first suggested in 1946 [60] and has been regularly re-enforced over the last 60 years. Although it is unlikely that there will be a return to the remarkable clinical and economic consequences of radical surgical management that occurred in World War II, there continue to be reports indicating that some patients still suffer very significant morbidity from the surgical treatment of pilonidal sinus disease [46, 47]. The few randomised controlled trials that have been carried out [24, 41, 69, 73] have not been very informative. Future trials should aim to improve on the Bascom I procedure [9, 10] so that the lateral wound is smaller and heals more quickly or is avoided, and there is a reduction in the 10% recurrence rate. The results achieved by the modifications of the Karydakis [11, 38] procedure may be improved by achieving fewer wound complications and even lower recurrence rates.

Fig. 23.13 Dr. George Karydakis

Virtually all surgical treatment of pilonidal sinus disease in the future should be done as a day-case with no or minimal open wounds that can be easily self-managed by the patient. They should be self-caring post-operatively, have minimal wound complications, no unhealed midline wounds, with an early return to work and low recurrence rates.

All of these aims can be achieved by the Bascom I procedure [9, 10] and the Kitchen/Bascom modifications of the Karydakis procedure [11, 38]. Other surgical treatments should at least match the benefits of these simple procedures, which do little or no harm and cure the majority of patients.

Appendix

Memories of Dr. George Karydakis (Fig. 23.13), by Paul Kitchen (June 2006), from notes taken at the times they met:

I first met Dr George Karydakis when visiting St Mark's Hospital on 17th October 1973. I was in London simply visiting major centres during my 2-year stay in Scotland, doing post-fellowship surgical training. He also was visiting St Mark's and was demonstrating his technique to a group of surgeons, and his host (and mine) for that day was Mr Henry Thompson. I did not actually meet the man, but looked over the shoulders of the surgeons around the table and saw what he did, and thought it looked sound. I therefore started treating pilonidal sinus that same way, especially in Nazareth, Israel, where I went to work in December of that year. I later read his paper, which was printed that year [33].

In June 1975, George Karydakis spoke on pilonidal sinus at the European Meeting of the Section of Proctology at the Royal Society of Medicine in a session chaired by C.V. Mann. He sent me the programme. In 1981, he wrote to tell me that between 1966 and 1975 he had done 2,445 cases. He wrote his doctoral thesis on pilonidal sinus in 1968.

In 1978 I wrote to Mr. Henry Thompson, who responded, recalling George as an honest man, but could not believe he had operated on the number of cases he claimed. He asserted that each of the surgeons at St Mark's would have to live for 400 years to accumulate that experience! He recalled that George worked in a military hospital and that "when young men go into the Army they are very well fed and gain weight". He considered that the subsequent enlargements of their buttocks and the natural hairiness of the Greeks predisposes them to the disease. Since then, others have suggested that he operated on all asymptomatic cases because the Army would not accept anyone with an evidence of even a small pilonidal sinus due to bad experience with pilonidal cases ("jeep-drivers disease"), and that if this is so, it might have added to his numbers and improved his low recurrence rate. I never asked George whether that was the case.

In 1978 I also wrote to George personally, and in reply (20th February 1978) he said that "hairs are forced to insert only at the depth of the intergluteal fold and not at the sides of that fold". I had suggested to him that one reason for his success is that the wound is based on fat in the midline (the fat of the flap) not on bone, so the wound is more mobile (than midline primary closure or open healing) and not subject to damage by the same stretching forces as an immobile wound. He replied that he disagreed. "A scar located at the side of the fold is not a door because of its location and not because its base is fat or more scar. Even an open wound at the side is not suitable for hair entrance. By its frequent ruptures, the scar at the depth of the intergluteal fold, offers portals of entry for the insertion of hairs at the point of entry of the insertion process. This is true whether under it is more scar or fat tissue. Indeed, in the second case, the insertion of hairs is easier because after a rupture of the superficial scar, hair has to penetrate more scar….while in the second case, the invasion of the fat presents much less resistance. This is why the late recurrence rate of the open method (scar on scarred base or bone) is 40%, while the recurrence after classical closed methods (scar on fat tissue at the depth) is more than 60%". I wonder where he got his figures!

In 1981, George wrote to tell me he had done more than 4,000 cases. Initially, it was only the first 960 that had careful follow-up, with 1% recurrence, but most of the subsequent cases had since also been contacted, and the recurrence rate had not changed. Some had been followed for 15 years. In that letter (9th August 1981) he stated: "the hairs responsible for recurrence are loose hairs coming hence from different parts of the body. They insert on their root end and not on their apex end".

On 14th July 1985, I was travelling to Israel to revisit friends in Nazareth, and went with Olympic Airlines. I had some extra time in Athens and planned to meet up with George, having written to him. There was a delay at the airport and we met for a shorter time than expected, but he showed me his consulting rooms and, upon request, he gave me a passport photo of himself taken at age 57 years. I showed him slides of a case I had done 5 days earlier. He said he agreed that what I was doing was the same as his operation, and was pleased that I had named it "the Karydakis operation". He said he often received letters from surgeons in Europe writing for pilonidal advice (2–3/week) and some were asking him if the Kitchen technique (described in Kitchen (1982) [37]) was the same as his. He told me that in 30 years of working and thinking about pilonidal sinus, he believed the solution is to "prevent something entering, not to find something to excise". He said he was puzzled why at recent proctological conferences in the USA and France, the pendulum seemed to be swinging back to the congenital theory of origin, yet pilonidals are never seen in children, only in the teenage to 40-year age group, the time of "hormonally induced pilosebaceous activity". He said children and the elderly don't have scales in the hairs, and scales are important for hairs entering by their roots to penetrate deeper into the tissues.

He said that 25% of young men who come to be examined for entry into the Greek Army have a pilonidal sinus, and that the incidence is lower in rural areas (8%) because the people there work harder and are thinner. The incidence in Greece was also low after World War II, and changed in subsequent years as people became more affluent. He believed the incidence was still increasing. In fact, he claimed that 35% of Athenian men had a pilonidal sinus!

He told me of a young soldier who came to his rooms and he noticed a hair entering a primary midline pit, partly appearing as a secondary opening. Instead of pulling it out, he asked the solder to walk around the block and then return the next day. On examination,

he saw more of the hair exiting the secondary opening, so he asked the soldier to walk around the block again. After that the hair had gone. To George, this demonstrated the "circulation of hairs" in a pilonidal sinus. He also told me he had experimented by putting painted hairs on the bodies of subjects under clothing and studied how in time they migrated to the intergluteal cleft!

When I asked about how many pilonidal operations he did, he said 13/day, 3 days/week, and that he had done well over 5,000 at that stage. At this point he was retired but still doing a lot, in fact 70–80% of his private work was pilonidal. There was no health insurance system and he often didn't receive payment for work done, sometimes having to pay the anaesthetist himself! In 1992 he reported having done 6,545 personal cases [34].

When asked how he thought up what he called the "lateral flap operation" or "advancing flap operation", and he said he used to do the Munro Z-plasty but many of them got a recurrence at the lower end. It troubled him that recurrences were always in the part of the wound that was in the midline, and he was trying to think of a way to get the whole wound off the midline. Then a peculiar thing happened. In the 1960's, he started to get a reputation in the military hospital as a "communist" because his patients were leaving with a "Z" on their buttock! The sign "Z" was seen to be a symbol of insurrection against dictatorship! At that time the letter "Z" was a political slogan symbolising the Greek word for 'Life' and was made famous in the film 'Z' about Gregoris Lambrakis, a famous Greek pacifist who was assassinated. He had to think of another way!

In terms of the surgery, he said, simply drainage of the abscess was all that was required, followed no less than 10 days later by definitive surgery. He didn't prefer local anaesthetic, but said it was possible to do it that way, and he was starting to move towards day-case surgery. He didn't allow caudal epidural anaesthesia because of a report of a death from that technique (injecting through infection into the spinal canal).

He said he could do the procedure in 15 minutes! He didn't use methylene blue because it could penetrate into normal tissue. He had the assistant press hard on the edge to gain haemostasis. He started his deep layer of closure at the bottom end. He used continuous chromic catgut for fat sutures, and placed a Penrose drain tube at the tip end. He was not concerned about leaving a hole at the top end, saying that recurrences don't occur at the top end of a lateralised wound. He allowed patients to mobilise immediately, took sutures out on day 6 (too early in my book!), and shaved around the wound only until it healed. He instructed patients to report early any new symptoms and said if "recurrences" are treated early, by pulling out hairs and covering the new pit (he used leucoplast, I use a suture), a true recurrence can be avoided. In fact he said that recurrence is never a problem and he never had to reoperate on them!

I asked whether he used his technique in all cases, even the early ones. He said "yes", especially if the patient is under 30 years (recurrence in his hand are rare after this age – I have not found this to be the case, my average age of cases is 26 years, average age of recurrence 24 years). He was concerned about teenagers in whom the new midline may assume features of the old raphe with wide pores where recurrences could form. He said he could lateralise a wound only 2 cm long.

I asked him about very lateral secondary openings. He said try a wedge off the side of the wound (I wrote about it in 1996 [38]). He also said they could be cleaned out and left, and that he doesn't always excise the whole track. Bascom has concluded from his writing (1992) that this means Karydakis taught that if the primary pit is excised, the circulation of hairs will cease, so the secondary track and opening should heal itself.

Strangely, he said that most secondary openings are on the left side, and that if one appears on the right, it may be because the patient is left-handed! He thought the buttock muscles might be strong on the right when a person is right-handed, pulling the raphe slightly to the right and allowing more opportunity for penetration on the left of the midline! This is strange, but maybe we should do a study to see where most secondary openings appear!

My third and final contact with George Karydakis was on 27th December 1990, again on my way to Israel. I was in Athens and met him at his rooms. I noticed he looked unwell and short of breath when walking upstairs. Soon after, he sent me a draft of a paper he wanted to publish in the *Australian and New Zealand Journal of Surgery*, and asked for my assistance, and that of Mr. John MacArthur, a general surgical colleague of mine in Melbourne who actually visited George in Athens and saw him perform his surgery. The paper "Easy and Successful Treatment of Pilonidal Sinus after Explanation of its Causative Processes" [34] was accepted for publication on 8th August 1991.

On June 21st after an enquiry, I received a letter from Dr. Theodore Mathiou, General Hospital, Athens,

who said George had died "some time ago" and regarding his operation that "at the moment it is not popular anywhere, the Army hospital included". Truly, in biblical terms "a prophet is not without honour, save in his own country". It is interesting that some of the subsequent papers on the technique have come from Turkey, Greece's neighbour and rival.

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Self-Assessment Quiz

Question 1

What is the primary cause of pilonidal sinus disease?

a. Poor hygiene
b. Obesity
c. Midline pits
d. Deep inter-natal cleft
e. Hairs

Question 2

How successful are the simple surgical treatments of pilonidal sinus disease, such as the Bascom 1 procedure?

a. 100%
b. 90%
c. 75%
d. 50%
e. 45%

Question 3

Which is the simplest procedure that can be done as a day-case under local anaesthetic to treat unhealed midline wounds or severe recurrent disease following primary surgery?

a. Z-plasty
b. Karydakis procedure
c. Limberg procedure
d. Rhomboid flap
e. Bascom's cleft-lift procedure

Question 4

What is the most important complication of patients having surgery for pilonidal sinus disease?

a. Bleeding
b. Infection
c. Recurrence
d. Difficult suture removal
e. Unhealed midline wound

Question 5

What is the most important additional treatment in the management of pilonidal sinus disease?

a. Hygiene
b. Antibiotics
c. Shaving
d. Bed rest
e. Reduction in physical activity

1. Answer: c
   Comments: All other factors are secondary.
2. Answer: c
   Comments: Although there are reports of 90% success, the longer these patients are followed up, the more cases will either recur or develop new midline pits and the disease. Nevertheless, the benefit of the simple procedures is that they do no harm and never cause unhealed midline wounds.
3. Answer: e
   Comments: This is the simplest procedure and it can be done under local anaesthetic as a day-case. It also probably gives the best cosmetic appearance. This operation is rarely needed after a Bascom I procedure, but may be after radical excision of the sinuses and abscesses, leaving long midline wounds.
4. Answer: e
   Comments: It is very difficult to get precise figures on the prevalence of this as it is rarely recorded. However, from reports of the extensive and radical procedures used to correct the bad results of wide excisional surgery, even if it only occurs rarely, it is a major problem to correct. As pilonidal sinus disease is a common condition in young patients, this is a complication that has significant economic and psychosocial implications.
5. Answer: c
   Comments: Although hairs are not the primary cause of pilonidal sinus disease, it is important after all surgical treatments to keep the area shaved until there is a complete healing of the wounds. Transient use of antibiotics and good hygiene are also important. Bed rest is of no value as virtually all of these procedures should be done as day-cases; a reduction in physical activity is also unnecessary other than to avoid resulting discomfort.

24 Dermatological Anal and Perianal Diseases

Bruno Roche, Eva Csatár and Joan Robert-Yap

CONTENTS

24.1 Introduction

Dermatological disorders appear frequently in the perianal region and require a precise and logical approach. This chapter demonstrates the tremendous importance of perianal skin diseases in a proctologic practice, and the great differential diagnostic problems caused by the often similar signs and symptoms of a large variety of disorders. An effective approach is almost entirely dependent on an exact diagnosis. Interdisciplinary cooperation is mandatory not only in the treatment of these patients, but also in the teaching of this often-overlooked discipline of medicine.

24.2 Characteristics of Perianal Skin

The skin is a large organ with an area of 2 m^2 and an average weight of 4 kg. The function of the skin is to protect the body from the aggression of the environment. Skin plays a role in contact with and the collection of information from the environment.

Starting at the most external part and going deeper, skin comprises the epidermis, dermis and hypodermis. The epidermis is as thick as a piece of paper. The thickness of the dermis ranges from 1 to 4 mm. The dermis is a resistant and elastic support structure that contains blood vessels, nerves and cutaneous appendages.

The epidermis is divided into four layers:

1. The basal cell layer: undifferentiated proliferating cells. These dome-shaped, dermal papillae help to fix the epidermis to the dermis. Cells migrate from the basal layer to the surface over a 4-week period following a process of differentiation.
2. The stratum spinosum: this layer produces keratin and derives its name from the intercellular bridges, which are like spines.
3. The stratum granulosum: cells in this layer acquire additional keratin and become flattened.
4. The stratum corneum: this layer is made up of keratin-filled devitalised cells, which are attached together by a lipid-rich cement barrier (Fig. 24.1).

A variety of glands can be found in the hypodermis. A particularity of the perianal skin is the presence of all types of glands (Fig. 24.2). Eccrine glands excrete sweat to the surface of the skin; they serve as the body's thermoregulator. About two to three million glands are distributed over the entire body surface, with a total capacity of secretion of 10 l/day. Apocrine gland se-

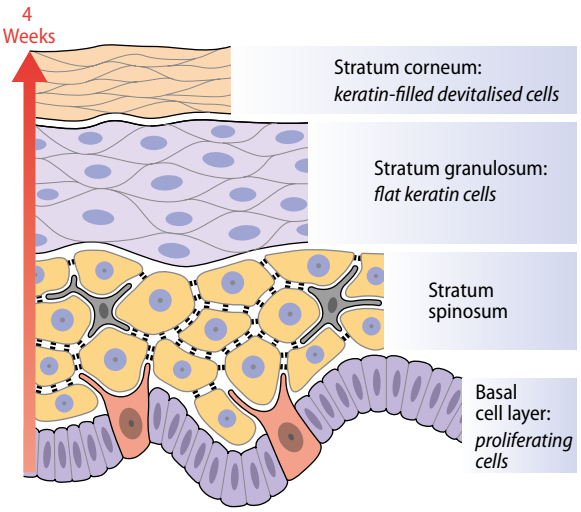

Fig. 24.1 Differentiation of the epidermis. The epidermis is divided into four layers: the stratum corneum, stratum granulosum, stratum spinosum and the basal cell layer

cretions are responsible for body odour. These glands are located mainly in the axillary and anogenital areas. The ducts of the apocrine glands drain into the hair follicles. Sebaceous glands produce an oily substance named sebum; this drains through the hair follicle to the surface of the skin. Sebum protects the skin from environmental challenges.

The anal and perianal skin share particular features that are important to an understanding of the specificity of proctologic dermatology:

1. It is thinner than the skin of other parts of the body.
2. It contains a high number of glands, and especially apocrine glands.
3. It is localised in a humid, dark, mechanically traumatised place that usually has a high concentration of bacteria.

In the perianal area, all of these factors lead to a special and specific presentation of classical dermatological diseases.

Numerous cutaneous diseases are localised to the perianal and perineal area (Table 24.1). This may be partly explained by the fact that many external irritative and infectious factors increase the probability of dermatoses becoming established in this intertrigous area. Other dermatoses are very often situated in this region for unknown reasons. And finally, dermatoses may be localised in the perianal area by chance. This last group will not be discussed here. Differential diagnosis is made difficult by the great number of these diseases and by their similar appearance, as external factors may modify the characteristic signs of many of them. However, only an exact diagnosis allows the correct treatment to be chosen and avoids the use of combined topical treatments, which are often responsible for chronic diseases. Table 24.2 should be used for differential diagnosis.

Table 24.1 Cutaneous diseases of the perianal and perineal region

Dermatitis (eczema)		Irritant
		Allergic
		Infectious
Infections	Viral	Herpes
		Condylomata acuminata
		Bowenoid papulosis
	Bacterial	Venereal diseases
		Tuberculosis
		Actinomycosis
	Mycologic	Candidiasis
		Dermatophytosis
	Protozoal	Amoebiasis
Dermatosis		Psoriasis
		Hidradenitis
		Bullous diseases
Erosive and ulcerous dermatosis		Ulcers after use of suppositories
		Decubitus ulcer
Systemic diseases		Crohn's disease
Paraneoplastic syndromes	Tumours	Benign
		Malignant
Congenital and genetic diseases		Chronic benign familial pemphigus (Hailey-Hailey disease)
		Dyskeratosis follicularis (Darier's disease)
		Acanthosis nigricans
		Darier's disease
		Behçet's disease
		Acrodermatitis enteropathica

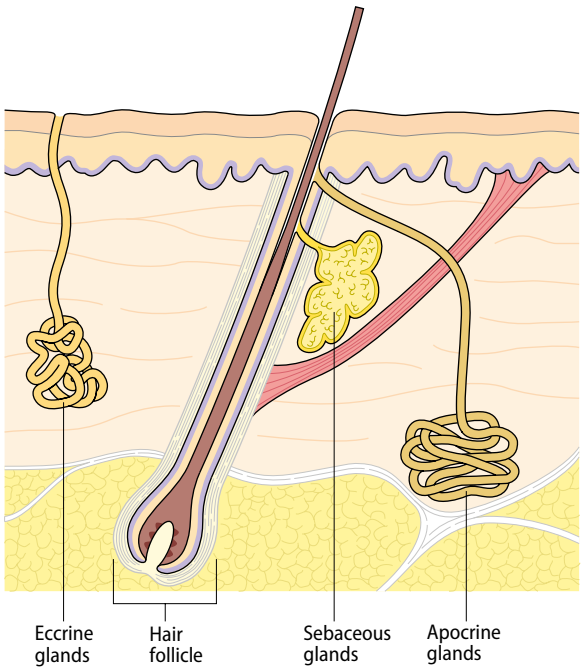

Fig. 24.2 The different glands of the skin. A particularity of the perianal skin is the presence of all types of glands

24.3 Dermatitis (Eczema)

The different forms of inflammatory diseases of the anal region represent the most common pattern seen in this site (Table 24.2).

24.3.1 Aetiology

The same factors as those causing anal pruritus are often responsible for anal dermatitis (see Chap. 25) [2, 37]. Scratching of the anal area will lead to erosion, and infection cannot be avoided. Furthermore, topical treatments with antibiotics and corticosteroids may favour the growth of *Candida*. Finally, it is nearly impossible to detect the primary cause [22, 51].

Table 24.2 Differential diagnosis of anal and perianal dermatosis: clinical aspect

Erythematous	Erosive	Ulcerous	Tumorous-vegetative	Fistulous
Dermatitis		Syphilis I	Syphilis II	Hidradenitis suppurativa
Candidiasis		Chancroid		
Dermatophytosis		Granuloma inguinale		Lymphogranuloma venereum
	Herpes		Condylomata acuminatum	
			Bowenoid papulosis	
Erythrasma	Behçet's Disease			
Acrodermatitis enteropathica	Pemphigus vulgaris	Crohn's disease		
		Pseudomembranous	Pemphigus ulceration	
Actinomycosis				
Fixed drug eruption				
Psoriasis	Chronic familial pemphigus			
Bowen's disease		Ergotism	Acanthosis nigricans	
Paget's disease		Decubitus		
Lichen sclerosus et atrophicans		Tuberculosis		
Darier's disease		Amoebiasis		
			Carcinoma	

24.3.2 Clinical Findings

The earliest changes are erythema and oedema (Fig. 24.3). These may progress to vesiculation, oozing and erosion (Fig. 24.4). If the process becomes chronic, the skin will be lichenified (thickened) (Fig. 24.5) with prominent skin marking, excoriated and either hyper- or hypopigmented. Itching is the main symptom and leads to the itch-scratch-lichenification cycle. It is mandatory to examine the fingers and the nails of the patients, where the same dermatitis can be found (Fig. 24.6).

The categories of perianal dermatitis include:

1. Irritant dermatitis
2. Contact dermatitis
3. Infectious dermatitis

Different factors frequently act simultaneously or sequentially.

24.3.3 Assessment

A precise history is very important. The possible contact allergen has to be identified by patch testing. Table 24.3 shows the main allergens in this location. In the presence of pustules, their content should be examined by Gram's stain. Cultures for *Candida* should be performed on fungal media. Bacterial cultures are not necessary because the infection is not specific. Viral examination should be performed, particularly if erosion is visible. In cases of well-delimited plaques, a biopsy specimen is necessary to eliminate dermatosis, as noted in Table 24.2.

24.3.4 Therapy

Table 24.4 shows all of the possible allergens that should be avoided and the measures that should be un-

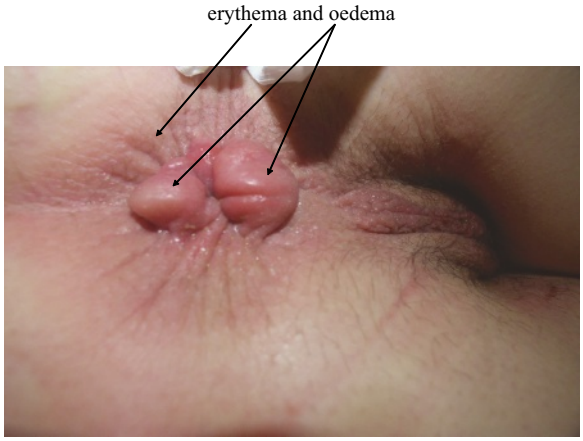

Fig. 24.3 Contact dermatitis

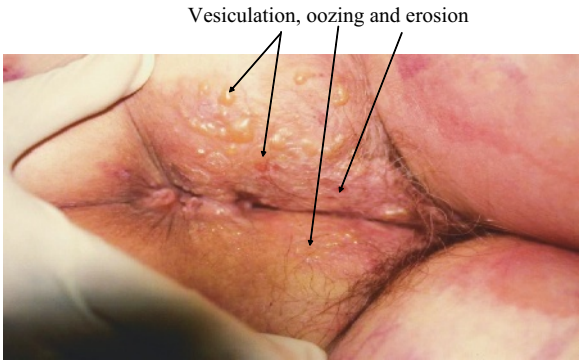

Fig. 24.4 Contact dermatitis

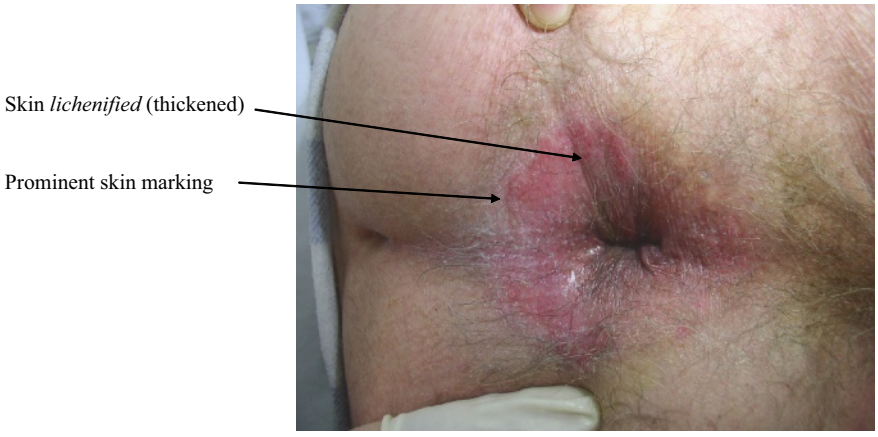

Fig. 24.5 Contact dermatitis

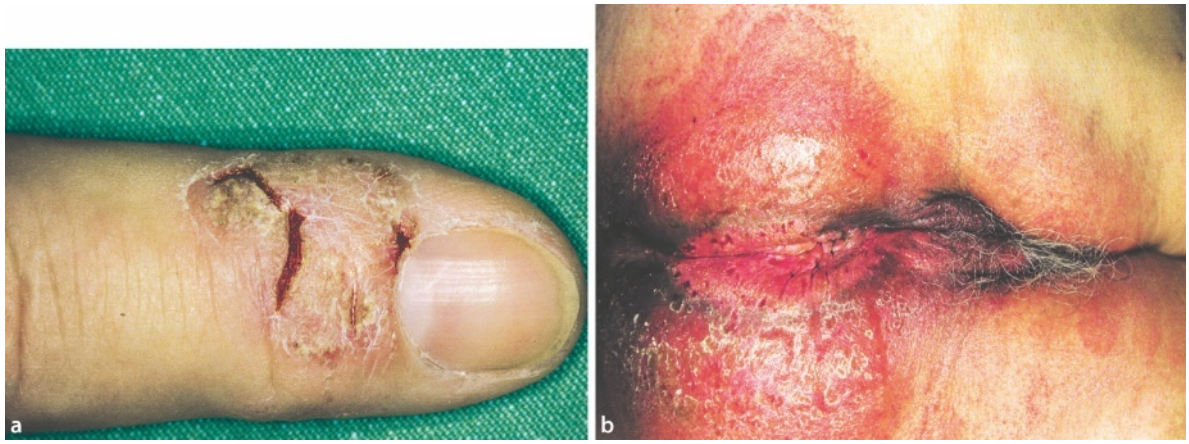

Fig. 24.6a,b Contact dermatitis. **a** Examine the finger and nail. **b** The skin is excoriated, and either hyper- or hypopigmented

Table 24.3 Main allergens responsible for perianal dermatitis

Benzocaine	Lanolin
Peroubalsam	Cocoa butter
Hamamelis	Iodine
Camphor	Resorcinol
Chamomile (concentrate)	Antihistamines
Neomycin	Phenol
Turpentine	

Table 24.4 Treatment of perianal dermatitis

Avoid	Recommended
Toilet paper	Cleaning with cool water or disinfecting lotion (hip bath)
Soap	
Rubbing	Drying gently with a cotton towel or a hair dryer
Moisture	
Ointments, creams	Astringent or disinfecting lotions
Allergens	

Table 24.6 Topical antibacterial agents for the anal area

Erythromycin 2% (lotion)
Silver sulphadiazine (Silvadene cream; Marion)
Flammazine cream (Philips-Duphar)

Table 24.5 Side effects of topical steroids

Antiproliferative effects:	– Atrophy of the epidermis, dermis and subcutaneous fat
	– Striae distensae
	– Delayed wound healing, especially with ulcerated lesions
Vascular changes:	– Telangiectasia (rubeosis steroidica)
	– Purpura, ecchymoses
	– Delayed wound healing especially with ulcerated lesions
Reduced immune response:	– Candidiasis
	– Impetigo
	– Folliculitis
	– Herpes simplex
	– Human papilloma virus infection
Other side effects:	– Induces or worsens perianal acne
	– Hypertrichosis
	– Pigmentary changes
	– Systemic side effects
	– Allergic reaction to corticosteroids

dertaken. The best cleaning is achieved with water (hip bath or shower). The beneficial effect of this is demonstrated by the observation that Greek babies do not get diaper dermatitis because these infants are cleaned under running water [10]. At home, patients should try to always take a shower after defaecating. To avoid moisture, the patient should not wear non-porous clothing or garments that keep the buttocks held tightly together. Instead of rubbing with toilet paper, drying can be done with a hair dryer. Instead of ointment, only lo-

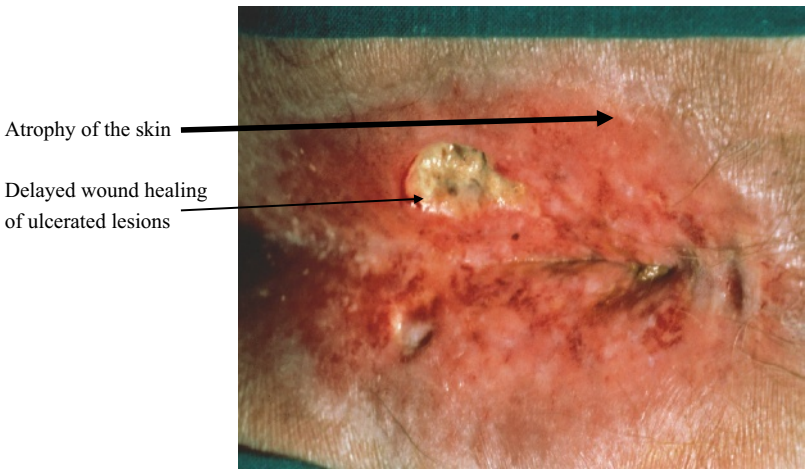

Fig. 24.7 Side effects of steroids. Antiproliferative effects include atrophy of the skin (*thick arrow*) and delayed wound healing of ulcerated lesions (*thin arrow*)

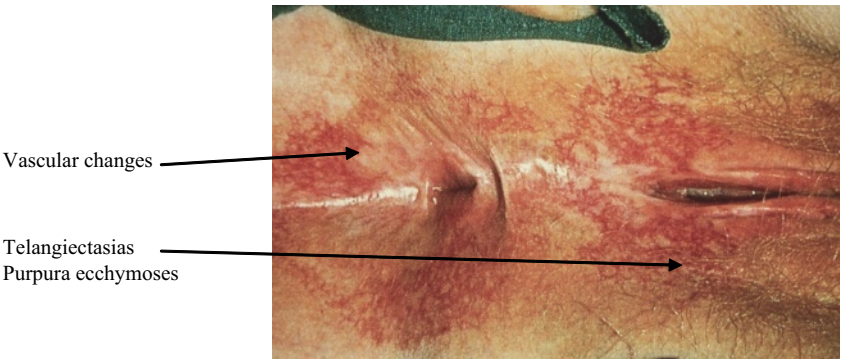

Fig. 24.8 Side effects of steroids

tions should be used. Every attack of pruritus should be "treated" by a cool hip bath. The use of topical steroids, the most important therapeutic tool for dermatitis, is not indicated in the anal region except in cases of acute allergic contact dermatitis.

Long-term topical application of fluorinated corticosteroids may induce side effects (Figs. 24.7 and 24.8); these are summarised in Table 24.5. It is better to employ lotions, or possibly creams, but not ointments. Fluorine steroids should be avoided. If they are absolutely necessary, their use should be limited to a strict minimum, and the rules of treatment with topical steroids must be strictly observed [33]. The potency of topical steroids varies a great deal; this fact must be taken into account when prescribing. They should be applied once a day because of the phenomenon of tachyphylaxis of the skin. Abrupt discontinuation of topical steroids will be followed by a flare-up. In the case of bacterial infection, only two topical antibiotics are recommended (Table 24.6). If *Candida* is present (which frequently occurs after prolonged application of topical corticoids), topical imidazole or nystatin, should be prescribed.

24.4 Fixed Drug Eruption

This is an unusual reaction to a drug or food additive. It can be seen anywhere on the skin, but is often localised in the anogenital region.

24.4.1 Aetiology

The exact allergic mechanism has not yet been fully explained.

24.4.2 Clinical Findings

An erythematous, well-defined, solitary or multiple patches showing rapid pigmentation. The lesions are frequently bullous and erosive. Relapses always occur in exactly the same places.

24.4.3 Assessment

A history of drug ingestion followed by eruption will allow the diagnosis. Drugs often implicated are: barbiturates, acetylsalicylic acid, non-steroidal anti-inflammatory agents, allopurinol, antibiotics, phenolphthalein-containing drugs, laxatives and wine.

24.4.4 Therapy

The first step is elimination of the drug. In the acute phase, topical steroids can be used. In the case of erosive lesions, antiseptic measures (see Table 24.7) should be undertaken to avoid infection.

Table 24.7 Antiseptic agents for cleaning the anal region

Potassium permanganate diluted to 1:4000–1:16000
Silver nitrate diluted to 0.1–0.5%
Chlorhexidine 0.1% (Hibitane; Ayerst, ICI)
Triclocarban (Septivon-Lavril; Porche-Lavril)

24.5 Infections

24.5.1 Viral

24.5.1.1 Herpes Simplex

Herpes simplex is a worldwide, and especially cutaneous, infection in humans. In addition to labial manifestation, genital lesions are also very common. Anorectal localisation is rare.

Aetiology

Herpes simplex virus is a DNA virus that only infects humans and has a universal distribution. Two types of herpes virus can be distinguished, but this is of no practical significance. Direct contact is the most obvious route of infection, as the virus does not survive in dry environments.

Clinical Findings

Primary infection can involve the entire genital area, extending to the anus. It is most frequently seen in girls and young women. This very painful eruption is characterised by erythema with vesicles, erosions and oedema (Fig. 24.9). Chronic and recurrent herpes is characterised by small vesicles clustered together followed

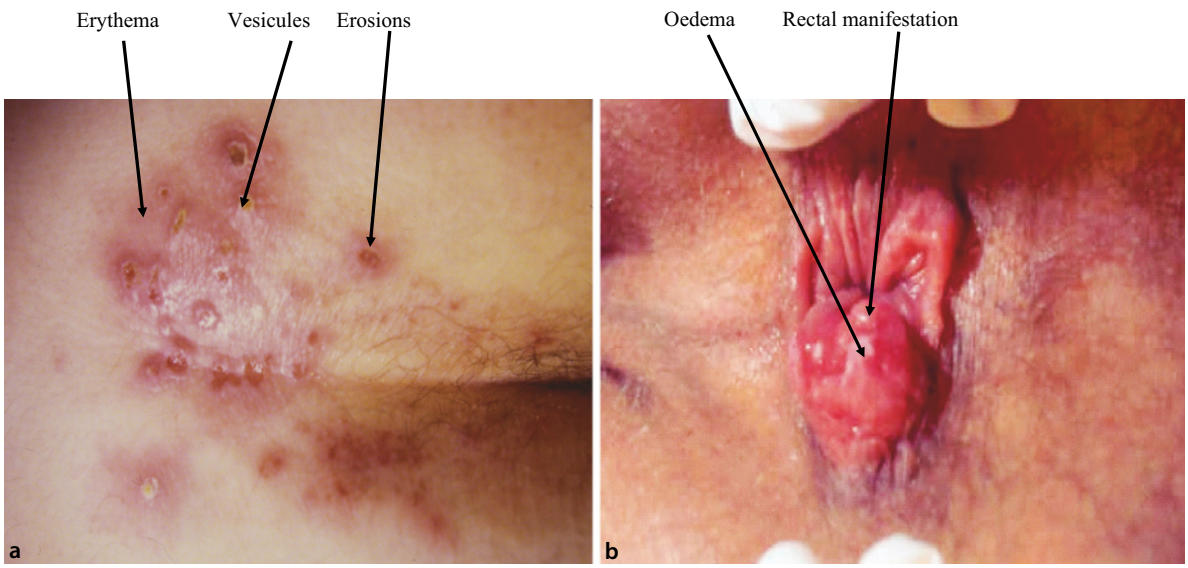

Fig. 24.9a,b Herpes simplex. **a** Eruption is characterised by an erythema with vesicles, erosions and oedema (see **b**). **b** Rectal manifestation

by erosive and crusted lesions. Patients with acquired immune deficiency syndrome (AIDS) may also exhibit a very extended, even ulcerous involvement including the anal mucosa (Fig. 24.10) [44].

Epidemiology

The anal manifestation of herpes simplex is mostly seen in homosexual men, and especially in immunocompromised persons (e.g. those with AIDS) [26].

Assessment

Cultures, electron-microscopic identification, and antibody titre evaluation are possible procedures. The most rapid and easy identification is the immunofluorescence method with a smear of the vesicular content, which can be examined for giant cells and inclusion bodies.

Table 24.8 Topical antiviral agents

Substance	Remarks
Lodoxyuridine (0.2%)	Rare allergy, insufficient concentration
Lodoxyuridine (10%)	
Tromantadine	Allergy
Acyclovir (5)%	

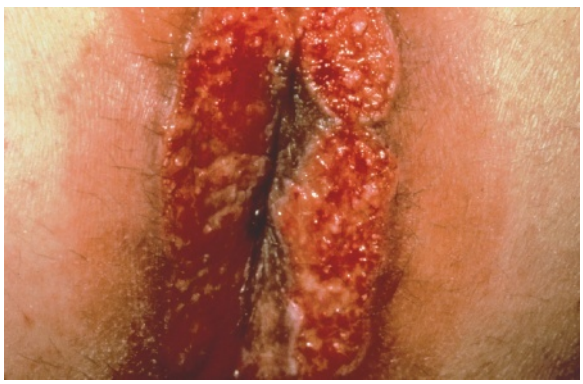

Fig. 24.10 Herpes genitalis + human immunodeficiency virus: expansion and ulcerous involvement

Therapy

Specific potent antiviral substances are available for topical treatment (Table 24.8). Systemic treatment is necessary in cases of primary infection and/or of very extended forms.

In the very beginning (i.e. the first 2 days), herpes should be treated with specific topical treatments (Table 24.8). Creams or ointments should be applied six times a day for 3 days. Acyclovir administered intravenously is indicated in all severe or primary infections, especially in immunocompromised persons: 5 mg/kg perfusion for 1 h repeated every 6 h. Oral administration (200–400 mg) should be started as soon as possible after the earliest signs of infection and repeated every 5 h for 3 days. In case of no response, imiquimod therapy can be effective [14], although it is not useful for the treatment of established lesions [49]. Immunostimulating medication (e.g. with methisoprinol, 50 mg/day for 5 days), has been shown to decrease the duration of relapsing herpes [41]. These specific treatments do not prevent recurrences. Older lesions will be easily infected and will require antiseptic treatment (Tables 24.6 and 24.7). Application of topical corticosteroids should be prescribed with caution.

24.5.1.2 Condylomata Acuminata

Condylomata acuminata (CA) are intraepithelial benign tumours that are caused by infection with human papilloma virus (HPV).

Aetiology

A variety of clinical warts is precipitated by different HPVs, but a specific virus type does not necessarily correspond with a distinct clinical picture. More than 140 types of HPV have been described. Some types (e.g. 16, 18, 31, 33) are oncogenic. In 90% of cases, epidermoid carcinomas are caused by HPV.

Clinical Findings

The clinical aspect of CA is very typical. These warts are elongated and pedunculated, sometimes with cauliflower-like excrescences localised on the genitalia and in the perianal region. One must thoroughly examine

the anal canal to rule out lesions here. They are painless and can grow to voluminous formations. Carcinomatous degeneration is possible if they persist for a very long time (Fig. 24.11).

Epidemiology

CA belong to the sexually transmitted diseases. Partners must be examined and treated simultaneously. Anal localisation is particularly frequent in homosexual men. Infection with HPV is very common in human immunodeficiency virus (HIV)-positive patients.

Assessment

The clinical findings are typical and sufficient for diagnosis. If there is doubt as to the diagnosis, application of 5% acetic acid will delineate the area of infection by turning the condylomatous area white. If the infection is long-standing and tumorous masses are present, histological examination is indispensable to exclude a malignant process.

Therapy

Many treatments have been used (Table 24.9). Spontaneous remission is common in warts localised elsewhere, but generally not with CA. It is thus not recommended to wait before starting treatment even if the signs are minimal. Inspection of the anal canal is mandatory.

Podophyllin diluted to 15–20% is most effective if the lesions are few and small. A twice-weekly application is recommended, but large areas should not be treated and excessive amounts should not be applied to the mucous

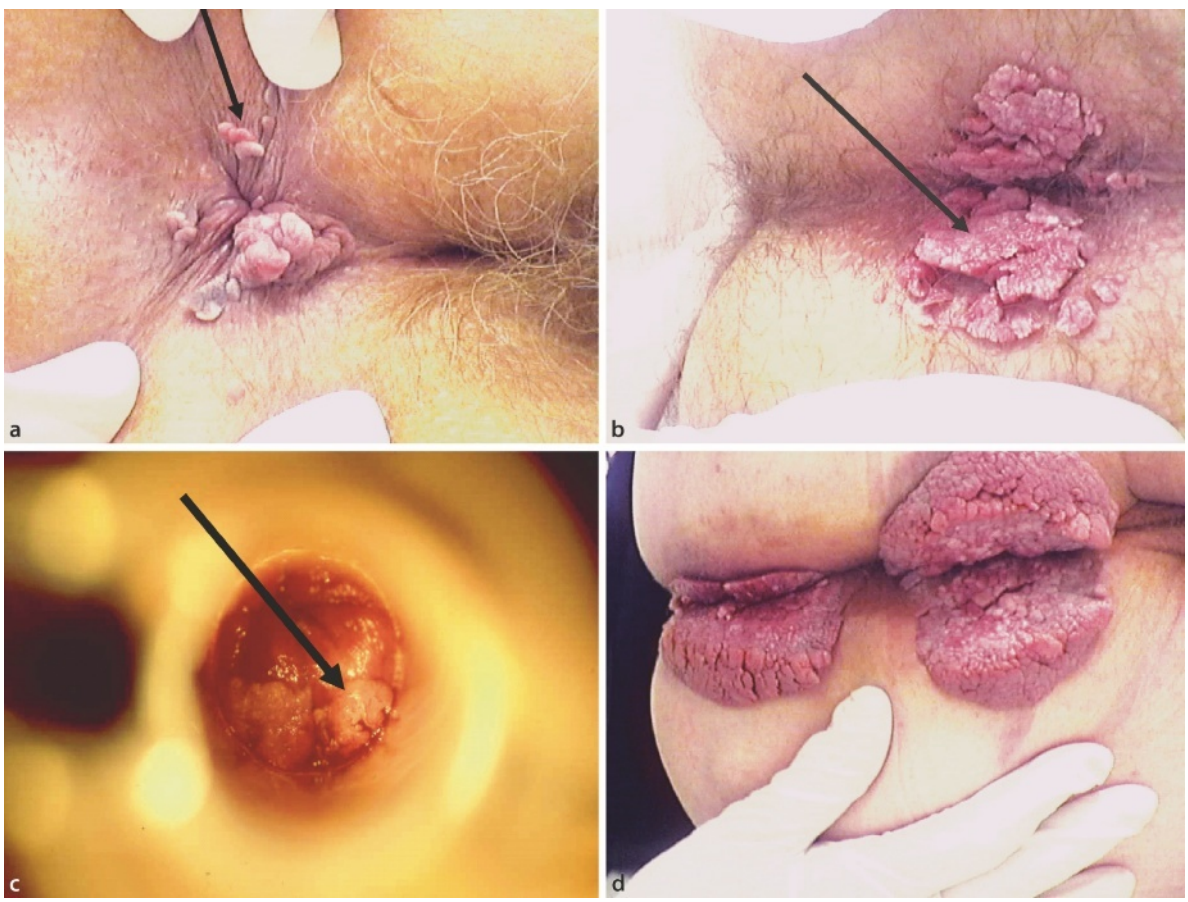

Fig. 24.11a–d Condylomata acuminata. **a** Warts are elongated and pedunculated. **b** Cauliflower-like excrescences. **c** Inspection of the anal canal is mandatory. **d** Buschke-Löwenstein tumour: condyloma gigantea

Table 24.9 Treatment modalities for condylomata acuminata

	Method of application
Podophyllin	Topical
Liquid nitrogen	Topical
Imiquimod	Topical
Curettage and electrosurgery	
Laser	
5-Fluorouracil	Topical
Immunotherapy:	
Isoprinosine (Newport)	Per oral
Interferons	Sublesional or subcutaneous injections

membranes as this substance can be absorbed through the skin, producing systemic side effects. One should cover the surrounding healthy skin with petroleum jelly in order to protect it from the effects of podophyllin. At the beginning of the therapy the liquid should be left on for 1–2 h and then washed off (otherwise severe irritation is possible). Later, podophyllin can be left for several hours. Cryosurgery will not produce scars if it is executed carefully. Electrosurgery, curettage and laser treatment should be performed under local anaesthesia. Laser therapy executed under magnification seems to give better results as recurrences are observed less frequently, and the healing is faster [45].

Various interferons (alpha, gamma) are currently undergoing clinical trials and promise to give an alternative treatment for HPV infections, which are resistant to other treatment. Local immunostimulation with imiquimod can be effective but may produce skin irritation around the anus [20].

24.5.1.3 Bowenoid Papulosis

Aetiology

Bowenoid papulosis is a new HPV infection caused by types 16 and 18, and possibly others [15, 16].

Clinical Findings

Multiple, flat, sometimes verrucous, reddish-brown to violescent papules are characteristic. They tend to group and coalesce, and may occupy the entire anogenital region (Fig. 24.12).

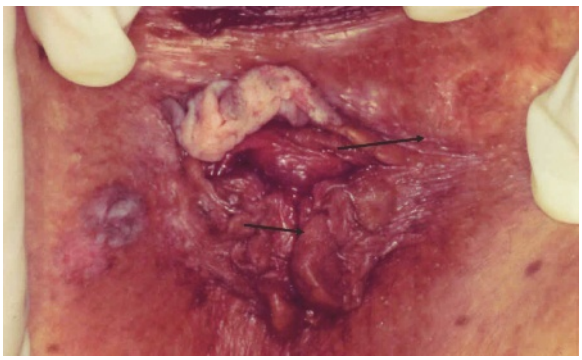

Fig. 24.12 Bowenoid Papulosis. Multiple flat, sometimes verrucous, reddish-brown to violescent papules (*arrows*)

Epidemiology

As is the case with CA, this infection is often seen in young adults who are sexually very active. Women may be affected in a particularly extensive way, including the whole genital and anal region. Cervical infection with the same virus is often observed.

Assessment

Contrary to CA, a biopsy specimen has to be taken for histological examination and typing of the virus by the hybridisation technique. Application of acetic acid (5%) is useful for visualisation of subclinical lesions.

Therapy

Essentially the same measures are used as for CA (Table 24.9). It has been noted that recurrences are very frequent, and a really effective treatment is not yet available. Repeated laser treatment associated with interferon or imiquimod [15, 16, 20] will perhaps give better results in the future.

24.5.2 Bacterial

There is a great variety of bacterial infections in the perianal region. The most common infectious agents are *Staphylococcus* and *Streptococcus* species [1]. The proctologist can expect a wide variety of bacterial infections as well as lesions that look infectious but have other origins. Perianal streptococcal dermatitis and erythr-

asma are discussed in detail as they often develop in the anogenital region.

24.5.2.1 Perianal Streptococcal Dermatitis

This disorder was first described in 1966 by Amren et al. [1] as perianal streptococcal cellulitis. The infection remains superficial and eczematous, and so the term "dermatitis" is preferred [24].

Clinical Features

Streptococcus B-haemolytic Group A is spread via the mouth-hand-anus route. Most patients are 3- to 4-year-old males [19, 30]. Infection results in a bright red perianal erythema. The inflamed skin can be weeping or thickened, and in some cases pustules or erosions can develop (Fig. 24.13). Patients complain of pruritus and pain on defaecation.

Diagnosis

The diagnosis is made with bacterial cultures. Differential diagnosis considerations include:

1. Toxic or allergic contact dermatitis
2. Enterobiasis
3. Psoriasis
4. Seborrhoeic dermatitis
5. Candidiasis
6. Sexual abuse

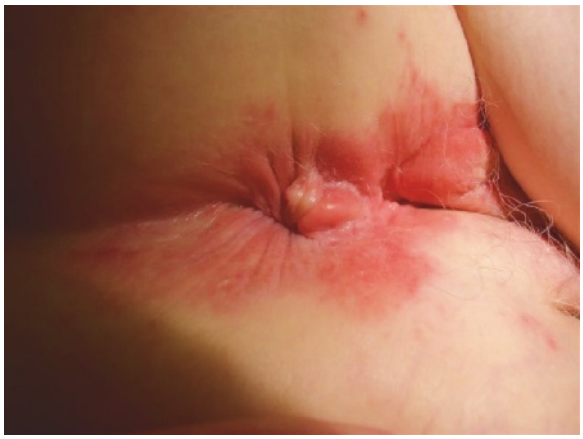

Fig. 24.13 Perianal streptococcal dermatitis. Note the bright red perianal erythema. The inflamed skin can be weeping or thickened, and in some cases pustules or erosions may be present

Treatment

Oral penicillin for 10 days is the treatment of choice. Muciprocin ointment can be applied locally twice a week as a prophylactic measure.

24.5.2.2 Erythrasma

Erythrasma is a superficial infection involving the intertriginous areas.

Aetiology

The pathogenic organism is *Corynebacterium minutissimum*. This dermatosis is not very contagious and is seen mainly in elderly male patients. Humidity (tropical climate) is the most predisposing factor.

Clinical Findings

Sharply marginated red-brown and slightly scaly plaques occupy the inguinal folds and may extend to the entire anogenital region (Fig. 24.14a).

Assessment

A coral-red fluorescence under Wood's light (UVA) is characteristic but may be lacking if the patient has washed before the examination because the colour-giving substance, a porphyrin, is water-soluble (Fig. 24.14b). The organism may be seen as a Gram-positive, filamentous and coccoid bacterium in affected scales.

Therapy

Topical imidazole derivatives [34] are the best treatment. Topical erythromycin, as used in acne therapy, and systemic erythromycin (1 g/day for 2 weeks) constitute other effective treatments [11, 50].

24.5.2.3 Tuberculosis

Different cutaneous forms of the infectious disease tuberculosis are possible. A primary chancre in the anal

region is exceptional; unilateral lymphadenopathy accompanies it. Lupus vulgaris and verrucous tuberculosis can spread widely over the buttocks and the anal region. The most likely form of tuberculosis seen anally is orificial tuberculosis, which occurs particularly in patients with advanced pulmonary or intestinal disease.

Aetiology

Orificial tuberculosis is a form of autoinoculation. The lesions are the result of direct inoculation or lymphatic extension around the anus.

Clinical Findings

Small red papules or nodules break down to shallow and very painful ulcers with undermined edges (Fig. 24.15). The ulcers are generally small, less than 2 cm, and do not tend to heal spontaneously.

Assessment

There is always evidence of tuberculosis, and bacterial confirmation is not difficult.

Therapy

No topical therapy is effective. Routine systemic antituberculous therapy must be employed.

24.5.2.4 Actinomycosis

Actinomycosis is a chronic infectious disease that is localised near an orifice and induces a suppurative and fistulating process.

Aetiology

Actinomyces isrealii is the most common filamentous bacterium that causes actinomycosis. Other bacteria such as *Actinobacillus actinomycetemcomitans* may also be associated.

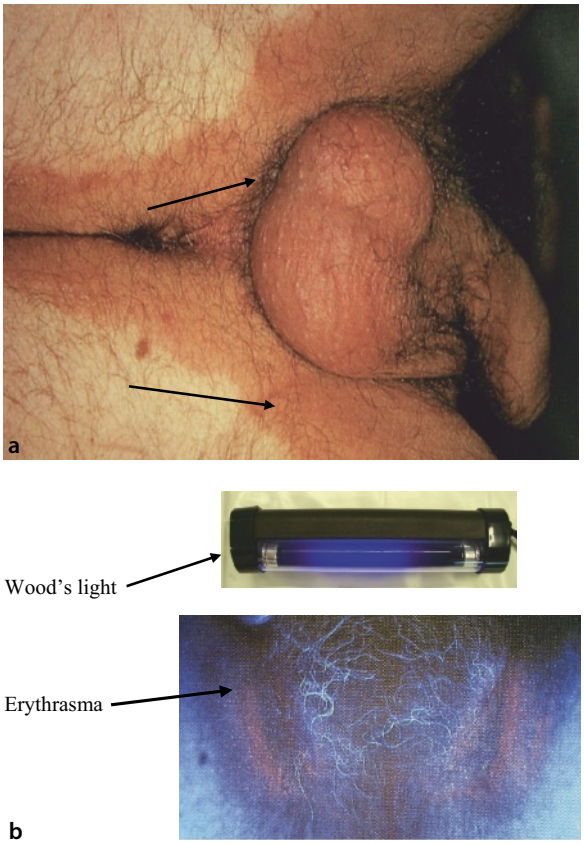

Fig. 24.14 **a** Erythrasma. Sharply marginated, red-brown and slightly scaly plaques occupy the inguinal folds and may extend to the entire anogenital region (*arrows*). **b** A coral-red fluorescence under Wood's light (UVA) is characteristic. The colour is derived from porphyrin

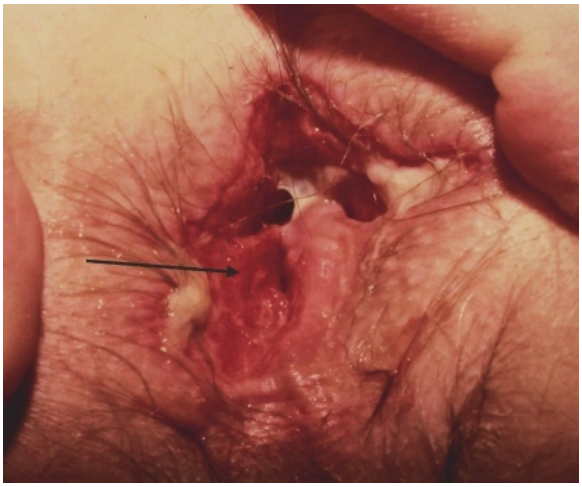

Fig. 24.15 Tuberculosis. Painful ulcers with undermined edges can be seen (*arrow*)

Clinical Findings

As in the more frequent cervicofacial form, the anal localisation is characterised by indurated nodules that break down, forming fistulae, sinuses and constricting scars.

Epidemiology

The distribution of the infection is worldwide. It rarely occurs in infancy; adults between the ages of 15 and 20 years are usually affected.

Assessment

Detection of typical sulphur granules in the pus is not always possible. A culture on a specific medium and detection of antibodies in the serum by immunofluoresence is diagnostic.

Therapy

Besides surgical drainage, administration of high-dosage antibiotics (aminopenicillin) is the best treatment [36]. Although many antibiotics are effective, they have to be used for a very long period (up to 6 months) because their penetration through the dense fibrotic areas surrounding the colonies is not optimal.

24.5.3 Mycologic

24.5.3.1 Candidiasis: Dermatophytic Infection (Ringworm, Tinea)

Fungal infections of the inguinal, genital and gluteal regions occur frequently in adult humans.

Aetiology

Fungus is a dermatophyte, which is a parasite of keratin (superficial layers of the skin, nails, hair). In this location it does not penetrate deeper into the epidermis or dermis.

Clinical Findings

Erythematous macules and papules develop forming symmetric, arciform and sharply delimited areas. The centres heal spontaneously, while the borders advance (Fig. 24.16).

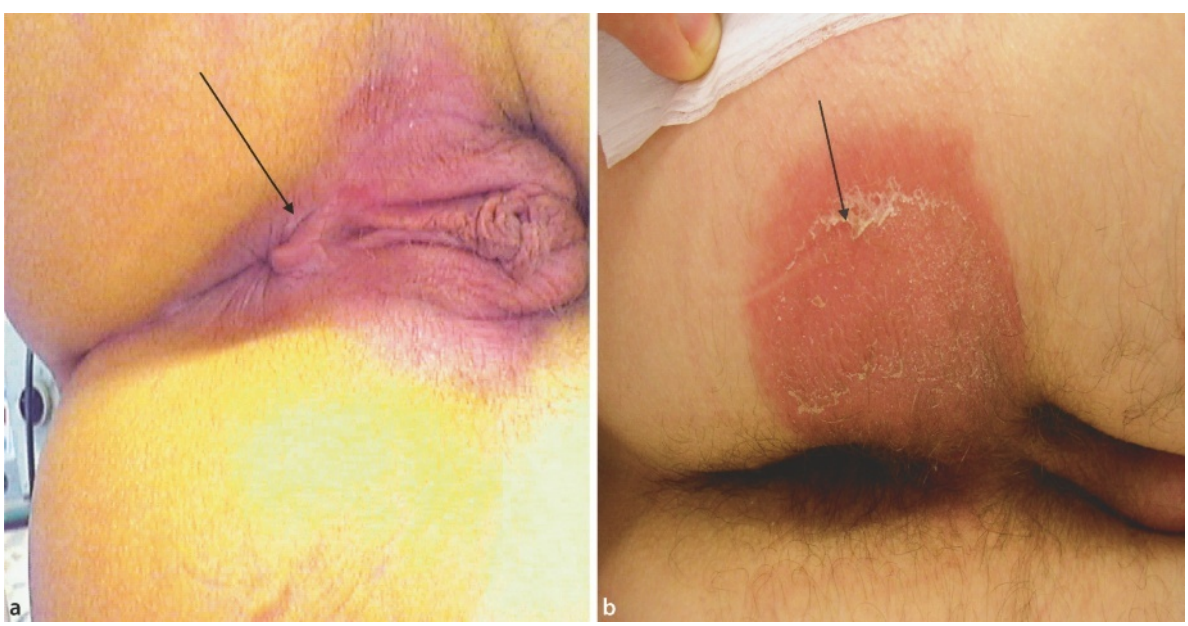

Fig. 24.16a,b Candidiasis. Erythematous macules and plaques are observed in an arciform and sharply delineated area (*arrows* in **a** and **b**)

Epidemiology

Heat (tropics), friction and maceration are predisposing factors. Inguinal tinea is often associated with tinea pedis. Infections can be caused by direct or indirect contact (common bathroom, towels) or by autoinoculation from the interdigital tineas [46, 48].

Assessment

The hyphae and spores can be identified microscopically in the scales. Fungal cultures are necessary for precise determination.

Therapy

Topical drugs play a central role in the treatment of superficial mycosis. Old preparations such as Whitfield's ointment are no longer in use because of the unpleasant properties of soiling and staining the underwear or the skin itself. All of the imidazole derivates are excellent broad-spectrum antifungal therapies: econazole, miconazole [34, 48] and clotrimazole, which is perhaps the best tolerated. They should be applied in lotions or creamy preparations twice daily for about 3 weeks, but in any case at least 2 weeks after the disappearance of clinical lesions. Their action is only fungistatic. A new class of antifungal substances are the allylamines. They too have a broad action but are fungicidal for dermatophytes and fungistatic for *Candida*. Naftifine is the only derivative that is available as both a cream and a lotion [4, 28]. In cases of acute, oozing, inflammatory lesions, wet compresses or hip baths (see Sect. 24.3) are indicated before specific topical antifungals. Systemic treatment should be given if the tinea recurs often, if tinea pedis is also present or if exceptionally furuncoloid forms are observed. In these cases, griseofulvin at 0.75–1.5 mg/day should be given for at least 1 month. Ketoconazole at 200 mg/day for at least 1 month is indicated only if griseofulvin cannot be given or if chronic complicated candidiasis is present.

24.5.4 Protozoal

24.5.4.1 Amoebiasis

Aetiology

Infection with the protozoon *Entamoeba histolytica* can induce anal ulceration by extension of an underlying amoebic disease of the bowel or by direct inoculation.

Clinical Findings

The ulcers either invade deeply, destroy the surrounding tissue rapidly and have serpiginous undermined edges, or they are filled with granulomatous tissue. Very painful adenopathy usually accompanies the ulcer.

Epidemiology

Direct inoculation may occur in endemic countries. Recent cases of this rare anal infection have been reported in HIV-positive individuals [32].

Assessment

Finding *E. histolytica* in a biopsy specimen from the edge of a lesion is diagnostic.

Therapy

Appropriate treatment of the bowel infection is necessary.

24.6 Dermatosis

24.6.1 Psoriasis Vulgaris

Psoriasis vulgaris is a frequent, chronic, inflammatory, proliferative dermatosis that can affect either gender at any age.

24.6.1.1 Pathophysiology

The pathophysiology is not clear, but it has been well established that psoriasis vulgaris is a hereditary disease

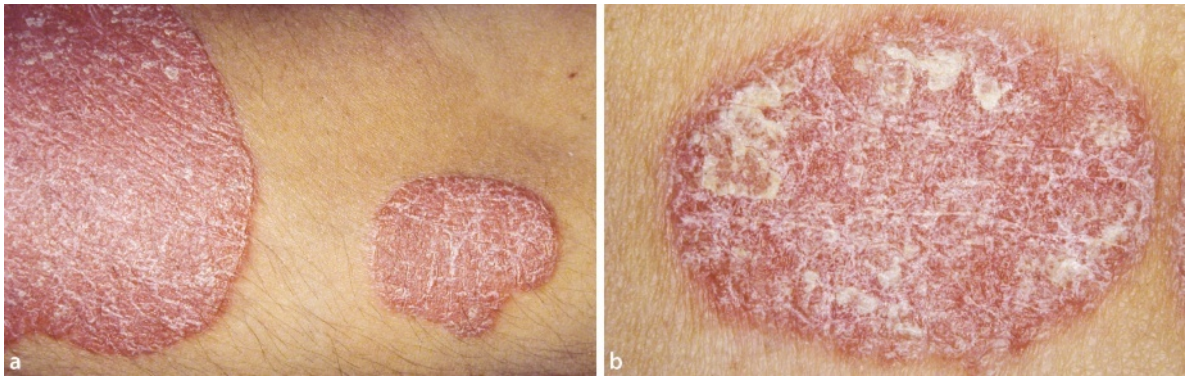

Fig. 24.17a,b Psoriasis. The typical lesion of psoriasis is an asymptomatic, erythematous, sharply defined plaque covered with loosely adherent scales, which appear especially after scratching

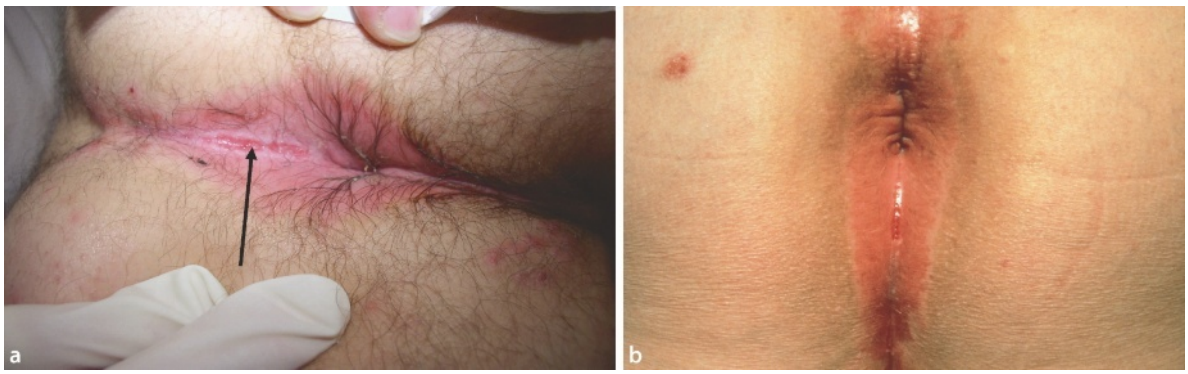

Fig. 24.18 a,b Psoriasis. **a** Longitudinal raghade (*arrow*). **b** There are no scales in the intertriginous localisations; instead there is a homogenous, symmetrical, dark red plaque

with variable penetrance. Exogenic (humidity, friction) and endogenic factors are likely to trigger psoriasis.

24.6.1.2 Clinical Findings

The typical lesion of psoriasis is an asymptomatic, erythematous, sharply defined plaque covered with loosely adherent scales, which appear especially after scratching (Fig. 24.17). There are no scales in the intertriginous locations; instead there is a homogenous dark red plaque (Fig. 24.18).

24.6.1.3 Assessment

The medical history and circumstances of onset or exacerbation may reveal the disease. Examination of the entire skin surface is necessary to detect other localisations with more specific lesions (Fig. 24.19). Biopsy can be useful, particularly if no other psoriatic lesions are present.

24.6.1.4 Therapy

In the acute phase, the same measures should be undertaken as for simple dermatitis. It is essential to promote drying and to avoid irritants. Specific treatment of psoriasis is generally not possible in the anal area because it is too irritating in association with the humidity and friction. For this reason dithranol, which is the main topical antipsoriatic agent, cannot be applied to the anal and perianal region. Imidazole derivates (miconazole as a lotion) are useful to combat acute inflammatory signs. Imidazoles seem to have not only an antifungal and antibacterial effect, but also a real antipsoriatic action. Alphosyl lotion (Stafford-Miller) containing allantoin 2% and coal tar 5% is the only antipsoriatic agent that can be applied to the perianal

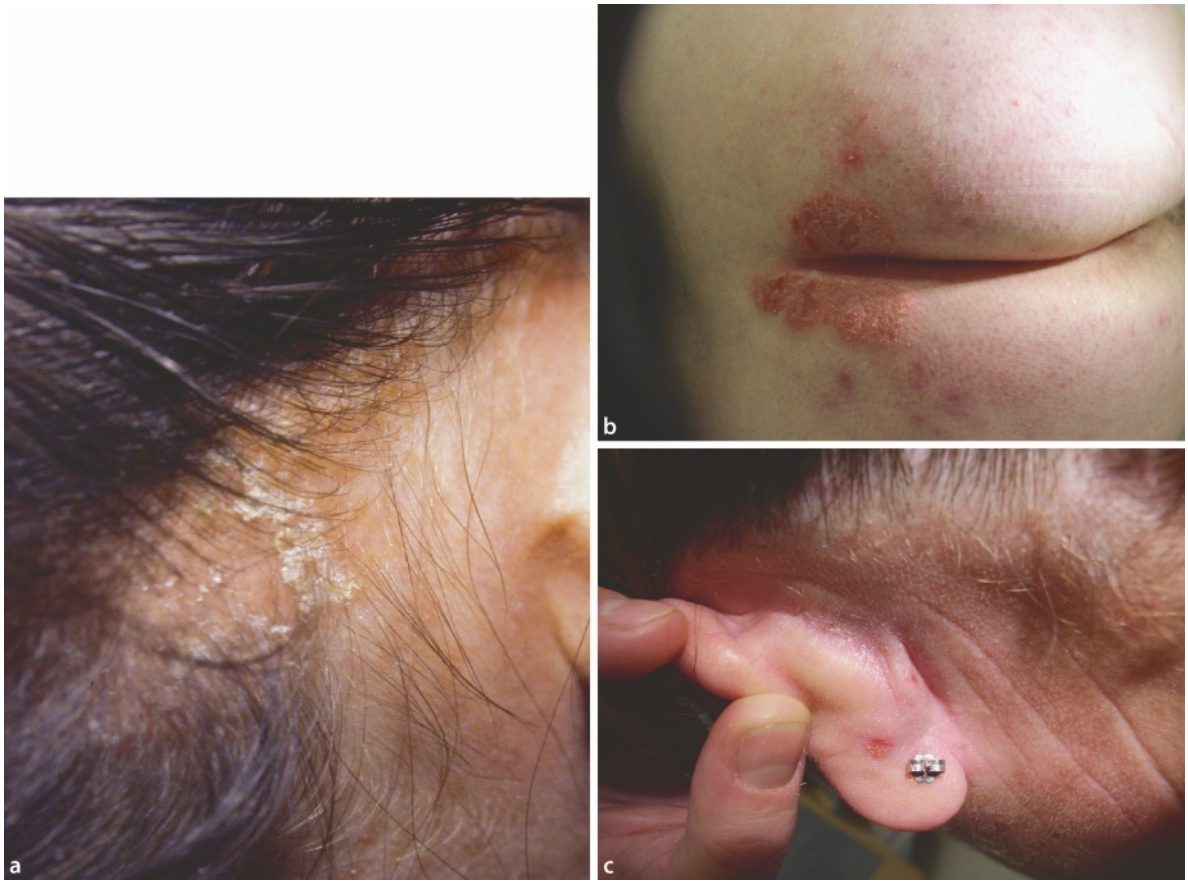

Fig. 24.19a–c Psoriasis. Examination of the entire skin surface is necessary to detect other localisations with more specific lesions

area. In the case of widespread extension in the whole inguinal and perigenital area, systemic treatment with retinoids is helpful. This treatment should be discussed with a dermatologist [18, 23, 40].

24.6.2 Hidradenitis Suppurativa and Acne Tetrad (or Apocrine Acne)

Hidradenitis suppurativa is an inflammatory and often chronic disease that causes a furunculoid appearance of the perianal region. It is often widespread over the buttocks. This fistulating, abscessing and scarring process is seen more often in men.

24.6.2.1 Aetiology

The aetiology is not yet well established, but it seems clinically evident that two diseases have to be distinguished [48]. Hidradenitis suppurativa was initially considered to be a disease of the apocrine glands (Verneuil's disease); on the basis of histological findings, hidradenitis suppurativa is now considered to be inflammatory and to originate from the follicular epithelium rather than the apocrine glands [54]. Acne tetrad is clinically identical to hidradenitis suppurative but is less severe and affects the sebaceous glands; it is therefore considered to be a form of acne.

24.6.2.2 Clinical Findings

All degrees of inflammation, torpid nodules, abscesses and fistulating processes with draining sinuses are seen. Severe scarring with frequent tunnelling formations is common.

24.6.2.3 Assessment

The distinction between the two entities is clinical. Verneuil's disease is localised only to the axillae and the perigenital-inguinal region (Fig. 24.20). Acne tetrad is present in the same places, but also on the neck and the scalp; it is often associated with pilonidal cysts.

24.6.2.4 Therapy

The treatment of the two entities differs in one respect: while acne tetrad responds extremely well to oral isotretinoin [11], this is far less effective with Verneuil's disease. Isotretinoin is given at a dosage of 0.5–1.0 mg/kg/day for 4–6 months (with contraception for women of childbearing age). Surgical treatment is often necessary after this period. Verneuil's disease responds well to oral antibiotics. Some new treatments have been proposed, such as anti-tumour necrosis factor infusion, ozone cream or local zinc applications; however, their long-term success rates have not been assessed [5]. Abscesses must be drained. Surgical treatment provides the only definitive healing [7]. Topical acne treatment is of no use for severe forms and is also not tolerated in the anal region.

24.6.3 Pemphigus Vulgaris

Pemphigus vulgaris is a chronic, autoimmune, cutaneous disease wherein bullous formations often begin on the mucous membranes. The anal and buccal mucosa is often affected.

24.6.3.1 Pathophysiology

Autoantibodies fixed to the surface of the keratinocytes are responsible for the dissociation in this layer, a process known as acantholysis.

24.6.3.2 Clinical Findings

Because of mechanical friction, no blisters are seen in the anal region, but there are superficial erosions that do not heal spontaneously.

24.6.3.3 Assessment

Direct immunofluorescence of a biopsy specimen is necessary for the detection of antikeratinocyte antibodies.

24.6.3.4 Therapy

Systemic corticosteroids are the most efficient treatment. The initial dosage must be sufficiently high (prednisone 100–120 mg/day) and the treatment should be continued for as long as the lesions are present. When the lesions have disappeared, the dosage is decreased until the lowest dosage that prevents lesions is found. Azathioprine (100–200 mg/day) or cyclophosphamide (50–150 mg/day) may be administered to enable the prescription of lower doses of corticosteroids. Topical prevention of the infection should be provided by antiseptic measures (Table 24.7).

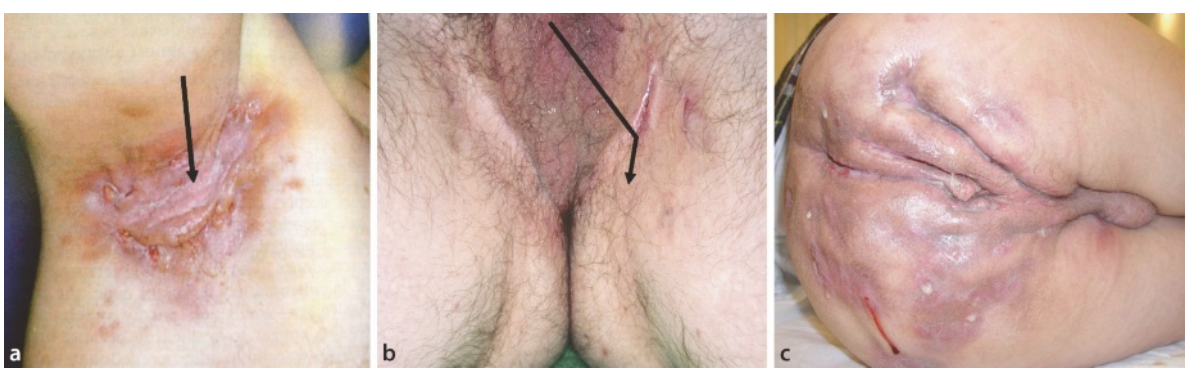

Fig. 24.20a–c Hidradenitis suppurativa: typical sites (intertriginous areas). Confluent infiltrations tend to merge at many points. **a** Axillaris (*arrow*). **b** Inguinalis (*arrow*). **c** Verneuil's disease. Pus, blood and fetid secretions (Gram-negative bacteria) emerge from the numerous fistulae

24.6.4 Pemphigus Vegetans

Pemphigus vegetans is a rare variant of pemphigus vulgaris and belongs to the group of autoimmune bullous dermatoses.

24.6.4.1 Pathophysiology

The pathophysiology is the same as for pemphigus vulgaris (see Sect. 24.6.3.1).

24.6.4.2 Clinical Findings

Blisters are rarely seen in pemphigus vegetans; only occasionally at the edges of the lesions. Instead, vegetations occupy the periorificial areas.

24.6.4.3 Assessment

The assessment is the same as for pemphigus vulgaris (see Sect. 24.6.4.3).

24.6.4.4 Therapy

In resistant or localised cases, surgical excision may be a good treatment.

24.7 Congenital and Genetic Diseases

24.7.1 Chronic Benign Familial Pemphigus (Hailey-Hailey Disease)

Benign familial pemphigus is a rare hereditary dermatosis that is mostly localised to the inguinal region.

24.7.1.1 Pathophysiology

This autosomal dominant disorder with variable penetrance is not related to the autoimmune bullous dermatosis of the pemphigus group. It can be precipitated and exacerbated by external factors such as humidity and infections.

24.7.1.2 Clinical Findings

Well-defined erythematous plaques are localised especially to the inguinal region, but may also appear in the anal and perianal areas. They are characterised by linear fissures, but vesicular and squamous lesions may also be seen.

24.7.1.3 Assessment

Histological examination showing acantholysis is necessary for an exact diagnosis.

24.7.1.4 Therapy

It is very important to keep the area as dry as possible. After antiseptic topical measures (Table 24.7), potent corticosteroids can be used. If there is no response, dapsone (100 mg/day) or surgery are further possibilities [29]. The whole affected area must be excised during surgery. When sufficient granulation tissue has developed, the wound is covered in a second step with a Thiersch graft. Short-pulsed and short-dwell-time carbon dioxide lasers give good aesthetic results [9].

24.7.2 Dyskeratosis Follicularis (Darier's Disease)

24.7.2.1 Aetiology

Dyskeratosis follicularis is a chronic autosomal dominant disorder of keratinisation that is seen mainly in adults.

24.7.2.2 Clinical Findings

When localised in the intertriginous area, the lesions of this disease are very similar to those in benign familial pemphigus. Brownish follicular papules may form large plaques. Fissures are seen but these are less regular than in benign familial pemphigus.

24.7.2.3 Assessment

Other locations such as the head, trunk, neck, palms and nails can be helpful for diagnosis. Mucous mem-

branes are often involved. Histological features are characteristic.

24.7.2.4 Therapy

Antibacterial and antiviral topical treatment is often necessary to overcome secondary infection. Topical treatment with retinoic acid can be tried at other locations but not in the intertriginous regions. Systemic retinoids such as etretinate 1 mg/kg/day may produce a very good response [27]. Markedly thickened lesions or reactive vegetating growths can be removed surgically.

24.7.3 Behçet's Disease

24.7.3.1 Aetiology

Behçet's disease is a systemic disease with multiple cutaneous signs of unknown aetiology. There may be ocular, articular, vascular and neurological manifestations, but not always simultaneously in the same patient.

24.7.3.2 Clinical Findings

Anal localisation of Behçet's disease is not frequent. The appearance of the lesions is absolutely identical to any other erosive onset. These simple erosions may develop into sharply demarcated ulcerations with a yellow base and an inflamed border. They are very painful.

24.7.3.3 Epidemiology

The disease predominates in males and usually begins between the ages of 10 and 30 years. Genetic transmission is probable since 60–80% of the patients belong to the HLA B5 group.

24.7.3.4 Assessment

The diagnosis of Behçet's disease is generally accepted in the presence of oral and genital aphthosis, and ocular lesions. If symptoms are sparse, cutaneous sensitivity (provocation of an aphthoid lesion at the point of injection) is a helpful test. Histology is not specific.

24.7.3.5 Therapy

No specific treatment is known. In the presence of ocular lesions or extensive aphthoid lesions, treatment with systemic corticosteroids is indicated (1 mg/kg/day) [53]. Heparin is given in the case of venous thrombosis. Colchicine has been tried successfully in erythema nodosum associated with Behçet's disease, but it has no influence on the aphthoid lesions. Sulphones have been tried with some success. Immunosuppressive treatment is limited to severe cases. The only therapy that has produced satisfactory results in the case of painful aphthoid lesions is thalidomide (50–300 mg/day for 2–3 months, beginning with the high dosage) [17, 31]. Topical management consists of antiseptic measures (see Table 24.7).

24.7.4 Acrodermatitis Enteropathica

24.7.4.1 Aetiology

Acrodermatitis enteropathica is a very rare disorder that is caused by a lack of zinc absorption [43].

24.7.4.2 Clinical Findings

This dermatosis is seen in young children. It begins in the periorificial zones as erythematous plaques with vesicles and crusting. Secondary infection with *Candida* is common. The same symptoms may be seen in alcoholic patients receiving parenteral hyperalimentation, which thus indicates a zinc deficiency [47].

24.7.4.3 Assessment

Typical localisation is associated with malnutrition. Histological examination is not relevant. Evaluation of the zinc levels in a blood test is diagnostic.

24.7.4.4 Therapy

Zinc supplementation with zinc sulphate (50–300 mg/day p.o. with food) rapidly resolves all symptoms, but this has to be continued for life.

24.8 Erosive and Ulcerous Dermatosis

Any erosive or ulcerous lesion in anal or perianal locations is susceptible to being a venereal disease. This possibility must be excluded even if the clinical findings are not characteristic. All erosive lesions might develop into ulcerous lesions due to secondary infection, which is difficult to avoid in the anal area.

24.8.1 Ulcers After Use of Suppositories

Two groups of drugs, ergotamine and the morphomimetics, have been shown to cause anorectal and vaginal ulcers after prolonged use [25, 52].

24.8.1.1 Aetiology

While ergotamine-induced ulcers can be explained by local vasoconstriction, there is no hypothesis for the group of morphomimetics.

24.8.1.2 Clinical Findings

Large and deep ulcerations on the anorectal mucosa have been described. They are indolent and can reach the level of the sphincter ani.

24.8.1.3 Therapy

No specific treatment is necessary because healing will occur spontaneously after the use of suppositories is stopped. Antiseptic dressings are useful.

24.8.2 Decubitus Ulcer

Decubitus ulcers frequently occur in pressure areas in elderly, immobile or paraplegic patients.

24.8.2.1 Aetiology

The determining factor of these trophic ulcers seems to be the loss of sensitivity, which leads to decreased movement and vascular stasis, especially in pressure areas [35].

24.8.2.2 Clinical Findings

Initial erythema and blistering lasting a few days precede ulceration. There is often deep destruction beneath the ulceration, leading to characteristic undermined edges and sinuses. Periostitis and osteomyelitis may also develop.

24.8.2.3 Therapy

The best treatment is prevention. Positioning, frequent bed making, use of special sheets and frequent turning of immobile patients are essential. The sitting position is unsatisfactory; the prone position is ideal but difficult to maintain. In addition to these mechanical measures, correction of anaemia, nitrogen imbalance and hypoalbuminuria is necessary. Caution with hypnotic agents and tranquillisers is important. Once a sore is established, all further pressure must be removed. Disinfection with a solution of potassium permanganate (see Table 24.7) or chlorhexidine (diluted to 0.5%) should be performed after every stool. The best disinfection for very large areas of ulceration is a hip bath for several hours per day, a procedure that simultaneously contributes to the elimination of pressure. The use of antibiotic ointments and soaked dressings is not well tolerated and does not accelerate the healing process. The use of modern dressings with adhesive plastic films is highly efficient and practical to use. Surgical excision and plastic surgery is sometimes recommended [6].

24.9 Systemic Diseases

24.9.1 Crohn's Disease

Anal manifestation may be present in about 25% of patients with Crohn's disease, which is a chronic inflammatory disease of the gut (see Chap. 30). It is important to emphasise that these manifestations may precede all other signs by months or even years.

24.9.1.1 Clinical Findings

Single or multiple non-indurated fissures, small or large ulcers and fistulae may be present. They are indolent and poorly granulating, and the borders are sometimes undermined (Fig. 24.21).

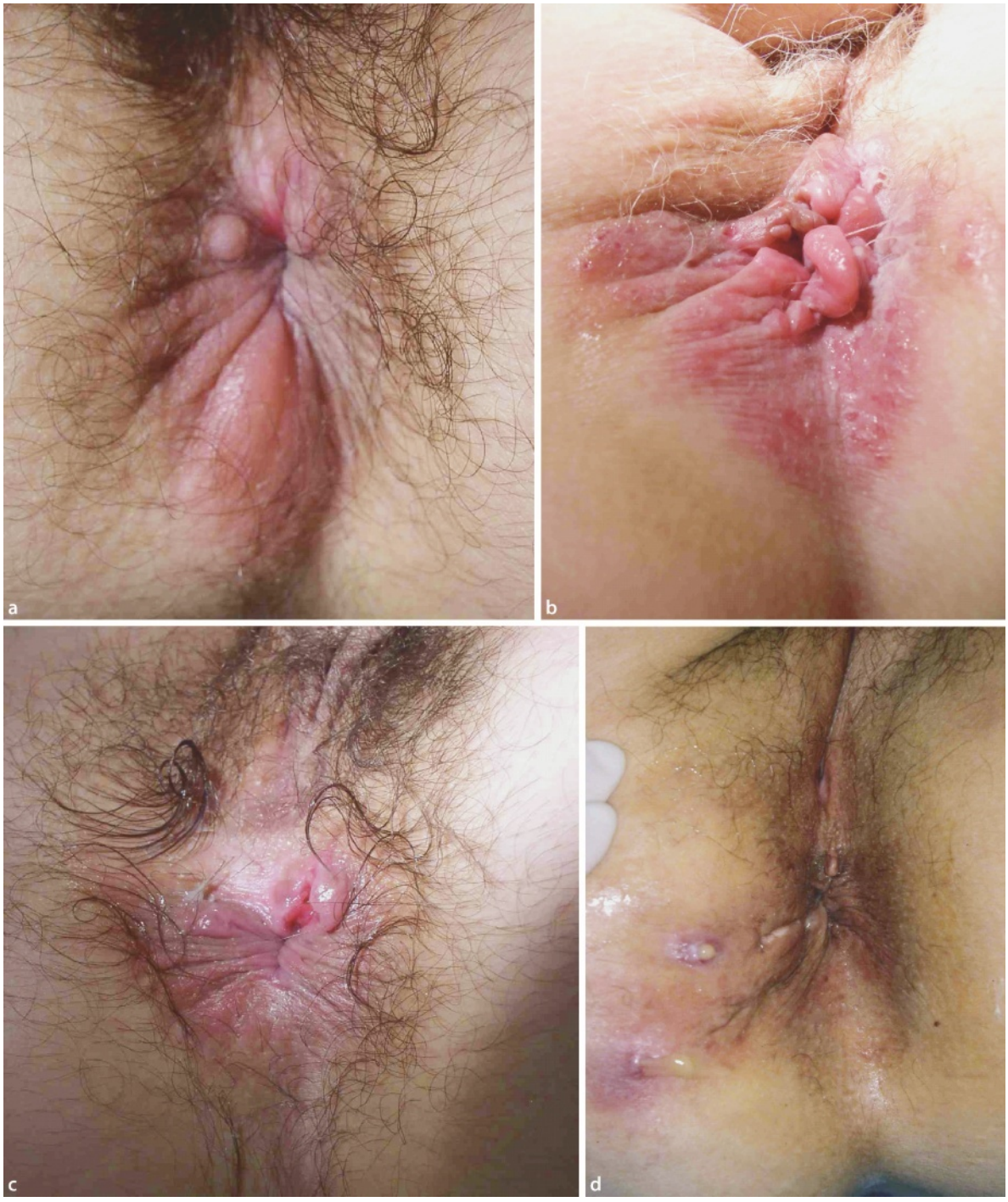

Fig. 24.21a–d Crohn's disease. **a** Abscess. **b** Skin tag. **c** Ulcer. **d** Fistulae

24.9.1.2 Assessment

Histological examination shows a characteristic granulomatous infiltration.

24.9.1.3 Therapy

No specific treatment is known. Abscesses and fistulae must be drained. Management with topical antiseptic agents is sometimes indicated (Table 24.7) [39].

24.9.2 Pyoderma Gangreno-Bullosus Pemphigoid

An uncommon but serious condition, pyoderma gangrenosum occurs almost exclusively in patients with inflammatory bowel disease. Lesions begin as erythematous plaques, papules or blebs that are usually situated on the pretibial region, but occasionally in the perineal region (Fig. 24.22). Lesions soon progress into ulcerated, necrotising and painful wounds with ragged purple-red margins. There appear to be two subgroups of patients with this disease. One group has active bowel disease, and the skin lesions in this case are related to bowel activity. In these patients, bowel resection is followed by rapid skin healing. In the second group, with quiescent bowel disease, an operation will not heal the skin lesions promptly [3].

24.10 Vegetative and Fistulous Dermatosis

In cases of vegetative and proliferating lesions of the anal area, syphilitic infection must be excluded as a first step (see Chap. 47).

24.11 Tumorous Paraneoplastic Syndromes

24.11.1 Acanthosis Nigricans

Acanthosis nigricans is a rare inhomogeneous condition that is characterised by cutaneous hyperkeratosis and pigmentation in the axillae, neck, anogenital region, groin and intertriginous folds.

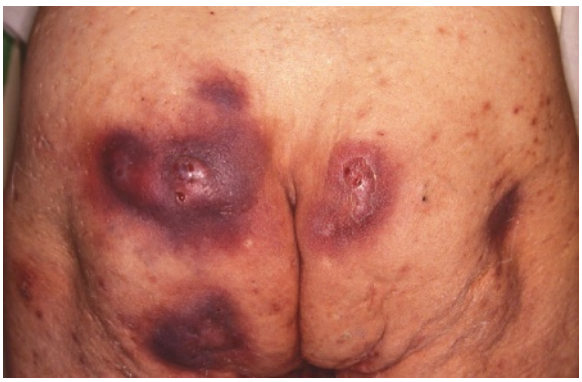

Fig. 24.22 Pyoderma gangreno-bullosus pemphigoid. The lesion begins as an erythematous plaque, papule or bleb, occasionally in the perineal region

24.11.1.1 Aetiology

An unidentified peptide secreted by a neoplasm or by the pituitary gland is assumed to cause the lesions. Acanthosis nigricans is associated with conditions that increase insulin levels, or it can be precipitated by medications. In some cases it can be inherited.

24.11.1.2 Clinical Findings

Brown verrucous lesions develop mainly on the intertriginous folds and are associated with hyperkeratosis of the palms and soles. Extension over the entire skin is possible.

24.11.1.3 Epidemiology

A benign form may be familial with irregular autosomal dominant inheritance. Another benign form, also called "pseudoacanthosis nigricans", is seen in obese young adults. The malignant form is always associated with a malignant disease.

24.11.1.4 Assessment

Clinical features are obvious. Differentiation between the benign and malignant form is possible with genetic investigations, age at onset and association with malignancies.

24.11.1.5 Therapy

No specific treatment is known. Malignant forms disappear when the tumour is excised or treated efficiently [42].

24.11.2 Glucagonoma Syndrome

Glucagonoma syndrome is characterised by the presence of a glucagon-secreting islet cell tumour of the pancreas.

24.11.2.1 Aetiology

In almost all cases the islet-cell tumour involves the α-cells of the pancreas. For as yet unexplained reasons there is a distinctive skin eruption. About 80% of glucagonomas are malignant and are found in the body or tail of the pancreas [8].

24.11.2.2 Clinical Findings

The initial changes are periorificial erosions around the mouth and in the anogenital region. The lesions spread peripherally, with central desquamation and pallor. Circinate patterns can form (Fig. 24.23). Perianal erosions are often associated with diarrhoea, and bleeding and pain at defaecation.

24.11.2.3 Diagnosis

The diagnosis can be confirmed on measurement of serum glucagon levels: normal values lie in the range 0.1–0.3 U/ml; in glucagonoma, glucagon levels can rise up to 800–3000 U/ml. In addition, the patient will suffer from hyperglycaemia and will produce an abnormal glucose tolerance test. If not too small, the tumour can be identified with ultrasound, computerised tomography and magnetic resonance imaging.

24.11.2.4 Therapy

Treatment consists of surgical tumour excision. The skin lesions heal within 48 h after resection of the tumour. In the case of non-resectable tumours, chemotherapy with tumour embolisation can be considered. Somatostatin analogues can suppress the secretion of glucagon and reduce the symptoms.

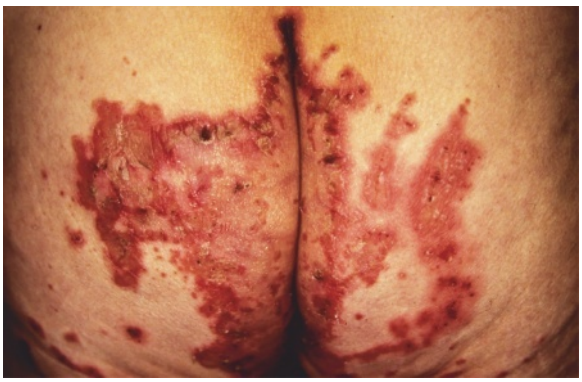

Fig. 24.23 Glucagonoma syndrome. The lesions spread peripherally with central desquamation and pallor. Lesions can form in circinate patterns

24.12 Premalignant Diseases

24.12.1 Paget's Disease

Paget's disease is a rare dermatosis that is generally seen in the breast but can be exceptionally localised to the anogenital region of ageing men or women.

24.12.1.1 Pathophysiology

The mammary and extramammary forms are linked to the apocrine glands. Paget's disease is the result of a carcinoma of the ductal part of these glands.

24.12.1.2 Clinical Findings

The characteristic feature is a very slowly advancing erythematous patch, which is always well defined (Fig. 24.24).

24.12.1.3 Assessment

Histological examination is diagnostic.

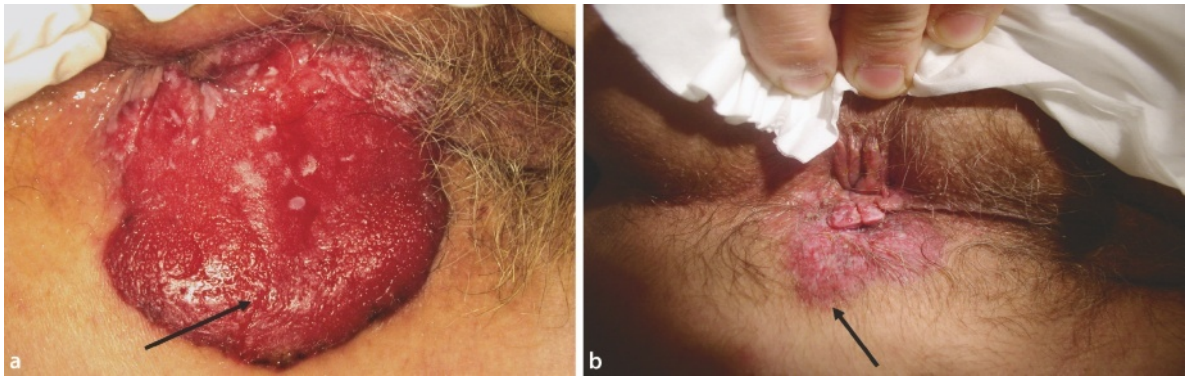

Fig. 24.24a,b Paget's disease. This is usually a unilateral, sharply limited, slowly advancing erythematous patch that is always well defined (*arrows* in **a** and **b**)

24.12.1.4 Therapy

Surgical resection with safety margins is the treatment of choice [21].

24.12.2 Bowen's Disease

24.12.2.1 Aetiology

Bowen's disease, which is a form of intraepidermal carcinoma, is seen in the anogenital area of both males and females at an advanced age. Carcinogenic factors such as age and arsenic exposure probably play a leading role.

24.12.2.2 Clinical Findings

The lesion is generally solitary, erythematous and slightly infiltrated. Well-defined and occasionally multifocal plaques can be localised anywhere on the skin surface, but the anogenital region is implicated. The plaques can be covered with scales and crusts, resembling dermatitis (Fig. 24.25).

24.12.2.3 Assessment

Histological examination is diagnostic.

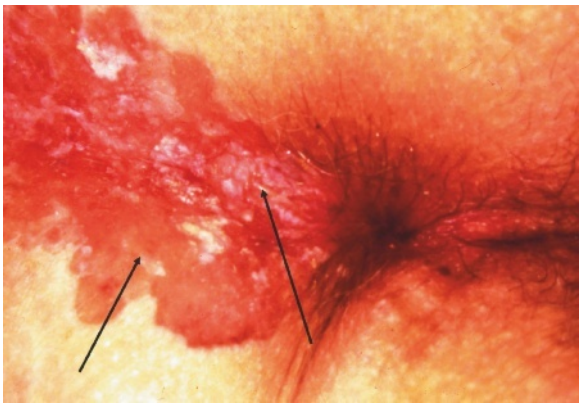

Fig. 24.25 Bowen's disease. This is a solitary erythematous, slightly infiltrated plaque, which can be covered with scales and crusts (*arrows*), resembling dermatitis

24.12.2.4 Therapy

Surgical excision with safety margins is the therapy of choice. Cryotherapy, electrocoagulation or laser therapy can also be used, but must be followed up regularly to avoid relapses.

24.12.3 Lichen Sclerosus et Atrophicans

24.12.3.1 Aetiology

Lichen sclerosus et atrophicans is a rare dermatosis that occurs predominantly on the female genital mucosa after menopause. The aetiology is unknown.

24.12.3.2 Clinical Findings

Small bluish-white macules form larger irregularly defined plaques. The skin in these plaques is thickened at the beginning and is later atrophic. Erosion fissures and scars are often observed. Severe pruritus is very common (Fig. 24.26).

24.12.3.3 Assessment

The typical clinical findings localised to the genital area are quite diagnostic. Histological examination is of help.

24.12.3.4 Therapy

Small lesions can be excised surgically. Topical treatment with potent corticosteroids or intralesional injection with steroids will decrease the pruritus [13]. Regular follow-up is indicated, as transformation into spinocellular carcinoma is possible. Testosterone (2%) in a steroid ointment can be tried [12].

24.13 Malignant Diseases

24.13.1 Carcinomas

Some of these diseases, which are discussed in more detail in Chap. 22, are difficult to differentiate from proctologic dermatological lesions. It is important to never underestimate an asymmetric lesion that does not respond to conventional therapy.

24.13.1.1 Epidermoid Carcinoma

Epidermoid carcinoma can be confused with a simple skin tag (Fig. 24.27) and only induration at palpation suggests the diagnosis. In all cases of doubt, histology should be performed and even repeated if negative.

24.13.1.2 Carcinoma Verrucosus

Carcinoma verrucosus may have the appearance of condylomatous disease (Fig. 24.28). Biopsy should be performed under local or general anaesthesia to confirm the diagnosis and thus provide accurate treatment.

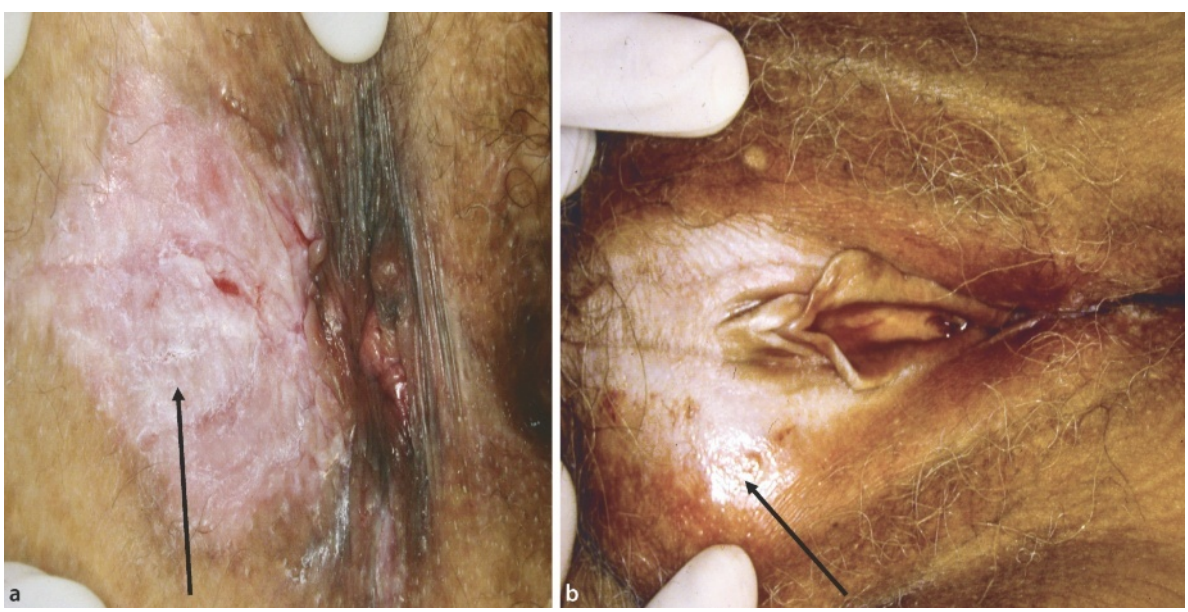

Fig. 24.26a,b Lichen sclerosus et atrophicans. Porcelain white macules are thicker at the beginning (*arrow* in **a**) and atrophic later (*arrow* in **b**), with erosion, fissures and scars

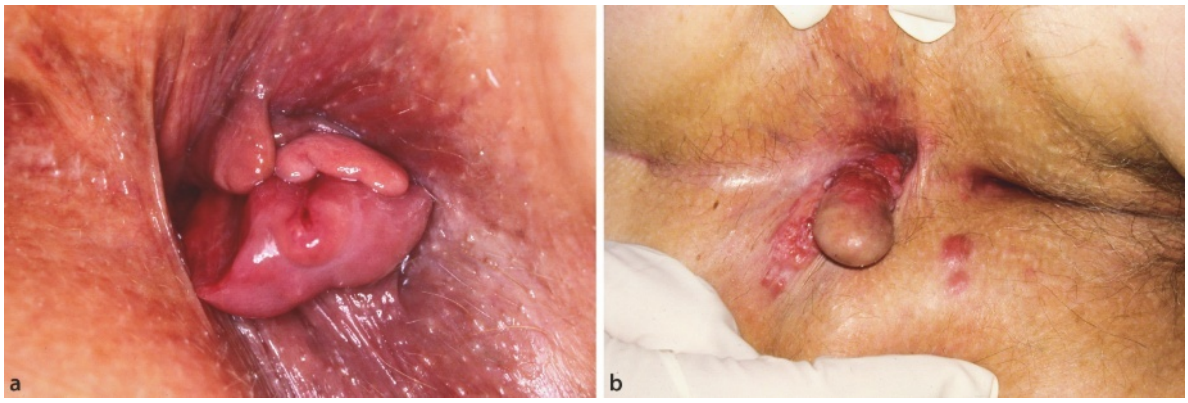

Fig. 24.27a,b Epidermoid carcinoma (**a**, **b**) can be confused with a simple anal skin tag

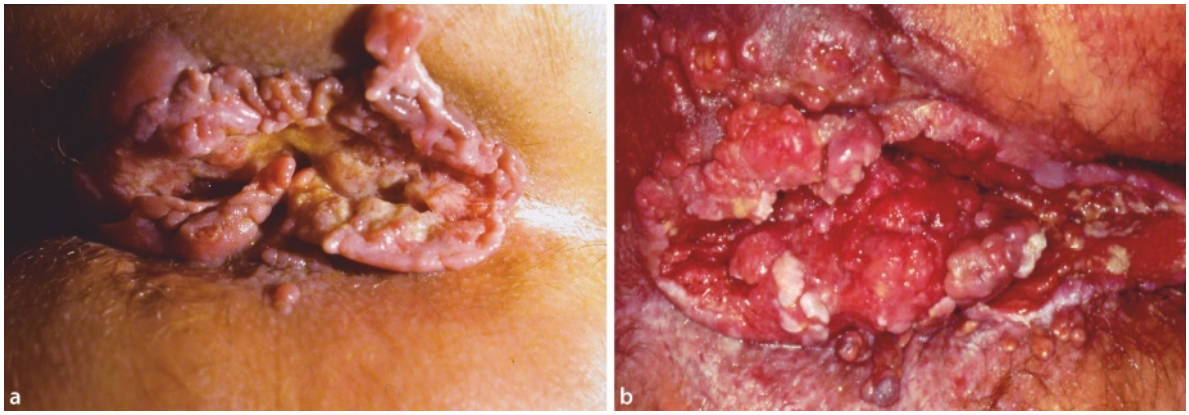

Fig. 24.28a,b Carcinoma verrucosus may simulate condylomatous disease

24.13.2 Malignant Melanomas

Malignant melanomas are fortunately rare. They can be localised at the anal margin (Fig. 24.29) or in the rectum. The clinical presentation often begins with metastasis and the prognosis is poor. Treatment consists of a classical melanoma treatment, which is total surgical resection with free margins. Sentinel-node biopsy may be useful to evaluate the spread of the illness [38]. In the case of anal localisation, the sentinel nodes are found in the groin. In some cases of rectal melanoma, abdominoperineal excision has been proposed. Unfortunately, this invasive surgery does not modify either the long-term recurrence rate or the life expectancy of the patient. These lesions are rare, but in view of the difficulty of surveillance, any pigmented lesion located at the anal verge should be removed before it becomes a cancer.

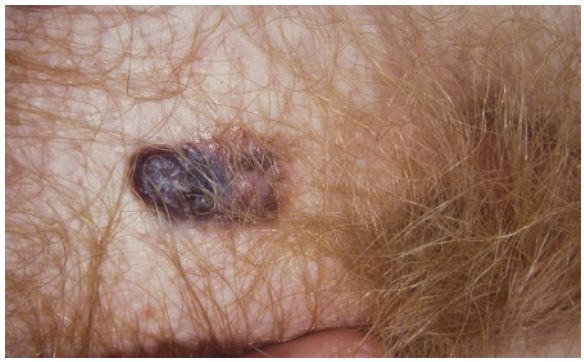

Fig. 24.29 Malignant melanoma in an anal and perianal location

24.13.3 Leukaemic Infiltrations

Leukaemic infiltrations can be painful and are often misdiagnosed as abscesses. It is important to examine the spread of the illness near the anal lesion (Fig. 24.30).

The leukaemia must be treated, and resolution of the basic pathology will lead to the healing of these skin infiltrations. In the case of resistant leukaemia, localised radiotherapy of 10–20 Gy can reduce the pain and temporarily treat the skin lesions.

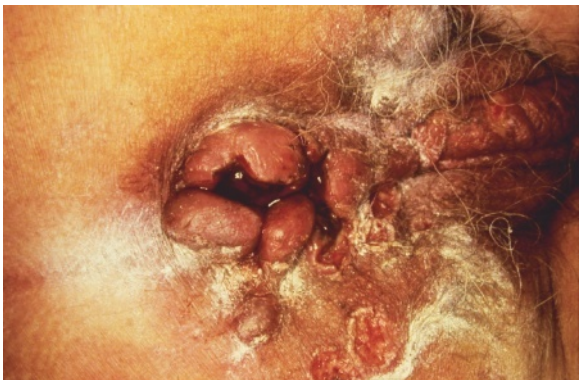

Fig. 24.30 Leukaemic infiltrations: abscess-like spread of the illness near to an anal lesion

24.14 Conclusion

Perineal dermatology is probably the less well-known part of proctology. Perineal dermatology is specific to this area. It is important in proctodermatology practice to recognise the condition and make a good diagnosis in order to administer the most appropriate treatment. The differential diagnostic of perineal dermatology is wide, and multiple pathologies can occur in the same patient simultaneously. Moreover, these disorders may often have similar signs and symptoms. It is mandatory for the surgeon and the dermatologist to pay particular attention to anoperineal dermatology.

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Self-Assessment Quiz

Question 1

1. Which characteristic may raise the suspicion that a lesion is malignant?

a. The lesion is symmetric.
b. The lesion is asymmetric.
c. The lesion is well defined.
d. The lesion is erythematous.
e. The lesion is thick.

Question 2

2. Perianal dermatitis treatment recommends:

a. To use toilet paper
b. To rub the skin
c. To use soap regularly
d. To clean with water only
e. To apply cream

Question 3

3. Acne tetrad responds extremely well to:

a. Prednisone
b. Isotretinoin
c. Oral antibiotics
d. Ketoconazole
e. Zinc

Question 4

4. Characteristic features of perianal tuberculosis can comprise:

a. Unilateral lymphadenopathy
b. Large macular lesions
c. Small ulcers <2 cm
d. Good response to topical treatment
e. Usually presents as the sole manifestation of tuberculosis

Question 5

5. Some particularities of the anal and perianal skin are important for the understanding of the specificity of proctologic dermatology, with which exception?

a. Perianal skin is thinner than the skin of other parts of the body
b. Perianal skin contains a high number of glands, and especially apocrine glands
c. Perianal skin is exposed to continuous friction
d. Perianal skin has special bacterial flora
e. Perianal skin has no melanocytes

1. Answer: b
Comment: Symmetric lesions usually result from friction of the buttocks. Proliferative lesions grow on one part of the perianal skin.
2. Answer: d
Comment: All of the other answers generate irritation and moisture retention.
3. Answer: b
Comment: Acne tetrad has an extremely good response to isotretinoin (0.5–1.0 mg/day over 4–6 months).
4. Answers: a and c
Comment: Perianal tuberculosis is often accompanied by unilateral lymphadenopathy; small ulcers of <2 cm result from the breakdown of small red papular lesions.
5. Answer: e
Comment: Perianal skin contains all of the other cells found in normal skin

25 Pruritus Ani

Olivier Gié

CONTENTS

25.1 Introduction

Perianal itching has always been an unpleasant and constant affliction of the human bottom. Previously widespread around the world, it remains a very common symptom that is difficult to handle and socially embarrassing. It affects approximately 5% of the population in the developed world and its incidence has increased in regions where intestinal infestations are endemic. Contrary to popular belief, males are four times more frequently affected than females [1]. The reasons for this epidemiological difference are still unknown.

Hygiene and eating habits play an important role in the etiology, but social environment and culture determine greatly the perception and tolerability of this symptom, warranting its high prevalence.

The anogenital area is a habitual location for itching because of its anatomy, site and function. This condition is far too easily described as idiopathic by the medical profession and consequently only general advice is often given. However, it is important to remember that itching remains substantially a symptom and not a diagnosis. For these reasons, affected patients should be specifically investigated and attention must be paid to concomitant signs and comorbidity.

The differentiation between itching, burning, and pain are fundamental for the meticulous clinician. This information is not spontaneously provided by patients, so it must be actively sought by means of specific questions. It is helpful to know whether scratching or fresh air alleviates itching. If the latter applies, then it certainly concerns burning. As a result, an allergic reason can be practically ruled out. In this case, it is rather more a matter of considering psoriasis vulgaris, lichen ruber planus or herpes simplex genitale as causes.

Different ways of classification based on etiology, condition of appearance, and manifestation have been proposed in the literature. In this chapter we consider two clearly identifiable categories of pruritus ani (PA): acute and chronic.

25.2 Definition and Pathophysiology of Pruritus

Samuel Hafenreffer, the author of the first textbook on dermatology in German-speaking countries, proposed in 1660 that: "…itching is an unpleasant sensation with the urge to scratch…" [2]. Pruritus is one of the most common symptoms in dermatology and general medicine and it is not only a submodality of pain, but also an individual complex sensation that originates from an interactive network between the skin and the peripheral and central nervous systems.

A recent hypothesis suggests that the origin of itch is a low activation of unspecific nociceptors [3]. Analysis of C-fibers shows a division between polymodal nociceptors that are insensitive to histamine, reacting to pain, mechanical, heat, and chemical stimuli, and "sleeping nociceptors," which do not respond to mechanical stimuli but are strongly activated by histamine. If artificially activated with low-intensity electrical stimulation, these histamine-sensitive fibers generate pruritus, and high-intensity electrical stimulation leads to the itching associated with a skin erythema.

The interaction between skin cells (keratinocytes and Langerhans cells), mediators, and sensory nerve

endings is fundamental to the generation of pruritus. Various endogenous peripheral mediators are released locally by epithelial, immune, and endothelial cells, which are able to activate specific receptors or the nerve endings responsible for itching. It now well established that not only histamine, but also other compounds such as serotonin, prostaglandin, endogenous opioids, and neuropeptides are the main mediators of pruritus.

After activation in the skin, the stimulus of itch is transmitted through unmyelinated nerve fibers to the posterior ganglia and spinal cord, and then to the thalamus. Here, specific areas are activated and then elaborated from the gray cortex. This complex interaction in the brain is still only starting to be understood.

The scratch reflex is a defensive behavior that promotes skin damage, fissuring of the stratum corneum, and generation of an inflammatory response. A self-reinforcing cycle thus begins, increasing localized tenderness and compromising the patient's ability to maintain personal hygiene. This further worsens the burning sensation and increases the need to scratch the affected area.

25.3 Investigation

The etiology of PA is often hidden by this unkind symptom; for this reason, a full history-taking and examination must be carried out, along with complementary investigations. The first step is to take a detailed anamnesis from the patient. Questions exploring social background, current and previous medications, food intake, bowel habits, sexual habits, and hygiene are fundamental to clarifying the problem (Table 25.1).

A precise examination of the anorectal region involves performing an external inspection (anogenital area), a per rectal examination, a proctoscopy, a rectoscopy that can be extended to a colonoscopy, and gynecological and dermatological examinations if necessary. Supplementary paraclinical investigations include laboratory tests (full blood count, erythrocyte sedimentation rate, glucose – random and fasting, iron levels).

Intestinal infestation must be excluded by examining the stool or blood for parasites, bacteria, and fungi (Table 25.2).

In some cases it is possible to perform mucosal and cutaneous biopsies at the border of a visible lesion (scalpel or punch biopsy) to clarify the diagnosis. If an allergic origin is suspected, cutaneous tests are necessary to determine the allergen (Fig. 25.1).

Table 25.1 History taken

- Personal habits
  - Eating (spicy foods)
  - Bowel movements
  - Sexual habits
  - Sport (bicycle, running, body building)
  - Hygiene
  - Travel
- Medical
  - Atopia
  - Medication (topical, general, previous, current, self-prescribed)
  - Comorbidity (dermatological, digestive, gynecological, endocrine)
  - Body mass index
  - General medical history
  - Family history
- Psychological background
  - Anxious
  - Depressed
- Social and professional

Table 25.2 Investigation. *FBC* Full blood count, *ESR* erythrocyte sedimentation rate

Investigation
- External inspection
  - Fungal research (potassium hydroxide)
  - Scotch test
  - Prick test
- Per rectal examination
- Proctoscopy, rectoscopy, colonoscopy
- Laboratory test
  - FBC, Eosinophilia
  - Total IgE level
  - ESR
  - Glucose random and fasting
  - Iron levels (ferritin level)
  - Zinc level
  - Serology for intestinal parasites
- Stool exams
  - Parasitic
  - Bacterial
  - Fungal
- Biopsy (if lesion is visible)

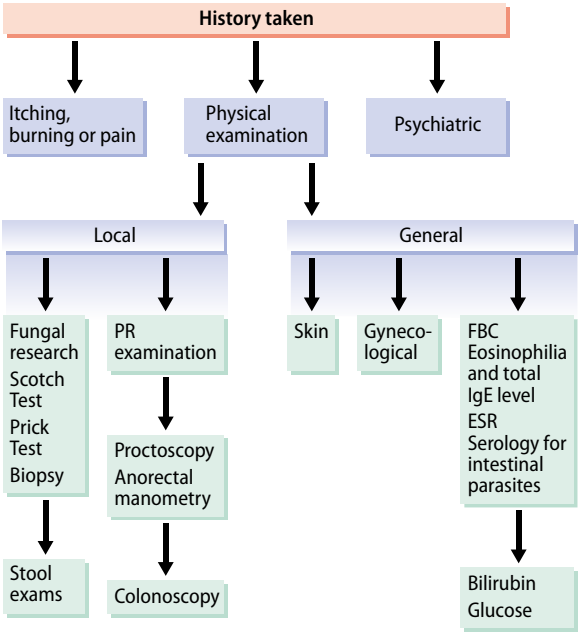

Fig. 25.1 Diagnostic schema for patients presenting with pruritis ani. *PR* Per rectum

25.4 Causes

25.4.1 Acute PA

The etiology of acute PA is often infectious in nature, with allergic and irritant contact dermatitis playing a role in some cases. Identification of the etiology may lead to a prompt resolution of symptoms with specific therapies. Itching appears suddenly and is unbearable, leading to intense scratching, which is responsible for consecutive lesions. Secondary infection with staphylococci or streptococci is common in damaged skin, which complicates the clinical situation and symptomatology. This condition can be extremely dangerous in children and immunocompromised patients, particularly if beta-hemolytic streptococci are involved. Such cutaneous infections can worsen to become cellulitis. Prompt investigation must be initiated in suspected cases, and a systemic antibiotic therapy established (Table 25.3).

Sexually transmitted infections are encountered frequently in patients who have an acute PA. Condyloma acuminatum in particular, which is associated with excessive sweating (the high pH of the sweat in the perianal region promotes maceration), can be extremely unpleasant and prurigenic.

Several topical agents may cause allergic contact dermatitis in the anogenital area. Manifestation is an acute eczematous dermatitis accompanied by erythema, seepage, and significant pruritus. Topical medications, more than cosmetics in this region, are well-recognized as causes of contact dermatitis (Table 25.4). Type IV hypersensitivity reaction should be considered in patients using medication for genital diseases. A history of contact with such allergens should be investigated and a patch test performed to confirm an allergic reaction.

Table 25.3 Common causes of acute pruritus ani

Infection
• Fungal infection (candidiasis)
• Bacterial infection (*Staphylococcus aureus*, group A *Streptococcus*)
• Viral infection (Herpes simplex virus, human papillomavirus, molluscum contagiosum)
Infestation
• Oxyuriasis
• Scabies
Contact dermatitis
• Irritant, allergic

Table 25.4 Topical agents that may cause allergic contact dermatitis in the anogenital area

- Topical medication
  - Anesthetic from the -caine group
  - Antibiotics (neomycin, framycetin)
  - Corticosteroid (clobetasol)
  - Antihistamines
  - Others (crotamiton…)
- Rubber accelerators associated with condoms
- Cosmetics
  - Fragrances in feminine hygiene products
  - Lanolin (cream and ointments)
  - Bubble bath and scented soaps
- Latex
- Propylene glycol (KY jelly)
- Colorant and fragrances used in toilet paper
- Washing powder
- Chlorhexidine, hexamidine (local antiseptic)
- Benzylalkonium chloride
- Spermatic fluid
- *Candida*

Irritant dermatitis may be caused by several behavioral practices. Women with PA perceive themselves as being unclean and may initiate a vigorous cleansing routine. Feminine hygiene products such as fragrances, spray deodorants, and shower gels contain many irritant ingredients that can exacerbate the subjacent pruritus. In addition, children and elderly institutionalized patients with urogenital soreness may suffer from an irritant ammoniacal dermatitis.

In conclusion, unfortunately there is a subgroup of patients who suffer from primary acute PA and who still have symptoms despite alleviating the obvious source of infection or irritation.

25.4.2 Chronic PA

Chronic pruritus is often less explosive and has a gradual onset. To diagnose chronic anal itching, all other acute etiologies must first be excluded. Depending upon the circumstance, some etiologies can lead to acute or chronic itching. A combination of source factors is possible. The commonest causes of anal itching in adults are dietary factors (Table 25.5) and fecal incontinence.

Anal seepage induces intense itching and skin irritation caused by repeated contamination of the perianal skin. When there is incontinence, a small amount of stool is found on anal skin. Fecal soilage can also be diagnosed with the saline infusion test: 1,500 ml saline solution is infused into the rectum; if this is the problem, retention is reduced to 600 ml (in a normal person retention volume is 1,300 ml). The irritation leads to worsening hygiene with vigorous scratching and wiping, and use of inadequate products that may worsen the symptoms and delay the healing process. Treatments comprise therapy for incontinence (e. g., mucilage, Imodium, sacral nerve stimulation), which are associated with regulation of hygienic habits (Table 25.6).

Amongst anorectal diseases (Table 25.7), the commonest causes of itching are hemorrhoids and anal fissure, but also malignancy in the form of rectal or anal cancer, and rarely colon cancer. Tumors lead often to low-grade pruritus-refractory cases; biopsy should be performed for suspected lesions and if in doubt, a proctoscopy or a colonoscopy should be considered.

Dermatological diseases are also of significance in the development of pruritus. The most frequent cause is contact dermatitis, which often has acute itching as a consequence. A delay in determining the allergens re-

Table 25.5 Drugs and food that cause anal itching

- Colchicine and quindine
- Tomatoes
- Citrus fruit
- Coffee, tea, cola, beer
- Chocolate
- Milk products

Table 25.6 Common causes of chronic pruritus ani

- Dietary factors and drugs (see Table 25.3)
- Fecal soilage: any cause of diarrhea, other anorectal pathologies, idiopathic
- Dermatoses (see Chap. 24)
- Chronic allergic or irritative contact dermatitis, psoriasis, seborrheic dermatitis, atopic dermatitis, lichen sclerosus, lichen planus, amyloidosis
- Anorectal diseases (see Fig. 25.1) – idiopathic pruritus: essential pruritus, neurodermatosis, lichen simplex chronicus
- Systemic diseases (see Table 25.4)
- Psychiatric diseases: depression, obsessive-compulsive neurosis, psychosomatic causes

Table 25.7 Anorectal disease in patients with secondary pruritus ani

Anorectal disease	%
Hemorrhoids	20
Anal fissure	12
Rectal cancer	11
Anal cancer	6
Idiopathic proctitis	6
Condyloma	5
Ulcerative proctitis	5
Colon cancer	2
Abscess	2
Fistula	2

Table 25.8 Systemic causes

- Diabetes mellitus
- Hepatic diseases (hyperbilirubinemia)
- Leukemia
- Aplastic anemia
- Thyroid disorders

sponsible for the sensitization may cause chronification of allergic dermatitis.

Amongst chronic illnesses, psoriasis is the one that leads more frequently to this symptom. Papulosquamous disorders, such as psoriasis and seborrheic and atopic dermatitis, rarely have only anal features – there are usually other signs in other areas of the body. In some systemic diseases (Table 25.8), pruritus can be the first symptom. It is important to think about a systemic cause of itching to make a diagnosis and instigate the correct causal therapy.

An increased tendency for depressive and obsessive-compulsive traits has been identified in patients with a chronic pruritic condition. These psychiatric problems may lead to a worsening of symptoms. In the absence of any organic origins, idiopathic PA can be related to psychological disturbance. Clinically psychosomatic anal itching presents the features of an initial erythematous stage, evolving into a chronic lichenification as a response. This is known as lichen simplex, and patients commonly have symptoms at night-time. *Pruritus sine materia* is a condition that is not evident on the skin and is often correlated with psychiatric pathologies. A psychiatric consultation is of fundamental importance for these etiologies.

25.5 Intestinal Infestation

Amongst the multiple infestations that can affect the bowel, oxyuriasis is the most frequent cause in children. Periodic pruritus at night with exacerbation during defecation is typical. This starts around the anus in particular and may later spread to the buttocks, perineal area, and the vulva.

An adhesive cellophane tape test for examination of the material obtained from the perianal skin is performed in the morning before getting up, at the time when the itching is at its most intense, allowing a diagnosis by finding adult worms as well as their eggs.

Scabies can even lead to PA, especially in children.

Anal itching in adults is frequently associated with intestinal malabsorption. The most frequent causes of this are lactose intolerance and celiac disease. In contrast, intestinal parasites are the more frequent cause in children. In this case, urticaria factitia is frequently observed, which manifests itself with a red dermographism and generalized itching, mostly in the region of the right scapula and pretibially on both legs.

Apart from sensitization to proteinous parasite antigens, pathogenetically speaking, malabsorption should be considered, which can be traced back to a deficiency in trace elements (in particular zinc and iron).

25.6 Approach to Treatment

Once the origin of anal itching has been determined, a causal therapy can be initiated. Foods and drugs leading to PA must be avoided. Constipation and diarrhea must also be avoided with a high fiber-diet and stool softeners (mucilage).

In dermatology, an efficient therapeutic approach comprises:

1. Use of acidic soaps for everyday hygiene.
2. Light, nonrestrictive clothing (e. g., jeans) are preferable to avoid increasing temperature and moisture in the area.

Specific treatment for individual pathologies is as follows:

1. Acute eczema: cold hip baths several times daily to reduce the exudative process and dry up vesicular lesions
2. Chronic eczema: topical corticosteroids twice daily for approximately 5 days, then lubricate using tacrolimus (Protopic 0.01%) once daily for 10 days
3. Psoriasis and seborrheic dermatitis: combination of topical steroids and antimycotics twice daily for 5 days
4. Candidiasis: systemic and topical antimycotic treatments (e. g., Ketokonazole)
5. Herpes simplex: exclusively systemic antiviral therapies

25.7 Conclusion

Anogenital itching is a common symptom that the inattentive doctor is frequently tempted to associate with psychological or sexual causes. Essential pruritus is in reality a clinical identification, which should only be used if all other possible causes have been ruled out.

An algorithm for making a diagnosis:

1. Assessment of the intensity of the itching from precise anamnesis. Look for possible lesions from scratching and evidence of chronic lichenization. Look for instances of dermographism (on the back).
2. Look for a localized cause of the pruritus, as well as a proctological one (constipation, anorectal pathologies) and a dermatological one (infectious, irrita-

tive/allergic or congenital in the case of seborrheic dermatitis, psoriasis, atopic dermatitis, inflammation due to lichen sclerosus, or lichen planus).

3. If a localized cause can be ruled out, a systemic one should be considered. In this case, it is important that total IgE, iron, and zinc levels be checked.
4. An increased total IgE level can occur either with atopy or a parasite. In the case of atopy, itching is associated with a distinct xerosis. In the case of intestinal parasites, a positive serology for a parasite responsible for intestinal disease is to be expected.
5. In the case of low serum iron or zinc, the principal causes for intestinal malabsorption are to be sought by:
   a. Screening for celiac disease using antigliadin-AK and antitransaminase
   b. Provocation test and genetic test for lactose intolerance

If neither clinical signs nor secondary examinations indicate a localized or systemic illness as a cause for PA, diagnosis of essential pruritus can then be determined. This is not to give parity to psychogenic causes, since it is not always an expression of stress, depression, or hypochondria. Various studies have been unable to prove any differentiation between the personalities of patients with secondary and those with essential pruritus [4].

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Self-Assessment Quiz

Question 1

Which intestinal condition is frequently associated with anal itching in adults?

a. Oxyuriasis
b. Intestinal malabsorption
c. Diverticulitis
d. Right colon carcinoma
e. Chronic constipation

Question 2

Can dietary factors be responsible for anal itching? Among these vegetables, which one corresponds to the commonest cause of perianal pruritus?

a. Spinach
b. Carrot
c. Tomato
d. Salad
e. Beetroot

Question 3

What is the definition of pruritus?

a. An itch or a sensation that makes somebody want to scratch
b. An unpleasant sensation originating in skin resulting from the activation of specific receptors stimulated by histamine
c. A submodality of pain
d. A sensation generated in the central nervous system, often without an organic etiology
e. A psychological disease

Question 4

If an allergic or irritant contact dermatitis is suspected, what is the correct attitude?

a. Daily sitz baths, using an alkaline soap and specific products to reduce the exudative process and dry up vesicular lesions
b. Cold-water sitz baths several times a day, to reduce the exudative process and dry up vesicular lesions, avoiding local medication or cosmetics (including soaps)
c. Local application of soothing creams
d. Combination of topical steroids and antimycotics twice daily for 5 days
e. Cutaneous tests

Question 5

A 7-year-old boy was seen by his general practitioner for acute anal itching. Suspecting an intestinal parasitosis, the physician decides to order a blood test. Which parameters have to be assessed?

a. Full blood count (FBC) only
b. FBC, iron level, zinc level, and fasting glucose
c. FBC, total IgE level, serology for intestinal parasitosis
d. Blood parameters are not necessary in this situation
e. Serology for intestinal parasitosis only

1. Answer: b
Comments: Lactose intolerance is a frequent but often not recognized cause of anal itching. The symptoms of this intestinal pathology may originate from anywhere in the digestive tract, from the mouth to the anus. If this problem is suspected, concomitant symptoms should be investigated.
2. Answer: c
Comments: Some people get anal itching only after they have ingurgitated specific foods, starting 24–48 h after intake. Foods associated with this symptom include tomatoes (including ketchup), citrus fruits and juices, coffee and tea, beer and alcoholic beverages, colas, nuts and popcorn, milk, chocolate, and spices (especially peppers).

3. Answer: a
Comments: Itch (Latin: pruritus) is defined as an unpleasant sensation that evokes the desire or reflex to scratch. Itch has many similarities to pain and both are unpleasant sensory experiences, but their behavioral response patterns are different. Pain creates a withdrawal reflex, while itch leads to a scratch one [5].
4. Answer: b
Comments: Healing the skin and keeping it healthy are of primary importance, both in preventing further damage and enhancing the patient's quality of life. Key factors are sitz baths several times a day. People with atopic dermatitis should avoid hot or long (more than 10–15 min) baths and showers. The doctor may recommend limited use of a mild bar soap or non-soap cleanser because soaps may desiccate the skin.
5. Answer: c
Comments: An increased total IgE level can occur with either atopy or a parasite. In the case of intestinal parasites, a positive serology for the parasite responsible for intestinal disease is to be expected. Secondary infection of a cutaneous lesion, with staphylococci or streptococci, is common in damaged skin, which complicates the clinical situation and symptomatology. Prompt diagnosis is necessary. Deficits in iron or zinc in such a young patient are unusual.

26 Clinical Management of Patients with Faecal Incontinence

Ian Finlay

CONTENTS

26.1 Introduction

Faecal incontinence is a disabling and distressing condition that affects all age groups. It is more common in women than men, with the highest prevalence being among the elderly. It has been estimated to affect 1–2% of the population over 40 years of age [1, 37, 38]. Faecal incontinence is associated with considerable morbidity, especially in the elderly, but is amenable to successful management. Despite this there is recent evidence to show that basic assessment and care are lacking [21] and could be improved.

26.2 Mechanism of Continence

Faecal control is maintained by an extraordinary and complex sphincter mechanism that is not fully understood. However, it is recognised to comprise the following components: an internal anal sphincter (IAS), an external anal sphincter (EAS), pelvic floor muscles and a sensory and motor nerve supply (see Fig. 26.1).

The IAS is an involuntary, slow-twitch, fatigue-resistant smooth muscle that is under autonomic control (sympathetic innervation is excitatory, parasympathetic supply is inhibitory). The IAS generates activity with a frequency of 15–35 cycles/min. The function of the IAS is to keep the anal canal closed at rest, and it contributes approximately 70–80% of the resting anal canal pressure. As a consequence, injury to the IAS leads to leakage of mucus and faecal staining rather than incontinence. The IAS is aided in this function by the presence of three anal canal cushions lying at the anorectal junction (Fig. 26.2). Tonic contraction of the IAS causes these cushions to be compressed, producing a complete seal. On histological examination these cushions are found to contain blood-filled vascular channels and connective tissue that bleeds easily when traumatised or if the cushions prolapse at the anal margin. It should be noted that these cushions are visible on proctoscopy and should not be mistaken for haemorrhoids. Anal canal cushions within the anal canal that occasionally bleed (first-degree haemorrhoids) should not be subjected to interventional treatment by injection or banding. Simple dietary advice will usually suffice.

The EAS muscle encircles the IAS and is in continuity with the puborectalis muscle and the other muscles of the pelvic floor. It is of note that during surgical dissection there is no visible separation between the EAS and the puborectalis muscle. The EAS is under volun-

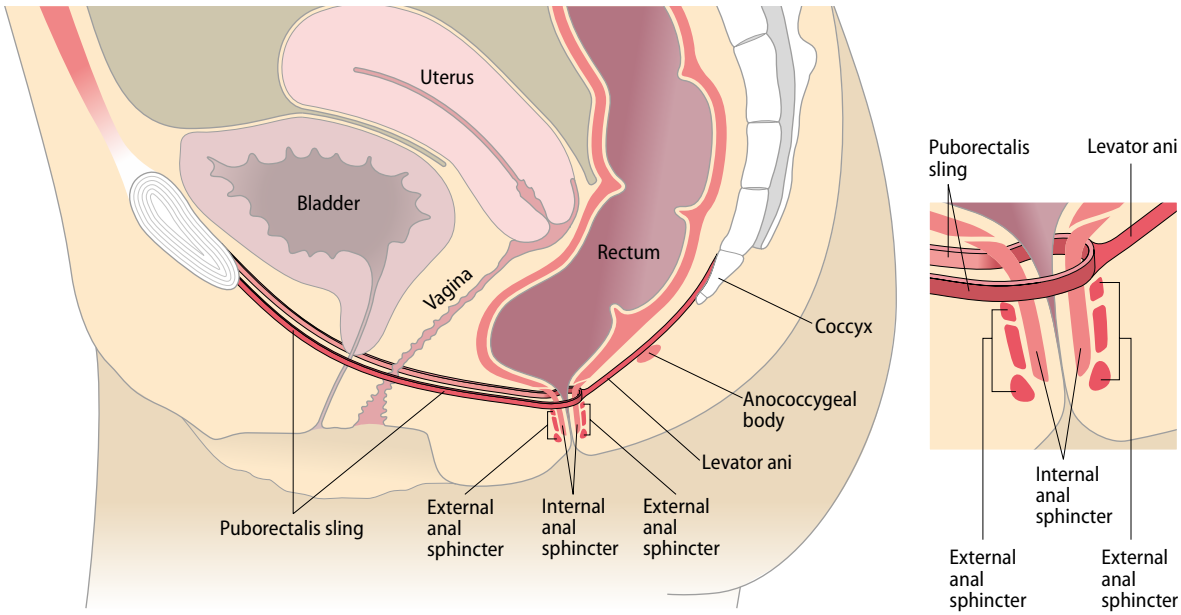

Fig. 26.1 Key components of continence

tary control as a consequence of innervation from the pudendal nerve, with connections to the ventral horn of S2 (Onuf's nucleus) and the corticospinal pathways. The motor neurones of Onuf's nucleus are unusual in that they are tonically active during sleep. The integrity of the nerve supply to the EAS may be determined on clinical examination by either stroking the perianal skin or asking the patient to cough; both should cause spontaneous contraction of the EAS. The EAS (in conjunction with the pelvic floor) may be voluntarily contracted by the patient to avert the call to stool, but this can be maintained for only a short length of time (approximately 45 s). Consequently, the principal symptom experienced by patients with an EAS defect is the inability to avert the call to stool, leading to urgency.

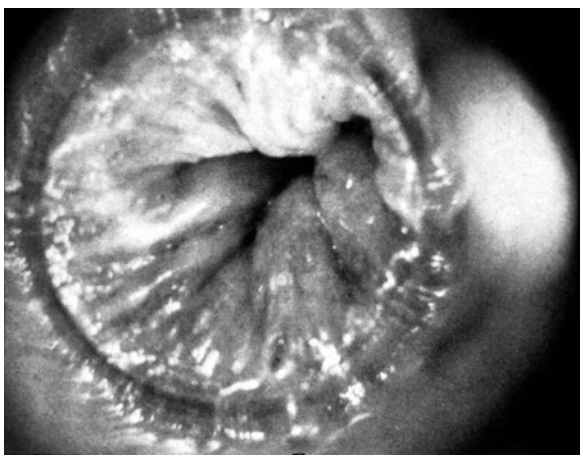

Fig. 26.2 Anal canal cushions on proctoscopy – a normal finding, not haemorrhoids

The muscles of the pelvic floor provide a "sling support" for the rectum and pelvic organs and comprise a sheet of striated muscle. Four component parts of the muscle have been identified: the puborectalis, pubococcygeus, iloecoccygeus and ischiococcygeus. The nerve supply to this muscle is uncertain, but includes ventral fibres from S2 and S3 that enter the muscle posteriorly from above, where they may be vulnerable to stretch or pressure injury during childbirth. When contracted, the puborectalis creates an angle of approximately 90° between the anal canal and the rectum. This is probably the single most important factor contributing to the continence of solid stool, but has no beneficial effect in controlling liquids, since in contrast to solids they flow easily around bends [2].

It would appear, therefore, that the control of loose stool or diarrhoea is provided predominantly by the voluntary contraction of the striated muscles (EAS and pelvic floor muscles), providing an explanation for the observation that the control of liquid stool is precarious even in normal subjects. This is important in clinical practice since many patients who seek advice regarding symptoms of incontinence are only symptomatic when they have loose stool. Those patients are

unlikely to respond to surgical intervention, and treatment should be directed towards alleviating the cause of the diarrhoea.

The precise contribution of the extensive sensory and motor nerve supply of the anorectum is not completely understood. The pudendal nerve arising from S2, S3 and S4 innervates the EAS and has sensory and motor functions, as evidenced by the fact that blocking the nerve causes loss of EAS motor function and loss of sensation in the perianal skin. An important component of continence involves the sensation of rectal filling and the initiation of the call to stool. This is poorly understood, but may involve stretch receptors within the pelvic floor muscle and "sampling" nerves within the anal canal at the mucocutaneous junction. The former have been shown in animal studies to be numerous. The pathway for rectal sensation is considered to be along the S2, S3 and S4 parasympathetic nerves, since the sensation of rectal filling and the ability to defecate is almost (but not completely) abolished when the nervi erigentes are divided.

An alternative, and perhaps complementary, explanation is that the rectal contents are periodically sampled by the specialised sensory nerves in the anal canal via transient relaxation of the IAS. It is of note in this respect that rectal distension produces a reflex reduction in anal canal pressure (the rectoinhibitory reflex). This reflex is abolished by division of the rectal wall but is preserved after spinal cord injury. It has been suggested that the arrival of flatus within the rectum initiates this reflex. Whatever the explanation, it is noteworthy that after a hand-sewn restorative proctocolectomy with excision of the rectal mucosa from the anal canal, the sensation of ileal pouch filling is near normal. This would suggest that the pelvic floor stretch receptors play a key role in sensing rectal filling.

It is an extraordinary fact that the anorectum, in conjunction with the sphincter muscles, can function such that it is possible for humans to expel gas in a downward direction while maintaining control of solids but not liquids. The probable explanation for this phenomenon is that the puborectalis contracts vigorously, producing an acute angle of less than 90° between the anal canal and the rectum. The EAS also contracts, resulting in "a retort shape" between the anal canal and the rectum. Air is then pushed from the rectal chamber by transiently raising the intra-abdominal pressure above sphincter pressure. This process is aided by the abundance of sensory fibres at the mucocutaneous junction in the anal canal, which stimulate sphincter contraction as soon as it is necessary.

26.3 Aetiology of Faecal Incontinence

There are numerous causes of faecal incontinence; the most important are given in Table 26.1. However, patients rarely have a single abnormality and the cause of symptoms is invariably multifactorial. As such, it is necessary to undertake a careful clinical examination and investigation of all patients if the cause is to be diagnosed [31]. In addition, it has been the author's experience that patients who have had episodes of incontinence find that the experience is most embarrassing and subsequently suffer from anxiety and apprehension that a repeat episode may occur. This further complicates both the clinical assessment and the efficacy of treatment.

IAS weakness leading to symptoms of faecal staining may be associated with autonomic neuropathy secondary to systemic disorders such as diabetes [62] or excessive alcohol consumption. The latter also frequently causes loose stool, which complicates the assessment. The IAS may be deliberately divided at surgery during internal sphincterotomy and fistulotomy for fistula-in-ano [32, 33], or inadvertently during haemorrhoidectomy, producing a "gutter deformity". Diffuse disruption of the IAS may also occur after a vigorous anal stretch operation. In a recent study of 12 men who developed incontinence after anal stretch for anal fissure/haemorrhoids, endoluminal ultrasound showed diffuse damage to the IAS in 11 patients; 3 of these patients also had damage to the EAS. It is of note that the pudendal nerve conduction time in these patients was normal [48].

Table 26.1 Causes of faecal incontinence

Congenital	Congenital anomalies including agenesis of the anorectum
Acquired	Faecal impaction and spurious diarrhoea
	Anorectal cancer and villous adenoma
	Conditions causing autonomic neuropathy (e.g. diabetes)
	Irritable bowel syndrome
	Inflammatory bowel disease
	Rectal prolapse
	Fistula-in-ano
	Sphincter injury to internal or external anal sphincters (e.g. caused by childbirth, anorectal surgery or trauma)
	Sphincter and pelvic floor neuropathy (e.g. caused by childbirth, spinal injury demyelination or cerebral vascular injury)

The EAS may also be subject to trauma, but the most frequent and important cause of injury occurs during childbirth [3, 14]. Post-partum perineal injuries that involve the EAS are defined as third-degree tears, while those that also involve the rectal mucosa are classified as fourth-degree tears. The risk of sustaining a tear is increased if the birth is complicated or prolonged; risk factors include multiparity, prolonged second-stage labour (more common with the routine use of epidural anaesthesia), large babies and the use of forceps [4]. Clinically apparent severe perineal tears have been reported over the past 50 years to occur in 0–27% of deliveries, but with modern obstetric practice it should be nearer 1% [15, 16]. The advent of endoluminal ultrasound, however, has shown that there are many more occult anal sphincter disruptions (Fig. 26.3) that are not evident on clinical examination at the time of the delivery. In a prospective study, Sultan et al. suggested that these occult injuries occur in 35% of primigravidae and in 44% of multigravidae [14]. These findings were supported by a meta-analysis published in 2004 in which it was suggested that the incidence of sphincter injury is 27% for primiparous women, with a further 8% of new defects occurring in multiparous women. Despite this high incidence of occult sphincter injury at the time of delivery, in fact most women do not suffer from incontinence in the short term after childbirth. These defects do, however, have a risk of becoming clinically important in middle age when the hormone changes associated with the menopause lead to loss of pelvic floor muscle tone.

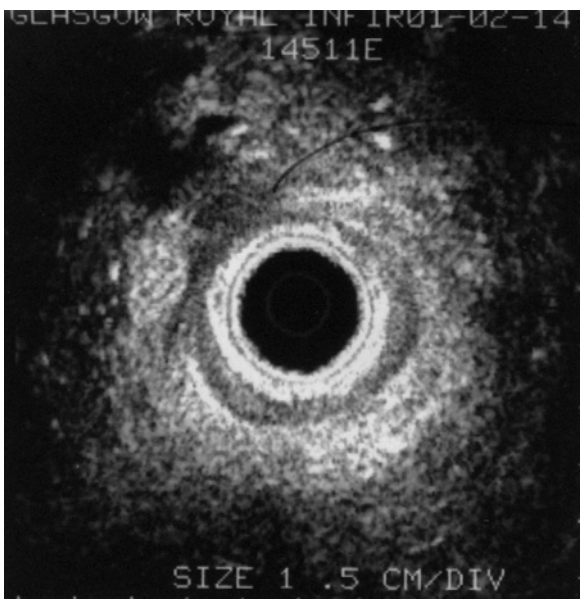

Fig. 26.3 Ultrasound view showing an anterior sphincter defect

The medical/nursing attendant at the delivery has a duty of care to identify the presence of a sphincter tear. The failure to identify a sphincter injury has been the subject of numerous cases of medicolegal litigation. When a tear is found it must be repaired in good light, under appropriate anaesthesia and by trained personnel. Evidence suggests that if patients have an immediate repair of a third- or fourth-degree tear, then subsequent incontinence to solid stool is infrequent (<5%), but leakage of liquid stool or gas has been reported in up to one-third of patients [5]. This contrasts with the poor results reported for delayed repairs [6]. Thus, missing a sphincter injury at the time of delivery has serious consequences for the patient. The poor results for late repairs probably relate to the fact that the divided muscle ends retract and are difficult to identify in scar tissue at a later operation. Despite guidelines highlighting the need for routine careful post-partum examination, it is recognised that sphincter tears continue to be missed by both obstetricians and midwives [17].

Childbirth also causes a neuropathic injury to the pelvic floor [3]. Electromyographic studies have shown that all vaginal deliveries cause a degree of injury to the pelvic floor muscles, but this is more extensive in complicated deliveries and is cumulative with multiple births. Although the late Sir Alan Parks proposed that there is a distinction between neuropathy of the puborectalis and the levator ani muscles, it is now generally accepted that the neuropathy of childbirth affects the entire pelvic floor and the EAS. Clinically, these patients have evidence of perineal descent leading to an obtuse anorectal angle. Whether this loss of the anorectal angle is the principal cause of the symptoms of incontinence remains the subject of debate, with proponents for and against the importance of the role of angulation at the anorectal junction in maintaining continence. Studies that have shown this angle to be unimportant, however, used liquid or semi-liquid contrast material for their experiments. As explained earlier, liquids flow easily around bends and this may explain why these studies failed to support a role for angulation in continence. In contrast, studies that have used simulated solid material for the experiments (albeit in in-vitro models) have found the angle to contribute greatly to holdback pressures [54].

The clinical condition of neuropathy of the pelvic floor muscles is usually named idiopathic faecal incontinence (IFI), although there is now sufficient evidence to attribute at least the onset of the neuropathic process

to childbirth. It has been suggested that IFI is associated with a prolonged pudendal nerve conduction time, leading to weakness of the EAS and reduced squeeze pressures in the anal canal. This explanation has been challenged by the observation that many patients with IFI have normal pudendal nerve latencies [72]. Paradoxically, as a consequence of the pelvic floor weakness, patients with IFI may also have difficulty emptying the rectum, necessitating straining; this in turn has the potential to causes further damage to the pudendal nerve. It is not uncommon, therefore, for these patients to complain of both "incontinence and difficulty in emptying". Since the neuropathy affects the entire pelvic floor, the patients may also have incontinence of urine with a vaginal/uterine prolapse [35]. It is of note that the most symptomatic patients frequently present in mid-life, after the menopause, leading to the suggestion that the condition is at least exacerbated by the fall in oestrogen levels. This would not be surprising since oestrogen receptors have been found in the striated muscle of the anal sphincter and oophorectomy has been shown to produce atrophy of the anal sphincter.

Loss of rectal support may cause a rectal intussusception or even an overt rectal prolapse. The exact cause of rectal prolapse is unknown, but many of the features observed in IFI are also found in patients with rectal prolapse, such as neuropathy of the pelvic floor musculature, perineal descent and abnormal colonic motility [66]. Rectal prolapse is a common cause of incontinence that merits surgical treatment unless there is a clear contraindication. In contrast, there is debate regarding the significance of the presence of a midrectal intussusception. In the absence of an overt rectal prolapse, intussusception, especially if it is diagnosed only on proctography, is unlikely to be the cause of incontinence.

Congenital abnormalities are an unusual but important cause of incontinence since they affect young adults who often seek a surgical solution. The severity of the abnormality varies, but pelvic magnetic resonance imaging (MRI) may help to define whether there is any evidence of either the IAS or EAS (usually absent) or evidence of the pelvic floor musculature (usually present). It is extraordinary, and important for our understanding of the physiology of continence, that those patients who have no IAS or EAS may have relatively few symptoms and cope remarkably well, confirming just how important the contribution of the pelvic floor is to the mechanism of continence.

It is frequently the case that human organs have substantial reserve function and are able to sustain a considerable degree of deterioration before symptoms develop. This also applies to the anorectum; substantial loss of a component of continence may occur before the patient becomes symptomatic. For example, the anal sphincter (IAS and EAS) is partially divided during the surgical fistulotomy procedure for fistula-in-ano, yet in most cases there are few consequences with regard to control other than some minor leakage. The exception is the female patient who already has a pelvic floor neuropathy from previous childbirth and in whom even a minor sphincter division may cause symptoms. These patients with neuropathy may also be rendered incontinent by an injudicious haemorrhoidectomy. It is for this reason that all patients with anorectal pathology require experienced and careful clinical assessment.

Irritable bowel syndrome (IBS) is a common and relatively unrecognised cause of faecal incontinence. It has recently been shown that up to 50% of patients who complain of faecal incontinence and are referred to a specialist clinic are found to have an abnormality of both rectal sensation and colonic motility [39]. These patients have a hypersensitive rectum with low maximum-tolerated volumes to balloon distension [40, 41]. There is also abnormal motility in the proximal colon (Fig. 26.4), similar to that observed in IBS [49] with evidence of colonic hypermotility in response to standard stimuli such as the ingestion of food or the injection of neostigmine. In brief, they have IBS fulfilling the Rome criteria. This gives rise to symptoms of severe urgency at stool [42–44]. It is important to identify the presence of IBS since it has a deleterious effect on the efficacy of surgical treatment. It is the author's experi-

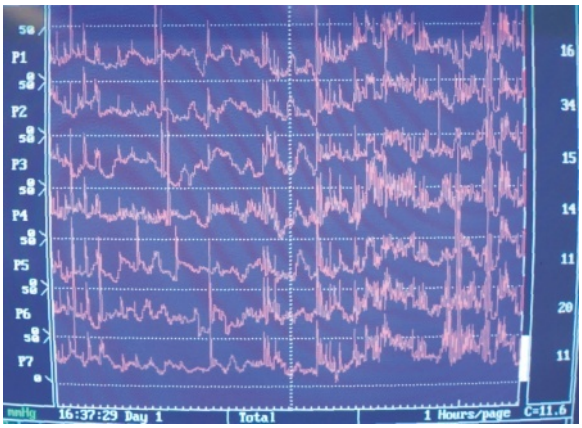

Fig. 26.4 Colonic motility study in a patient with incontinence secondary to irritable bowel syndrome, showing hypermotility. Traces P1–7 from the proximal to the distal colon, respectively

ence that if at all possible, surgical treatment of incontinence should be avoided in these patients until the irritable bowel symptoms have been treated. Patients with incontinence may also have rectal hyposensitivity, although this more frequently causes constipation rather than incontinence [30].

A further and increasingly common cause of incontinence is the use of preoperative radiotherapy before reconstructive surgery for rectal cancer [34, 36]. In this situation the cause of the incontinence is multifactorial. Resection of the rectum with total mesorectal excision (TME) removes the rectal reservoir, which can be improved but not completely alleviated by creating a colonic pouch. The radiotherapy impairs sensation and sphincter function, and in prospective randomised studies has been shown to produce more bowel dysfunction than is observed in patients treated by TME alone.

26.4 Investigation of Patients with Incontinence

All patients with faecal incontinence for whom surgery is being considered should be investigated with a view to identifying the exact aetiology of the incontinence [46]. Patients who have had a change of bowel habit or have large-bowel symptoms require a fibre-optic examination of the hindgut to exclude neoplastic conditions or mucosal inflammation, such villous adenoma, carcinoma, radiation proctitis and inflammatory bowel disease.

26.4.1 History and Clinical Examination

As in any other clinical condition it is important to obtain a careful history and perform a full clinical examination, since the cause of the patient's symptoms may be due to systemic disease. In brief, it is especially important to identify whether the patient actually has faecal incontinence. Many patients referred with incontinence have urgency of stool with a "fear" of incontinence. Having determined that the patient truly has incontinence, it is important to identify whether this is for solid or only for liquid stool, the latter being much more common. In addition to a routine clinical examination, specific attention should be paid during inspection of the anus to the presence of an obvious sphincter defect, the degree of anal tone, evidence of prolapse or any other anal distortion such as a gutter defect. Neurological examination should include testing for the anocutaneous reflex and any other evidence of loss of sensation to pin-prick in the perineum and lower limb. The finding of a sensory neuropathy in the buttock or lower limbs may point to an underlying abnormality in the cauda equina.

26.4.2 Investigations

The principal investigations include anorectal physiology studies, evacuation proctography, endoanal ultrasound and MRI.

26.4.2.1 Anorectal Physiology Studies

These are invariably used in specialist colorectal units and are of benefit in selected patients. Anal canal manometry allows the estimation of anal sphincter function, although the accuracy and reproducibility of the technique is uncertain. Estimates may be obtained of anal canal length and the basal and squeeze anal canal pressures. This may be useful for identifying patients with a low anal canal pressure who have an autonomic injury to the IAS that may not be evident on ultrasound.

Physiology studies also include measurement of the pudendal nerve conduction time. Although this may be identified as being prolonged, numerous studies have shown that the correlation between pudendal nerve neuropathy, the patient symptoms, clinical findings such as perineal descent and the outcome after surgery is inconsistent [58]. In the author's opinion the most useful physiological investigation is that of measurement of rectal sensation/filling. In particular, the identification of a hypersensitive rectum with intolerance to balloon distension is both diagnostic of IBS and an adverse factor for the outcome of surgical intervention. Complex studies of rectal compliance and concentric needle electromyogram are principally research tools but may be helpful in selected complex cases.

26.4.2.2 Evacuating Proctography

This is less useful for investigating patients with incontinence than in those with outlet obstruction disorders, but may show an unexpected rectal intussusception/prolapse. It also provides objective evidence for

perineal descent. It is the author's practice not to accept radiological evidence for the presence of an occult prolapse as proof that a "clinically significant prolapse" is present, since minor degrees of mucosal prolapse are common on proctography. In patients who have a clinical history suggestive of a clinically significant "occult" prolapse (sensation of perineal heaviness and tenesmus), it is the author's practice to perform an examination under anaesthesia; only those patients in whom the rectum may be easily drawn through the anus are considered to have an intussusception/prolapse. It has been shown that the outcome for patients diagnosed in this way is similar to those after surgical correction for overt rectal prolapse [60, 61].

26.4.2.3 Anorectal Ultrasound Examination

This tool represents a major advance and is an indispensable investigation in patients with faecal incontinence. A clear image of the integrity of the IAS and EAS may be obtained in experienced hands. This may include a spectrum of abnormalities from minor atrophy of the IAS to complete disruption of sphincter integrity (see Fig. 26.3). As discussed earlier, the advent of the technique in the late 1980s allowed the identification of many previously occult sphincter defects. Recent computer software has also allowed the technique to produce helpful three-dimensional imaging of the entire sphincter complex.

26.4.2.4 Magnetic Resonance Imaging

MRI can be useful in selected patients, such as those who have a congenital abnormality, when it aids in defining the anatomy. It also plays an important role in assessing patients with complex fistula-in-ano who may have residual sepsis contributing to their symptoms of leakage in addition to loss of integrity of the sphincter complex. Finally, it should be used routinely in patients who are identified as having evidence of lower-limb/perineal neuropathy that may point to a spinal lesion.

26.5 Treatment

Treatment is based upon careful clinical assessment. It is important to identify the cause, or in most cases, causes, for the incontinence.

26.5.1 Medical Management of Incontinence

Many patients with minor incontinence only require reassurance and will respond to the judicious use of anti-diarrhoeal agents and other conservative measures. In one study, 50% of patients with incontinence referred to a specialist unit were treated successfully using only conservative treatment options [24]. Patients with spurious diarrhoea secondary to faecal impaction should be treated with enemas or bowel washouts. This is an important group to diagnose since patients with incontinence secondary to impaction are often reluctant to accept that the cause is "constipation". Clinicians should be aware that although most common in the elderly, this condition can occur at any age.

Relatively simple methods of treatment include the use of anal plugs and retrograde rectal/colonic irrigation. Of these, rectal irrigation is most frequently used, especially in younger patients [22], and has been shown to be beneficial in patients who have suffered a spinal cord injury [23] when compared with other conservative regimens.

Biofeedback is also a non-invasive mode of treatment for faecal incontinence that has been shown to eliminate symptoms in up to 50% of patients and to improve symptoms in approximately two-thirds of patients [25]. Many studies, however, have methodological flaws and as a consequence the mode of action of biofeedback therapy is unknown. In particular, there are few randomised controlled trials to determine whether there is measurable physiological improvement in anal canal/pelvic floor physiology following such treatment, and it has been suggested that the observed clinical improvement is due to coping strategies as a result of the "patient–therapist" interaction [25]. Despite this caveat, biofeedback has been reported to improve patients with a wide variety of causes for the incontinence including sphincter defects and radiation [26, 27]. The treatment is more effective if patients undergo at least six training sessions and are female with severe incontinence. The technique has been shown to be less effective in males with minor symptoms of incontinence [26]. Irrespective of the mode of action, since it is a non-invasive tool, biofeedback is an important first-line treatment.

It is especially important to identify those patients described above who have IBS since they are numerous and often respond to treatment with amitriptyline [49, 51]. It is unknown whether the efficacy of this treatment is due to a central or a peripheral effect. It is the

author's practice, however, to prescribe treatment even in cases of doubt because of the beneficial effects observed. Indeed, amitriptyline has been shown to be efficacious in the treatment of incontinence in the absence of IBS symptoms [50]. This observation merits further investigation.

Symptom improvement has also been reported by post-menopausal women when they commence hormonal replacement therapy. Female patients who have evidence of a pelvic floor neuropathy may attribute the onset or exacerbation of their symptoms to the menopause.

The alpha-1 adrenergic agonist phenylephrine has been used for the treatment of mild incontinence. The rationale for using phenylephrine is that it causes contraction of the IAS and therefore increases the resting anal canal pressure. However, it has not gained wide acceptance as a treatment option and has been shown in prospective randomised trials to confer no benefit over placebo [29].

26.5.2 Surgical Management

The efficacy of surgery for faecal incontinence remains uncertain predominantly because most published studies have involved few patients, and are retrospective and non-randomised. Furthermore, no incontinence severity score has been universally adopted despite the fact that one has been validated [52], and quality of life measures are rarely reported. It is recognised that surgery is indicated in less than 10% of patients who undergo investigation for faecal incontinence. When surgery is offered to patients, it is important that they are carefully consented before the operation with regard to the risks as well as the potential benefits that may ensue. In particular, all patients should be warned that there is a risk that surgical intervention could make the symptoms worse.

26.5.2.1 IAS Repair and Correction of an Anal Canal Deformity

IAS disruption in isolation most commonly results from surgical interventions such as internal sphincterotomy, excision of fistula-in-ano or the creation of gutter defects after haemorrhoidectomy. Repair of the IAS after sphincterotomy has been reported to be effective, but the reported series have been small and the author's experience has been that the results of surgery are disappointing. Furthermore, there is a risk that attempting surgery to the IAS may make the symptoms worse. In contrast, surgical correction of a gutter or keyhole deformity after haemorrhoidectomy is frequently highly successful. Although defects may be directly repaired, a cutaneous advancement flap is usually required. The technique has been described elsewhere in this publication (see Chap. 21).

Generalised disintegration of the IAS after manual dilatation of the anus does not have a surgical solution and it for this reason that anal stretch should be avoided.

26.5.2.2 EAS Repair

The availability of endoanal ultrasonography has led to the identification of increasing numbers of patients with an EAS defect. Although these can occur as a consequence of anal trauma, the majority are secondary to perineal tears during childbirth. The resulting defect may be partial or complete. Since the sphincter is under tension, a complete division allows retraction of the muscle ends and may lead to a defect that is half, or more, of the circumference of the anal canal. In this circumstance the ends become embedded in scar tissue, making mobilisation to facilitate an adequate repair difficult.

EAS defects often occur in association with IAS defects, pelvic floor weakness, pudendal nerve neuropathy and symptoms of IBS. Although these associated abnormalities are not necessarily a contraindication to attempting a sphincter repair, they may contribute to a poor outcome. It is the author's preference to repair an IAS defect en-bloc with the EAS. The literature has produced conflicting reports regarding the effects of pudendal nerve neuropathy, age and the size of the defect on the outcome after anal sphincter repair.

In one of the largest series, which comprised 100 patients who had an overlap sphincteroplasty, it was found that 62% of patients with bilateral normal pudendal nerves had a successful outcome after surgery. This contrasted with a success rate of only 16% for patients with unilateral or bilateral prolongation of pudendal-nerve terminal motor latencies [62]. Similarly, albeit in a smaller series of 15 patients, only those with normal pudendal nerve conduction subsequently had a successful outcome [63]. Indeed, the authors of the latter report concluded that "both pudendal nerves must be intact to achieve normal continence after sphincter repair". There are, however, several reports in which

the opposite conclusion is reached [64–67]. Young and colleagues reported the outcome after sphincter repair in 57 patients; they found that 22% of repairs associated with neuropathy failed, compared to a 10% failure rate in patients without neuropathy. They concluded that the presence of pudendal nerve neuropathy should not detract from undertaking a repair. It is of note that they also found that the age of the patient at the time of surgery had no detrimental effect on outcome. Goffeng and colleagues came to a similar conclusion, noting that an excellent outcome could still be obtained despite the presence of severe neuropathy. This group also showed that the size of the defect was not correlated with outcome. Considering all of the available evidence, it would appear that the presence of neuropathy leads to a poorer clinical outcome overall, but it does not preclude excellent results in individual patients. Consequently, evidence of either unilateral or bilateral pudendal nerve neuropathy should not prevent the surgeon from attempting a repair. Similarly, surgical repair should not be denied on the basis of the size of the defect or the age of the patient. In the author's experience, however, the presence of diarrhoea-predominant IBS will limit the success of a repair. IBS should be treated before attempting surgery because it is technically difficult to achieve a repair that will be sufficiently good to provide continence for liquid stool.

Several techniques have been reported for EAS repair, but overlap repair remains the method of choice for most surgeons [7, 8]. This contrasts with the simple direct repair that is used if the disrupted sphincter muscle is identified immediately after delivery (see Fig. 26.5). This is because the use of a simple suture repair for late repairs produces disappointing results. In performing a late repair it is necessary in the first instance to identify the scar tissue within the defect and dissect laterally until pliable and mobile muscle is identified. Care must be taken in large defects to avoid injury to the pudendal nerves that enter at the 3 and 9 o'clock positions. The anatomical site of these nerves limits the extent of the dissection that is possible. Indeed, it has been shown that injudicious dissection may cause a pudendal nerve neuropathy and be one factor that contributes to a poor long-term outcome after overlap sphincter repair. Given the potential importance of the pudendal nerves, some surgeons advocate the routine use of a nerve stimulator to identify their exact positions.

Having identified the muscle ends, it is necessary to reconstitute the anal sphincter. The author usually uses an overlap repair, but on occasion a "keel-type" repair may be employed. The type of suture material used varies between surgeons; the author now uses PDS, since non-absorbable sutures such as Prolene often need to be removed at a later stage. Fast-absorbing sutures are also avoided because early disruption of the repair has been observed [18]. The author frequently recommends the use of a defunctioning colostomy if a major repair is undertaken. This prevents faecal impaction with disruption of the repair, and is more comfortable for patients. It should be noted that the only randomised trial, albeit including only small numbers of patients, showed no benefit with the use of a stoma. That study, however, included patients who had undergone only limited repairs and who have a much less troublesome post-operative recovery than patients who undergo a major repair of a large defect.

Early reports suggested that the efficacy of surgery for EAS repair was excellent, with continence restored in approximately 70% of patients. Unfortunately these

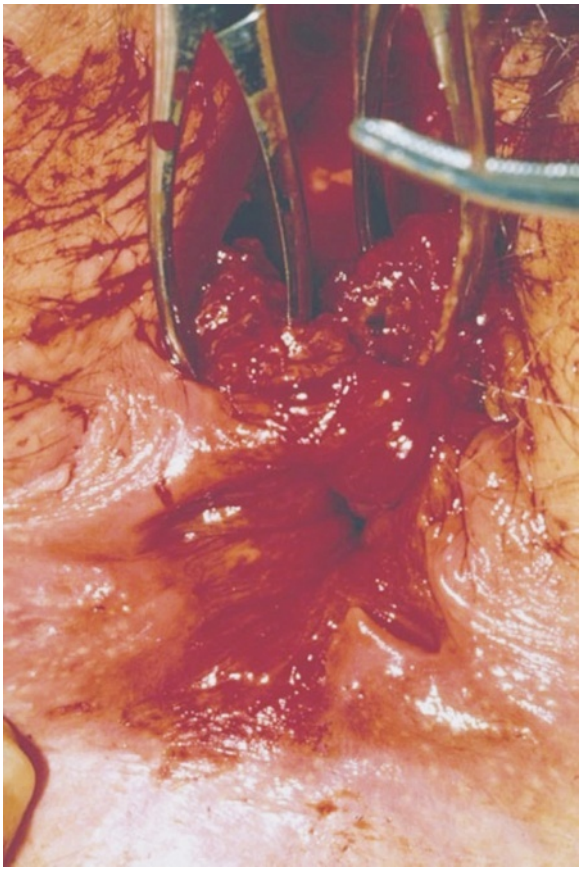

Fig. 26.5 The dissection of an anterior sphincter defect showing the "clean ends" of the sphincter muscle prior to suture repair

results were not maintained and after 10 years follow-up only 10–30% of patients remained continent [6]. However, excellent long-term results can be obtained in individual patients [45]. It is sometimes evident that the failure is due to disruption of the repair. Although repeat repairs may be attempted, the surgery is technically difficult and the outcome likely to be poorer than that obtained after primary repair. Other postulated causes of long-term failure include aging, scarring and progressive pudendal nerve neuropathy.

A recent study has suggested an alternative approach for patients with post-obstetric incontinence that may be used in selected cases. It is postulated that the long-term failure of traditional overlap repair may be due to the fact that the surgery involves division of intact anal sphincter muscle [19]. The procedure involves the mobilisation and plication of the anterior anal sphincter muscle [20] and is considered to have equivalent results to overlap repair in the short term. The author has used a similar technique in selected cases with reasonable success.

Patients in whom sphincter repair fails frequently seek salvage surgery. The options include repeat sphincter repair, biofeedback, implantation of an artificial anal sphincter and sacral nerve stimulation (SNS).

26.5.2.3 Post-anal Repair

Patients with a pelvic floor neuropathy have evidence of perineal descent and an obtuse anorectal angle. Posterior anal repair surgery, which was devised by Sir Alan Parks, aims to recreate an acute anorectal angle by plication of the pelvic floor muscles behind the anus after an intersphincteric dissection. Early reports suggested that the procedure was highly efficacious in restoring continence, with success rates of over 70%, but later reports were less favourable and the procedure is now rarely used [44, 71].

26.5.2.4 Rectal Prolapse Surgery

Rectal prolapse is a relatively common cause of faecal incontinence, although it produces other distressing and compelling symptoms. Consequently, surgical repair is usually recommended for patients who are otherwise fit. The condition is characterised by a neuropathy of the pelvic floor muscles, diatases of the levator ani muscles, a patulous anal sphincter and abnormal hindgut motility [68].

Although over 100 different operations for rectal prolapse have been described, they share common principals. Surgery may be undertaken by either the abdominal or perineal route. The former involves dissection of the rectum followed by fixation and in some cases excision of the redundant bowel. These operations are highly effective in correcting the prolapse but often produce a poor functional outcome, with approximately 50% of patients suffering from severe constipation. Indeed this may be the mechanism whereby incontinence is corrected. Sigmoid colectomy has been advocated in an attempt to avoid constipation, but this may increase the risk of post-operative incontinence. It is the author's practice to avoid colectomy in patients undergoing surgery for rectal prolapse when incontinence is the predominant symptom [60]. Despite this selective approach, approximately one-third of patients who have undergone abdominal rectal prolapse surgery will suffer from incontinence.

Perineal operations are usually reserved for patients who are unfit for abdominal surgery, since they are less effective at correcting the prolapse. However, there is evidence that the functional results are superior, with less constipation and incontinence. The treatment of rectal prolapse is covered in full elsewhere in this book.

26.5.2.5 Stoma

Since faecal incontinence is such a socially devastating symptom, the option of creating a stoma should not be overlooked. Used in conjunction with techniques such as colonic irrigation, a stoma may greatly improve the quality of life of these patients.

26.5.2.6 Selecting Patients with Faecal Incontinence Who May Benefit from Surgery

In a study of 100 consecutive patients referred to the author's department in whom the principal symptom was faecal incontinence, only 13 patients (13%) subsequently underwent surgical intervention. The operations that were performed are listed in Table 26.2. It should be noted that since these patients were referred for consideration of surgical intervention, they were already a highly selected group.

According to the department protocols and because of our research interests, all 100 patients underwent full investigation. This included standard anorectal physi-

Table 26.2 Surgery performed in 13/100 consecutive patients with faecal incontinence who were referred to a specialist unit

Surgery	*n*
External anal sphincter repair	3
Post-anal repair	1
Stoma formation	2
Perineal repair of rectal prolapse	2
Abdominal repair of rectal prolapse	5

ology studies including the measurement of pudendal nerve conduction times. In addition, first rectal sensation was measured with maximal tolerated volumes to rectal filling. Radiological investigation included proctography and endoluminal ultrasound. The mean age of the patients was 55 years; 79 (79%) were female.

A sphincter defect was identified in ten patients (IAS alone, three; EAS alone, one; both IAS and EAS, six). Only three of these patients subsequently underwent sphincter repair. The proctogram showed severe perineal descent in 22 patients, of whom 7 had overt rectal prolapse. All seven of these patients subsequently underwent surgery for prolapse.

Potentially the most important finding from this study was that 63 patients had evidence of a hypersensitive rectum on the basis of balloon-distension studies. As discussed earlier, patients with a hypersensitive rectum also have abnormal motility in the proximal colon consistent with the presence of IBS. It is of note that only 20% of all of the patients in this study had evidence of prolonged pudendal nerve conduction.

The author would wish to emphasise the importance of identifying patients with incontinence in whom either the principal or contributing cause is IBS. These patients who have urgency with incontinence of loose stool are unlikely to be improved by surgery even if a sphincter defect is found, unless the IBS is treated prior to the operation. It is note that a surgical procedure has been described specifically for this clinical condition which involves rectal augmentation. Although initial results were promising long term outcomes are awaited [47].

26.5.2.7 Artificial Bowel Sphincters

With the exception of operations to correct a sphincter defect, surgery for faecal incontinence has largely been disappointing. It is for that reason that there has been interest in the development of an artificial anal sphincter [56]. Despite many attempts to produce a device, only two are currently on the market; these are the artificial bowel sphincter (ABS) and the prosthetic anal sphincter (PAS).

The ABS is a larger version of the successful artificial sphincter used for urinary incontinence. In this design a circular inflatable cuff is implanted around the urethra (AMS 800; American Medical Systems, Minneapolis, Minnesota, USA). When inflated, this cuff produces a triangular lumen that applies squeeze pressures to the urethra. Continence is achieved when the squeeze pressure exceeds intravesical pressure.

The ABS for faecal incontinence also has three component parts: a cuff that encircles the anus and is implanted via the perineum, a constant-pressure balloon and a hydraulic control pump. The system is filled with fluid, which can be transferred from the cuff component to the constant-pressure balloon. This action, which opens the device to facilitate defaecation, is achieved by the patient manually depressing a small pump that is implanted in a subcutaneous pocket. This action facilitates evacuation. The fluid in the system then spontaneously "bleeds" back, slowly closing the device.

The ABS has been shown to be highly effective in restoring continence [69, 70]. Indeed, such is its efficacy that patients often report difficulty with emptying. Unfortunately the reported complication rate has also been high, with failure of the device predominantly due to infection and erosion. However, these failures may in part be due to deficiencies in operative technique or case selection for surgery, since individual surgeons have reported success with an acceptable complication rate [9].

It has been suggested that the serious complications of infection and erosion may occur because the device is implanted in the perineum, where it is difficult to ensure sterility. Since it is implanted immediately below the perianal skin, the device can also easily erode to the surface. A further putative cause of these complications is that the bowel may be compressed between the triangular pads in the ABS, leading to ischaemia. It has been shown in an experimental model that if the bowel was to become crenated between the inflated triangular pads, then it would be subject to excessively high pressures [57].

The new PAS (see Fig. 26.6), which was designed and developed by the author and colleagues, aims to overcome the difficulties that were encountered with the ABS [10]. As with the ABS, the design utilises a constant-pressure reservoir and is mechanically driven

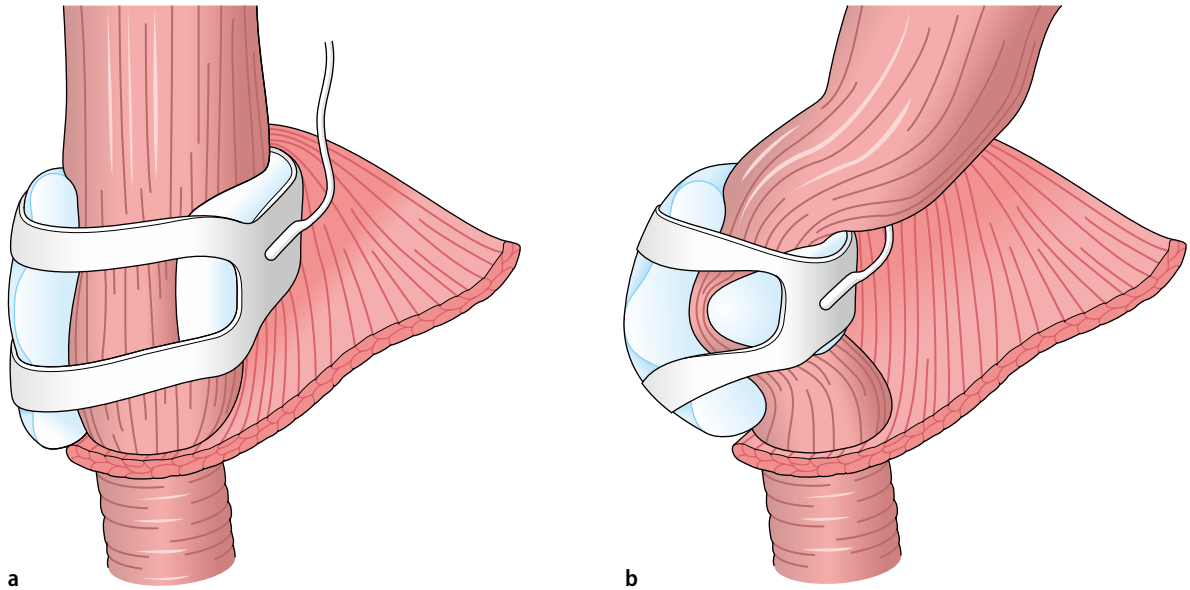

Fig. 26.6a,b Position of the prosthetic anal sphincter implanted above the levator ani muscles shown in the open (**a**) and closed (**b**) positions

by a subcutaneous pump. The cuff component and the pump design, however, differ from the ABS.

In brief, the PAS consists of a sphincter element that is placed around the bowel at the level of the anorectal junction (see Fig. 26.6) and is implanted via an abdominal approach, a constant-pressure balloon reservoir (with a sigmoid pressure–volume relationship) and a control pump. The sphincter component comprises an inflatable linear expander, which when inflated flattens the bowel against a soft, gel-filled pillow. The balloon reservoir provides the hydraulic pressure to drive the system and as it is set to operate at the "pressure plateau" of the balloon, a constant maximum pressure is maintained in the system irrespective of inflation volume. The control pump is placed in a subcutaneous pouch in the right iliac fossa, where it is operated by the patient. The pump provides the energy to transfer fluid between the sphincter component and the balloon reservoir. Pumping transfers fluid from the sphincter to the reservoir (opening the sphincter). Pressing the control button on the pump allows fluid to flow back to the sphincter (closing the sphincter), which then remains in dynamic continuity with the reservoir.

The key design feature of the PAS relates to the cuff or sphincter component and is based upon the results of physiological studies of continence in humans [53]. These studies suggest that angulation of the anorectum as a result of contraction of the puborectalis is an important factor in the control of solids. In contrast, the control of liquid is dependent upon the voluntary squeeze of the EAS and pelvic floor muscles, and as a consequence is precarious. Informed by these studies, the PAS flattens and angulates the bowel. This allows continence for solids at squeeze pressures of only 30–40 mmHg and minimises the risk of ischaemia. Fur-

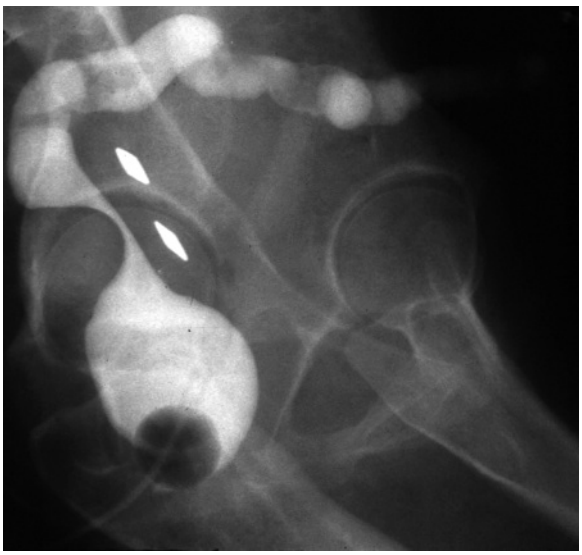

Fig. 26.7 X-ray examination of a patient with a prosthetic anal sphincter in the closed active position showing the angulation

thermore , since it is implanted above the pelvic floor (see Figs. 26.6 and 26.7), the risk of erosion is reduced and it is easier to maintain sterility during surgery.

The report of the initial PAS clinical trial appears to be promising, suggesting that the problems of infection and erosion experienced with the ABS have been overcome [55, 59]. However, as yet the patient numbers are small and it will be necessary to await the outcome of larger studies before drawing firm conclusions. The PAS may be appropriate for those patients who fail to respond to SNS and has been approved by the UK regulatory body, the National Institute for Health and Clinical Excellence.

26.5.2.8 Dynamic Gracilis Muscle Transposition

Attempts have been made to improve continence in patients with deficient anal sphincters by wrapping the gracilis muscle around the anal canal. One or both muscles may be used. Although initial reports were promising, the technique proved to be disappointing with longer follow-up. In particular, patients either lacked control or were unable to empty the rectum because the muscle produced adynamic constriction.

In an attempt to improve the outcome, the gracilis muscle was electrically stimulated in an attempt to change the characteristics of the muscle fibres from "fast-twitch" to "slow-twitch", which would be less likely to fatigue. The surgery performed in expert hands can be highly effective in restoring continence [11]. Unfortunately, the operation has high complication rates, thus limiting the value of the procedure. Since the advent of SNS, it is now rarely used.

26.5.2.9 Sacral Nerve Stimulation

Of all the treatments for faecal incontinence to emerge over the past 25 years, SNS is perhaps the most promising. Sacral nerve stimulators were first used in the early 1980s to treat urge incontinence of urine. It was noted in these patients that there was also an improvement in bowel function. SNS was first reported to have been used in patients with faecal incontinence in 1995. Since then it has been used and reported to be successful in patients who have suffered incontinence from a variety of causes including spinal cord injury, idiopathic degeneration, post-rectal prolapse repair, after low anterior resection and even in patients with a sphincter defect [12, 13]. Although the numbers of patients in these studies were small, improved continence for liquid and solid stool was reported in 50–75% of patients.

SNS has the advantage that patients may have a trial of treatment using a temporary electrode before being subjected to the surgical procedure required to place a permanent electrode. It usual to attempt to place the electrode through the third sacral foramen, although both the second and fourth have also been used successfully. Open implantation has recently been superseded by percutaneous techniques, but it remains necessary to make a subcutaneous pocket for the stimulator. Work is currently being undertaken to compare unilateral with bilateral stimulation and to define the optimal settings for the stimulator.

It is important to note that the mode of action of SNS is currently unknown. In particular, it is unknown whether it has a peripheral or central action. There is some evidence, however, that it may modify rectal motility and sensation. This would be especially interesting given the high number of patients with faecal incontinence who have IBS. It has been suggested that SNS does not work as a placebo, although it would be interesting to compare SNS with a traditional treatment such as amitriptyline in a randomised cross-over trial.

SNS is arguably the most promising tool currently available for the treatment of faecal incontinence, but it should be remembered that many treatment options have previously been reported to be promising only to disappoint with long-term follow-up. Given current knowledge, SNS should be tried first after failed medical management, with implantation of artificial sphincters reserved for SNS failures.

26.6 Conclusion

Faecal incontinence is a common and often unrecognised clinical entity. The aetiology is frequently multifactorial. Patients should be carefully assessed and investigated to identify the cause. IBS is a common contributing factor in the aetiology. It is important to identify those patients who have an EAS defect. Consequently, all patients should have an ultrasound examination.

Over 50% of patients are treated successfully by conservative measures such as biofeedback and/or the prescription of amitriptyline. Patients who fail to respond to conservative measures may be improved by SNS.

Only 10% of patients are suitable for surgery. The most commonly employed procedures are anal sphincter repair and the correction of rectal prolapse. Implantation of artificial anal sphincters may be useful in selected cases.

Incontinence will be an increasing and major health concern for aging societies over the next three decades. It is for this reason that current research is directed towards regenerative medicine as a solution, and in particular the possible application of muscle-derived stem cells, satellite cells, chondrocytes and adipose-derived stem cells in restoring sphincter function [28].

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Self-Assessment Quiz

Question 1

1. Which of the following features does NOT apply to the external anal sphincter?

a. Innervated by the pudendal nerve
b. Under voluntary control
c. Innervation from the dorsal horn of S2
d. No anatomical distinction at surgery from the puborectalis muscle
e. Disruption most frequently due to childbirth

Question 2

2. Which of the following factors is associated with biofeedback treatment?

a. Mode of action is clearly understood
b. Effective in only 10% of patients
c. Is ineffective in male patients with minor symptoms
d. Has been subjected to high-quality prospective clinical trials
e. Has been shown to be superior to amitriptyline treatment

Question 3

3. Which of the following statements does not apply to the surgical repair of external anal sphincter defects?

a. Long term studies show a 70% success rate
b. Usually repaired using an overlap technique
c. Rapidly absorbable sutures should be avoided
d. May be performed with or without a colostomy
e. Evidence of pudendal nerve neuropathy does not preclude successful repair

Question 4

4. Which of the following statements does not apply to the use of sacral nerve stimulation?

a. Has been shown to effective in patients with anal sphincter defects
b. Has been shown to be effective in patients with spinal cord injuries
c. Should not be used in patients who only have incontinence to loose stool
d. Has been shown to reduce rectal sensitivity
e. Exact mode of action is unknown

Question 5

5. Which of the following statements does not apply to artificial bowel sphincters?

a. Have been approved in the UK by the National Institute for Health and Clinical Excellence
b. The artificial bowel sphincter and prosthetic anal sphincter (PAS) have been reported to restore continence in over 70% of patients
c. The PAS has been designed to overcome the risks of infection and erosion
d. The artificial sphincters are operated electronically
e. Reproduce the normal physiology of continence

1. Answer: c
   Comments: Innervation from the ventral horn of S2.
2. Answer: c
   Comments: Only c is correct. Biofeedback provides improvement to over 50% of patients, but has not been subject to high-quality clinical trials.
3. Answer: a
   Comments: The long-term success after 10 years follow-up is poor. At best only 10–30% of patients report success.
4. Answer: c
   Comments: The results of sacral nerve stimulation are unpredictable and may be attempted in all symptomatic patients.
5. Answer: d
   Comments: Both devices are hydraulic.

27 Sacral Nerve Stimulation for Fecal Incontinence

Klaus E. Matzel

CONTENTS

27.1 Introduction

The maintenance of fecal continence, both control of bowel content and bowel emptying, is a result of the integrated function of the rectal reservoir system, the distal colon, sphincteric outlet resistance, and the sensory lining of the anal canal. Their functional interaction is attained by a convergence of somatomotor, somatosensory, and autonomic innervation, mediated by fibers traveling with the sacral spinal nerves. Sacral nerve stimulation (SNS) potentially effects all of these functions.

The concept of recruiting residual function of an inadequate anorectal continence organ by electrostimulation of its peripheral nerve supply (i.e., the sacral spinal nerves) was adapted from the field of urology in the early 1990s. The rationale for applying SNS to fecal incontinence was based on the clinical observation of its beneficial effect on bowel habits and anorectal continence function in urological patients with SNS, functional considerations (increased anorectal angulation and anal canal closure pressure during SNS), and anatomical findings (a dual peripheral nerve supplies the striated pelvic floor muscles that govern these functions [31], with the sacral spinal nerve site being the most distal common location of this dual nerve supply). SNS was first applied in 1994 for the treatment of fecal incontinence in a highly selected group of incontinent patients presenting with functional deficits of the anal sphincter but no morphologic defect [33]. Patients were selected because conservative treatment had failed, traditional surgical options such as sphincter repair were conceptually questionable, or the benefit of sphincter-replacement procedures, such as artificial bowel sphincter and dynamic graciloplasty, with their high morbidity, would not outweigh the risk in this population [2, 23, 56]. Since then the technique has undergone continuous development, the patient selection process has been modified, the spectrum of indications has expanded, and our knowledge and understanding of its mechanism of action has grown steadily, but remains incomplete. Today, the treatment can be considered part of the armamentarium for treating fecal incontinence.

27.2 Technique

The technique for SNS consists of two diagnostic stages, followed by a third therapeutic stage. Since it has been described in detail previously [11, 32, 49], the following will outline the procedure and highlight recent technical developments.

27.2.1 Acute Percutaneous Nerve Evaluation

Acute percutaneous nerve evaluation (PNE) aims to determine whether, in the prospective patient, contraction of the striated pelvic floor muscles can be elicited by stimulation of the spinal nerve(s). In doing so it aims to establish the integrity of the sacral spinal nerves and to test the individual relevance of each sacral spinal nerve to anal sphincteric contraction and anal canal

closure [29]. It is intended thus to identify the optimal site of stimulation and future electrode placement. The procedure can be performed under either general or local anesthesia.

For acute PNE, needle electrodes (Medtronic Model 041828 or 041829 Foramen Needles, Medtronic, Minnesota, USA) are inserted into the dorsal sacral foramina of S2, S3, and S4. Ideally, the foramen electrodes are positioned close to the site where the sacral spinal nerves enter the pelvic cavity through the ventral opening of the sacral foramen and proximal to the sacral plexus [31].

For correct placement, palpable anatomic landmarks are helpful in identifying the sacral foramina; intermittent stimulation with graduated amplitudes and visual confirmation of the motor response of the pelvic floor and anus will optimize the position of the needle electrode. Although the effect of stimulation on pelvic-floor and lower-extremity activity may vary among individuals, the following typical responses can be observed:

1. S2 stimulation: clamp-like contraction of the perineal muscles and an outward rotation of the leg
2. S3 stimulation: contraction of the levator ani and external anal sphincter, resulting in a bellows-like movement, along with plantar flexion of the first and second toes
3. S4 stimulation: bellows-like contraction of the levator ani without movement of the leg, foot, or toe [49]

If this acute stimulation successfully elicits contraction of the pelvic floor, subchronic percutaneous stimulation is initiated.

27.2.2 Subchronic PNE

The sacral spinal nerve(s) found in acute testing to be most effective with regard to muscular contraction and anal canal closure pressure – most commonly, but not consistently, S3 – are stimulated continuously for a set period of time sufficient to demonstrate a potential effect of low-frequency stimulation on fecal incontinence. The observation period depends upon the frequency of incontinent episodes; bowel habits, such as frequency and degree of involuntary loss of stool, are documented with standardized bowel diaries.

Two technical options are used for subchronic PNE: a temporary, percutaneously placed, test-stimulation lead (or multiple leads; Medtronic 041830, Temporary Screening Lead) that will be removed at the end of this phase, or operative placement of a quadripolar lead, the so-called "foramen electrode" (Medtronic Model 3886), which will stay if this testing phase was clinical successful and permanent stimulation is indicated. Recently, a less invasive technique has been increasingly used that uses a foramen electrode with a modified anchoring device, the so-called "tined lead" placed through a trochar (Medtronic Model 3550–18) [50]. Both types of lead (the temporary lead and the potentially permanent foramen electrode) are connected to an external pulse generator for screening (Medtronic Screener 3625, Medtronic), the latter with a percutaneous extension cable [12].

Percutaneous placement of temporary test-stimulation leads can be done on just one sacral spinal nerve or on multiple spinal nerves to offer the option of testing the effect of stimulation of different sides and levels or of synchronous stimulation of multiple nerves [51]. The operative placement of foramen electrodes is usually limited to one site.

With both techniques the selected sacral spinal nerve is continuously stimulated (pulse width 210 μs; frequency 15 Hz), except during voiding and defecation. The amplitude of stimulation may require adjustment depending on the position, tissue reaction, or electrode movement, and is adjustable by the patient within a limited range (1–10 V) according to his or her perception of muscle contraction or perianal sensation.

At the end of the screening phase, the percutaneously placed temporary test-stimulation lead is removed and, if successful, a permanent system consisting of an electrode, connecting cable, and pulse generator is implanted at the successfully tested nerve site. The operatively placed foramen electrode is either removed if unsuccessful or, if successful, connected to an implanted pulse generator (so-called "two-stage implant" [12]), offering the advantage of identical pvositioning of the electrode during screening and therapeutic stimulation.

27.2.3 Chronic Stimulation with a Permanent Implant

Because no other predictors of SNS outcome exist at present, patients are uniformly selected for operative implantation of a permanent neurostimulation device on the basis of clinical improvement during test stimulation, documented with standardized questionnaires and diaries. The testing procedure is most commonly considered therapeutically effective if the frequency of episodes of fecal incontinence documented by bowel-

habit diary is alleviated by at least 50% and if the improvement is reversible after discontinuation of SNS.

Chronic stimulation with a fully implantable device aims to make permanent use of the therapeutic effect achieved by temporary test stimulation. Patients who undergo test stimulation with a temporary lead receive simultaneous operative implantation of the quadripolar foramen lead and the pulse generator (Medtronic Itrel II/X-Trel, 7495, Extension kit, Medtronic 3023 INTERSTIM implantable pulse generator). Those with a foramen electrode already in place undergo removal of the percutaneous extension before placement of the pulse generator subcutaneously into the abdomen [11] or gluteal area [47].

Today, a less invasive technique that uses a foramen electrode with a modified anchoring device placed through a trochar (Medtronic Model 3550–18) and positioned with the help of fluoroscopy is most commonly used [50]. As noted earlier, this technique can be applied either for stage one of the two-stage implant or for electrode placement after successful screening with wire electrodes. It can be performed under local anesthesia. The method of choice for permanent stimulation is the unilateral implantation of a foramen electrode into the spinal nerve site demonstrated to be therapeutically effective during the test-stimulation phase. Bilateral foramen electrodes can be considered if unilateral stimulation is insufficient and bilateral test stimulation reveals acceptable results [35], or on conceptual considerations [42].

The foramen electrode contains four contact electrodes. The electrode combination most effective with regard to the required voltage and the patient's perception of muscle contraction of the perineum and anal sphincter is chosen for permanent stimulation. The parameters used are those found to be clinically effective and to cause no damage to the nerve: pulse width, 210 μs; frequency, 15 Hz; on-off: 5–1 s or continuous stimulation; the level of stimulation is usually above the individual patient's perception of muscular contraction and adjusted if necessary [48]. The pulse generator is activated by telemetry (Medtronic Model 7432 Console Programmer). Patients are instructed to interrupt stimulation with a hand-held programmer (Medtronic Model 3031) only for defecation and urinary voiding.

27.3 Patient Selection and Indications

Today, fecal incontinence attributable to a variety of causes can be treated with SNS. The current spectrum of applications reflects the continuous development and expansion of the initial indication. Initially, SNS was confined to patients with deficient function of the striated anal sphincter and levator ani, but with no morphologic defect [33], as residual function of the continence organ would be recruited by electrical stimulation. Thus, the initial patient selection for the SNS protocol was based on the clinical and physiologic finding of reduced or absent voluntary sphincteric function, but existing reflex activity, indicating an intact nerve–muscle connection, as confirmed by intact anocutaneous reflex activity or by a muscular response to pudendal stimulation with the St. Mark's electrode [38]. In this group of patients with heterogeneous etiologies, the common denominator was reduced function with intact morphology. The causes varied, covering a spectrum from postoperative sphincteric weakness consequent to anal and rectal procedures, to total lack of voluntary sphincteric control as a sequela of cauda syndrome secondary to lumbar spine fracture. The latter suggested the potential use of SNS in neurogenic incontinence [30].

This initial concept and its spectrum of indications, and the positive clinical outcome have been confirmed by single-center reports [19, 38, 52], and recently by a prospective multicenter study (Table 27.1) [37].

During the initial work, it became apparent that the selection of patients with two phases of diagnostic stimulation – acute and temporary – was highly predictive of the therapeutic effect of permanent SNS [38, 52]. Consequently, patient selection became more pragmatic and liberal and was no longer based on a conceptual consideration of a potential mechanism of action. Test stimulation as a trial-and-error approach was indicated, not by an underlying physiologic condition, but by the existence of an anal sphincter and residual voluntary or reflex sphincteric function. Absolute contraindications include pathologic conditions of the sacrum preventing adequate electrode placement (such as spina bifida), skin disease at the area of implantation, anal sphincter damage amenable to direct repair or requiring a sphincter substitute (e.g., artificial bowel sphincter, dynamic graciloplasty), trauma sequelae with micturition disorders or low bladder capacity, pregnancy, bleeding complications, psychological instability, low mental capacity, and the presence of a cardiac pacemaker or implantable defibrillator.

This pragmatic, trial-and-error patient-selection process has resulted in numerous publications [38, 52]. Most studies have represented patients with highly heterogeneous pathophysiologic conditions, thus outlining the range of patients who might benefit from SNS. Only one study with 75% of the participants suffering

from fecal incontinence of neurologic origin describes a more defined patient population [46].

Most commonly, clinical outcome is reported as an improvement in incontinent episodes or days with incontinence during the period of observation, and in quality of life. In these studies, which varied with regard to design and number of patients, a general agreement regarding the two-step stimulation for selection for permanent implant can be noted.

Some small case series and individual case reports have recently shown a beneficial effect of SNS in groups of patients presenting with distinct conditions and well-defined anorectal physiology findings (e.g., muscular dystrophy [4], a history of rectal resection and neoadjuvant chemoradiation [42], a sphincteric gap requiring surgical repair [5], neurologic dysfunction [15], rectal prolapse repair [16], and rectal resection for cancer [17]). It is hoped that this approach will pinpoint clinical predictors of responders, potentially obviating test stimulation. In addition, by focusing on a distinct pathophysiologic condition, it may be helpful in improving our understanding of how SNS works. These limited results are promising, but need to be confirmed in large prospective trials.

Table 27.1 Sacral nerve stimulation for fecal incontinence: clinical results. Data are presented as the median value, unless otherwise indicated

Report	Patients *(n)*	Prestimulation	Stimulation		Follow-up (months)
			Temporary	Permanent	
Frequency of episodes of incontinence to solid or liquid stool over a 7-day period					
Initial concept					
Matzel [30]	6	9 (2–19)	1.5 (1–5)	0 (0–1)	59 (5–70)
Leroi [24]	6	2 (1–7)	0 (0–4)	0.5 (0–2)	6 (3–6)
Ganio [6]	5	3 (2–14)	0	0	14 (5–37)
Ganio [7]	16	5.5 (1–19)	–	0 (0–1)	10.5 (3–45)
Matzel [37]	34	8.3 (1.7–78.7)	–	0.75 (0–25)	23.9 (1–36)
Current concept					
Rosen [46]	16	2 (1–5)	–	0.7 (0–5)	15 (3–26)
Kenefick [9]	15	11 (2–30)	0 (0–7)	0 (0–4)	24 (3–80)
Ripetti [43]	4	12†	–	2†,‡	24
Uludag [53]	50	7.5 (1–18)	0.67(0–4)	0.8(0–5)‡	12.0†
Altomare [1]	14	14 (11–14)§	–	0.5 (0–2)§	14 (6–48)
Jarrett [14]	46	7.5 (1–78)	–	1 (0–39)	12 (1–72)
*Cleveland Clinic Continence Score***					
Malouf [28]	5	16 (13–20)	–	2 (0–13)	16
Matzel [36]	16	16 (12–19)	–	2 (0–7)	32.5(3–99)
Rasmussen [41]	10	19.5 (14–20)	–	5.5 (0–20)	4.5 (1–12)
Altomare [1]	14	15 (12.5–17.5)	–	5.7 (2–6)§	14 (6–48)
Hetzer [10]	30	14 (6–20)	–	5 (0–13)	6

– Not available
* Data at last follow-up
† Median value; SD and range not available
‡ Follow-up value: median of values at published follow-up intervals
§ Median values during a 2-week period,
** Cleveland Clinic Score [18]: 0 = continent, 20 = incontinent

27.4 Results

27.4.1 Symptomatic Outcome

As noted above, quantitative measures are used to describe the clinical benefit, such as days with incontinent episodes/period of observation, absolute number of incontinent episodes/period of observation, ability to postpone defecation (in minutes), and percentage improvement. Clinical symptoms were significantly improved during permanent stimulation. Approximately 90% of patients experienced a substantial (>50%) improvement, and 50% of patients gained full continence. Not only was the number of incontinent episodes or days with incontinence improved during the period of observation, but also the ability to postpone defecation intentionally was significantly increased [37, 38, 52].

Even though published reports differ with regard to the patient population, a general pattern of outcome can be observed (Table 27.1):

1. The results of the screening phase are reproduced with the permanent implant.
2. When compared with baseline status, the clinical outcome is highly significant.

The short- and mid-term therapeutic effects of SNS have been demonstrated in multiple single- and multicenter trials for both the initial concept and the current concept. The favorable clinical outcome data confirm the current pragmatic selection process. Today, a broad spectrum of patients is successfully selected.

27.4.2 Quality of Life

As with indications, outcome assessment has also evolved. Subsequent to the quantitative assessment of the number of incontinent episodes or days with incontinence during a set observation period, aspects of quality of life were added to the evaluation (Cleveland Clinic Continence Scoring System [18], the 36-item short form (SF36) [55], and the Fecal Incontinence Quality of Life (FIQL) Score [44]). The therapeutic impact of SNS is most evident when disease-specific quality-of-life instruments are applied. The disease-specific FIQL demonstrated a highly significant improvement in all four categories – lifestyle, coping/behavior, depression/self-perception, and embarrassment – in both single- and multicenter studies (Table 27.2) [38, 52].

27.4.3 Anorectal Physiology

Numerous efforts have been made to correlate the clinical outcome of SNS with the results of anorectal

Table 27.2 Permanent sacral nerve stimulation for fecal incontinence: clinical results – quality of life (adapted from [38]). *SF36* The 36-item short form – 36 questions, *FIQL* Fecal Incontinence Quality of Life score, *RE* role-emotional, *GH* general health, *MH* mental health, *BP* bodily pain, *RP* role-physical, *SF* social function, *V* vitality, *HAT* health transition, *PF* physical functioning

Report	Patients (*n*)	SF36	FIQL			
		Categories improved	Lifestyle	Coping/behavior	Depression/ self-perception	Embarrassment
Malouf [28]	5	SF, RE, MH, RF	–	–	–	–
Rosen [46]	16	–	Increased*	Increased*	Increased*	Increased*
Kenefick [9]	15	all*except: HT	–	–	–	–
Ripetti [43]	4	SF*, RE*, PF*	–	–	–	–
Matzel [36]	16	–	Increased*	Increased*	Increased*	Increased*
Altomare [1]	14	–	Increased*	Increased*	Increased*	Increased*
Matzel [37]	34	SF*, MH, RE, RP, BP	Increased*	Increased*	Increased*	Increased*
Hetzer [10]	30	SF*, PF*, MH*, V*	–	–	–	–

* Significant
– Not available

physiology studies, but the effect of chronic stimulation varies greatly among published reports [38, 52]. Data are in part contradictory and inconclusive, and sometimes not reproducible. This inconsistency of findings seems to be due to the heterogeneous pathophysiological conditions of the treated patients. The most common finding has been an increase in striated muscle function, expressed as improved squeeze pressure. In one study the duration of voluntary contraction was shown to be increased [24]. The effect on resting pressure and rectal perception is inconsistent, although a trend toward decreased sensory and urge thresholds is apparent. The hyposensitivity of the rectum improved during chronic stimulation [45].

Rectal manometry (24-h) has indicated that the effect of SNS is not limited to sphincteric function and rectal perception. The reductions in spontaneous rectal motility complexes [53, 54] and spontaneous anal sphincter relaxation [54] are qualitative changes in anal and rectal motility. Changes in blood flow recorded by rectal Doppler flowmetry during stimulation give a further indication that SNS affects the autonomic function of the distal bowel [21]. Improvement in anal sensory function and sensibility of the perianal and perineal skin during SNS has been reported in one study [46]. In some patients, clinical success was obtained with subsensory threshold stimulation, indicating that the clinical effect of SNS seems not always to be dependent on the perception of stimulation [22]. Physiologic changes induced by SNS can be observed not only on the peripheral target organ, but also in the central nervous system [3, 26].

27.4.4 Complications

As the operation is of limited invasiveness and the operative field is not in the proximity of a naturally contaminated area, the rate of complications is relatively low [38, 52]. Those that do arise include infection, pain at the site of the electrode or pulse generator, electrode dislodgement or breakage, loss of effect, and deterioration in bowel symptoms. In only approximately 5% has it been necessary to discontinue treatment and remove the device because of loss of effect, deterioration of symptoms, pain lead dislocation, or infection. When infection has necessitated removal, reimplantation at a later date has been successful [28].

27.5 Conclusion

The use of SNS for the treatment of fecal incontinence has been constantly evolving since its first application. From selection based on conceptual physiologic considerations, it became a technique applied by a pragmatic approach. Based on the positive outcome, the technique established its place in the current treatment algorithm. It is by exploring new indications with the help of the minimally invasive, highly predictive test stimulation (which can be considered to be a diagnostic investigation) that its application will be expanded and some paradigms of traditional surgical thinking will be challenged. The current treatment algorithm for fecal incontinence is challenged by the successful primary therapeutic use of SNS in patients with sphincteric disruption [5] in whom surgical repair would previously have been considered. This is of special interest, as we have learned in recent years that the short-term benefit of sphincteric repair deteriorates over time; indeed it has been shown to be less favorable after mid-term [8, 27]. However, data regarding the long-term efficacy and durability of SNS are themselves limited and need to be assessed.

Outcome has been measured quantitatively by focusing on the frequency of fecal incontinence episodes and parameters of quality of life separately. The indications for a permanent implant have only been based on the clinical effect on incontinence during test stimulation, not on the impact of SNS on quality of life. Integrating the effects of SNS on incontinence and quality of life into the decision-making process in a defined manner should better serve the needs of patients suffering from a condition that affects their quality of life enormously.

Our knowledge of the mechanism of action of SNS remains limited. Various physiological changes can be observed. Thus, the clinical effect of SNS is likely multifactorial, based on multiple physiologic functions. The understanding of the relative importance of each of these functions and their dependence on pathophysiologic preconditions is unclear. It may simply be that SNS works differently in different patients. The number of studies with a homogenous patient population is limited, and most studies represent a heterogeneous aggregation of patients with a wide variety of underlying pathophysiologic conditions selected by pragmatic means. Thus, any firm conclusion regarding the underlying mechanism of action is unreasonable. Only recently have some small studies aimed to apply the

technique in various, highly selected patient groups presenting with distinct pathophysiological conditions. This may help to further increase our insight into its mode of action.

A potential placebo effect of SNS can not be totally excluded, but seems to be unlikely because:

1. A long-term benefit has been shown to be sustainable.
2. Patients who experienced clinical deterioration had their therapeutic benefit restored after technical problems with the neurostimulator, of which they were unaware, were corrected.
3. The clinical effect has been confirmed in a double-blind crossover trial [25].

Technically, the efficacy of SNS depends on optimal electrode placement. The optimal site is currently determined by clinical observation. Electrophysiologic testing during electrode placement may further improve the outcome and longevity of the pulse generator. To increase its efficacy, SNS has been applied bilaterally, although to date in only a few patients. It remains to be determined whether bilateral stimulation per se leads to an improved and more durable clinical response; the observed increased effectiveness of bilateral SNS or of unilateral stimulation of more than one nerve may depend on the individual innervation pattern of the patient [34]. If anatomic pathology prevents appropriate electrode placement, stimulation at a more peripheral level (i. e., stimulation of the pudendal nerve [39] or tibial nerve [40]) can be considered.

The indications for SNS have been expanded over time, despite the fact that our knowledge of its mode of therapeutic action remains limited. This is a dynamic process with a relatively new treatment concept, and we must constantly reconsider our understanding of anorectal physiology and neurostimulation in the treatment of anorectal functional disorders. However, despite the very positive clinical outcome, increased use, and broadened acceptance of this tool, further distribution of SNS is hampered by economical considerations. Proof of cost effectiveness is equivocal [9].

The indications for SNS have also been expanded beyond the field of fecal incontinence to slow-transit constipation and outlet obstruction. Preliminary data indicate that it may be beneficial [13] and that this benefit is unlikely to be a placebo effect [20]. Not only is the effect of SNS on functional disorders of the colorectum and anus of interest, but also its interaction with the anterior and middle compartments of the pelvis and pelvic floor will become important in the future if we are to identify further conditions in which SNS can be of clinical value.

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Self-Assessment Quiz

Question 1

The so-called "two-staged procedure" is:

a. A stepwise diagnostic approach to fecal incontinence
b. A sequential implantation of a foramen electrode for temporary test stimulation and subsequent connection and implantation of the pulse generator based on the outcome of the test stimulation
c. The sequence diagnostic percutaneous nerve evaluation and subchronic/temporary stimulation-therapeutic chronic stimulation
d. Application of sacral nerve stimulation (SNS) secondary to other treatment of fecal incontinence
e. A stepwise change in stimulation settings

Question 2

Indication for permanent implant of the SNS device is based on:

a. The existence of voluntary external sphincter function
b. The presence of reflex sphincter function
c. The morphological integrity of the anal sphincter
d. The clinical outcome of a timely limited period of test stimulation
e. Normal pudendal nerve terminal motor latency

Question 3

The efficacy of SNS has been show in:

a. Patients with sphincter weakness
b. Patients with sphincter gaps prior to sphincter repair
c. Patients after rectal prolapse repair
d. Patients with neurogenic causes of incontinence
e. All of the above

Question 4

SNS aims to stimulate the sacral spinal nerve:

a. In the sacral canal
b. At their target organs
c. At the ventral opening of the sacral foramen
d. Most commonly at level S2
e. At the level of the lumbar spine junction

Question 5

The mode of action of SNS is:

a. A change of the phenotype of external anal sphincter fibers
b. A change of rectal and internal anal sphincter motility
c. Mediated through the autonomic nervous system
d. Based on changes in the central nervous system
e. Not known in detail, potentially any of the above

1. Answer: b
Comments: Timely limited test stimulation serves as the diagnostic tool with which to select patients for permanent implant. Two techniques are used:
1. Temporary electrodes, which need to be removed after testing.
2. Foramen electrode (including "tined lead"), which needs to be placed operatively, but can stay in place if the testing is successful. A pulse generator needs to be added if therapeutic permanent stimulation is indicated. This approach is termed "two-staged."
2. Answer: d
Comments: Currently no other indicator for the successful permanent stimulation exists than temporary test stimulation. Test stimulation is highly predictive of the outcome of permanent stimulation.
3. Answer: e
Comments: Based on a trial-and-error approach with test stimulation, patients with a wide variety of underlying pathomorphologic and pathophysiological conditions have been selected for successful permanent stimulation.
4. Answer: c
Comments: Placement of the foramen electrode aims to position the electrode close to where the relevant nerve enters the pelvic cavity through the ventral opening of the sacrum. The ventral edge of the sacrum serves as an anatomic landmark for "tined-lead" placement with the aid of fluoroscopy. Stimulation is most commonly applied to S3.
5. Answer: e
Comments: The precise details of the mode of action are unknown. Various changes in anorectal physiology have been reported. The functional relevance of each of these in an individual remains unclear, but hypothetically it depends upon the underlying pathophysiological condition.

28 Essential Anorectal or Idiopathic Perianal Pain

Lukas Degen and Walter R. Marti

CONTENTS

28.1 Introduction

Anorectal or perianal pelvic pain may be caused by any number of different underlying diseases. It is often the result of common and readily recognisable disorders such as inflammatory processes (perianal fistula and abscesses, cryptitis, anal fissures or Crohn's disease), haemorrhoids, anal fissures, tumours, prostatitis or gynaecological or other anomalies. In certain circumstances, however, the origin is uncertain or the pathophysiological mechanism is unclear. This is what is known as idiopathic pain or functional pain syndrome.

In some patients it may be difficult to distinguish between organic and functional disorders. Structural abnormalities are often found in asymptomatic individuals with no significant anorectal discomfort. Generally speaking, women are more likely than men to experience a variety of recurrent pains, particularly in the pelvic region [23].

Most of the clinicians involved acknowledge that anorectal or perianal pelvic pain syndrome is a complex problem with no obvious therapeutic solution, for its aetiology remains uncertain. Some authors even challenge its existence and tend to associate the symptoms with underlying psychological distress.

Like other functional gastrointestinal disorders, functional pelvic pain syndrome often presents together with irritable bowel syndrome (IBS). Different studies have shown the rate of occurrence of IBS in women with chronic pelvic pain to range from 29 to 79% [29]. Conversely, 35% of women suffering from IBS report chronic pelvic pain [25].

28.2 Definition

In the last few decades the Rome criteria for defining functional gastrointestinal disorders have become widely accepted as a legitimate diagnostic tool. The latest and recently published revision, known as Rome III, includes criteria for functional anorectal disorders [3].

The definitions of functional anorectal and pelvic pain syndromes are primarily symptom-based [27]. Because patients may not accurately recall pain symptoms, prospectively obtained symptom diaries can improve reliability. Functional anorectal and pelvic pain syndromes are characterised by the presence of pain severe enough to prompt the patient to seek medical care. It is defined as pelvic pain unrelated to any pathological organic condition, having lasted for at least 3 months over the last 6 months [3].

Pursuant to the Rome III criteria, only chronic proctalgia and proctalgia fugax are regarded here to be entirely functional disorders (Table 28.1).

Table 28.1 Classification of functional anorectal and pelvic pain (according to the Rome III criteria)

1. Chronic proctalgia
   1a Levator ani syndrome
   1b Unspecified functional anorectal pain
2. Proctalgia fugax

28.3 Chronic Proctalgia

Chronic proctalgia is also known as levator ani syndrome, levator spasm, puborectalis syndrome, pyriformis syndrome or pelvic tension myalgia. The pain is often described as a vague, dull ache or pressure-like sensation high in the rectum, which may be more intense when in a sitting or prone position. It may last anywhere from a few hours to a few days. These symptoms, which are compatible with levator ani syndrome, affect 6.6% of the general population, although the rate is higher in women than men [4]. While only 29% of these individuals seek care, the existence of associated organic dysfunctions appears to be significant. Over half the patients are between 30 and 60 years old, with a downward trend in prevalence after the age of 45 years [4].

A diagnosis of chronic proctalgia can only be delivered when all of the following are present:

1. Pain or aching must be chronic or recurrent and last at least 20 min.
2. The symptoms must be present for ≥3 months in the last 6 months prior to diagnosis.
3. All organic causes of rectal pain must be ruled out.

A diagnosis of levator ani syndrome is likewise reached by clinical examination. The signs include predominantly left-sided tenderness of the puborectalis with characteristic discomfort or pain upon digital posterior traction of the muscle. If no tenderness is detected during posterior traction, the symptoms are attributed to unspecific functional anorectal pain.

Clinical evaluation usually includes sigmoidoscopy and appropriate imaging studies such as defaecography, ultrasound, and pelvic computed tomography or magnetic resonance imaging to exclude other pathologies.

Although some authors have hypothesised that levator ani syndrome is due to spastic or overly contracted pelvic floor muscles [7], the actual aetiology is unknown. Some reports suggest that the levator ani syndrome is associated with psychological stress, tension and anxiety [10].

With such a heterogeneous group of patients, a variety of treatments designed to reduce tension in the levator ani muscles has been reported: digital massage of the levator ani muscles; sitz baths; muscle relaxants such as methocarbamol, diazepam, and cyclobenzeprine; electrogalvanic stimulation; and biofeedback training.

Most of these reports are anecdotal and have not been subjected to controlled trials for evaluation. Unfortunately, many patients fail to respond to treatment. Surgery, which comprises lateral division of the puborectalis muscle sling, as introduced by Kamm et al. [12], should be avoided due to the high rate of functional complications involved, such as incontinence [2].

28.4 Proctalgia Fugax

Proctalgia fugax is defined as a sudden, severe pain in the anal area that lasts for several seconds or minutes, then subsequently disappears entirely. Patients are wholly asymptomatic between episodes. Such attacks are infrequent in over half the patients, with fewer than five episodes a year [22]. Prevalence is estimated to range from 8 to 18%. As in other similar functional disorders, only 17–20% of the people affected report the symptoms to their physicians [3]. The reason why these individuals seek medical advice is unknown.

All of the following criteria must be met to deliver a diagnosis of chronic proctalgia fugax:

1. Recurrent episodes of localised pain in the anus or lower rectum
2. Short duration, from seconds to minutes
3. Absence of anorectal pain or discomfort between episodes

Here also, the diagnosis is based on symptoms alone (i. e. there are no physical examination findings or laboratory tests to support the diagnosis). The short duration and sporadic, infrequent nature of this disorder render the identification of physiological mechanisms difficult. Several studies suggest that smooth muscle spasms are the cause of proctalgia fugax [5]. According to psychological test results, many patients with this condition also suffer from anxiety and exhibit perfectionist and/or hypochondriac tendencies.

For most patients, the episodes of pain are so brief that treatment consists of merely reassurance and explanation. In a small percentage of patients, however, proctalgia fugax may appear on a regular basis. In these patients particularly, the inhalation of salbutamol (a beta-adrenergic agonist) may help to reduce the duration of proctalgia episodes [17]. Recommendations for the use of clonidine or amylnitrate have yet to be substantiated.

28.5 Coccygodynia

Coccygodynia comprises pain in or around the coccyx that may be aggravated by sitting or prolonged standing, bending or lifting [18]. The cause of the pain may be a specific event (e. g. fracture following a backward fall or childbirth) or a chronic stimulus due to poor sitting posture, leading to osteoarthritis of the sacrococcygeal and coccygeal joints, which in turn causes chronic coccygodynia. The patient may describe severe tenderness of the coccyx that is distinctly perceptible when sitting or, more rarely, when changing from a sitting to a standing position. Pain may also be felt in nearby structures, such as the lumbosacral spine, the sacrum, or the anococcygeal ligament. It may also be prompted by massaging the coccyx. X-rays of the sacrum and coccyx with the patient in standing and sitting positions may support the diagnosis. For the most part, however, X-ray findings reveal no significant abnormalities [11]. Initially, treatment for coccygodynia includes protection of the painful tip of the coccyx by sitting on a pillow or an inner tube, sitz baths, pelvic relaxation therapy or pelvic massage. A second-line therapy would involve local infiltration of anaesthetics either alone or in combination with steroids. Manipulation of the coccyx under anaesthesia, with repeated flexion and extension, has also been shown to be effective [28]. Cryoablation of the posterior rami of the lower sacral nerve roots and the coccygeal nerve has also been advocated [6]. Coccygectomy may be considered as a therapy of last resort in a tiny proportion of patients suffering severe and unresponsive pain [8].

28.6 Perineal Neuralgia and Alcock's Canal Syndrome

Two other syndromes that prompt chronic anorectal or pelvic pain are perineal neuralgia and Alcock's canal syndrome.

Women having had prior surgery involving the pelvic viscera, lumbar spine or anus may present with perineal neuralgia. Radiculopathy as a result of post-surgical sacral nerve-root compression or ischaemia of the pelvic nerves is a potential underlying cause. Patients report continuous, localised anal and perianal pain. Present for months, it is characterised as intense throbbing or burning, extending into the sacrum, back of the thighs, the pelvis or the abdomen. Lying down or standing up may relieve the symptoms. Physical examination of the body area reveals no anomalies [21]. Analgesics are not usually helpful, but for some patients, injection of anaesthetics in combination with steroids into the pudendal nerve affords relief. Treatment also includes psychotropic medication.

Alcock's or pudendal canal syndrome involves nerve entrapment [19] as a result of internal pudendal nerve injuries. This lesion is caused either by the constriction of the internal pudendal nerve between the sacrotuberal and sacrospinal ligaments in its musculo-osteo-aponeurotic tunnel, or by straddling of the nerve by the falciform process of the sacrotuberal ligament [14].

Here also, pain may be relieved by infiltration of a combination of anaesthetics and steroids into Alcock's canal. The patient lies in a procubitus position with the painful site on the pelvis raised at a 30° angle. A long needle is guided fluoroscopically through the gluteal muscle and along the medial part of the ischium to its spine to infiltrate Alcock's canal. The results of this procedure are inconsistent, however, and not immediately perceptible. Due to the duration of injection-induced compression, pain may subside only gradually.

28.7 Analgesics and Adjuvant Pharmacologic Management

As a general rule, idiopathic anorectal and perianal pain therapy is non-invasive and primarily based on analgesics. The World Health Organisation guidelines for pain control in non-malignant diseases constitute a basically sound therapeutic approach [13; 15]. Initial analgesic therapy includes non-steroidal anti-inflammatory agents; for non-responders a mild opioid (such as tramadol) may be added. Patients with persistent, long-lasting pain may require a strong opioid such as morphine or fentanyl, or a long-acting opioid (methadone). A combination of different drugs is not uncommon in therapeutic practice to relieve pain.

Invasive analgesic procedures to block nerves may include injections of active drugs into trigger points. Myofascial pain is most likely to respond to this type of therapy. Alternatively, neurostimulation may be considered in certain cases. Stimulation of the third sacral nerve root with an implantable device has been shown to reduce the severity and frequency of chronic pelvic pain. This technique has been applied mainly in patients with concomitant bladder voiding or stool incontinence problems [20].

Adjuvant drugs such as tricyclic antidepressants or anticonvulsants may be considered for patients with neuropathic conditions [9]. Other pharmacological options effective in the treatment of patients with chronic pelvic pain include antihistamines, muscle relaxants, alpha-2-agonists and dextromethorphan.

28.8 Psychological Aspects/Somatisation

Patients with multiple physical symptoms not fully explained by a known general medical condition or a correlated organic disease may be diagnosed with a somatisation disorder [1]. According to the Diagnostic and Statistical Manual of Mental Disorders (4th edition) published by the American Psychiatric Association, this condition entails the presence of at least four different sites of pain, two gastrointestinal symptoms other than pain, one neurological symptom and one sexual or reproductive problem other than pain. Some psychiatric practitioners report that as many as 70% of women with chronic pelvic pain syndrome have an attendant somatisation disorder [1]. The prevalence appears to be much lower in centres specialising in chronic pain, however.

As with other functional disorders, the successful treatment of patients with anorectal or idiopathic pelvic pain is greatly facilitated when the physician is able to win their trust and confidence. This is best accomplished by listening carefully to the patient and performing a thorough, symptom-based evaluation. Ultimately, reassurance and explanation of the known causes, together with the commitment to help, may be the basis of beneficial therapy [16]. Most patients are able to understand that there are no instant cures and are satisfied with the knowledge that their physicians will make an honest effort to help them in a gradual and stepwise fashion.

A higher incidence of physical or sexual abuse has been reported in the history of female patients with chronic pain, and this also appears to be true for anorectal or idiopathic pelvic pain. Up to 25% of women with chronic pelvic pain disclose a history of physical and sexual abuse [26]. Past traumatic experiences such as a history of abuse may alter the neuropsychological processing of pain signals and permanently alter pituitary–adrenal and autonomic responses to stress.

Depression also seems to be more common in patients with anorectal or idiopathic pelvic pain than in the population at large. The causal relationship between depression and chronic pelvic pain remains uncertain, however [24].

28.9 Conclusions

A multidisciplinary diagnostic and therapeutic approach, often combined with psychological support, should be adopted for patients with chronic pelvic pain. Functional anorectal pain syndromes continue to constitute a clinical area worthy of further research. Specifically, effective treatments remain limited today, and more prospective and randomised trials are needed.

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Self-Assessment Quiz

Question 1

The Rome III criteria define the following functional anorectal pain syndromes:

a. Chronic proctalgia
b. Coccygodynia
c. Perineal neuralgia
d. Alcock's canal syndrome
e. Pyriformis syndrome

Question 2

Anorectal pain therapy:

a. Is easy to perform because it is non-invasive
b. Comprises, under the best strategy, of eliminating the source of pain
c. Is based primarily on tricyclic antidepressants
d. Adopts a multidisciplinary approach, often combined with psychological support
e. Depends wholly on analgesic drugs

Question 3

Proctalgia fugax is caused by smooth muscle spasms and therefore calls for:

a. Immediate injection of Botox into the sphincter muscle to avoid muscular necrosis
b. No active therapy, as a general rule, since it rarely occurs over long intervals
c. Enhancement of sphincter tone, making sphincterotomy the therapy of choice
d. Psychological therapy
e. Long-acting methadone to ensure pain relief

Question 4

In levator ani syndrome:

a. Pain may last from seconds up to 2 min.
b. Pain is usually localised in the coccyx.
c. Digital posterior traction on the puborectalis muscle causes pain.
d. Neither psychological stress nor anxiety appears to be involved.
e. Therapy comprises lateral division of the puborectalis muscle.

Question 5

Which of the following statements is correct regarding patients suffering from coccygodynia?

a. The pain can be reproduced by massaging the coccyx.
b. Symptoms are localised in the anus.
c. Coccyx subluxation is a typical radiological finding.
d. Initial treatment comprises the local injection of anaesthetics.
e. Coccygectomy is a highly successful option and the treatment of choice.

1. Answer: a
Comments: The latest revision of the criteria, known as Rome III and published in 2006, draws a distinction between chronic proctalgia and proctalgia fugax as functional anorectal pain disorders. Chronic proctalgia is further subdivided into levator ani syndrome and unspecified functional anorectal pain [3].
2. Answer: d
Comments: Inasmuch as the aetiology of the pain is poorly understood, therapy is often complex and based on several

approaches including physiotherapy, physical therapy, analgesics and adjuvant drugs such as antidepressants or anticonvulsants [23].

3. Answer: b
Comments: Proctalgia fugax is defined as a sudden, severe pain in the anal area lasting several seconds or minutes, which subsequently disappears altogether. Attacks are infrequent, occurring less than five times a year [3]. For most patients, episodes of pain are so brief that treatment consists only of reassurance and explanation.

4. Answer: c
Comments: In levator ani syndrome pain is often described as a vague, dull ache or a sensation of pressure high in the rectum. Digital posterior traction on the puborectalis causes characteristic discomfort and pain. If no tenderness is detected during posterior traction of this muscle, the symptoms are ascribed to unspecified functional anorectal pain. The syndrome is associated with psychological stress, tension and anxiety [10]. A variety of treatments designed to reduce tension in the levator ani muscles has been reported: digital massage of the levator ani muscles, sitz baths; muscle relaxants, electrogalvanic stimulation and biofeedback training. Surgery, which comprises lateral division of the puborectalis muscle sling, as introduced by Kamm et al. [12], should be avoided due to the high rate of functional complications involved, such as incontinence [2].

5. Answer: a
Comments: Coccygodynia comprises pain in or around the coccyx that can be typically reproduced by massaging the coccyx. Pain may also be felt in nearby structures, such as the lumbosacral spine or the sacrum. Some X-rays may reveal pathologies, but most yield normal results [11]. Initially, treatment for coccygodynia includes protection of the painful tip of the coccyx by sitting on a pillow or an inner tube, sitz baths, pelvic relaxation therapy or pelvic massage. Anaesthetic infiltration is regarded to be a second-line therapy only, while coccygectomy must be set aside as a therapy of last resort for a very small proportion of patients with severe and unresponsive pain [8].

29 Complications of Anal Surgery

Andrew J. Shorthouse and Steven R. Brown

CONTENTS

29.1 Introduction

In an era of increasing specialisation and fragmentation of general surgery, coloproctology continues to be an increasingly important growth area. This reflects the multiple disease processes that we are called upon to manage, particularly in and around the perianal region. An abundance of pathology is matched by an ever-expanding armamentarium of therapies, increasing pressure from purchasers and managers to reduce hospital stay to curtail costs, and the need to minimise the risk of litigation. For this reason it is important to be aware of potential complications by appropriate training and keeping up to date with evidence-based practice. Effective treatments such as conventional haemorrhoidectomy have been around for many years and have stood the test of time, whereas other procedures, such as post-anal repair, have been abandoned in favour of other recent developments, such as sacral nerve stimulation.

The success of a procedure is not only gauged by its ability to "cure" the disease, but also its potential for harm. This chapter highlights the potential complications arising from anal and perianal surgery.

29.2 Perianal Abscess

29.2.1 Recurrence

Recurrence after simple incision and drainage of perianal abscess is nearly always due to an underlying fistula, or sometimes hidradenitis [1, 2]. Primary suture following drainage and curettage with antibiotic cover

may result in faster healing, shorter hospital stay and less pain [3].

Occasionally, an abscess may be missed, requiring a second anaesthetic to achieve complete drainage. The risk of a breach of the anorectal mucosa during curettage, resulting in an iatrogenic fistula, is minimised by limiting the procedure to simple incision and drainage. Suprasphincteric and extrasphincteric fistulas may not be primarily of cryptoglandular origin, but are probably mostly iatrogenic, arising from aggressive or inaccurate probing in the presence of acute inflammation [4]. Definitive fistula exploration should be deferred until the acute septic episode has settled, especially in the presence of an ischiorectal abscess; otherwise, the risk of incontinence is increased, while not necessarily reducing the risk of recurrence [1]. On the other hand, if the internal opening of an associated fistula can be easily identified and laid open, the recurrence rate may be as low as 1% [5], and it is claimed to be lower than after simple incision and drainage. If no internal opening is obvious, the safest approach is to perform simple drainage, accepting a potentially increased recurrence risk. Overall, no internal opening is identifiable in 57–86% of cases, and persistence or recurrence ranges from 3.7 to 36%, confirming that simple acute drainage does not always lead to fistula formation [6].

29.2.2 Faecal Soiling, Flatus and Urge Incontinence

Accurate assessment of the amount of sphincter being divided is more difficult in the presence of acute sepsis [1]. Sphincter damage will be permanent. In a recent systematic review, there was a slightly increased risk of minor incontinence but lower recurrence after fistulotomy at the time of abscess drainage (R.L. Nelson, personal communication, 2006).

29.2.3 Unresolved Sepsis

Unresolved sepsis may follow abscess drainage, especially in immunocompromised or diabetic patients, and antibiotics should be given. Occasionally sepsis fails to settle in the presence of beta-haemolytic streptococcal infection. It is important to check bacteriology reports.

29.2.4 Necrotising Fasciitis

This is rare, but requires urgent computed tomography (CT) scan assessment, appropriate antibiotics, resuscitation, radical debridement and possibly a diverting stoma, particularly in a severely septic, immunocompromised or diabetic patient (see Sect. 29.7).

29.3 Anal Fistula

29.3.1 Persistence, Recurrence and Incontinence

Sphincter-saving treatment carries a low risk of faecal incontinence, but at the expense of lower cure and higher recurrence rates than the more traditional laying-open techniques. Discussion with patients needs to include cure, recurrence and incontinence risks for the various treatment options for informed decision-making. In general terms, sphincter-saving techniques are more appropriate initially to minimise the risk of incontinence, unless the fistula is simple and low.

Accurate assessment of fistula tracts, with an understanding of their relationship to the sphincters and pelvic floor musculature is essential to minimise recurrence and faecal incontinence. The classification of Parks et al. is widely accepted [7]. Although the majority of fistulas are cryptogenic, a careful history, examination and appropriate investigation occasionally reveal evidence of inflammatory bowel disease as the underlying cause, in which case more conservative treatment may be appropriate. Soiling and urge incontinence may be more of a problem after sphincter division in Crohn's patients, who may have loose stools.

Digital assessment of primary tracks is approximately 60% accurate, compared with 80% for endoanal ultrasonography (EAUS) and 90% for magnetic resonance imaging (MRI) [8]. Therefore, imaging should supplement digital assessment in any complex fistula in order to identify tracts that might otherwise be missed, thus increasing the risk of persistence or recurrence. All but low primary simple intersphincteric fistulas should be imaged.

A fistulotomy involving more than 30% of the external sphincter (EAS) is associated with a greater risk of incontinence compared with more conservative division [9]. The precise extent of EAS being divided under anaesthesia can be difficult without MRI guidance. A preoperative MRI scan reduces the risk of recurrence

to 16%, compared with 57% when the preoperative scan result is ignored [8]. MRI is essential for differentiating chronic supralevator and infralevator sepsis. The former arises from an upward extension of an intersphincteric fistula, and the latter from the ischiorectal aspect of a transsphincteric fistula. Clinically, they are extremely difficult to differentiate, and treatment differs. Supralevator extensions should be drained directly into the rectum and not through the levator, which would otherwise create an extrasphincteric track that is almost impossible to cure.

Preoperative anorectal manometry is advisable if fistulotomy is being considered, especially in multiparous females. Used in conjunction with sphincter-preserving surgery, anorectal physiology, including EAUS, improves functional results with less risk of faecal incontinence [10].

29.3.2 Fibrin Glue

Fibrin glue [11] is a simple and safe tool that carries no risk of incontinence when used as a sole procedure. Failure rates are disappointing, with reported healing of only 14–60%. Of those that do heal, however, only 6% recur [11–13]. In a recent randomised controlled trial, only 3/6 low and 9/13 complex fistulas healed [14], but even if glue fails, the patient is not compromised; the technique can be repeated with the prospect of 50% success and should therefore be the first-line treatment. Addition of antibiotics to glue is unhelpful.

Evidence is lacking for the relative merits of bowel preparation, management of the internal opening and instillation methods in reducing failure and recurrence rates [12].

29.3.3 Fistula Plug

Data on the efficacy of the Surgisis anal fistula plug is currently scanty and evidence is limited to a few single-centre studies. No randomised controlled trials have been carried out. Armstrong's group [15] recently published their follow-up at 12 months; only 17% fistulas failed to heal, with a better outcome if there was only one external opening, although this was not significant. Most failures were apparent within 1 month, due to extrusion of the plug from inadequate anchorage, excessive patient activity, multiple tracks or sepsis. Although a pre-existing seton facilitated insertion of the plug, its presence or absence did not affect outcome. In a prospective trial [16], fibrin glue was compared with the fistula plug; 60% of the glue group had persistent fistulas at 3 months, compared with 13% of the plug patients. These preliminary results are encouraging. The technique appears safe, straightforward and inexpensive, and may be appropriate as a first-line treatment of fistulas to avoid sphincter damage, but more data from randomised controlled trials are required. Potentially, there could also be a place for the plug in the management of Crohn's anal fistula. Sixteen of 20 patients with a total of 36 Crohn's anal fistula tracts were treated with fistula plugs, and only 4 (20%) failed at a median follow-up of 10 months [16].

29.3.4 Loose Seton

Definitive treatment by loose seton alone for high fistula treatment preserves the EAS. The rate of persistence or recurrence after removal of the seton varies between 10 and 56% in the short term, and is 80% in the long term. Minor incontinence has been reported in 0–58%, and is probably related to the internal sphincterotomy employed to drain intersphincteric space infection in some of these cases; major incontinence is rare [17–24].

29.3.5 Core-Out Procedure

Recurrence (1–14%) and incontinence (7–17%) are a low risk after core-out and layered closure of the mucosa and sphincter [25]. However, in a randomised controlled trial comparing lay open with core out combined with lay open, Kronborg found that recurrence and the need for reoperations were similar [26]. Delayed healing can be minimised by staying close to the track, which is easier with a fibrotic, well-defined fistula [26]. Lewis described core out of 67 low fistulas combined with laying open of the resultant tunnel, with only one recurrence. There were only 3 recurrences from 32 complex fistulas, treated by core out followed by layered anatomical suturing of the cored-out tunnel, with closure of the internal opening. The external part of the wound was left open. Four patients required a stoma, one of which was permanent [27].

29.3.6 Advancement Flap

The rectoanal flap technique has the advantage of sphincter preservation, avoidance of anal canal defor-

mity, and rapid healing. Key to a success is a partial-thickness flap consisting of mucosa, submucosa and circular muscle fibres, and its apex should be no less than half its base dimensions. Addition of gentamicin-collagen beneath the flap to systemic antibiotic prophylaxis did not improve results [28]. Recurrence occurs in 7–19% of cases, and incontinence in 0–8% [29, 30]. Surprisingly, incontinence has been reported to be similar to that after fistulotomy [31], and may reflect the use of retractors to gain access or potential disturbance to the upper sphincter mechanism when flaps other than simple mucosal ones are fashioned. Care should be taken when using anal retractors, especially when gaining access for rectoanal advancement flaps. Use of Parks' retractor was associated with a significant fall in resting pressure and increased incontinence, when compared with a Scott retractor [32].

The results of anocutaneous flaps are probably inferior to those for rectoanal advancement. However, cutaneous island flaps are technically easier, especially if anal fibrosis or stenosis is present. Reported recurrence is 20–54% [33, 34] and there is a single report of incontinence as high as 18% [34]. Dermal island flap was compared with fistulotomy for high transsphincteric fistula, and no significant difference was found in continence after a mean of 36 months follow-up [35]. The type of anocutaneous flap is unimportant. We prefer a V-Y configuration after core fistulectomy. Incomplete closure reduces the risk of haematoma, sepsis and flap failure. Full preoperative mechanical bowel preparation is no more effective than a phosphate enema.

29.3.7 Loose Seton as a Preliminary to Staged Fistulotomy

This technique can be used to treat a high transsphincteric fistula with or without secondary extensions, and other types of complex fistula. It avoids the pain sometimes associated with a cutting seton. Thompson and Ross [17] cured 18 of 34 (57%) complex high transsphincteric fistulas with a loose seton, 83% remaining fully continent. Those whose fistula persisted underwent sphincter division, and nine (68%) reported varying degrees of incontinence to solid stool, three subsequently needing a sphincter repair. None of the former group had any major incontinence. In another series, only 22% of cases failed to heal after the same technique [18].

Overall, failure to heal or recurrence is unusual (0–8%), but there is a significant risk of major (10–42%) incontinence, and minor incontinence as high as 54–62% [21, 36].

29.3.8 Fistulotomy

Fistulotomy, as a first-line treatment should be reserved for those patients with a simple low transphinteric fistula involving not more than one-third of the EAS, or a simple intersphincteric fistula involving division of the internal sphincter (IAS) to the dentate line. Wound healing may be prolonged and deformity of the anal canal contributes to soiling.

False tracks can be avoided by gently directing the probe under anaesthesia towards the internal opening at the dentate line, with a finger placed in the anal canal.

Published recurrence data are difficult to compare due to different patient populations, variable follow-up, thoroughness of reporting, complexity of the fistula, and experience of the surgeon. Recurrence is reported to be between 0 and 9% [37–39].

Incontinence following fistulotomy has a prevalence of 0.1–45%, and is found more frequently in females, in the anterior position, or in Crohn's disease [38, 39]. For many years, it was believed that continence would be preserved provided that the puborectalis was largely preserved, even when the sphincter below had been divided. The degree of incontinence is proportional to the amount of sphincter sacrificed: the higher the fistula, the greater the risk of incontinence. Minor disturbances occur even when division is limited to the distal IAS, and patient perception is more important than manometric disturbance. The patient may need to make a balanced decision between fistula cure and the incontinence risk, as fistulotomy gives the highest cure rate at the expense of continence.

Marsupialisation significantly reduces healing time, with a similar recurrence risk and better preservation of EAS function than with fistulotomy alone [40]. There is no evidence that marsupialisation predisposes to recurrence.

Fistulectomy is associated with both longer healing times and a higher incidence of incontinence than fistulotomy [26].

29.3.9 Cutting Seton

Fistula persistence or recurrence is found in 2–29% of patients, but incontinence is common (10–54%), with

major incontinence occurring in as high as 39% of cases [36, 41, 42]. The results are similar to those for staged loose seton and delayed fistulotomy. A cutting seton may be painful and, in view of the high incontinence rates, should be reserved as a last resort for those patients who have failed sphincter-preserving procedures.

29.3.10 Long-Term Loose Seton Drainage

An alternative strategy is long-term loose seton drainage, as employed in many patients with Crohn's disease or human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS). Drainage is minimal after the track has epithelialised.

29.3.11 Crohn's Anal Fistula

Joint management with a gastroenterologist is essential. Acute sepsis should be drained urgently, with insertion of a loose seton, and the patient referred back to the physician for immunomodulating treatment. Before anti-tumour necrosis factor-alpha (infliximab) treatment, an MRI scan ensures there is no residual undrained abscess, which otherwise risks potentially fatal sepsis. Infliximab is effective in closing 55% of fistulas, but more than 50% recur at a median of 3 months [43]. In a more recent series, the seton was removed after the second of three cycles of 5 mg/kg infliximab, resulting in complete and partial healing in 47% and 53%, respectively. Despite external healing, MRI will show persistence of almost all tracts, and clinical recurrence is likely unless infliximab is given on a long-term cyclical basis. Seton placement and infliximab followed by maintenance immunosuppression achieves complete or partial healing in 86% of cases [44]. Crohn's recto- or pouch-vaginal fistulas fare worse after infliximab than perianal disease, failing to heal in 60% of cases [45]. Prognostic factors related to failure are the number of Crohn's sites, extraintestinal disease and proctocolitis. Whether or not involvement of the small bowel with Crohn's disease is a factor remains controversial.

Complex fistulas may be treated by long-term seton drainage [21]. Advancement flaps are less successful in Crohn's disease. Infliximab might improve the results of surgery, but no randomised trials are available to confirm this. Further attempts at repair are worthwhile. Global healing rates after rectal advancement flap in Crohn's disease are 85% for anorectal fistula and 70% for rectovaginal fistula [46]. Following initial success in healing rectovaginal fistula in 58% of patients, global healing after repeat repair reached 75%. There was no evidence that a stoma improves results. Late recurrence was found in 16%, and 6% ultimately had a proctectomy [47].

Faecal diversion may be necessary where perianal Crohn's disease is refractory to medical treatment. Over 50% eventually need a permanent stoma. Proctectomy should be considered in the presence of severe anorectal disease uncontrolled by infliximab and immunosuppressants, a strictured anorectum, incontinence, poor quality of life or failed local surgery.

29.3.12 Malignancy, Tuberculosis and HIV

In view of its rarity, the possibility of malignancy is easily overlooked, resulting in delayed diagnosis. All long-standing fistulas should be curetted for histopathological examination [48].

Tuberculosis should be suspected when complex fistulas occur in association with rectal stricture, particularly in patients from areas where tuberculosis is endemic, and in immunocompromised patients. Curettings should be examined histologically for acid-fast bacilli and, where indicated, *Mycobacterium-tuberculosis*-specific polymerase chain reaction requested. Fresh tissue should be cultured. Perianal sepsis should be drained and antituberculous treatment given [49].

Patients with advanced HIV should be treated minimally with abscess drainage and loose setons. Sphincter division should be avoided, as the risk of incontinence increases from disease and treatment-associated diarrhoea. Fistulas presenting in early, well-controlled HIV can be treated conventionally [50].

29.4 Hidradenitis Suppurativa

29.4.1 Introduction

Hidradenitis suppurativa gives rise to chronic recurrent sepsis in the apocrine glandular areas, particularly the axillae, groin and perineum, and is thought to be due to blocked, infected terminal hair follicles and spread of infection to adjacent apocrine glands, rather than primary infection in the apocrine glands themselves [51]. Organisms isolated from hidradenitis include

Streptococcus milleri in 21 of 32 patients, *Staphylococcus aureus,* anaerobic streptococci*, Proteus*, and *Bacteroides spp*. [52]. *Chlamydia trachomatis* has been implicated [53]. It presents as relapsing, discharging sinuses from areas of painful subcutaneous induration as the apocrine glands are destroyed. Cysts and tracts lined with squamous epithelium are also found. Although the diagnosis is usually straightforward, fistula-in-ano, pilonidal disease or perianal Crohn's disease may cause confusion or even coexist [54]. Infected sebaceous cysts, perianal abscess, actinomycosis, tuberculosis or lymphogranuloma inguinale may also cause diagnostic difficulty, and all excised tissue requires histopathological and selective bacteriological examination to exclude these conditions where appropriate.

29.4.2 Recurrence, Progression and Failure

This is a common problem after initial treatment with skin cleansers, sitz baths, topical and systemic antibiotics, hormone agonists or antagonists, isotretinoin and immunomodulating agents, including infliximab. Non-surgical treatment is only effective when presenting very early.

Surgical treatment should be wide local excision or deroofing. Simple incision and drainage usually results in failure to heal. Wide local excision [55, 56] may require split skin grafts and temporary stoma formation in extreme cases to avoid delayed healing and contractures [56, 57]. Incision and deroofing of abscesses and tracks [58, 59], with curettage of granulation but preserving the epithelialised or fibrotic sinus tract base, is less radical. To avoid recurrence or persistence, all indurated areas must be explored and deroofed, and no overhanging skin edges should remain. There is no evidence that this more conservative approach is less effective, and healing is faster, although no randomised controlled trial has been carried out. Excision and primary closure has been advocated for limited disease, but recurrence is high [60]. Flap or split skin-graft closure of larger defects has met with mixed success [61]. Marsupialisation is generally unsuccessful and is associated with higher recurrence [62].

An incorrect diagnosis, particularly fistula-in-ano or Crohn's disease, may be a cause of unresolved or recurrent sepsis, particularly if tracks extend to the dentate line. The axillae, groin and perineum should be examined for hidradenitis. Recurrence should be treated by wide local excision or deroofing.

29.4.3 Malignant Change

Malignant change is rare, but should be considered, particularly when disease is longstanding (median 16 years), and histopathological examination of all excised tissue is essential [57].

29.5 Fournier's Gangrene

29.5.1 Introduction

Fournier's gangrene is due to involvement of the anogenital and perineal region by synergistic polymicrobic necrotising fasciitis, and is characterised by endarteritis obliterans of the subcutaneous arteries [63]. The severity of clinical presentation varies from minimal cutaneous necrosis to rapidly spreading skin and underlying soft-tissue necrosis along fascial planes, and may be fatal. It is a surgical emergency requiring awareness of the condition, and prompt diagnosis and treatment, particularly in immunocompromised patients or diabetics [64].

In the majority of cases, anaerobic and aerobic gut bacteria or perineal commensals are cultured, usually a combination of *Escherichia coli*, staphylococci, streptococci, *Proteus*, Clostridia, *Klebsiella*, *Bacteroides* and *Corynebacterium*. An average of three organisms is isolated in each case [52]. Males outnumber females by 10:1. Anorectal (ischiorectal, perianal and intersphincteric) abscesses (19–50% of cases), genitourinary infections and trauma are the most common causes [64].

Associated comorbid conditions include diabetes mellitus (10–60%), alcoholism and immunosuppression after transplantation, chemotherapy, steroids, leukaemia or HIV. Reported antecedent events are hernia repair, vasectomy and anorectal examination with mucosal biopsy, Thiersch wire insertion for rectal prolapse, haemorrhoid banding or injection sclerotherapy, stapled anopexy and open haemorrhoidectomy, urethral catheterisation, neonatal circumcision, prostatic biopsy, penile prosthetic implants, femoral angiography, stapler insertion for colorectal anastomosis, and chicken or fish bone impaction in the anal canal. Predisposing intra-abdominal conditions include renal abscess and urethral stone or stricture, although intestinal pathology is more common, such as appendicitis, colorectal carcinoma or diverticulitis [52]. Patients often show generalised symptoms and signs of sepsis to a variable degree. Careful clinical examination of the perineum, genitalia and anorectum usually reveals tender induration, crepitus, blotchy purplish discoloration or frank

skin and subcutaneous necrosis. Urgent investigation by CT scanning is required to exclude intra-abdominal or pelvic sepsis, and to demonstrate the extent of fascial spread, which may be far more extensive than visible cutaneous necrosis. MRI is useful. Scrotal ultrasound will confirm normal testes and can demonstrate gas in the scrotal skin [65]. Other investigations include full blood count, plasma urea, creatinine and electrolytes, blood cultures prior to starting antibiotic therapy and resuscitation. Blood transfusion may be necessary. Urgent examination under anaesthesia, with proctosigmoidoscopy, should then be arranged [66] Bowel preparation with phosphate enemas, if clinical condition permits, will facilitate this. Extensive debridement reaching viable tissue is then required, regardless of the resultant defect. Follow-up surgical exploration should be arranged 24–48 h later [64]. Multiple debridements may be required to control spread. A colostomy may be necessary to avoid faecal wound contamination. A suprapubic catheter will be required in the presence of a urologic origin of sepsis, urethral stricture, or urine extravasation [67]. Whether or not hyperbaric oxygen reduces mortality is controversial and there is no consensus about its place as an adjunctive treatment in controlling further extension of disease or in subsequent wound management [64, 68].

29.5.2 Mortality

Mortality ranges from 3 to 38% [69, 70]. Patients over 60 years old have a higher mortality [71, 72]. Immunocompromised patients also have a higher mortality [73], but there is no consensus about the impact of diabetes mellitus, although logically it should increase mortality. Sepsis originating from the anorectum carries a greater mortality than a urological source [74]. Patients with major haemodynamic instability are more at risk, reflecting age, comorbidity, septicaemia and delay [70]. Delayed diagnosis, inappropriate antibiotics and deferred surgical debridement, even within a few hours, will increase mortality [72, 75]. This may result from poor awareness of the condition, its varied mode of presentation, and sometimes insidious onset. In the early stages, perianal pain may be disproportionate to clinical signs. Patients may present initially with fever, malaise, non-specific abdominal pain, perineal swelling or general features of infection without specific perineal symptoms and signs. Any patient with evidence of perineal sepsis or questionable skin viability requires regular review throughout the day, checking for evidence of spreading cellulitis or early skin necrosis. Patchy purple skin discoloration, with or without crepitus, is an early sign, and precedes frank black dermal necrosis [64]. Avoidable delays in organising a CT scan or access to an emergency operating room may result in rapid deterioration and increased mortality.

Underlying intra-abdominal pathology may initially be missed. The testes are usually spared when the scrotum is involved, due to their abdominal blood supply. Coexistent testicular gangrene indicates an intra-abdominal source of infection, demanding urgent CT scan, laparoscopy or laparotomy. Cystourethroscopy and colonoscopy with biopsy may also be required to exclude underlying malignancy.

The presence of Fournier's gangrene limited to the genitalia should not preclude an anorectal examination. There is a danger, especially in an era of specialisation and reconfiguration of surgical services and sometimes on remote sites, of patients presenting to the urologist with penile or scrotal gangrene and who may have an underlying colorectal or anal source of infection, or vice versa. Both urethral and perirectal infections reach the superficial perineal space to produce the same pattern of disease [76].

29.5.3 Stomas and Outcome

The construction and timing of a diverting stoma remains controversial, and a decision should be made on the basis of severity and aggression of the disease process, the degree of anorectal and perineal involvement, wound management considerations and the general condition of the patient. In a series of 45 patients, the mortality of those not needing a stoma was 7%, compared with 38% when a stoma was constructed [77]. These differences probably reflect case selection based on severity of disease, rather than being due to construction of the stoma per se. In severe cases it may be logical to defer stoma construction until there is improvement in physiological status [78]. Fewer than 10% patients open their bowels within the first 48 h postoperatively, so delayed stoma construction is unlikely to result in additional contamination.

29.5.4 Failure to Identify Causative Organisms

Negative bacterial cultures are occasionally obtained, even in the presence of putrid, discharging necrotic tissue, considered due to poor technique in specimen collection [52]. Pus should be aspirated for anaerobic

and aerobic culture, in addition to using simple culture swabs.

29.5.5 Failure to Identify Persistent or Progressive Gangrene

Debrided areas must be closely and regularly inspected to avoid the pitfall of failing to recognise progressive disease.

29.5.6 Inappropriate, Ineffective Antibiotics

It is wise to discuss suspected cases with the microbiologist before starting antibiotic treatment. Broad-spectrum antibiotics should be started immediately, regardless of culture results or Gram staining. They must be highly effective against staphylococci, streptococci, Gram-negative coliforms, *Pseudomonas*, *Bacteroides* and Clostridia [63]. Generally, penicillin, metronidazole, a third-generation cephalosporin, and gentamicin are recommended.

29.5.7 Malnutrition

Patients are often seriously ill and need to be maintained in positive nitrogen balance otherwise healing is compromised. Enteral feeding is adequate and avoids the complications of parenteral nutrition [52].

29.5.8 Loss of Perineal and Scrotal Skin

The scrotum and perineum have remarkable regenerative capacity, but a split skin graft or sometimes a myocutaneous flap may be necessary to prevent excessive scarring and testicular fixation in large wounds. Early discussion should be held with a plastic surgeon. If necessary, the testes may be protected in subcutaneous abdominal skin pockets or with skin flaps [64]. However, when scrotal skin loss is extensive, orchidectomy may overcome the problem of housing of the testes in selected cases [79]. Orchidectomy has been performed only rarely for scrotal abscess complicating Fournier's gangrene, and in exceptional circumstances, testicular gangrene. After healing, unacceptable cosmesis may require reconstructive surgery [80]. Its effect on fertility and libido is unknown.

29.5.9 Involvement of the Rectum and Anal Sphincters

In most cases, the rectum remains uninvolved, but occasionally it is extensively damaged, necessitating abdominoperineal resection [81–83]. Perineal gangrene may extend into and destroy the EAS, requiring extensive debridement and resulting in sphincter dysfunction and a permanent stoma (personal observation).

29.5.10 Penile Loss

Penile gangrene may result in total loss of the penis, either surgically or spontaneously [52].

29.5.11 Diabetes Mellitus

Fournier's gangrene may be the first presentation of diabetes. Associated ketoacidosis may potentially be fatal [52].

29.5.12 Delayed Discharge

This usually results from delayed healing of the perineum and scrotum. Hospital stay ranged from 2 to 278 days in one series [84].

29.5.13 Carcinoma

Squamous carcinoma arising in scar tissue has been reported as a long-term complication [85].

29.6 Anal Fissure

29.6.1 Introduction

Anal fissure is an ulcer in the squamous epithelium of the anus located just distal to the mucocutaneous junction and often in the posterior midline. Severe pain on defaecation is associated with spasm of the IAS. Relief of spasm is associated with relief of pain and healing of the fissure without recurrence. Although non-surgical therapies have gained popularity recently, surgical intervention remains common, as no available medical therapy (glyceryl trinitrate – GTN, calcium channel blockers such as diltiazem, botulinum toxin, indoramin, arginine, minoxidil and sildenafil) has yet proved to be

as effective as lateral sphincterotomy [86]. Operative techniques used for fissure include anal stretch, lateral sphincterotomy (open and closed), tailored lateral sphincterotomy, posterior midline sphincterotomy, fissurectomy with or without botulinum toxin (Botox), and dermal advancement flap. Post-operative morbidity, principally incontinence, was once thought to be extremely rare [37], but has been reported more widely in recent years [87], emphasising the importance of correct treatment choice.

29.6.2 Haematoma/Haemorrhage

A haematoma is rare and usually a result of failure to apply adequate pressure after an incisional technique. Haemorrhage is extremely unusual, but is more common after open sphincterotomy. Perianal haematomas can also occur after Botox injection [88].

29.6.3 Infective Complications

Perianal sepsis complicates 1–2% of sphincterotomies (usually closed procedures) and is probably the result of penetration of the anal mucosa by the knife blade. Treatment involves adequate drainage and laying open of a fistula if present. Fistulas occur in 50% of such abscesses [89].

29.6.4 Keyhole Deformity

A keyhole deformity is a troublesome consequence of a sphincterotomy carried out in the posterior midline. The resultant defect causes mucous discharge, soiling and pruritus. Although the true incidence of a symptomatic keyhole deformity is probably rare [90], posterior sphincterotomy is not recommended because of this deformity unless there is an associated superficial fistula or an intersphincteric abscess cavity that needs laying open.

29.6.5 Incontinence

Faecal incontinence is the most serious post-operative complication following fissure treatment. The risk depends on the type of operation performed. For instance, the keyhole deformity seen with a midline sphincterotomy increases the incidence of minor incontinence compared with a lateral sphincterotomy [91]. Anal stretch results in higher rates of incontinence than lateral sphincterotomy [91, 92]. Conversely, when given alone or in conjunction with a fissurectomy or advancement flap, Botox injection results in lower rates of incontinence because there is no surgical defect in the sphincter [93, 94]. However, two cases of long-term incontinence after Botox injection have been reported [95, 96].

Even for the same procedure, there is still marked variation in the reported incidence of incontinence, varying from 0 to 20% for lateral sphincterotomy [97]. Case mix and intensity of follow-up probably explain this variance. Females have shorter sphincters and the potential for developing pudendal neuropathy after childbirth. An equivalent sphincterotomy may be more significant in terms of continence in females than in males. Beware the female who has a hypertonic IAS but a weak EAS, which may undergo decompensation after an internal sphincterotomy. Sphincterotomy should also be avoided in postpartum females with a normotonic or hypotonic IAS. If in doubt, anorectal physiology is useful before embarking on sphincterotomy. Production of an anocutaneous advancement flap is a more appropriate technique to avoid incontinence in these patients.

Technical variation, such as the length of the sphincterotomy, may be important. Lateral sphincterotomy tailored to the length of the fissure reduces the incontinence risk [97]. Finally, it is important to quantify exactly what is meant by incontinence. Minor soiling or mucus seepage that is considered normal by one person can be unbearable for another.

Anal stretch is worthy of specific comment; it produces uncontrolled disruption of the IAS, resulting in varying degrees of sphincter injury. Endosonography has demonstrated the potential for extensive multifocal disruption [98, 99]. As a result, the majority of surgeons have abandoned the procedure in favour of lateral sphincterotomy.

29.6.6 Persistence and Recurrence

Reports of persistence after sphincterotomy vary widely from 3 to 29%; most studies indicate an incidence of less than 5% [97]. For these patients it is important to exclude a secondary cause such as Crohn's disease, HIV infection, sexually transmitted disease, tuberculosis or lymphoma, particularly if the fissure is atypical [100].

If secondary causes have been excluded, two factors should be considered before contemplating further surgery. Was the original operation adequate? EAUS suggests that a significant proportion of persistent fissures have had an inadequate sphincterotomy, and that a further sphincterotomy should be undertaken [101, 102]. Secondly, what is the incontinence risk if a contralateral sphincterotomy is undertaken? Physiological assessment with manometry and EAUS are essential before considering another sphincterotomy, especially as continued conservative treatment with fibre and high fluid intake will achieve healing in over 60% of cases [103, 104].

29.6.7 Other Complications

Ecchymosis is possibly the most common complication of fissure surgery, but is of no significance. Urinary retention, although more common after haemorrhoidectomy, is nevertheless occasionally seen after lateral sphincterotomy [105].

29.7 Haemorrhoids

29.7.1 Introduction

Haemorrhoidal disease results from distal enlargement of the anal cushions, the fibrovascular structures involved in maintaining continence. Surgery has traditionally involved excision of these cushions, and leaving the wounds either open (Milligan-Morgan) or closed (Ferguson). Haemorrhoidal disease is claimed to arise from disruption of the suspensory ligament, resulting in mucosal prolapse [106]. Stapled haemorrhoidopexy is based on this premise and aims to restore anatomical integrity by reconstituting the ligament without recourse to haemorrhoidal excision.

Operative treatment for haemorrhoids carries a daunting list of potential complications. However, many of these can be avoided by careful pre- and post-operative care.

29.7.2 Pain

Management of pain is an important aspect of pre- and post-operative care. Excisional techniques are notorious for their potential to cause pain, maximal at the time of first defaecation and worsened by difficult defaecation. Treatment should therefore be aimed at avoiding the passage of a hard stool. Timely administration of laxatives is imperative not only post-operatively (particularly if the patient is on opiate analgesia), but also more importantly preoperatively [107, 108]. Analgesia should be given liberally and include both oral non-opiates and topical anaesthetics. Opiates may be necessary, but their constipating side-effect should be countered with laxatives. Topical GTN relieves spasm and reduces pain [108]. Metronidazole may reduce pain by reducing the incidence of microabscesses and IAS myositis [108, 109]. Sitz baths are helpful. Pain usually subsides significantly after a few days following the first defaecation. Our regime is lactulose 20 ml daily, metronidazole 200 mg three times daily, GTN paste 0.2% three times daily, local anaesthetic gel as required and diclofenac 50 mg three times daily, all for 1 week, together with hot baths as necessary, and lactulose continued for a further week.

Stapled haemorrhoidopexy involves no cutaneous wound and all surgery is carried out above the dentate line. Reduction in post-operative pain has been confirmed in several randomised controlled trials [110]. However, reports of persistent pain and faecal urgency in 2–16% after stapled haemorrhoidopexy are worrying [111–113]. Rectal pain is usually intense and dull, refractory to treatment and associated with urgency. The cause remains unclear, but is possibly due to fibrosis around the staple line affecting the visceral nerve endings of the rectal ampulla [112]. If the staple line is inadvertently placed at or distal to the dentate line (a haemorrhoidectomy rather than -pexy), such symptoms are common. Whatever the aetiology, some respond to nifedipine [113].

29.7.3 Bowel Dysfunction

Urgency affects 23% of cases after stapled haemorrhoidopexy [114], but generally settles after several months, and is claimed to be due to reduced rectal capacity, but is probably more associated with rectal irritability before the staple line completely heals. Urge faecal incontinence occasionally occurs, and severe irritable bowel syndrome was triggered by the procedure in one of our own cases. Conversely, 5% have problems with straining at defaecation and a feeling of incomplete bowel emptying [112]. Possible reasons are stenosis or a residual pocket between the staple line and sphincter, effectively creating the equivalent of a rectocele.

29.7.4 Urinary Retention

Retention is the most common complication after haemorrhoidectomy. Although some studies have suggested that up to 20% of patients will have some form of urinary complication [115], these can be minimised by meticulous surgical technique, restriction of intra- and post-operative fluids, avoidance of rectal packing and adequate analgesia. Fluid overload has been shown to be a major factor in inducing urinary retention and if fluids are restricted, it can be reduced by up to 75% [116, 117].

Other important factors that influence retention include ambulatory surgery [118] and the use of spinal or local anaesthesia, the latter sometimes given as an adjunct to a general anaesthetic [119]. Urinary retention may follow faecal impaction, presenting as increasing anorectal discomfort, fullness and soiling. The problem usually resolves with catheterisation and administration of a phosphate enema. Failing this, disimpaction under anaesthesia will be required.

29.7.5 Constipation and Faecal Impaction

Pre- and post-operative laxatives have already been emphasised for the management of pain. A mild stimulant laxative for 5 days before operation, then continued for 5–7 days after the procedure either with, or replaced by, a bulk laxative is one regime [107, 120]. Prompt augmentation of laxative use with a stimulant laxative such as movicol or picolax should be considered if defaecation has not occurred within 72 h in order to avoid faecal impaction (see Sect. 29.7.5).

There is no justification for the patient remaining in hospital before evacuation provided a robust bowel-management programme is in place.

29.7.6 Haemorrhage

Bleeding can be immediate (i. e. in the operating room due to technical problems with the pedicle), reactionary (within 12 h of the procedure) or delayed (3–14 days). Although reactionary bleeding may be treated initially with topical or submucosal adrenaline and digital pressure, a prompt return to the operating room for a rectal washout should be considered at an early stage and is sometimes the only intervention required. Tamponade using a Foley catheter may be successful, but in the authors' view, early return to the operating room is preferable. Often, no bleeding source can be identified after a rectal washout, but suture ligation is effective if a bleeding vessel is identified [121]. Haemorrhage may be occult, with retrograde passage of blood, and should be suspected if hypovolaemic shock occurs in the absence of overt rectal bleeding with a closed sphincter. A rectal examination and proctoscopy will confirm bleeding, and the patient should be returned immediately to the operating room after appropriate resuscitation.

Delayed haemorrhage occurs in about 2% of patients [115]. Topical or submucosal adrenaline injection may be tried initially, with suture ligation or argon plasma coagulation (APC) in the operating room if unsuccessful. An alternative is Foley balloon catheter tamponade [122]. Persistent bleeding should raise a suspicion of a blood dyscrasia, such as Von Willebrand's disease.

Introduction of the stapling device PPH-03, which provides a more haemostatic closure, has significantly reduced the problem of early haemorrhage after stapled haemorrhoidopexy to less than 5%, equivalent to that for conventional haemorrhoidectomy [123]. Nevertheless, meticulous haemostasis is required and early return to theatre recommended if bleeding does occur. Delayed bleeding is rare [124], so same-day discharge is feasible and safe provided there is no sign of blood loss or excessive discomfort, and the patient has passed urine.

29.7.7 Infection

Overt sepsis after haemorrhoid surgery is rare, with an incidence of less than 0.5% [125]. Fulminant necrotising perineal sepsis has only rarely been reported following both excisional and stapled haemorrhoidectomy [116, 126, 127]. Some of these cases have occurred in immunocompromised patients, prompting caution in this group [126, 127]. Between 2000 and 2003, several reports of life-threatening complications after stapled haemorrhoidopexy were published: one patient died and most of the others required a stoma. Similar numbers of severe septic complications have been published after standard haemorrhoidectomy, but over a 40-year period (1964–2003). Therefore, the risk of life-threatening complications after stapled haemorrhoidopexy may be higher than after standard haemorrhoidectomy [114].

Microabscess formation may be the reason that metronidazole reduces pain after surgery [108]. Sec-

ondary haemorrhage is classically attributed to local sepsis, prompting some to advocate antibiotic treatment [128], although there is little microbiological justification.

Although no guidelines recommend antibiotic prophylaxis for stapled haemorrhoidopexy, it is logical that a single dose of intravenous antibiotics is given at the time of operation to all patients [129], and our choice is metronidazole and a cephalosporin. As severe sepsis is not limited to stapled procedures, perhaps prophylaxis should be given to all patients undergoing haemorrhoidectomy.

"Rectal pocket syndrome" may complicate stapled haemorrhoidopexy by causing intramural sepsis due to faecolith entrapment, and requires laying open. It is probably attributable to incorrect purse-string placement [130].

Emergency haemorrhoidectomy, although increasing the overall complication rate [131], does not appear to increase the infection rate [125] even after a stapled procedure [132].

29.7.8 Residual Skin Tags

Tags may result from inadequate resection, hypertrophic scarring after resection, thrombosis, or lymphatic and venous obstruction within residual skin bridges. Difficulty in cleaning and pruritus ani may follow. Residual tags are more common after a stapled haemorrhoidopexy, which does not deal directly with the cutaneous component. It remains controversial whether to excise the tags at the time of the original procedure (perhaps negating the advantage of a stapled haemorrhoidopexy in terms of post-operative pain) or to leave them for a later operation. If left in situ, they may partially resolve.

29.7.9 Ectropion

There is a tendency for the mucosa to reline the denuded anal canal more readily than the skin, probably due to increased mobility. In extreme cases, if the entire anal canal is removed, Whitehead's deformity results. Ectropion results in mucous discharge, leading to pruritus ani. Treatment can be simple excision with anchorage of the proximal mucosa to the underlying muscle, or alternatively fashioning an anocutaneous advancement flap.

29.7.10 Anal and Rectal Stricture

Excessive skin removal may result in fibrosis and stenosis. Adequate skin bridges must be left even in the patient with circumferential piles. Although secondary haemorrhoids may be "filleted" from the overlying residual skin bridge, there is a risk of ischaemia, necrosis and development of stenosis. In this situation, a stapled haemorrhoidopexy may be more appropriate [132]. The contracted anal canal may predispose to fissure formation, necessitating internal sphincterotomy or preferably anoplasty by means of an anocutaneous advancement flap. Hegar dilatation may be successful, but anoplasty is preferred for those who require repeated dilatations. Rectal strictures, although rare, result from excessively high ligation of the pedicles, and require dilatation, operative lysis or rectoplasty.

Rectal stricture is more of a problem with stapled haemorrhoidopexy [133], but is still unusual. The stricture is often diaphragm-like and easily dilated digitally or treated by incision.

29.7.11 Pseudopolyps/Epidermal Cysts

Ligation of the pedicle can result in a pseudopolyp. Often these are asymptomatic and can be ignored. Retention of keratin, hair or exfoliated skin cells may rarely result in inclusion cysts. If troublesome, pseudopolyps and cysts can be excised locally.

29.7.12 Faecal Incontinence

It is unusual for a haemorrhoidectomy to result in incontinence. There are several mechanisms by which it occurs. IAS damage has been confirmed by EAUS following stapled haemorrhoidopexy [134], resulting from anal dilatation with the 33-mm stapling device [135]. However, incontinence rates are the same or less after stapled haemorrhoidopexy than after excisional techniques [124]. Direct injury to the IAS results from poor surgical technique, and can be prevented by clear identification of the sphincter as the pile dissection proceeds, aided by *gentle* retraction with an Eisenhammer retractor. Overstretching of the anal canal by more energetic retraction or stapler introduction may fragment the sphincter, and patients at risk are those with a tight sphincter or scarring [114]. Weak sphincters are unlikely to be damaged. Removal of the anoderm in

open or closed haemorrhoidectomy can destroy normal continence sensory mechanisms, and removal of the haemorrhoid potentially compromises the plug effect of the anal cushions that contribute to overall continence. Stapled haemorrhoidopexy preserves the anal cushions and aims to return them to their anatomical position. Incontinence should therefore be less frequent. On the other hand, haemorrhoids lose elasticity from inflammation and fibrosis, and are therefore unlikely to be totally restored as efficient anal cushions in the "fine tuning" of continence [114]. Faecal soiling will significantly affect quality of life and needs to be avoided [136].

29.7.13 Recurrence

Recurrence of significant haemorrhoidal disease is rare after excisional techniques (<1%) and can be explained by enlargement of collaterals in the remaining mucosal bridges. Recurrent symptoms are often due to skin tags or small external haemorrhoids, requiring only minor surgery. Recurrence after a stapled haemorrhoidopexy may be more common [110]. Again, many symptoms are resolved by the excision of skin tags. Small internal haemorrhoids may resolve after rubber-band ligation. A reintervention rate of 11% was reported 1 year after stapled haemorrhoidopexy, mainly due to chronic pain, bleeding and recurrent prolapse [137].

29.7.14 Other Complications

Fistula formation is rare and is associated more with the closed technique. The track is invariably superficial and simple laying open usually cures the problem without compromising the sphincter.

There are rare complications that are specific to stapled haemorrhoidopexy. Inadvertent rectal perforation is a disastrous complication for a minor benign condition, and is due to poor surgical technique [138]. Rectal obstruction has also been described [139]. We too have experienced this problem early in the learning curve, due to failure to place the open stapling device through the lumen at the level of the purse-string suture, but positioning it accidentally to one side in the cul-de-sac created by traction on the purse-string during introduction of the stapling device in a patient where excessive mucosal prolapse obscured vision. The completely closed purse-string was then drawn into one side of the stapling device before it was engaged. Firing completely sealed off the rectal lumen. As this was mucosal only and immediately recognised, the situation was easily rectified by a limited Delorme's procedure. As the submucosal dissection proceeded past the level of obstruction, the rectal lumen was re-entered and Delorme's procedure completed uneventfully. Alternative explanations are that the stapling device was inserted between the mucosa and purse-string through an excessive gap left inadvertently between adjacent sutures, or that the suture had simply pulled out of the mucosa, leaving a gap large enough for the stapling device to pass through at this point.

To minimise complications, new techniques such as stapled haemorrhoidopexy require appropriate training and mentorship until the technique has been mastered. Audit of results is essential, and ideally under the auspices of national colorectal professional associations and societies.

29.8 Pilonidal Abscess

29.8.1 Persistence and Recurrence

Up to 42% patients fail to heal after simple incision and drainage of pilonidal abscess [140, 141], and of those healing initially, surgical treatment eventually becomes necessary in 15–40% [142]. Definitive treatment of abscesses by excision and primary closure and antibiotics leads to initial failure in 30% and recurrence in a further 30% [143]. Many patients will require definitive treatment, although a conservative approach in selected cases is acceptable, and preferable for asymptomatic disease [141].

29.9 Chronic Pilonidal Sinus

29.9.1 Introduction

Ideally, treatment should be simple, ambulatory and performed under local anaesthesia with minimal disability and rapid return to normal activity. Recurrence rates should be low. Recurrence (0–38%) and unhealed wounds (0–12%) after surgery for chronic pilonidal disease vary widely from series to series [144]. Many techniques have been described, but few randomised controlled trials have been performed. The Bascom I procedure [145] is the treatment of choice for mild and

moderate disease. More extensive disease, unhealed midline wounds and recurrence can be treated satisfactorily by Bascom II (cleft-lift operation) [146]. Karydakis' procedure [147] is an alternative and equally satisfactory approach (see Chap. 23).

29.9.2 Delayed Healing and Unhealed Wounds

Delayed healing and unhealed wounds may be due to re-entry of hair, residual missed tracks, or suboptimal wound care, and early re-exploration in the prone jackknife position should be considered. Ambulation adds to the problem, causing shearing and midline wound friction, particularly in the presence of obesity and a deep gluteal cleft.

29.9.3 Recurrence After Complete Initial Healing

Recurrence after complete initial healing is due to new pilonidal disease or incomplete removal of tracks at the primary procedure. Instillation of dilute methylene blue via a midline pit or secondary lateral opening, and gentle use of Lockhart-Mummary probes may aid identification. The operative strategy is usually identical to that described for unhealed wounds. The choice of procedure will be determined by the presence of scars (which should be excised if compromising the vascularity of skin flaps), depth of the natal cleft, and extent of the disease. Very long lateral or cephalad tracks extending outside the cleft and beyond the limits of the proposed reconstruction are curetted and left open to granulate or are treated with vacuum-assisted closure (VAC) [148].

29.9.4 Midline Approaches

29.9.4.1 Excision of Midline Pits and Track Clearance

The disadvantage of this simple procedure, which is carried out under local anaesthesia, is the need for meticulous wound care with regular shaving. Many patients default, with up to 43% recurrence, compared with 11% in those who complete outpatient treatment [149].

29.9.4.2 Wide Excision

Midline wounds are generally considered to be the underlying reason for high recurrence (0–28%) and protracted healing rates due to shearing forces and reintroduction of hair into the wound. Meticulous wound care is important to avoid delayed healing and recurrence, which is the major disadvantage of wide excision and healing by secondary intention. Hair at the wound edges tends to grow into midline wounds [150, 151]. Open wounds should therefore be kept meticulously shaved, and desiccation avoided by use of paraffin gauze or alginate dressings. Loose hair should be removed by irrigation or picked from the wound. Regular outpatient review is essential until healing is complete. Recurrence is minimised by the removal of surrounding hair by depilating agents or electrolysis, and good hygiene removes debris and loose hair from the area.

Excision and VAC are useful, especially for those who have had multiple recurrences [148]. Wide excision, leaving the wound to granulate, has declined in popularity in recent years because of delayed wound healing (mean 70 days), and has been largely superseded by asymmetric excision or cleft-lift techniques. However, wide excision with immediate VAC accelerates healing significantly and continues to have a place in management.

29.9.4.3 Lay Open with Marsupialisation

This reduces the size of the residual wound and accelerates healing without compromising recurrence (4–13%). Prolonged healing affects 2–4% of patients [152].

29.9.4.4 Excision and Primary Closure

In a randomised controlled trial, healing time after excision and primary closure was shorter than after wide excision, with healing in 90%, but more recurrence (24%) than after wide excision (15%) [153]. Other series report a wide range of recurrence after excision and primary closure (1–46%; median 9–10%). Simple plain midline excision and primary suture under local anaesthesia resulted in healing in 88% of cases within 2 weeks, with failure in only 8%, requiring further excision [154]. The advantage of excision and primary clo-

sure is that it can be performed under local anaesthesia as a day case, and the period of disability of 2–3 weeks compares well with 2–10 weeks after wide excision. Suction drainage for 48–72 h and antibiotics reduce the risk of infection.

29.9.4.5 Excision and Application of Fibrin Glue

Performed under local anaesthesia, healing occurred in 96% of patients within 2 weeks [155].

29.9.5 Cleft and Asymmetric Closure Techniques

Many authors now consider that the essential points in the treatment of pilonidal sinus are to eliminate and lift the cleft, avoiding exposure of the surrounding skin to moisture, hypoxia and bacteria. An asymmetric wound is fashioned away from the midline to minimise shearing forces and disruption.

29.9.5.1 Karydakis Procedure

Karydakis achieved a remarkably low recurrence rate of 1% in 7,471 patients, using an advancement flap technique to avoid a midline wound. Hospital stay was 3 days and infective complications occurred in 8.5% [151]. Suction drainage reduces the incidence of abscess formation.

Akinci et al. [156] prospectively evaluated 112 cases of uncomplicated pilonidal sinus disease treated by asymmetric excision and flap mobilisation to release the cleft from the sacrococcygeal fascia, with primary closure and suction drainage. Follow-up was a mean of 2.4 years. Twenty-eight (25%) cases had recurrent or persistent pilonidal disease. The complication rate was 7%, with wound infections in two cases (1.8%), wound dehiscence in two cases (1.8%), abscesses in three cases (2.7%), and recurrence in one case (0.9%). Mean hospital stay was 2.6 days, and mean time off work 12.4 days. The average healing time was 13.2 days.

Wound haematomas and infections occurred in 10% of Kitchen's series. Delayed healing was found in 3% and recurrence in 4%. Further surgery was needed in 5% [157].

29.9.5.2 Bascom I Operation

Midline pits are excised and tracks are approached and curetted, ideally under local anaesthesia, through a lateral incision away from the midline. Missed pits are a source of recurrence and may not be evident if the procedure is attempted in the acute phase. The pits are "picked" and sutured, and the lateral wound is left open to granulate, resulting in a flattened natal cleft [145]. Recurrence was found in 10%. Bleeding (5.0%), abscess formation requiring reopening and digitation of the lateral wound (3.7%), and failure of the midline to heal (0.6%) are other complications (Senapati, 1996, unpublished data) [158].

29.9.5.3 Bascom II Operation (Cleft Lift)

Cleft lift, previously termed cleft closure, was developed specifically to treat refractory or recurrent pilonidal disease. Bascom claimed that changing the shape of the gluteal cleft improves results [159]. Wounds in 31 patients with severe refractory pilonidal disease healed, 28 after a single procedure, the majority of which was performed under local anaesthesia. Healing was achieved within 1 week in 22 patients. Infection in the others was treated by drainage at the lower end of the wound, and antibiotics. There was no recurrence in this series.

Senapati et al. [158] used this technique to achieve short-term healing in 30–40% of unhealed midline wounds, and all healed eventually with no recurrence.

29.9.5.4 Rhomboid Excision and Rhomboid (Limberg) Flap

This technique has been used for both primary and recurrent pilonidal disease, with a reported recurrence of 0–7%. In a series of 200 patients (26 with recurrent disease), there were 5 long-term recurrences (2.5%), but hospital stay averaged 3.1 days and general anaesthesia was usually required.

In a randomised controlled trial of 200 patients, the results of rhomboid excision with a Limberg flap were significantly better than those of excision and primary closure in terms of post-operative pain, length of stay, post-operative complications, time before going back to work, and recurrence (0 vs. 11%) [160].

The cosmetic results may be unsatisfactory, particularly in females. Skin anaesthesia also occurs in the flap.

Other complications include a variable degree of flap necrosis (3%), seroma formation (1.5%) and wound infection (1.5%) [161]. The main disadvantage is the large wound and the need for general anaesthesia with a longer hospital stay.

29.9.5.5 V-Y Advancement Flap Closure Following Excision

This is an alternative technique for extensive or severe recurrent disease. A randomised trial of 34 patients compared midline with lateral suture lines. After 32 months median follow-up, no patient in the laterally placed suture-line group developed recurrence, flap necrosis, haematoma or seroma, irrespective of whether or not suction drainage was used. There were two recurrences in the midline group [162].

29.9.5.6 Other Procedures

Alternative procedures, particularly for larger wounds, include rotational buttock flap and gluteus maximus myocutaneous flap [148, 161, 163, 164]. More superficial midline unhealed wounds can be managed by Z-plasty with a recurrence rate of 0–10% [165]. Some favour excision and an immediate split skin graft, with a reported recurrence of 0–5% [166].

29.9.6 Confusion with Other Conditions

Occasionally there are difficulties in distinguishing pilonidal disease from complex fistula-in-ano and other conditions, which might be an underlying cause of recurrent or unhealed "pilonidal" disease. MRI features of perianal and deep-seated sepsis, characteristic of fistula-in-ano, are also found in patients with pilonidal sinus, but the absence of intersphincteric sepsis or an enteric opening allows reliable MRI-aided distinction between the two [167]. MRI in selected cases will exclude the presence of a sacrococcygeal sinus, which may communicate with the thecal space, risking meningitis. Confusion may also arise with presacral dimples, which are types of traction dermoid. Misdiagnosis of inclusion dermoids is possible, especially if infection occurs. Hidradenitis may also extend to the natal cleft, but is usually evident elsewhere in the perineum. The sinuses contain no hair. Hidradenitis and pilonidal disease may coexist, causing confusion.

Squamous cell carcinoma is very rare in patients with an average disease duration of 23 years, but justifies the submission of excised tracks for histopathological examination, although the clinical appearance with induration would generally raise suspicion of malignancy [168].

The authors' preferred treatment algorithm is the Bascom I procedure for limited new disease, cleft lift (Bascom II) for more extensive primary disease or recurrence, and excision with a rhomboid flap for very extensive recurrent disease. The key to success is an asymmetric approach, cleft lift, and staying out of the midline.

29.10 Perineal Procedures for Rectal Prolapse

29.10.1 Introduction

The aims of rectal prolapse surgery are to minimise operative risk in the elderly, eradicate the prolapse, improve continence, avoid bowel dysfunction and minimise recurrence. There is no true consensus on which procedure should be performed for complete rectal prolapse [169]. Remarkably few randomised trials have been performed and it is difficult to achieve complete follow-up as many patients are infirm and elderly. In a series of 20 Altemeier procedures, only 2 patients were alive after a mean follow-up of 66 months [170]. Short-term complications are easier to assess.

Restoration of anatomy by correction of the prolapse can be achieved by either an abdominal or perineal procedure, but recurrence and bowel dysfunction are important longer-term complications. In the past few years, laparoscopic abdominal rectopexy has largely superseded the perineal approach in fit patients, including fit elderly patients [171]. Laparoscopic ventral rectopexy performed by a limited anterior, rather than posterior rectal mobilisation avoids the serious risks of presacral bleeding and autonomic denervation causing intractable constipation [172]. In this series, there were no major post-operative problems, and patients were discharged at a mean of 5.8 days. After a median of 61 months, only 2 of 42 (5%) patients had recurrent prolapse, 90% had improved continence and there was an improvement in 84% who had obstructed defaecation. New-onset obstructed defaecation developed in 5%, but there was no instance of denervation causing constipation. In the absence of randomised trials, these results set the current standard by which other procedures, including perineal approaches, should be compared.

Occasionally, a rectal prolapse on presentation may be non-reducible or strangulated. Alternatives to operative intervention (unless gangrenous, when resection is required) are application of table sugar granules, hyaluronidase injection and application of elastic compression dressings, all of which decrease tissue oedema, allowing spontaneous bowel reduction [173]. Early elective repair is then performed.

29.10.2 Recurrence

Perineal procedures are very well tolerated and safe, but usually reserved for elderly and/or comorbid, poor-risk patients who are unsuitable for a more major abdominal procedure, and can be performed under either spinal or general anaesthesia. Recurrence is more common after perineal procedures than with abdominal rectopexy, and usually occurs in the first 2–3 years.

Recurrence following Delorme rectopexy is common, with pooled recurrence data from 356 patients in 11 series ranging from 6 to 37% (average 18%), and increasing with time. Kaplan-Meier analysis after 12 months follow-up of a large series of 118 Delorme's procedures predicted that the recurrence-free period for 50% of patients was 91 months (95% confidence interval 77–105 months) [174]. Recurrence is more common in the elderly [175] and in those with more severe sphincter degeneration and a grossly patulous anus [176]. Inadequate mucosectomy leads to early recurrence. The dissection should proceed as far proximally as possible towards the level of the perineum when the bowel is under slight tension, but the point where dissection stops is subjective. High recurrence rates for primary and repeat Delorme's procedures should be explained to patients. The operation can be repeated, although the authors' preference for recurrence in compromised patients is an Altemeier procedure, as fibrosis results in difficulty with defining the submucosal plane when Delorme's operation is repeated, in contrast to the ease of performing an Altemeier procedure in this situation.

Recurrence after the Altemeier procedure [177] ranges from 0 to 60% (average 20.7%; pooled data from 996 patients in 14 series).

Anal encirclement (Thiersch operation) [178] is now largely obsolete, with high rates of recurrence ranging from 0 to 44% (average 26%, pooled data from 356 patients in 7 series). In contrast, abdominal rectopexy is associated with significantly less recurrence. Pooled data show an average recurrence for Ripstein's procedure in 920 patients of 3.4% (range 0–10%), 4.4% (range 3–10%) after Well's procedure in 338 patients, 1.8% (range 0–4%) with suture rectopexy in 282 patients, and 4.5% (range 2–9%) after resection rectopexy in 333 patients [179]. Comparative results are shown in Table 29.1.

29.10.3 Residual Incontinence

Pooled data from 31 series of abdominal and perineal prolapse repair [179] indicate that continence restoration following the Delorme and Altemeier procedures is similar, but fails completely in about half of cases. These failures are thought to be due to reduction in the rectal reservoir and residual weakness of the sphincters. Very weak or absent preoperative sphincter tone, perineal descent and previous sphincter injury predispose to failure [176]. A hypothetical risk of precipitating incontinence in previously fully continent patients, by sphincter retraction to gain operative access, or in-

Table 29.1 Recurrence after rectopexy

Procedure	Number of patients	Recurrence	Range
Anal encirclement	356	26.0%	0–44%
Delorme	356	18.5%	6–37%
Altemeier	996	20.7%	0–60%
Ripstein	920	3.4%	0–10%
Wells	338	4.4%	3–10%
Suture rectopexy	282	1.8%	0–4%
Resection rectopexy	333	4.5%	2–9%

sertion of sutures directly into the IAS, is not reported in the literature. Continence is often helped by improved rectal sensation, return of the sphincter to normal size, improved sphincter tone due to abolition of maximal inhibition of the IAS by chronic prolapse, and sphincter augmentation. When levatorplasty (anterior, posterior or both) is combined with the Altemeier procedure, restoration of continence improves further in more than 75% cases. In contrast, abdominal procedures are significantly more likely to restore continence than perineal operations (Table 29.2) and are associated with significantly lower recurrence rates, although there is little randomised controlled trial data currently available to address the large degree of selection bias in the choice of procedure. Sacral nerve stimulation should be considered for patients with persistent faecal incontinence after any type of rectal prolapse repair if it is resistant to conservative treatment [180].

On the other hand, and in contrast to abdominal rectopexy, post-operative constipation is not a problem after Delorme's procedure, and 50% of those constipated preoperatively improve thereafter [181].

Anal encirclement is also associated with improved continence. In seven series cited by Madoff [179], incontinence failed to improve in only 27%, but recurrence rates were high.

29.10.4 Other Complications

29.10.4.1 Anal Encirclement

These procedures have largely fallen out of use due to high complication rates, which include infection, extrusion, erosion through the rectal wall, recurrence if too loose, faecal impaction if too tight and fracture. Single or multiple silicone or silastic slings, or the Angelchik collar have not improved these complications [182]. Infection and erosion will generally require removal of the sling.

29.10.4.2 Delorme's Procedure

Mortality is rare (0–1.2%) [175]. Submucosal infiltration with 1:300,000 adrenaline solution or saline, and a high coagulation setting for diathermy dissection, reduce intraoperative haemorrhage. Post-operative bleeding is unusual, but may require re-exploration under general or spinal anaesthesia if bleeding continues. If the site of bleeding is not easily identified, the repair should be taken down, removing sufficient sutures to gain access to the source for haemostasis by suture or APC. There may be difficulty in reconstructing the repair as the tissues will be distorted by oedema and haematoma. Sepsis and anastomotic dehiscence (3%) is unusual [181]. Late stenosis may occur and can be treated by dilatation if necessary. Pitfalls in performing this procedure relate primarily to associated perineal and colonic conditions. Most prominent among these conditions are weak or absent sphincter tone, perineal descent and previous sphincter injury. Extensive diverticular disease may prohibit effective and complete proximal mucosectomy. An inadequate mucosectomy sets the stage for early recurrence of a prolapse. If the prolapse is limited and early there may be technical difficulty with access, and therefore an increased risk of complications when the prolapse cannot be fully delivered from the perineum to complete the procedure. Bleeding, sepsis and inaccurate placement of plicating sutures is more likely to occur. Lumen patency needs to be checked with a rigid sigmoidoscope.

Table 29.2 Preoperative incontinence and improvement after rectopexy

Procedure	Preoperative incontinence	Improved by surgery
Altemeier	72.0%	66.0%
with levatorplasty*	95.3%	77.0%
no levatorplasty	52.6%	49.3%
Delorme	69.0%	54.4%
Suture rectopexy	42.2%	77.2%
Resection rectopexy*	47.0%	83.1%
Anterior sling	46.0%	62.7%
Posterior sling	58.6%	71.2%

* Best incontinence outcomes

29.10.4.3 Altemeier's Procedure

Mortality is very low [183]. It is surprising that so few anastomotic leaks occur, but in this event a permanent stoma may be necessary, especially if peritonitis ensues. Examination under spinal or general anaesthesia, with adequate drainage of the dehiscence and antibiotics may avoid a stoma if the leak is confined. Other complications include abscess formation [177] or bleeding from the anastomosis [183], which may stop spontaneously, but otherwise may require direct suture or application of APC. Bleeding may herald an anastomotic leak. Care is needed if there has been a previous sigmoid resection, particularly for cancer, which may have resulted in high ligation of the inferior mesenteric artery. Subsequent rectal resection and ligation of the superior haemorrhoidal artery risk producing a segment of ischaemic colorectum. Delorme's procedure should be considered as an alternative approach in this situation.

The authors' approach to the management of rectal prolapse is pragmatic in the absence of reliable randomised control trial evidence. We prefer the simpler and safer perineal approach, ideally using Altemeier's operation combined with levatorplasty, for the elderly and comorbid, or when there is recurrent prolapse. Day-care treatment (up to 24 h) is possible under local or regional anaesthesia in up to 80% of patients without mortality [184]. We aim for a 24- to 48-h stay with both procedures. Younger males treated by the Delorme procedure avoid the risk of sexual dysfunction that is associated with abdominal rectopexy, but there is an increasing trend towards laparoscopic rectopexy, with or without resection, for most patients who are fit for general anaesthesia, including the elderly and male patients. In our view, younger females will achieve better function and less recurrence with abdominal rectopexy. We base a decision to resect the sigmoid on the presence of slow-transit constipation. Forthcoming publication of the Association of Coloproctology of Great Britain and Ireland PROSPER trial, which aims to recruit and randomise 1,000 patients with rectal prolapse, will address many of the uncertainties about functional outcome and complications associated with each type of repair.

29.11 Faecal Incontinence

29.11.1 Introduction

Surgical intervention is usually carried out if appropriate assessment (including clinical history with EAUS and physiological evaluation of the neuromuscular units) indicates the presence of a surgically correctable defect. Such surgical procedures usually involve direct repair of the defect, whilst some are aimed at augmenting the pelvic floor by bulking the sphincter, forming a neosphincter, or stimulating the pelvic nerves [185]. There are other procedures that do not themselves correct the underlying faulty continence mechanism but instead aim to reduce the symptoms and inconvenience of faecal incontinence by creating an irrigation system (e. g. percutaneous endoscopic colostomy, Maloney antegrade colonic enema or anal bypass – colostomy or ileostomy). This latter group of procedures does not involve direct surgery to the anal canal and will therefore not be discussed further.

With such a heterogeneous list of interventions, many of the complications remain specific and unique to the procedure carried out. It is therefore more appropriate to deal with each procedure group individually.

29.11.2 Interventions Designed to Correct Abnormalities of the Pelvic Floor and Sphincter

29.11.2.1 Immediate Repair of Obstetric Third-Degree Tears

Many third-degree tears are missed. Immediate repair results in 30% residual incontinence [186]. Outcome is poorly documented, and it remains uncertain whether immediate repair gives better results than delayed repair [187]. A recent Cochrane systematic review suggests that early primary overlap repair compared with end-to-end repair is associated with a lower risk of faecal urgency and anal incontinence [188]. In an audit of immediate repair, 65% were completely asymptomatic despite persistent sphincter defects in 61%. Flatus incontinence and/or urgency occurred in 19%, and significant faecal incontinence was found in 16%. Incontinence tended to be seen in those with a residual IAS defect (37%) or a combined IAS and EAS defect (24%). Only 5% had incontinence in the presence of

intact sphincters, consistent with the low prevalence of pudendal neuropathy seen after first deliveries [187]. Other complications are bleeding, sepsis and faecal impaction, sometimes leading to repair disruption. The long-term results of immediate repair remain unknown.

29.11.2.2 Delayed Overlapping Anterior Anal Sphincter Repair

Short-term results are good in 60–90% [189–191], but continence deteriorates significantly over time. Of 38 patients assessed, none was fully continent after 5 years, and only four were continent to liquid and solid stool. Twenty wore a pad and 25 had lifestyle restrictions [192]. Factors leading to failure are the presence of excessive fibrosis, which impairs sphincter activity and rectal emptying, and leads to perineal pain and dyspareunia. Short-term failure is also associated with prolonged pudendal nerve terminal motor latency, perineal descent, aetiology, parity, duration of incontinence, obesity, age, a persistent defect on EAUS, previous repair and failure to restore anal canal length, and anal pressures and sensation [187, 193–195]. Wound infection occurs in up to 24%, but is often mild with no serious sequelae [193, 196]; it can, however, predispose to dehiscence of the sphincter repair. The use of a drain or leaving the skin partially open to drain may reduce the consequences of sepsis [197]. Wound disruption occurs in about 10% of cases, two-thirds of which require further surgery for complications including rectovaginal fistula. Disruption is more likely if faecal impaction develops in the immediate post-operative period. Therefore, it makes sense to prescribe laxatives initially, even if the consequence is an exacerbation of incontinence. A randomised controlled trial of bowel confinement compared with a clear liquid diet in the immediate post-operative period showed no difference in outcome, particularly with respect to sepsis and restoration of continence [197]. Our own practice has been to give a high-fibre diet immediately post-operatively, laxatives and a phosphate enema via a Foley catheter inserted carefully past the repair into the rectum. There is no evidence that a defunctioning stoma improves outcome, and most consider it unnecessary, except for cases of perianal sepsis, severe trauma or Crohn's disease [193, 198]. A stoma predating delayed sphincter repair should not be reversed until the repair has healed and confirmed to be intact.

Poor results are found more commonly after obstetric damage than after sphincter injury from trauma or fistula defects [199]. Irritable bowel syndrome patients do badly.

Patients in whom continence is not restored should be reassessed with anorectal physiology and EAUS. Repeat sphincteroplasty is appropriate when disruption of the repair has been confirmed, but should be delayed by at least 6 months. Targeted behavioural therapy (biofeedback) may be helpful, but results are variable (20–85%). If the sphincter ring is intact, sacral nerve stimulation is appropriate.

29.11.2.3 Post-anal Repair

Post-anal repair results in early improvement in up to 80% of cases, but function deteriorates over time, with only 30% remaining continent after 5–8 years [200, 201], probably due to progressive neuropathy. Other complications include haematoma (21%), skin necrosis in the anterior skin flap (25%), infection (11%) and fistula (2%) [128]. Consequently, post-anal repair has largely been abandoned in favour of sacral nerve stimulation.

29.11.2.4 Anterior Levatorplasty

This is one of the few techniques to be compared with conservative treatment in a randomised controlled trial setting. Although continence improved in 84%, this was no better than the conservative regimen [202].

29.11.2.5 Total Pelvic Floor Repair

Anterior levatorplasty with sphincter plication has been performed in patients who have failed post-anal repair. Continence improved in 42% [203]. Synchronous repair has resulted in 55% improved continence. In a randomised controlled trial, total pelvic floor repair was more effective at restoring continence after 2 years than either anterior or posterior repair, but 86% remained incontinent to a variable degree, although overall, incontinence scores remained better than pre-operatively in 77% [204].

29.11.3 Interventions Designed to Augment the Sphincter

Included in this group are the artificial neosphincter and muscle transposition techniques as well as procedures that attempt to bulk up or tighten the sphincter complex; for example, Thiersch wires, silastic slings, injectable bulking materials such as silicone, collagen, autologous fat and Teflon paste, and the SECCA procedure, which involves application of temperature-controlled radiofrequency energy to the sphincter, resulting in collagen contraction and healing and remodelling of muscle fibres [205].

29.11.3.1 Gracilis Muscle Transposition

Gracilis muscle transposition has been used for the treatment of end-stage faecal incontinence for 50 years. The main indications are failed previous repair, particularly if there is greater than 50% sphincter loss, and congenital lesions of the anorectum in children. Electrical stimulation of the gracilis, which is wrapped around the anal canal, by an implantable pulse generator was introduced nearly 20 years ago, and long-term results are available. In Madoff's series, continence improved in 66% of patients, but with significant morbidity [206]. Approximately one-third of patients develop a major wound problem involving the perineum, the stimulator device and/or the leg wound. Technical failure was another source of complication; examples include fibrosis and displacement of electrodes and the battery, or fracture of the leads. Other complications are physiological (e. g. overflow incontinence, soiling and evacuation disorder) [207].

In a prospective multicentre trial, post-operative complications after gracilis transfer, implantation of electrodes and neurostimulator were saphenous nerve palsy, lymphoedema, wound infection, parastomal hernia, ileostomy fistula, leg wound or perineal sepsis, stimulator sepsis, deep-vein thrombosis and neuropraxia [208].

Baeten's group reported on 200 patients. Treatment failed in 28%, but results were better when faecal incontinence was trauma related (18% failed). As distinct from the functional deterioration seen after muscle plication techniques or sphincteroplasty, continence was maintained in the long term. Evacuation problems occurred in 16% of cases. Pulse-generator battery failure occurred at a median of 405 weeks. [209].

Another series listed 53 complications in 36 patients, from a total group of 67 who underwent the procedure. Fifteen patients (22%) were complete failures [210]. Most patients previously deemed suitable for gracilis transfer and stimulation are now offered sacral nerve stimulation, which is simpler and has fewer complications.

29.11.3.2 Artificial Anal Sphincter

Approximately 70% of patients achieve restoration of continence after implantation of an Acticon artificial sphincter, but complications are frequent. This is usually the result of erosion of the device into the rectum or ulceration through the perianal skin, leading to explantation in up to one-third of all patients [207]., Surgical revision is usually necessary even if the device is not explanted. The incidence of infection can be reduced by careful placement of the cuff around the anal canal to prevent tissue erosion and slippage, with meticulous aseptic technique and routine use of prophylactic antibiotics. A recently developed device can now be implanted intra-abdominally and is associated with a reduction in septic complications [211].

A large prospective multicentre cohort study has examined the safety and efficacy of the Acticon artificial bowel sphincter. There were 384 device-related adverse events in 99 patients. Of these, 138 required intervention, of which 73 revisional operations were required in 46% of implanted patients. Devices were explanted in 37%, with seven patients reimplanted. Improved quality of life in 85% of functioning devices was at the expense of high morbidity [212].

Revision is often required for device malfunction (cuff rupture, balloon and pump leaks, and migration). Other common complications include pain and faecal impaction. Chronic pain occurs in 4–17% after activation of the device [210, 213]. Faecal impaction affects up to 83% of patients [213]. Treatment options include medication, enemas and manual evacuation. Other less common adverse events include rectocele, urethral fistula, urinary tract infection, phlebitis, and perineal or abdominal haematoma.

29.11.3.3 Bulking Agent Injections

Complications of bulking-agent injection are minimal, with one series reporting only mild transient discomfort in 6 patients of 82 undergoing injection of silicone

[214]. Failure of passive incontinence to improve at a median of 18 months occurred in only one of six patients [215]. The potential for migration has been reported [216, 217], raising the possibility of granuloma formation, but recent animal studies appear to refute this [218]. Similarly, concerns about an association between silicone and autoimmune disease appear unfounded [219, 220]. Studies on patients have so far failed to identify any allergy problems [214, 221, 222].

29.11.3.4 Interventions Involving Electrical Stimulation Alone

Sacral nerve stimulation involves implantation of a wire through the sacral foramen (usually at S3) to stimulate the sacral nerve plexus directly. Complications are few and mainly mild. Data from a systematic review suggest an adverse event frequency of 13% [215]. Kenefick has recently reported St Mark's Hospital results [223]; continence improved in all 19 patients involved, 14 of who were fully continent. There were no major complications, no infections of permanent implants and no implants that needed to be removed. One superficial skin infection resolved after removal of the temporary electrode, followed by successful delayed permanent implantation. There were two lead dislodgements, which were replaced surgically. Minor electric shocks were experienced in ambient electric or magnetic fields; this was resolved by deactivation of the pulse-generator magnet.

Perhaps the most important potential complication is infection (2%), which may require removal of the device [224]. Following implantation, 75–100% of cases achieve complete continence, with 0–25% failing to experience any improvement. Lead dislodgement affects 5% of patients at any time after insertion (from 3 days to 2 years). Reimplantation is relatively easy, but dislodgement can be minimised by the use of tined leads and secure fixation of the implants to the periosteum [185, 223]. Pain after device insertion has been reduced by the development of a minimally invasive wire-insertion technique, but may be a problem if the stimulator lead is sited too superficially over a bony prominence, such as the iliac crest. Local anaesthetic and steroid injections may be curative. Fine adjustment of the stimulator characteristics (amplitude, frequency, polarity) usually resolve any occasional discomfort felt over the battery. Reflex interactions between the bladder and the distal gastrointestinal tract are well known and demonstrated by occasional urinary retention [185, 225]. Conversely, urinary dysfunction may improve [226, 227], although the benefit may be short term [227].

The cost of sacral nerve stimulation is comparable to that of other surgical procedures and has a far lower complication and failure rate. There is a financial gain over long-term conservative treatment after 5 years [223].

29.12 Obstructed Defaecation Syndrome

29.12.1 Introduction

Straining at defaecation, rectal pain, incomplete evacuation of stool and the need to digitate vaginally, rectally or by exerting pressure on the perineum characterise obstructed defaecation syndrome (ODS). Straining may be an important underlying cause of rectal intussusception, which is often seen in ODS. Intrarectal pressure and volume rise against a closed sphincter. Transverse forces contribute to the development of a rectocele or aggravate a pre-existing one caused by an earlier vaginal delivery that has disrupted the rectovaginal septum. Longitudinal forces contribute to pudendal neuropathy and perineal descent, already present in a proportion of multiparous females from childbirth trauma, and eventually resulting in full-thickness prolapse in a proportion of females with anal sphincter weakness.

The mechanical components of ODS are rectocele and intussusception. It is uncertain whether each anatomical and functional abnormality is a cause or effect.

A rectocele is considered to be primary when precipitated by delivery, particularly a traumatic one. A secondary rectocele occurs if the primary event is straining from constipation; subsequent vaginal deliveries causing pudendal neuropathy, hormonal changes and aging also tend to accelerate the development of rectocele, intussusception, prolapse and weak sphincters.

Even though the primary event may be functional, it is equally possible that a primary mechanical problem exists in some patients (e. g. intussusception). An alternative primary functional defect could be inappropriate puborectalis or EAS contraction during defaecation straining (anismus). There are other related features, such as enterocele and genital prolapse, which can be identified on MRI proctography as part of the ODS complex. Defaecating proctography, anorectal physiology, EAUS and transit studies should ideally be per-

formed prior to any intervention to attempt to identify those patients with anismus who are unlikely to benefit from surgical intervention.

Treatment options are initially conservative, with stool softeners, glycerine suppositories, elastic band ligation, biofeedback and retrograde colonic irrigation. Antegrade colonic enemas might be considered in severely refractory cases. Operative treatment is not necessarily aimed at correcting the primary underlying cause, which may not be identifiable.

29.12.2 Rectocele Repair

29.12.2.1 Functional Failure

Surgical correction of rectocele has been reported to be successful in 80–90% of patients by vaginal [228], perineal [229] or transanal routes [230], with relief or improvement in ODS symptoms [134]. However, success depends on appropriate patient selection to exclude those with anismus. The presence or absence of an associated intussusception does not appear to affect the functional outcome. Although in our own series of 35 patients we failed to identify any predictive factors for failure (unpublished data), successful vaginal digitation of the rectocele preoperatively probably does predict a good post-operative outcome in terms of relieving constipation [231]. Other reported factors predicting success are small rectocele size, barium trapping in a low rectocele and normal colonic transit times [231, 232]. Patient selection probably accounts for the variation of between 50 and 92% of reported successful functional outcomes in terms of rectal evacuation [230–234]. We have also demonstrated that restored function deteriorates with time. Early post-operative improvement occurred in 86% after transanal rectocele repair, falling to 68% at 16 months (unpublished data). Obese patients, habitual strainers and patients with high, wide rectoceles or pelvic pain appear more likely to fail.

29.12.2.2 Other Complications

Complications other than functional failure range from 3 to 36% [228, 230, 233, 235] and include persistent pelvic pain and dyspareunia after vaginal repair [228], flap retraction, haemorrhage, faecal impaction, stenosis, sepsis, fistula-in-ano, rectovaginal fistula, dysuria, faecal incontinence and rectocele recurrence. Septic complications generally respond to conservative measures with antibiotics and drainage [230], although a diabetic patient in our own series developed a suprasphincteric fistula that eventually required a permanent stoma after a series of failed repairs and sphincter reconstruction. In our view, transperineal levatorplasty with Marlex mesh repair [236] has no advantage over the technically easier transanal repair, with the additional risk of mesh infection potentially leading to chronic sepsis, fistula formation and pain. However, a transperineal approach with levatorplasty or anterior sphincteroplasty may be preferable in those cases where a rectocele is associated with incontinence without mucosal prolapse. Incontinence failed to improve in only 27% of patients [235]. Combined use of a single transanal circular stapling device and levatorplasty [237, 238] corrects both mucosal prolapse and rectocele but delays healing, and dyspareunia compromises good short-term functional results [239].

29.12.3 Delorme's Procedure

29.12.3.1 Functional Failure

Does Delorme's procedure have a place in the treatment of ODS when rectal intussusception (internal rectal prolapse) is the dominant clinical finding? Proximal internal prolapse with rectosacral separation at defaecography, preoperative chronic diarrhoea, faecal incontinence and descending perineum (>9 cm on straining) were adverse factors leading to a poor outcome in six out of eight patients (75%) who were either unchanged or worse than preoperatively. Stringent patient selection based on exclusion of these criteria resulted in improved outcomes in all 11 subsequent patients [240].

Delorme's procedure is inappropriate for midrectal solitary rectal ulcer (SRU), although it may be successful for distal changes associated with accessible prolapsing distal mucosa, with five of nine patients improving (56%) [241]. Without overt prolapse, however, the procedure can be technically difficult. Every effort should be made to pursue a conservative line of treatment. Long-term follow-up after biofeedback for SRU showed that 31% of patients were asymptomatic, 30% improved and 39% failed at 9 months, although in the longer term at 36 months, only 7% were asymptomatic, 39% maintained some improvement and 54% failed [242]. Consensus is emerging in favour of surgery for failed conservative treatment, but only when internal intussusception or overt prolapse is clearly evident, in

the absence of "puborectalis paradox" (anismus) and with severe intractable symptoms.

Rectopexy is the favoured approach. The risks, benefits and success rates must be clearly explained, as abdominal surgery may also fail, ultimately leading to a stoma. Rectopexy successfully corrects prolapse and alters rectal configuration, but both factors appear unrelated to functional outcome.

The St. Mark's group has shown that prolonged preoperative evacuation on proctography predicts a poor result. Sitzler et al. reviewed the St. Mark's long-term follow-up of surgical treatment for SRU. Most were treated by rectopexy (49/66); 22 (43%) failed [241].

29.12.4 Stapled Transanal Rectal Resection

Recently, stapled transanal rectal resection (STARR) has been described for the treatment of ODS [239, 243], but results have been variable [244]. Further comparative and long-term studies are needed, with information about cost effectiveness. In the short term, several studies with follow-up from 2.3 to 20 months showed that ODS symptoms resolved or improved in 80–100%, quality of life improved, and anatomy was restored in the majority [239, 245–248]. In the multicentre study of 90 patients by Boccasanta et al. [239], early complications were urinary retention (5.6%), bleeding with readmission (4.4%) and a chest infection. At 1 month, faecal urgency affected 17.8%, 8.9% had flatus incontinence, and stenosis occurred in 3.3%. At 12 months, faecal urgency and flatus incontinence (1.1%) had reduced significantly, but stenosis had developed in a further patient (3.3%). In another smaller study comprising 14 patients [246], the authors concluded that parity, spastic floor syndrome and psychoneurosis predicted failure of STARR, which resulted in severe complications and early recurrence of symptoms, requiring reoperation in unselected patients with ODS, particularly those with anismus. However, the problem is being able to make a confident diagnosis of anismus preoperatively. Different preoperative investigations (MRI proctography, conventional contrast defaecography, electromyography and expulsion of a rectal balloon) provide variable information (personal observations).

Of 14 patients in the study by Dodi et al., severe bleeding occurred in two patients, persistent anal pain was found in seven, and pelvic sepsis occurred in one patient [246]. Half of these patients developed early ODS recurrence.

Further concern about the STARR procedure centres on reports of rectovaginal fistulas, bowel perforation, peritonitis and fatal pelvic sepsis, and persistent ODS symptoms at 19 months in 38% of patients [249–251]. Patients with psychological problems, enterocele and anismus should probably not be offered the procedure until the outcomes and complications have been reliably established by further data. To this end, a prospective UK registry was established in 2006 under the auspices of the Association of Coloproctology of Great Britain and Ireland to clarify the efficacy and risks of STARR in the management of obstructed defaecation. A vital component of optimal management is that STARR is a specialist procedure that should not be performed without adequate training, preceptorship and willingness to participate in prospective data collection [252]. Further data on complications after STARR by other groups are required, and long-term studies are needed to demonstrate whether or not early success is maintained.

29.13 Condylomata Acuminata

Excision is required when medical treatment fails. All excised tissue should be submitted for histopathological examination to exclude malignancy. Bleeding occurs in up to 3% of cases after scissor excision. Blood loss is minimised by generous local infiltration of 1:200,000 adrenaline solution, which also elevates and expands the area, allowing more accurate excision with preservation of skin islands and strips between the lesions. Failure to preserve normal skin may result in anal stenosis. Deep burns and stenosis may occur after diathermy excision, but the risk can be minimised by careful application of needle-tip cautery using adrenaline infiltration [253]. There is theoretical concern about transmission of viable virus in the diathermy smoke. Recurrence risk and speed of recurrence are greater in immunosuppressed patients. Anal condyloma is the most prevalent condition found in HIV-positive patients (43%), and 10% have associated anal intraepithelial neoplasia [254]. In HIV-seropositive patients, CD4 counts should be optimised to prevent early recurrence [255].

29.14 HIV and AIDS

Delayed wound healing is now less of a problem due to improved HIV management and a healthier HIV-positive population. Symptom control is the prime aim,

irrespective of the CD4 count. Incontinence following anal surgery is a greater risk than in normal individuals because of the higher prevalence of diarrhoea and sphincter damage from anoreceptive intercourse in some patients.

Haemorrhoids may require excision if thrombosed or where conservative management has failed. Wound healing and other complications in HIV-positive patients are similar to those in non-HIV individuals [256], although there is a risk of necrotising fasciitis after haemorrhoid banding in immunocompromised patients. Others claim that the procedure in healthy HIV-positive patients is safe [257]. Injection sclerotherapy is also safe [258].

Urgent drainage of perianal sepsis with antibiotics minimises the risk of uncontrolled systemic infection. Loose seton drainage of fistulas is the treatment of choice to minimise incontinence. Kaposi's sarcoma and other malignancies can present with abscess formation.

The surgeon should be protected from contamination of mucous membranes of the eyes, mouth and nose by patients' blood and body fluid splashes by wearing appropriate operating clothing, including double gloving and visor. Feet need to be protected from blood spillage and handling of sharp instruments and needles. Sharps should be avoided wherever possible by using diathermy and laser.

The risk of a surgeon contracting HIV is 0.3% with needle-stick injuries and 0–0.1% after mucous membrane exposure [259]. Risk increases with frank blood on the needle, deep puncture, or the patient dying within 2 months from AIDS. Antiretroviral prophylaxis, which reduces seroconversion by 80%, should be given within hours of exposure and continued for several weeks.

29.15 Anaesthetic Complications of Anal Surgery

29.15.1 Introduction

Anaesthetic complications are described in excellent detail by Karulf [260], and a synopsis of this chapter apropos anal surgery is presented below.

29.15.2 Local Anaesthesia

Simple local infiltration or anal block gives no muscle relaxation, so access may sometimes be limited. Overdose of local anaesthetic agent is caused by accidental intravenous injection and can be avoided by frequently aspirating the syringe each time the needle position is changed.

The maximum dose of lignocaine (< 5–7 mg/kg) and bupivicaine (< 2–4 mg/kg) should not be exceeded. Clinical signs of overdose are tinnitus, confusion, dizziness, seizures, respiratory arrest, nystagmus, visual disturbance, muscle irritability, peroral sensory change and loss of consciousness.

Side effects of adrenaline, if added to local-anaesthetic agents, include sweating, tachycardia, palpitations and anxiety, and they generally resolve with no specific treatment.

29.15.3 Caudal Anaesthesia

Complications are failure to access the sacral hiatus or thecal space, hypotension, and dural or blood vessel puncture. Sepsis and transient paralysis are both rare. Spinal anaesthesia gives regional muscle relaxation and may therefore give better access. Complications are similar to those for caudal anaesthesia, but spinal headaches occasionally occur and generally resolve spontaneously; otherwise, an epidural blood patch is appropriate.

29.15.4 Epidural Anaesthesia

Excellent post-operative pain relief is achieved for longer procedures, or as an alternative to general anaesthesia. Complications, in addition to those seen after spinal or caudal anaesthesia, are hemi-block and, infrequently, severe hypotension, toxic reaction or transient paralysis.

29.15.5 General Anaesthesia

Complications of general anaesthesia include throat soreness, voice hoarseness, cardiac problems, aspiration, atelectasis, awareness and airway complications.

29.15.6 Positioning

All of the operating team must take responsibility for the correct positioning of the patient to avoid pressure injuries, which are a potent source of litigation. Anal

procedures are generally performed in the lithotomy or prone jack-knife positions, and occasionally left lateral.

Anal procedures are sufficiently short such that soft-tissue damage and ischaemia are rarities. The prone jack-knife is contraindicated in morbidly obese patients having general anaesthesia, but otherwise gives excellent access to both the surgeon and assistant for most anal procedures. Soft-tissue injury (genitalia and breasts), aspiration, ulnar nerve injury and displacement of the endotracheal tube are specific risks of the prone position under general anaesthesia.

Eye care is the responsibility of the anaesthetist, and the patient's eyes should be adequately lubricated and taped. Complications include conjunctivitis, corneal abrasion and ulceration. Retinal artery occlusion from direct pressure is a remote risk, particularly in prone patients.

29.15.6.1 Nerve Injury

Nerve injuries are caused by direct compression or traction, and should be avoided by placing patients in relatively neutral positions if possible, avoiding extreme hyperflexion of the hips. The back should be well supported in the lithotomy position to avoid hyperextension. All vulnerable points should be well padded.

Sciatic nerve injury (L4, 5, S1–3) results from direct pressure on a hard table edge or hyperflexion of the hips in the lithotomy position, causing weakness or paralysis in the hamstrings and all of the muscles below the knee. Sensory changes occur in the foot, except in the medial aspect (supplied by the saphenous nerve), and the lower two-thirds of the posterolateral aspect of the calf. Injury results in foot drop due to loss of plantar and toe flexion, and sensation is altered in the sole of the foot.

Injury to the lateral peroneal nerve also results in foot drop due to paralysis or weakness of the peroneal and anterior compartment muscles, together with sensory change in the lateral two-thirds of the calf, dorsum of the foot and the skin between first and second toes. This is caused by compression in stirrups at the point where the nerve winds around the lateral aspect of the head of the fibula.

Femoral nerve injuries (L2–4) occur in extreme hip flexion in the lithotomy position with compression of the nerve at the groin, although self-retaining retractor injuries in Pfannenstiel incisions are a better-recognised source of injury. This results in quadriceps weakness, reduced knee reflex, and sensory change in the anterior thigh and medial lower leg (saphenous nerve).

Inguinal compression is a rare cause of genitofemoral nerve injury (L1–2), causing sensory change to the femoral triangle, scrotum or labia.

Direct compression of the lateral cutaneous nerve of the thigh (L2–3) causes sensory change in the lateral thigh.

Nerve injuries in continuity are usually followed by remyelination after 1–2 months, with return of function depending on the degree of injury. More severe injury, with axonotmesis, risks permanent loss of function to a variable degree and takes much longer to recover.

The anaesthetist should ensure appropriate padding and positioning to protect the brachial plexus, and ulnar and radial nerves from traction or direct pressure injury.

29.15.6.2 Deep Vein Thrombosis and Pulmonary Embolism

These are specific risks of lithotomy, and consideration should be given to prophylaxis.

29.15.7 Urinary Retention

This is a common problem, particularly after spinal anaesthesia, and overloading with intravenous fluids should be avoided.

29.16 Conclusion

There is no doubt that surgical treatment of perianal disease is challenging and the list of potential complications is daunting. However, with a thorough understanding of the disease processes, meticulous surgical technique, appropriate choice of procedure and careful aftercare, many of the potential complications can be limited or avoided altogether. Although resectional surgery for rectal cancer and inflammatory bowel disease is traditionally thought to be the mark of a specialist coloproctologist, mastery of a multitude of anal and perianal techniques, the ability to make evidence-based decisions and successfully avoid surgical pitfalls in proctology is the mark of the expert.

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Self-Assessment Quiz

Question 1

In fistula surgery:

a. Sphincter-sparing treatment of an anterior transsphincteric fistula in a woman is advisable whatever the level of the track.
b. Goodsall's rule is a sensitive indicator of fistula track anatomy.
c. Fistulectomy is more effective than fistulotomy in the treatment of low transsphincteric fistula.
d. Marsupialisation after fistulotomy increases the incidence of recurrence.
e. A course of infliximab will heal over 80% of Crohn's fistulae.

Question 2

In haemorrhoidal surgery:

a. Prophylactic antibiotics are not necessary with a stapled haemorrhoidopexy.
b. Recurrence rates after stapled haemorrhoidopexy are similar to those with conventional (Milligan-Morgan) excision.
c. Emergency haemorrhoidectomy is less effective if it involves limited resection rather than excision of all symptomatic haemorrhoidal tissue.
d. Incontinence after haemorrhoidectomy indicates sphincter damage.
e. Whitehead's deformity is named after a specific operation for haemorrhoids.

Question 3

With anal fissures:

a. The incontinence risk after posterior sphincterotomy is similar to that with lateral sphincterotomy.
b. Long-term incontinence is never a problem after botulinum toxin injection.
c. Fissure recurrence after lateral sphincterotomy is a contraindication to repeat sphincterotomy.
d. Sepsis following sphincterotomy is nearly always associated with an iatrogenic fistula.
e. Tailored and standard lateral sphincterotomies are equally effective in curing fissures and are associated with similar incontinence rates.

Question 4

With rectal prolapse and rectocele:

a. Altemeier's procedure is contraindicated in a patient who has undergone sigmoid resection.
b. Megarectum is not a recognised complication of abdominal rectopexy.
c. The stapled transanal rectal resection procedure rarely results in urgency.
d. Sexual dysfunction is common in males after a Delorme's procedure.
e. Levatorplasty has little effect on restoration of continence after Altemeier's procedure.

Question 5

With faecal incontinence:

a. Sacral nerve stimulation may result in meningitis.
b. A low-residue diet following anterior sphincter repair reduces septic complications.
c. Intra-abdominal implantation of an artificial bowel sphincter may reduce complications.
d. Over 70% of patients who undergo anterior sphincter repair can expect to be continent after 10 years.
e. Patients whose incontinence recurs after anterior sphincter repair cannot have a second successful repair.

1. Answer: a
Comment: The anterior sphincter is narrow, particularly in a woman. Even cutting a small proportion may result in incontinence.

2. Answer: e
   Comment: Whitehead's operation involves a circumferential excision at the dentate line with excision of the submucosal and subdermal haemorrhoidal tissue, and advancement and resuturing of the rectal mucosa to the perianal skin, often resulting in the ectropian deformity that now bears the name.
3. Answer: d [89]
4. Answer: a
   Comment: Previous sigmoid resection, particularly for cancer, may have resulted in high ligation of the inferior mesenteric artery. Subsequent rectal resection and ligation of the superior haemorrhoidal artery risk producing a segment of ischaemic colorectum.
5. Answer: c
   Comment: Many of the complications associated with the Acticon sphincter relate to sepsis and erosion due to perianal incision and implantation. Recent advances have led to the development of a device that can be implanted intra-abdominally. Data are limited but suggest a reduction in septic complications [211].

Section III Colorectal Conditions

30 Anorectal and Colonic Crohn's Disease

Neil Mortensen and Simon Travis

CONTENTS

30.1 Introduction

Crohn's disease most frequently presents in late adolescence or early adulthood and is equally distributed between the genders [1]. Symptoms at presentation vary depending on the location, behaviour and severity of disease, as well as extraintestinal manifestations and medication. The aim is to establish the diagnosis and distribution of disease using appropriate techniques, since this influences the choice of therapy.

Originally, Dr. Burrill Crohn and colleagues described regional ileitis as a chronic inflammatory disease restricted to the terminal ileum in association with intestinal stenoses or fistulae, but not crossing the ileocaecal valve [2]. Although Crohn subsequently recognised colonic disease in conjunction with ileitis [3], it was Basil Morson and Lyn Lockhart-Mummery who put colonic Crohn's disease on the diagnostic map [4, 5].

Population-based studies now recognise that Crohn's disease affects the small bowel alone in about 30% of cases, the colon alone in 30% and both in about 30%, with only 10% having disease elsewhere [1]. Perianal disease may be present with disease in any location, but is most common when Crohn's affects the colon. Perianal disease is included as a specific modifier in the most recent classification of Crohn's disease based on disease location and behaviour [6].

30.2 Onset and Initial Presentation

30.2.1 Typical Features

Chronic diarrhoea is the most common presenting symptom of colonic Crohn's disease [7, 8]. Abdominal pain and weight loss are most common when there is small-intestinal involvement. Blood and/or mucus in the stool is observed in up to 40–50% of patients with Crohn's colitis, but much less frequently than in ulcerative colitis (UC) [8]. Extraintestinal manifestations are more common when Crohn's disease affects the colon

[9]. In population-based studies, the incidence of perianal disease varies between 21 and 23% [10, 11]. The cumulative frequency is 12% at 1 year, 15% at 5 years, 21% at 10 years and 26% at 20 years. The prevalence varies according to disease location. Perianal fistulae were noted in 12% of cases with isolated ileal disease, 15% with ileocolonic disease, 41% with colonic disease and rectal sparing, and 92% with colonic disease involving the rectum [10].

30.2.1.1 Clinical Examination

In the absence of extraintestinal manifestations or perianal disease, clinical examination in uncomplicated Crohn's colitis is usually unremarkable. The alert clinician should listen out for comments from patients (or their primary care physician) about "piles", pruritus or previous fistulae. Inspection of the perineum and anorectal examination is fundamental, looking for the oedematous or violaceous skin tags that are characteristic of perianal Crohn's disease, any fissure in an unusual location (that is any other than posterior), current fistulae or scarring from previous fistulae.

30.2.1.2 Sigmoidoscopy and Colonoscopy

Colonoscopy with multiple biopsy specimens is well established as the first-line procedure for diagnosing colitis [12]. The most useful endoscopic features of colonic Crohn's disease are discontinuous involvement, anal lesions and cobble stoning. Colonoscopy predicts the anatomical severity of Crohn's disease colitis with a high probability [13]. The anatomical criteria of severity are defined as deep ulcerations eroding the muscle layer and mucosal detachments or ulcerations limited to the submucosa but extending to more than one-third of a defined colonic segment (right, transverse, left colon) [13]. The value of full colonoscopy is limited by a higher risk of bowel perforation when there is severe, active disease; in these circumstances, initial flexible sigmoidoscopy is safer and ileocolonoscopy should be postponed until the clinical condition improves. If colonoscopy is incomplete due to a stricture, then double-, or even single-contrast barium enemas are the procedures of first choice. Computed tomography (CT) colonography can reveal the mucosal pattern and show colitis proximal to a stricture, but may not identify all strictures seen on colonoscopy [14].

30.2.1.3 Histology

Focal (discontinuous) chronic (lymphocytes and plasma cells) inflammation and patchy chronic inflammation, focal crypt irregularity (discontinuous crypt distortion) and granulomas (not related to crypt injury) are the generally accepted microscopic features that allow a diagnosis of Crohn's disease [1]. The patchy nature of the inflammation is only diagnostic in untreated adult patients. Inflammation can become patchy in UC under treatment, and young children (age < 10 years) with UC may present with discontinuous inflammation [15].

30.2.1.4 Cross-Sectional Imaging

CT and magnetic resonance imaging (MRI) are highly accurate in complicated Crohn's disease, especially for the detection of fistulae, abscesses and phlegmons. The major advantages of MRI compared to CT include superior tissue contrast, absence of radiation exposure, capability of selecting cross-sectional planes (transverse, coronal, sagittal) and higher sensitivity for intestinal and extraintestinal changes in Crohn's disease [16]. MRI has an accuracy of 76–100% compared to examination under anaesthetic (EUA) [17] for fistulae and may provide additional information. When perianal pain is present, an abscess is almost always the cause. If an abscess is present or suspected, a prompt EUA is the procedure of choice to prevent the destructive effective of pus under pressure. It should not be delayed until an MRI has been performed unless the MRI scan is immediately available.

30.2.2 Differential Diagnosis

Diagnosis is not usually difficult, but there is no single way to diagnose Crohn's disease. The current view is that the diagnosis is established by a combination of clinical presentation, endoscopic appearance, radiology, histology, surgical findings and possibly serology (see Table 30.1) [1]. This still results in diagnostic obstacles. A change in diagnosis to UC during the 1st year occurs in approximately 10–15% of cases. Inflammatory bowel disease (IBD) restricted to the colon that cannot be attributed to Crohn's disease or UC is best termed "colitis unclassified", and the term "indeterminate colitis" confined to operative specimens as originally described [6, 18]. The indiscriminate use of

Table 30.1 Differential diagnosis of colonic and perianal Crohn's disease. *HIV* Human immunodeficiency virus, *UC* ulcerative colitis, *CT* computed tomography

Condition	Comment
Infection • Tuberculosis • HIV • Syphilis • Chlamydia • *Entamoeba histolytica* • *Yersinia enterocolitica*	Tuberculosis usually includes peritoneal involvement. May be indistinguishable from Crohn's. Other infections usually of short duration; may complicate existing Crohn's colitis (especially *Clostridium difficile*). HIV may cause perianal ulceration indistinguishable from Crohn's. Beware missing amoebic colitis if there is any history of travel. *Yersinia* commonly causes joint pain and presents as an acute illness.
UC	Recurrent or complex perianal fistulae effectively exclude UC. Partially treated UC may show patchy histology.
Colitis Unclassified	Having features of both UC and Crohn's colitis; the term "indeterminate colitis" should be reserved for colectomy specimens.
Vasculitis • Behçet's	Any vasculitis may cause focal colonic ulceration. Behçet's may cause perianal ulceration.
Diverticulitis	Beware confusing diverticulitis and Crohn's by depending too much on CT scan appearance.
Lymphoma • Mantle cell lymphoma	Mantle cell lymphoma in elderly males may be indistinguishable from Crohn's colitis at colonoscopy: histology should discriminate.
Other • Hidradenitis suppurativa • Rectal mucosal prolapse	Hidradenitis may present with florid buttock and perianal fistulae and be difficult to discriminate. Prolapse may cause rectal ulceration that looks (and feels) like Crohn's; histology should discriminate.

the term "indeterminate colitis" to cover all cases of diagnostic uncertainty is confusing in the literature and imprecise in practice.

30.3 Classifying Perianal Crohn's Disease

There is no agreed classification of perianal fistulae in Crohn's disease. In clinical practice most use a classification of simple or complex (Table 30.2) [19]. From the surgical point of view, Parks' classification is more descriptive and can influence surgical decisions, but it is complicated to use in routine practice [20]. This describes fistulae in precise anatomical terms, using the external sphincter as the reference point. The perianal Crohn's disease activity index (Table 30.3) is used to score severity and activity for the purposes of clinical trials [21]. In practice it is important to determine whether or not perianal disease is associated with active Crohn's disease elsewhere, because this affects management. Perianal disease cannot be expected to heal if active Crohn's remains untreated, so sigmoidoscopy at the time of EUA is necessary in addition to determining the anatomy of fistulae.

Table 30.2 Classification of fistulae [19]

Simple	Complex
Superficial	Transsphincteric
Intersphincteric	Suprasphincteric
	Extrasphincteric

30.4 Management of Active Disease in Outpatients

30.4.1 Colorectal Disease

Prednisolone is usually effective [22] for active colonic Crohn's disease, and immunomodulators are appropriate steroid-sparing agents for those who have relapsed. A standard approach is to start prednisolone 40 mg/day for 1 week, then 30 mg/day for 1 week, then 20 mg/day for 1 month before decreasing thereafter by 5 mg/day each week, but regimes vary between hospitals. Oral budesonide plays little role in the therapy of colonic disease unless it primarily affects the proximal colon (with or without ileal involvement).

Table 30.3 Perianal Crohn's disease activity index [21]

Criterion	Score
Discharge	
None	0
Minimal mucous discharge	1
Moderate mucous or purulent discharge	2
Substantial discharge	3
Gross faecal soiling	4
Pain and restriction of activities	
No activity restriction	0
Mild discomfort, no restriction	1
Moderate discomfort, some limitation of activities	2
Marked discomfort, marked limitation of activities	3
Severe pain, severe limitation of activities	4
Restriction of sexual activity	
No restriction	0
Slight restriction	1
Moderate limitation	2
Marked limitation	3
Unable to engage in sexual activity	4
Type of perianal disease	
None or skin tags	0
Anal fissure or mucosal tear	1
< 3 perianal fistulae	2
≥ 3 perianal fistulae	3
Anal sphincter ulceration or fistulas undermining skin	4
Degree of induration	
None	0
Minimal	1
Substantial	2
Gross fluctuance or abscess	3
	4

Sulphasalazine 4 g daily is more effective than placebo for active colonic disease, but cannot be recommended as first-line therapy in view of the high incidence of side effects. It may be appropriate in selected patients, however, such as those with an associated arthropathy. Opinion varies about the value of mesalazine enemas as adjunctive therapy in left-sided colonic Crohn's disease, but there is no evidence base. Distal colonic Crohn's disease, however, presents an occasional therapeutic dilemma and some use it in these circumstances. Metronidazole 10–20 mg/kg/day induces a response (change in CDAI-97 score for 20 mg/kg, –67 for 10 mg/kg vs –1 for placebo, $p = 0.002$) for colonic disease, but not remission [22]. It is consequently not recommended as first-line therapy and has a high incidence of side effects, but has a role in selected patients with colonic disease who wish to avoid steroids.

All medical treatment has to be placed in the context of a high likelihood of needing surgery. In 592 patients followed over 13 years, 91% of those with ileocolic disease, 72% with pancolonic, 65% with isolated small-bowel, and 29% with segmental colonic disease came to surgery [23]. Therefore, surgery should always be considered as an option. Both the indications and timing are important interdisciplinary issues. With the advent of infliximab, a conservative option has emerged for cases with severe inflammatory activity, and it is in these that primary surgery will often be inappropriate. Thus, neither conservative nor surgical options should be given precedence over the other, but in these difficult cases the best approach should be tailored to the individual. Interestingly, infliximab appears to be twice as effective for isolated colitis (odds ratio, OR = 1.91, 95% confidence interval, 95% CI = 1.01–3.60) as it is for isolated small-bowel disease (ileitis), and four times more effective in steroid-refractory Crohn's colitis (OR = 4.9, 95% CI = 2.2–11.0) [24].

30.4.2 Perianal Fistulae

For simple perianal fistulae it is important to know if they are symptomatic. If they are not, nothing has to be done. Only when simple fistulae are symptomatic are the options of loose seton or fistulotomy recommended. Antibiotics, metronidazole (750–1,500 mg/day) or ciprofloxacin (1,000 mg/day) should be added [9]. For complex fistulae (Table 30.2), antibiotics and/or azathioprine/6-mercaptopurine should be used as the first choice of therapy or in combination with surgical therapy, in spite of a lack of clinical trials [9]. The presence of a perianal abscess should be ruled out, and if present it should be drained. Infliximab should generally be used as a second-line treatment. Infliximab was the first agent shown to be effective in a randomised controlled trial for inducing closure of perianal fistulae and for maintaining this response for 1 year without increasing the risk of abscess formation [25]. However, complex fistulae were not specifically examined. Seton placement should be recommended and a diverting ostomy can rapidly restore the quality of life of highly symptomatic patients (below).

30.5 Management of the Severe Episode in Hospital

30.5.1 Examination Under Anaesthetic

Although an assessment of the severity of perianal disease can be made in a patient having colonoscopy under sedation, the best assessment needs to be made with a patient under general anaesthesia (EUA) in the lithotomy position [22]. The number and disposition of external openings of fistula tracks can be assessed. The site and depth of any atypical anal ulceration and, with an anal retractor in place, the site of any internal openings can be identified. The precise anatomy of the tracks can be assessed using a combination of palpation, fistula probes and the judicious use of hydrogen peroxide placed in an external opening with a retractor in the anal canal looking for the egress of peroxide in the inside of the anal canal. Any obvious abscess can be laid open, and once laid open again, an internal opening can be sought. On occasion, pressure on the abscess will result in a bead of pus or more at the internal opening within the anal canal. Palpation will reveal the cord-like band of the tract, the presence of any induration around the anal canal and especially the presence of induration above the levator muscles, suggesting a secondary tract passing up above the levator plate causing a retrorectal abscess.

Once the tract has been located and any abscesses drained and cleaned out, the fistula tracts are first treated with single, or if necessary multiple, setons. Coloured silastic vessel loops or suture material can be used and the important principle in Crohn's disease is to leave these as loose setons. The purpose here is to maintain open external and internal openings to allow free drainage of the fistula tracts and for any associated sepsis to settle. The presence of deep cavitating ulceration or anorectal stenosis will be noted and may make the assessment more difficult. It must be emphasised that any abscess has to be drained to relieve the patient's pain and allow safe subsequent medical therapy.

After an EUA for a perianal abscess or complex fistulae in Crohn's disease, the patient's pain should be relieved. If it is not, then it is highly likely that a collection persists. MRI scanning and endoluminal ultrasound can be difficult to interpret in these circumstances, and there should be a low threshold for a repeat EUA by an experienced colorectal surgeon prior to giving any infliximab [26].

30.5.2 Timing of Anti-Tumour-Necrosis-Factor Therapy

National guidelines govern the use of the anti-tumour necrosis factor (TNF) drug infliximab. There is a unanimous view that infliximab is appropriate for steroid-dependence, -refractoriness or -intolerance, and that it should be considered for the treatment of Crohn's disease that remains active in spite of azathioprine or methotrexate [22]. There remains the occasional patient who presents with severely active Crohn's colitis and is admitted to hospital; intravenous steroids are usually initiated, but if there is little response within a few days, early treatment (top-down therapy) with infliximab may be appropriate to induce rapid remission and allow time for immunomodulators to take effect. Specialist advice should be sought. Re-treatment is necessary after a variable interval (most commonly 8–16 weeks). All patients should receive an immunomodulator (azathioprine or methotrexate) unless these cannot be tolerated, since this reduces the development of antibodies to infliximab that in turn may reduce its efficacy and increase side effects. The principal contraindications are sepsis, exposure to tuberculosis, malignancy and cardiac failure. Before treating a patient with perianal disease, an MRI scan, rectal ultrasound or EUA is recommended to exclude an abscess. If there is no initial response to infliximab at a dose of 5 mg/kg, increasing the dose to 10 mg/kg may work, but there is no point in a third infusion if there is no response to the first two. Infliximab is not recommended as pretreatment of refractory disease to facilitate surgery. Other anti-TNF agents are becoming available (notably adalimumab and certolizumab), but convenience as a subcutaneous injection, rather than additional efficacy is likely to influence their use [27].

30.6 Special Situations

30.6.1 Rectovaginal and Other Non-perianal Fistulae

There are no trials on the effect of medical treatment for non-perianal fistulating Crohn's disease, other than the subgroups of the ACCENT II trial (a Crohn's disease clinical trial evaluating infliximab in a new, long-term treatment regimen in patients with fistulating Crohn's disease). For the 25 patients (out of 282) with

rectovaginal fistulae in the ACCENT II trial, infliximab was only modestly effective (45% closure at week 14) [28]. Low anal-introital fistulae may be almost asymptomatic and not need surgical treatment. If the patient has a symptomatic fistula, surgery is usually necessary (including a diverting ostomy). Rectovaginal fistulae failing conservative treatment should have surgery with an advancement flap (see below) and/or diverting ostomy if they are associated with unacceptable symptoms. Sigmoid-gynaecological or rectovesical fistulae can usually be treated with resection of the diseased bowel segment, usually with a diverting ostomy.

30.7 Longer-Term Management and Complications

30.7.1 Maintenance of Remission

In clinical trials designed for the maintenance of remission, relapse rates among patients receiving placebo range from 30 to 60% at 1 year, and from 40 to 70% at 2 years [22]. The probability of relapse during the first 3 years after diagnosis correlates well with that observed during succeeding years. Colonic involvement appears to increase the risk of relapse [29].

In view of the adverse effect of cigarette smoking on the course of Crohn's disease [30], smoking should be discouraged in all patients. Despite the common use of mesalazine for maintenance of remission in Crohn's disease, there is no consistent evidence that it works, and a meta-analysis indicates no benefit [22]. A systematic review on mesalazine for maintenance of remission in Crohn's disease showed an OR of 1.00 (95% CI = 0.80–1.24) for mesalazine compared to placebo in six studies of maintenance for 12 months [31]. It is just conceivable that the doses or delivery system were inappropriate. Azathioprine is recommended if remission is induced with steroids, or if the frequency of relapse is >1/year [22]. If remission has been achieved with infliximab, azathioprine or methotrexate are appropriate for maintenance. Induction therapy with infliximab in steroid-dependent disease also treated with azathioprine consistently doubles the remission rate: from 38 to 75% at week 12 ($p < 0.001$), from 29 to 57% at week 24 and from 22 to 40% at week 52 ($p = 0.04$) [32]. This is a similar outcome to maintenance therapy with regular infliximab infusions [33], which should be considered if immunosuppression fails, but surgery should always be considered as an option.

30.7.2 Risk of Cancer

Patients with extensive Crohn's colitis carry an increased risk of colorectal cancer [34]. Endoscopy with biopsy can be used for secondary prevention and the detection of dysplasia (intraepithelial neoplasia) in UC. Surveillance colonoscopy has also been associated with a reduced risk of cancer in Crohn's colitis [34]. It has been estimated that 33 biopsy specimens are required to give 90% confidence in the detection of dysplasia, if it is indeed present [35]. These studies on UC have not been replicated in Crohn's colitis. The focal nature of inflammation in Crohn's colitis, the possibility of strictures and prevalence of segmental resection means that surveillance practice in UC cannot be transferred directly to Crohn's colitis. Nevertheless, it seems sensible to consider surveillance (see Chap. 31) for extensive Crohn's colitis of > 10 years duration.

Anecdotal reports of anal cancer complicating severe anorectal Crohn's disease are commonplace, but the risk is difficult to quantify [36]. Adenocarcinoma may develop in fistulous tracks, or squamous cancer may complicate chronic perianal disease. It is a factor to be considered when deliberating about defunctioning chronic perianal sepsis.

30.7.3 Massive Haemorrhage

Massive gastrointestinal haemorrhage is an uncommon complication of Crohn's disease, but is more common in Crohn's colitis (81–90%) than small-bowel disease [37]. Spontaneous cessation of haemorrhage has been reported in 41–65% of cases, but one-third of patients treated conservatively will have recurrent haemorrhage and require surgical intervention. Lesions amenable to endoscopic intervention are uncommon and angiography with a view to embolisation or surgery should be considered at an early stage.

30.8 Surgery for Perianal and Colorectal Crohn's Disease

30.8.1 Indications

Surgical treatment is sometimes necessary for simple fistulae, but is always necessary for complex perianal disease. It includes abscess drainage, fistulotomy and seton placement, depending on the symptoms caused

by the location and complexity of the fistulae. A diverting ostomy or proctectomy may be necessary for severe disease that is refractory to medical therapy.

30.8.2 Elective Surgery for Refractory Disease

Crohn's colitis can occasionally present as an acute severe attack for which the treatment will be the same as that for UC; namely, a total abdominal colectomy with preservation of the rectum and ileostomy [38]. The resection specimen can then be carefully checked via histopathology for the presence of Crohn's disease. This may allow a subsequent ileorectal anastomosis if there is no perianal or rectal disease.

Crohn's disease in the colon may also have a patchy discontinuous distribution, and areas of severe disease resulting in stenosis can be treated by segmental resection, preserving as much normal colon as possible [39].

30.8.3 Defunctioning

Defunctioning loop ileostomy can be a very useful measure for diffuse colonic disease that is refractory to medical therapy where the patient is not acutely ill. The defunctioned colon can then be subsequently examined by colonoscopy, and after a period of medical therapy there may be the possibility of restoration of intestinal continuity – but this is only effective in about one-third of patients in the longer term. The other major indication for defunction is where the patient has had multiple setons put in place, appropriate medical therapy has been given, the perianal region is failing to come under control and the patient has persistent discharge, pain and poor quality of life. Here, the defunction will act to gain control of the situation as a temporising measure [40]. If subsequent medical therapy and surgical intervention is able to heal up the perianal disease there may be the possibility of restoration of intestinal continuity, but more often the defunction is a bridge to proctectomy, buying time for a younger patient to become accustomed to the idea of a long-term stoma. A laparoscopic approach will allow inspection of the upstream small bowel and the creation of a loop ileostomy, with minimal adhesions and impact on the abdominal cavity.

30.8.4 Proctectomy

Where a combination of aggressive medical therapy, setons and even defunction have failed, proctectomy will be necessary as a last resort. Patients with long-term perianal fistula and Crohn's disease may develop adenocarcinoma in the tracts. This may be a difficult diagnosis and equally difficult management [35]. In patients with confirmed carcinoma, appropriate staging by MRI, CT and positron emission tomography scans will determine those patients with operable disease, the surgery often being carried out after neoadjuvant chemoradiotherapy.

Proctectomy is usually carried out in the mesorectal plane, and unlike UC it can be difficult to use the intersphincteric plane to preserve the external sphincter and the pelvic floor where there is widespread perianal fistulation and abscess formation. These patients may have a large perineal defect after resection, which may require a rectus abdominus or similar myocutaneous flap to fill the pelvis.

Chronic perineal sinus is a common complication of proctectomy for Crohn's disease. It may be avoided by aggressive preoperative medical therapy, drainage of any sepsis and control of fistula tracts by setons. Any abscesses, fistula tracts or mucosal tissue left behind will make a perineal sinus more likely. The treatment of established perineal sinus includes accurate imaging, the exclusion of enteroperineal fistula, vigorous curettage, irrigation and antibiotic therapy with ciprofloxacin and metronidazole. Aggressive wound management including vacuum dressings may be necessary and on occasion after many months the excision and re-suturing, with or without a myocutaneous flap, of the persisting cone of unhealed perineal tissue [41].

30.9 Conclusion

Crohn's disease is a chronic IBD that causes both minor and major morbidities in a predominantly young age group. The presence of perianal fistulae at diagnosis is a poor prognostic marker that is used increasingly to guide medical management towards early biological therapy (with adalimumab or infliximab) in conjunction with surgical (seton) drainage. Immunomodulators (such as azathioprine) are best started at the diagnosis of perianal disease, with or without biological therapy. Fistulising Crohn's disease will not heal while there is active colonic disease. Although colonic Crohn's

disease appears to respond better to medical therapy than does small-intestinal Crohn's disease, surgical defunctioning of the colon is a highly effective way of controlling colonic and perianal Crohn's disease that is refractory to medical therapy, thereby improving the patient's quality of life. Anorectal and colonic Crohn's disease are best managed by a physician and surgeon working together, often most easily coordinated by running parallel clinics and supported by a multidisciplinary team of specialist gastrointestinal histopathologists, radiologists, nurses, physiologists and dieticians to achieve the best outcome.

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Self-Assessment Quiz

Question 1

Patchy focal chronic inflammation is diagnostic for Crohn's disease:

a. Always
b. Only in adults
c. Only in untreated adults
d. In young children
e. Only when seen in rectal biopsies

Question 2

When managing perianal Crohn's disease:

a. Computed tomography (CT) is the best for showing an abscess.
b. Endoluminal ultrasound is the most effective method for showing a fistula tract.
c. Endoscopy is the best overall assessment.
d. Magnetic resonance imaging (MRI) best demonstrates the full spectrum of active disease including fistula abscess and anorectum in multiple planes.
e. A simple digital rectal exam in clinic is all that is necessary.

Question 3

Managing colonic Crohn's disease:

a. Steroids are not as effective in Crohn's colitis as in UC.
b. Sulphasalazine is usually front-line therapy.
c. Crohn's colitis, unlike UC, has no cancer risk long term.
d. Budesonide is used for its steroid-sparing effect.
e. Infliximab is more effective in colonic than small-bowel Crohn's.

Question 4

Managing perianal disease:

a. Infliximab should be started immediately as part of a top-down therapy.
b. Cutting setons are more effective than loose setons.
c. An MRI is better than an EUA.
d. Pain usually indicates an undrained abscess.
e. Multiple setons are usually ineffective.

Question 5

Surgery for colorectal and perianal Crohn's disease:

a. Is rarely necessary
b. Usually involves proctocolectomy
c. Defunction with a loop ileostomy is of no value
d. An ileorectal anastomosis is rarely indicated
e. Chronic perineal sinus after proctocolectomy is common

1. Answer: c
   Comments: Inflammation can become patchy in ulcerative colitis (UC) under treatment, and young children under 10 years with UC may have discontinuous disease. A rectal biopsy alone is unreliable.
2. Answer: d
   Comments: Although an exam under anaesthesia (EUA) is the gold standard, MRI is rapidly becoming as accurate. CT doesn't show up relationships with the pelvic floor and anorectal musculature as well and has the disadvantage of radiation exposure in young patients. Endoluminal ultrasound, even with hydrogen peroxide, can show the anatomy of a track but not its relationship to the surrounding structures, and is operator dependent. Endoscopy will only show mucosal changes, and a simple digital exam may be painful and miss occult abscesses.
3. Answer: e
   Comments: Steroids are equally as effective in Crohn's colitis and UC, but budesonide only really works on the proximal colon. Sulphasalazine is used once remission is induced. Infliximab is being used increasingly in severe Crohn's colitis, and in the long term there is a similar cancer risk as in UC.

4. Answer: d
Comments: An MRI may be used to guide an EUA where the main strategy is to detect and drain any abscess. This is mandatory before the use of infliximab. Any identified tracks are treated with loose setons so that no muscle is cut and the patient is pain-free. Persisting pain suggests an undrained abscess. Multiple setons, often left for many months, are highly effective.

5. Answer: e
Comments: The majority of patients will require surgery at some point in their lives. Proctocolectomy is only used when there is a combination of colonic and perianal disease. This is often complicated by poor healing and a chronic perineal sinus. Ileorectal anastomosis is used when there is rectal sparing. Defunction for perianal disease is an important option for stabilising severe perianal destructive inflammation.

31 Ulcerative Colitis

Simon Travis and Neil Mortensen

CONTENTS

31.1 Introduction

Bloody diarrhoea is the hallmark of acute ulcerative colitis (UC), which in most patients runs a clinical course that is characterised by unpredictable relapses interspersed with periods of remission. It can be defined as continuous mucosal inflammation of the colon without granulomas on biopsy affecting the rectum and a variable extent of the colon in continuity.

Diagnostic precision is essential. The diagnosis should define the distribution and pattern of disease, because this influences treatment of both the active phase and maintenance of remission. Review of the diagnosis is fundamental when dealing with refractory symptoms or when considering surgical intervention. The potential to predict the pattern of the disease at diagnosis, or to deploy pharmacogenetics in tailoring treatment to an individual is immensely exciting. Nevertheless, technology will never remove the need for an empathetic clinician, who must first take the clinical history of miserable symptoms in a sensitive manner.

31.2 Onset and Initial Presentation

31.2.1 Typical Features

Patients usually present with a gradual onset of symptoms, often intermittent, but which become progressively more severe. When the inflammation is confined to the rectum (proctitis), patients often pass fresh blood, but may complain of constipation rather than diarrhoea. When the inflammation extends beyond the rectum there is usually diarrhoea with the passage of altered blood, together with urgency and tenesmus. In severe colitis, affecting all or most of the colon, patients become anorectic, nauseous and lose weight.

A classic paper in 1963 described the clinical pattern and prognosis in 624 patients with UC between 1938 and 1962 [1–3]. The duration of symptoms before first presentation was < 1 month in 20%, 1–6 months in 58% and 6–12 months in 22%. The age of onset was < 20 years in 10%, 20–59 years in 73% and > 60 years in 17%. The median decade of onset was 30–39 years (7%) and there was no "second peak" in older age, although 3% presented over the age of 80 years. More recent data [4, 5] indicate that little has changed. In a prospective pan-European study, 1,379 patients with UC presented over a 2-year period. The predominant presenting symptoms were bowel frequency (93%) and visible blood in the stools (96%). Abdominal pain, while mild or moderate in 55% of cases, and absent in 41%; only 4% had severe abdominal pain and weight loss was minimal. This is in striking contrast to the clinical presentation of Crohn's disease, in which visible blood is present in 48% of cases, severe abdominal pain occurs in 21% (and absent in only 19%) and weight loss in 73% [4]. The distinction is important because in making a diagnosis of UC the clinical symptoms must be considered in the context of endoscopic and histological examination. For instance, if rectal bleeding is absent or if there is severe abdominal pain, then the presentation is atypical for UC and other interpretations must be considered.

31.2.1.1 Clinical Examination

Examination of patients with mild or moderate attacks is usually unremarkable. Weight should always be recorded and, for children and adolescents, both height and weight should be recorded on growth charts. Bowel sounds are normal and rectal examination is also normal apart from blood. Patients with a severe attack may look deceptively well: a tachycardia and tender colon may be the only physical signs (see assessment of severity below). However, many of these patients are obviously ill, with fever, salt and water depletion, anaemia and evidence of weight loss [6]. There may be oral candidiasis, aphthous ulceration, leuconychia and peripheral oedema. The abdomen may then be distended, with reduced bowel sounds and marked colonic tenderness.

31.2.1.2 Sigmoidoscopy and Colonoscopy

The rectal mucosa in mildly active UC looks hyperaemic and granular. As the disease becomes more severe, tiny punctate ulcers appear, which then become confluent, while the mucosa becomes intensely haemorrhagic. Continuous inflammation from the anal verge is characteristic and the line of demarcation at the proximal extent of the disease is often striking: a change from inflamed mucosa to normal-looking mucosa may occur over a few millimetres. In a prospective study of 357 patients with colitis, the most discriminating endoscopic features for a diagnosis of UC were continuous mucosal inflammation (98% negative predictive value, NPV), granularity (84% positive predictive value, PPV), loss of vascular pattern (76% PPV, 77% NPV), tiny ulcers (90% PPV) and rectal involvement (76% NPV) [7]. A "caecal patch" lesion has been recognised in patients with typical clinical, endoscopic and histological features of limited UC who have an isolated area of erythema and inflammation around the appendiceal orifice [8]. It should not trap the unwary into a diagnosis of Crohn's colitis. In patients with long-standing disease, inflammatory polyps ("pseudopolyps") may develop in the colon; the significance is that they may identify patients at higher risk of subsequent malignancy [9]. As the disease regresses, the colonic mucosa may return to normal.

31.2.1.3 Histology

The histological features of UC are beyond the scope of this chapter, but readers are referred to official guidelines [10, 11]. It should be remembered that while a diagnosis of UC should not be made without evidence of chronic mucosal inflammation during an acute episode, the diagnosis should not be based on histology alone.

It is the combination of clinical, endoscopic and histological features that allows a definitive diagnosis to be made.

31.2.2 Differential Diagnosis

Diagnosis is usually not difficult, except in acute presentations when infective colitis must be excluded, or in a small proportion with atypical features in whom Crohn's colitis, colitis yet-to-be classified, or drug-induced colitis should be considered (Table 31.1).

31.2.2.1 Diagnostic Pitfalls

Any rectal sparing is usually relative, and a normal-appearing rectum in UC is usually due to topical therapy. However, normal rectal mucosa has rarely been reported in patients presenting for the first time with acute severe colitis [12]. The diagnosis of UC should be questioned when rectal bleeding is absent during an acute attack. Diarrhoea without bleeding is more common in Crohn's colitis, but it may be impossible to distinguish histologically between UC and Crohn's colitis in severe disease. In the 10% of patients in whom it is not possible to distinguish between UC and Crohn's colitis after reviewing the history, endoscopic appearance and histology, the term "colitis unclassified" (or inflammatory bowel disease type unclassified) is preferred to indeterminate colitis [10, 13, 14], which is a precisely defined term after colectomy and has specific prognostic implications, especially relating to subsequent ileoanal pouch formation. Evaluation of biopsy samples taken during a quiescent phase of the disease often resolves the dilemma and most such patients behave as if they have UC.

31.3 Assessing Disease Severity

Objective assessment of the disease severity is fundamental to the initial management of a patient, whether as an outpatient or in hospital, because patients can look deceptively well [9]. The distribution and pattern of disease are best considered independent of severity [13], although all have a bearing on therapeutic decisions.

There are at least nine different clinical activity indices used in clinical trials, which creates great confusion [15]. Only one index is simple enough to remember and has the enormous value of distinguishing between severe UC that merits hospital admission and those who can be managed as outpatients: the Truelove and Witts' criteria [16]. The outcome for severe UC as defined by these criteria has been validated in multiple papers [15, 17], but it only assesses a patient at a single point in time. Minor modification is needed to give objective values to the "moderate" category. The other indices can be used to monitor response to treatment, but are best left to clinical trials [10].

Table 31.1 Differential diagnosis of ulcerative colitis (UC). *NSAID* Non-steroidal anti-inflammatory drug

Condition	Comment
Infective colitis: *Campylobacter spp.* *Shigella spp.* *Clostridium difficile* *Escherichia coli* 0157 H7 Cytomegalovirus	Usually short duration; may complicate existing colitis (especially cytomegalovirus)
Crohn's colitis:	
Colitis yet-to-be classified	Having features of both UC and Crohn's colitis; the term "indeterminate colitis" should be reserved for colectomy specimens
Ischaemic colitis	Exceptionally rare to affect the rectum
Diverticular colitis	Never affects the rectum
NSAID colitis	May be impossible to discriminate from UC: ask about NSAID ingestion and alert the pathologist
Rectal mucosal prolapse	May be confused with proctitis; histology should discriminate

The likelihood of colectomy increases when there are two or more Truelove and Witts' criteria in addition to a bloody stool frequency of ≥6/day on admission. In data from Oxford yet to be published in full, 8.5% (11/129) of patients who had a single criterion in addition to a bloody stool frequency of ≥6/day required colectomy, compared with 31% (29/94) of patients who had ≥2 additional Truelove and Witts' criteria (odds ratio, OR 4.01, 95% confidence interval, CI 2.24–7.19, $p = 1.2\times10^{-6}$).

Every patient with active UC should have their full blood count (FBC), inflammatory markers (C-reactive protein (CRP) or erythrocyte sedimentation rate (ESR)), electrolytes and liver-function tests measured, along with a stool sample for culture and sensitivity as well as assay of *Clostridium difficile* toxin.

Patients with severe UC (Table 31.2) should have a plain abdominal radiograph, not only to exclude colonic dilatation (>5.5 cm), but also to obtain a rough estimate of the extent of disease and look for features that predict response to treatment. The proximal extent of disease broadly correlates with the distal distribution of faecal residue; in 51 episodes of severe colitis, this guide overestimated the extent in 18% of cases and underestimated it in 8% [17]. The presence of mucosal islands (small, circular opacities representing residual mucosa isolated by surrounding ulceration) or more than two gas-filled loops of small bowel on the radiograph is associated with a poor response to treatment [18, 19].

31.4 Management of the Acute Episode in Outpatients

Therapeutic decisions depend on disease activity and extent. Activity is assessed according to the simple criteria noted above (Table 31.2). Extent can be divided into proctitis, left-sided and extensive disease (Table 31.3) [13]. Although this has yet to be validated, it coincides with the approach to treatment.

Topical management is appropriate for some patients with active disease. This is usually the case for those with proctitis and often the case if the disease extends into the sigmoid. For those with more extensive disease, oral and parenteral therapy are the mainstays of treatment, although some of these patients may gain additional benefit from topical therapy.

31.4.1 Mild or Moderate Active Proctitis

Active colitis limited to the rectum should first be treated topically. Suppositories are more appropriate than enemas, because suppositories target the site of inflammation, while only 40% of foam enemas and 10% of liquid enemas can be detected in the rectum after 4 h [20]. Topical mesalazine is more than twice as effective as topical steroids (OR 2.42; 95% CI 1.72–3.41) [21]. Mesalazine suppositories 1 g daily are highly effective [22]. There is no dose-response to topical therapy, and 1 g mesalazine is optimal. Clinical (and endoscopic) remission occurred in 64% (52%) of cases within 2 weeks on Pentasa suppositories, compared to 28% (24%) on Claversal suppositories ($p < 0.01$) [22]. Topical steroids should be reserved as second-line therapy for patients who are intolerant of topical mesalazine [23]. Patients who fail to improve on topical mesalazine or topical corticosteroids should be treated with oral prednisolone, as if the colitis was more extensive or severe (below). Refractory proctitis is beyond the scope of this chapter, but has recently been reviewed [24]. Specialist advice from a gastroenterologist with a special interest in inflammatory bowel disease is appropriate, especially concerning the role and long-term outcome of anti-tumour necrosis factor (TNF) therapy.

31.4.2 Mild or Moderate Left-Sided Active Colitis

Active left-sided UC should be treated with aminosalicylates (mesalazine) or corticosteroids to give prompt relief of symptoms [10, 25]. Topical mesalazine alone or oral mesalazine alone are effective, but less effective than both together [26], so combination therapy is appropriate. However, controlled trials show that only half of mild-to-moderate attacks of colitis respond to mesalazine within 6 weeks. In a systematic review of all nine placebo-controlled trials of aminosalicylates for active UC, the overall remission rate was only 20% (giving a "number-needed to treat" of 10; 95% CI 7–21) [27]. There is something of a transatlantic divide regarding the threshold for using steroids. The European approach is often to introduce oral steroids at an early stage because aminosalicylates cannot match the speed of response for patients suffering miserable symptoms. The concern in the US about steroid-induced side effects is shared by patients, but may also be self-fulfilling. Late introduction of steroids will select a more refrac-

Table 31.2 Truelove and Witts' clinical index of severity (modified from [16]). *ESR* Erythrocyte sedimentation rate

Criteria	Mild	Moderate	Severe
Bloody stool frequency	<4	≥4	≥6
Pulse rate	Normal	Normal	>90 beats/min
Temperature	Normal	Normal	>37.8 C
Haemoglobin	Normal	Normal	<10.5 g/dl
ESR	Normal	Normal	>30 mm/h

Table 31.3 Montreal classification of UC according to disease extent [13]

	Extent	Description
E1	Ulcerative proctitis	UC limited to the rectum (i.e. proximal extent is distal to the rectosigmoid junction)
E2	Left-sided UC	Involvement limited to the colon and rectum distal to the splenic flexure (including the distal UC)
E3	Extensive UC	Involvement proximal to the splenic flexure (includes pancolitis)

Table 31.4 Treatment of active left-sided UC

	Mild	Moderate
Mesalazine	2–2.4 g/day AND enema If rectal bleeding persists after 14 days, start steroids (below)	4–4.8 g/day for 2 weeks AND enema If rectal bleeding persists after 14 days, start steroids (below)
Mesalazine enema	At night for 1 month	At night for 1 month
Prednisolone	20 mg/day for 1 month 15 mg/day for 1 week 10 mg/day for 1 week 5 mg/day for 1 week	40 mg/day for 1 week 30 mg/day for 1 week Then as for mild attacks

tory population who may require higher doses for longer periods. Consequently, the choice now lies between high-dose (>4 g/day) mesalazine and steroids [10, 28]. The median time to cessation of rectal bleeding using high-dose mesalazine is 10 days, so a general rule is that if rectal bleeding does not cease within 2 weeks on mesalazine, decisive treatment with steroids should be started [29]. A simple guide is shown in Table 31.4.

31.4.3 Mild or Moderate Extensive Active Colitis

The approach is similar to that described for left-sided colitis, with the important caveat that there should be a lower threshold for decisive treatment with systemic steroids. Moderately active disease and failure of mild disease to respond within 2 weeks to mesalazine are indications for oral prednisolone. The reason for this proactive approach is the risk of complications (including toxic dilatation) in patients with extensive disease who are under-treated. Topical mesalazine is still of benefit in extensive colitis. Oral Pentasa 4 g/day with a 1-g Pentasa enema in 116 patients induced clinical remission by 8 weeks in 64% compared to 43% oral Pentasa alone ($p=0.03$) [30]. The speed of response to mesalazine is slower than can be expected with oral steroids. In an ideal world, colorectal surgeons and gastroenterologists will be running parallel clinics, so advice on medical therapy (or surgical intervention!) is readily accessible to both. The message for colorectal surgeons treating UC is: do think of disease distribution, do evaluate the severity (it only means counting bloody stool frequency!), do start medical therapy and don't treat everything as if it is mild proctitis.

31.5 Management of the Severe Attack in Hospital

31.5.1 Standard Management

The natural history of untreated severe UC has a mortality of 24%. This was reduced to 7% with the introduction of intravenous corticosteroids, and subsequently to less than 1% with timely and expert surgical input. Within the last 5 years, a mortality of 24% has been reported in non-specialist centres, so there is no room for complacency [31]. Immediate admission to hospital is warranted for all patients fulfilling Truelove and Witts' criteria (Table 31.2) for acute severe colitis. The number of criteria in addition to a bloody stool frequency of ≥6/day influences outcome, with three times as many patients coming to colectomy with two or more criteria in addition to a bloody stool frequency of ≥6/day (above). Joint management between the gastroenterologist and colorectal surgeon should be considered a fundamental criterion of the quality of care.

Intravenous corticosteroids remain the mainstay of therapy and should not be delayed whilst awaiting microbiological results for possible infective causes. They are generally given as hydrocortisone 100 mg four times daily or methylprednisolone 60 mg daily. Treatment is best given for about 5 days, since extending therapy beyond 7–10 days is of no benefit. If the patient objectively responds to treatment, oral prednisolone is instituted at 40 mg daily and tapered (Table 31.4). Intravenous fluid and electrolyte replacement is needed to correct dehydration or electrolyte imbalance, together with blood transfusion to maintain a haemoglobin level of >10 g/dl. Subcutaneous heparin is appropriate to reduce the risk of thromboembolism. Nutritional support (by enteral or parenteral route) is appropriate if the patient is malnourished, but controlled trials have not shown that "bowel rest" or total parenteral nutrition alters the outcome. Antibiotics offer no additional benefit [24]. Anti-cholinergic and anti-diarrhoeal agents, and non-steroidal anti-inflammatory and opioid drugs, which risk precipitating colonic dilatation, should be withdrawn.

Monitoring includes daily physical examination to evaluate abdominal tenderness and rebound tenderness, recording vital signs four times daily and a stool chart to record the number of bowel movements, including the presence or absence of blood. Measurement of FBC, ESR or CRP, serum electrolytes, serum albumin and liver function tests should be performed every 24–48 h. Daily abdominal radiography is appropriate if signs of colonic dilatation (transverse colon diameter ≥5.5 cm) are detected. Around 60% of people will not respond completely to corticosteroids; this figure has stayed remarkably constant for 50 years [31].

31.5.2 Predicting Outcome

Attempts have been made to identify at an early stage those who will come to colectomy [10, 32]. The simplest approach is objective re-evaluation on the 3rd day of intensive treatment. A stool frequency of >8/day or CRP >45 mg/l at 3 days predicts the need for colectomy on admission in 85% of cases [17]. This measure has been confirmed independently [33] and if these criteria are met, then it is appropriate to ensure that the patient has seen the colorectal surgical team and stomatherapists by way of contingency planning, and to start "rescue therapy".

31.5.3 Rescue Therapy

No individual patient wants a colectomy, and it is becoming easier for physicians to agree with patients to defer decisions as the number of other therapeutic options increases. Delaying the decision may not be in the patient's interests, and there the difficulty lies. There is every reason to explore new approaches to treating severe UC, because the response to intensive treatment with steroids has not changed for 50 years. The question is how to do this safely. There are two principal options: cyclosporin (CsA) and infliximab (IFX), but as the number of medical options increases, decisions become harder.

In the largest randomised study of CsA to date, 73 patients were randomised to either 2 mg/kg or 4 mg/kg of intravenous CsA [34]. Response rates at 8 days were similar in both groups (83% and 82% respectively), with 9% coming to colectomy in the 2-mg/kg group and 13% in the 4-mg/kg group. The downside of CsA remains longer-term toxicity and the lack of sustained response [35]. CsA was associated with the deaths of 3/86 patients from opportunistic infections at a single centre: 2 from *Aspergillus* species infection and 1 from *Pneumocystis carinii* [36]. Furthermore, a study from Pennsylvania of 41 patients given CsA found that the highest costs, longest length of stay and highest number of overall complications occurred in 18 patients who failed CsA and required colectomy on admission [37]. This illustrates the potential consequences of CsA

delaying colectomy, although experience from Oxford found no increase in septic complications after CsA and surgery [38].

The alternative is IFX. A Swedish-Danish study treated 45 patients (24 IFX and 21 placebo) [39]. No patient died. Seven in the IFX group and 14 in the placebo group had a colectomy within 3 months ($p = 0.017$; OR 4.9, 95% CI 1.4–17). The response of UC to IFX is consistent with the results of the two Active Ulcerative Colitis Trial (ACT) studies on outpatients [40]. The patients in the ACT trials were different to the Swedish-Danish trial, even though "severe" is included in the ACT methodology. This inconsistency in terminology is confusing and slightly irritating because the definition, outcome and predictive factors for severe UC have been established (at least in Europe) in multiple trials over several decades. The qualifications for using IFX for UC are notable adverse events (sepsis, neoplasia, neuropathy) after treatment with IFX, for a steroid-free remission rate of only 24% after 7 months. Furthermore, prolonged medical therapy for a premalignant condition with anti-TNF therapy creates its own anxieties. Physicians should inform their patients that there is just one attempt at rescue therapy, because only one patient at their hospital needs to die from the consequences of delayed colectomy to change the balance of benefit between medicine and surgery [10, 41]. Ultimately, it's about saving lives, not colons.

31.5.4 Timing of Surgery

Medical indecision-making is the bane of management. This reflects the difficulty in making an irrevocable decision about colectomy, which neither the patient nor physician (or indeed the surgeon) wants. It helps to know that most of those who have an incomplete response to intensive treatment (stool frequency > 3/day, or those with visible blood in the stools at day 7) come to colectomy in the following months [17]. As a general rule, patients who do not respond to steroids within 3–5 days should have medical rescue therapy, since the failure of continued steroids in these poor responders is predictable. For CsA, the median time to response is 4 days [34], and for IFX the median time to response is about 7 days [40], so failure to respond by this time is usually an indication for colectomy. This is why surgeons should encourage their physicians to make early decisions rather than contribute to delay and risk perforation or post-operative complications.

31.6 Longer-Term Management

Maintenance therapy to prevent relapse is recommended [10, 24], although the potential of mesalazine to have a chemopreventive action against colorectal cancer is an added incentive. The distribution and pattern of disease need consideration.

31.6.1 Distribution and Progression of Disease

In a population-based study of 1,161 patients with UC, 48% had proctitis or proctosigmoiditis, 32% had left-sided colitis, and 18% total colitis, with 2% undefined at presentation [42]. Others have found similar results. The risk of proximal extension of proctitis has been debated. It has conventionally been estimated at around 15%, but appears to be higher. In a study of 341 patients with proctitis followed up for a mean 52 months, proximal extension occurred in 27%, but rarely beyond the splenic flexure (risk 1% per year) [43].

31.6.2 Pattern of Disease

Three patterns of colitis were described in early studies [44] and remain relevant: (1) intermittent (≤2 relapses/year, 70–80% of patients), (2) frequent (≥3 relapses/year) and (3) chronic continuous disease (10% of new patients). Two useful observations that help patient management are derived from a population-based study. The chance of experiencing 1 year in remission after a relapse is 30% (which is an encouragement to take maintenance therapy), while the chance of remaining in remission after a full year of remission is 80% if treatment remains unchanged [42]. The pattern of disease was unrelated to the distribution of disease.

31.6.3 Maintenance of Remission

The main role for aminosalicylates is maintenance of remission in UC. Individual mesalazine derivatives all show comparable efficacy to sulphasalazine [27, 45]. Life-long maintenance therapy is generally recommended for all patients, especially those with left-sided or extensive disease and those with distal disease who relapse more than once a year. Discontinuation of medication may be reasonable for those with distal disease

who have been in remission for 2 years and are averse to such medication.

The principal advantage of mesalazine derivatives over sulphasalazine is that they are better tolerated. For the maintenance of remission, oral mesalazine 1–2 g daily or balsalazide 2.5 g daily should be considered as first-line therapy [24]. Mesalazine suppositories 1 g daily may be used in patients with proctitis, with or without oral mesalazine, but patients are less likely to be compliant [46]. All aminosalicylates have been associated with nephrotoxicity, which appears both to be idiosyncratic and in part dose-related [47]. Reactions are rare, but patients with pre-existing renal disease are at higher risk. Occasional (perhaps annual) measurement of creatinine is sensible, although there is no evidence that monitoring is either necessary or effective. Aminosalicylates should be stopped if renal function deteriorates. Patient adherence to treatment and not the choice of aminosalicylate is probably the most important factor for maintaining remission. The risk of relapse increases five-fold (OR 5.5, 95% CI 2.3–13.2) when patients take < 80% of the prescribed mesalazine [48]. For this reason, once-daily dosing may be an advantage [49], but trials have yet to show that this effectively improves adherence and outcome.

Azathioprine (AZA) 1.5–2.5 mg/kg/day or mercaptopurine 0.75–1.5 mg/kg/day are both effective at maintaining remission in UC. A study from Milan has shown that steroid-free clinical and endoscopic remission was achieved in 53% of AZA-treated patients, compared to 21% of those on 5-aminosalicylic acid (5-ASA; OR 4.78, 95% CI 1.57–14.5) in patients with active, steroid-dependent UC [50]. For arbitrary but practical purposes [51], AZA is considered appropriate for:

1. Patients who have had a severe relapse
2. Those who require two or more corticosteroid courses within a calendar year
3. Those whose disease relapses as the dose of prednisolone is reduced below 15 mg
4. Relapse within 3 months of stopping steroids

These are the patients who should be referred to a gastroenterologist, whatever the extent of disease. Patients with gastrointestinal intolerance of AZA may be cautiously tried on mercaptopurine before being considered for other therapy or surgery. Steroids are ineffective at maintaining remission, and steroid-dependent UC in spite of AZA is an indication for surgery, after options such as IFX have been discussed.

IFX (5 mg/kg every 8 weeks) is also effective at maintaining remission in patients who have disease refractory to 5-ASA or immunomodulators. It is important to recognise that the effect is, however, less impressive than often promoted, lest patients or their physicians think this is the ultimate answer to treating UC. Large (364 patients) trials of IFX have shown remission rates at week 54 of 35% (5 mg/kg every 8 weeks) and 34% (10 mg/kg), compared to 17% given placebo [10, 40]. The proportion of patients with a sustained clinical remission at *all* time points was 7% (placebo) and 20% (5 mg/kg) after 54 weeks. The steroid-free remission rates in the 74 patients receiving corticosteroids at baseline were very modest, although still statistically significant. IFX is a useful option for treatment-refractory UC, but only in the context of careful discussion about risks and benefits, as well as other options including surgery.

31.6.4 Chemoprevention and Risk of Cancer

Although it is clear that long-term UC carries a colorectal cancer risk, its magnitude has been difficult to estimate. Most cancers arise in pancolitis and there is general agreement that there is little or no increased risk associated with proctitis, while left-sided colitis carries an intermediate cancer risk. A meta-analysis of all published studies reporting a colonic cancer risk in UC shows the risk for *any* patient with colitis to be 2% at 10 years, 8% at 20 years and 18% after 30 years of disease [10, 52]. Much appears to depend on the population studied, with the most recent data from Copenhagen showing no increased risk overall [53]. This group, however, have an active approach to maintenance mesalazine and surgery for refractory disease.

Advances in the understanding of the mechanism of action of mesalazine, including activation of the peroxisome proliferator-activated-receptor-gamma pathway, suggest a rationale for a chemopreventive action of mesalazine [54]. A meta-analysis of nine studies estimated that 5-ASA approximately halved the risk of a patient with UC developing colorectal cancer or dysplasia and that the protection increased with the time for which 5-ASA was taken [55].

31.6.5 Surveillance

The value of surveillance colonoscopy in UC, although widely practised, remains debated. It is important to discuss with individual patients their risk of colorectal cancer, the implications should dysplasia be identified, the limitations of surveillance (which may miss dyspla-

sia) and the small, but definable, risks of colonoscopy. A joint decision on the appropriateness of surveillance can then be made, taking the patient's views into account. It is advisable that patients with UC should have a colonoscopy after 8–10 years to re-evaluate disease extent. Whether patients with previously extensive disease whose disease has regressed benefit from surveillance is yet unknown.

For those with extensive colitis opting for surveillance, it is recommended that colonoscopies should be conducted every 3 years in the second decade, every 2 years in the third decade and annually in the fourth decade of disease [10, 56]. The conventional approach has been to take 2–4 random biopsies every 10 cm from the entire colon, with additional samples of suspicious areas. The value of random biopsies has been questioned. Chromoendoscopy with dye-spray is more sensitive.

Colectomy is recommended following the detection of high-grade dysplasia or where there is low-grade dysplasia associated with a dysplasia-associated lesion or mass (DALM). The significance of low-grade dysplasia in otherwise flat mucosa is much more controversial and in our practice is not an indication for a prophylactic colectomy, but for colonic surveillance every 3–6 months [57]. There has been controversy recently over the distinction between a DALM and an adenomatous lesion or mass. In an older population with UC there would be an expected incidence of adenomas and cancers similar to the normal population. It was previously thought that the presence of an adenoma in a patient with an underlying UC was an indication for colectomy, but a more conservative approach has been taken recently and in certain circumstances local excision of an adenoma in otherwise quiescent UC is undertaken. Such a strategy requires careful and compliant follow-up [10, 58–60].

31.7 Surgery for UC

31.7.1 Indications

The principal indications for surgery can be divided into emergency – acute severe colitis, toxic dilatation, perforation and haemorrhage – and elective, where there is refractory disease either steroid-dependent or steroid-resistant with frequent hospital admission, poor quality of life and an impact on work and home circumstances. An increasing indication is in those patients with osteoporosis who are having a repeated course of steroids. Dysplasia and cancer change as described above is also an important indication.

31.7.2 Elective Surgery for Refractory Disease

The choices include proctocolectomy and permanent ileostomy, a colectomy and ileorectal anastomosis or an ileoanal pouch procedure. A joint medical and surgical decision is important here to minimise the effects of treatment on the patient's schooling, secondary education and work. Recent evidence suggests that resection of the rectum, whether it is a proctocolectomy or pouch operation, results in a major reduction in fertility, probably from tube occlusion. This may be an indication in some female patients for an abdominal colectomy leaving the rectum in place, and a terminal ileostomy whilst the patient completes their family and then subsequently has the rectum excised and a pouch formed.

31.7.3 Emergency Colectomy

The principle here is to remove the entire abdominal colon, preserving the rectum and creating an end ileostomy. The rectum has to be left long enough to allow for an easy subsequent pelvic dissection for any possible pouch formation. The colectomy and ileostomy strategy allows the patient to experience a stoma and to withdraw steroid and other medications to allow complete recovery in the best circumstances for subsequent elective surgery. The rectum can be divided at the sacral promontory, brought out as a separate mucus fistula or closed at the lower end of the abdominal wound. Dissection of the rectum down to the pelvic floor must be discouraged. There is a high incidence of breakdown of the closed anus and navigation into the pelvis and subsequent attempts at restorative surgery can be made extremely difficult.

31.8 Ileoanal Pouches

31.8.1 Formation and Management

Ileal pouch anal anastomosis (IPAA) or restorative proctolectomy has become the standard of care for patients with UC who ultimately require colectomy. It was initially developed by Parks and Nicholls during the 1970s [61]. Their ileal pouch was anastomosed to the dentate line using a per-anal suturing technique after a mucosectomy, stripping the lining of the upper anal canal of its columnar epithelium. The advent of stapling instruments has simplified the anastomosis, but it still remains a major procedure with a potential

for significant morbidity. It is clearly preferred by many young patients since it avoids the need for a long-term stoma. The ideal result is the patient having five to six semi-formed bowel motions per day with no nighttime evacuation and no incontinence.

Although age was at one time an important part of patient selection, there is no evidence that those in the 50- to 70-year age group have any worse function than younger patients, and a pouch operation would be considered even in those over 75 years of age [62].

The diagnosis of indeterminate colitis is made in 10–15% of patients having a colectomy, especially when carried out for severe colitis in the emergency situation. Provided the histopathology has been carefully checked, it is reasonable to offer patients with indeterminate colitis an ileoanal pouch procedure. A small proportion of these patients will in time come to be regarded as having Crohn's disease, but the majority behave in the same way as those with UC [63, 64]. Those with Crohn's colitis have usually been regarded as a contraindication to ileal pouch surgery. Recent studies from France suggest that patients with Crohn's disease confined to the colon may have ileal pouch surgery with comparatively favourable long-term results, but this remains highly controversial. There is only a small group of patients who have universal colitis, a normal anus without any perianal disease and no inflammation involving the rectum in those with a clear diagnosis of Crohn's disease [65].

The presence of dysplasia or an early cancer in the colon or high rectum does not preclude ileal pouch operation. Careful consideration has to be given to a mucosectomy in these patients to remove all columnar epithelium where there is multifocal dysplasia or there are multiple tumours.

31.8.2 Ileal Pouch Surgery Technique

The triple-limb or S-shaped pouch was originally devised by Parks and Nicholls. This required hand suturing and suffered from kinking or narrowing of the efferent limb, requiring revision. Most surgeons now use a J-pouch design, although W and H pouches have also been described. Compliance of the ileal reservoir, a strong anal sphincter and intact anal reflexes seem to be the most important factors resulting in a good outcome from pouch surgery. The J pouch is easy to construct by stapling and uses a reduplicated loop of 20 cm in each limb of terminal ileum. Emptying is reliable and functional results seem to be equal to those of other reservoir designs.

31.8.2.1 Mucosectomy or Double Stapling

Early pouch surgery included a mucosectomy combined with a perianal hand-sewn anastomosis, allowing the precise placement of the anastomosis and the removal of the columnar epithelium in the upper anal canal. It has several disadvantages, however. It is more complex to perform and may predispose to higher rates of sphincter damage and incontinence, especially nighttime soiling. The area of mucosectomy also includes the anal transitional zone, which may be important for sampling and sensation. In non-experienced hands the mucosectomy may also involve anal dilatation with an effect on subsequent sphincter function [66].

The double-stapled pouch technique preserves the anal transitional zone without any prolonged anal dilatation, but does leave a short strip of columnar epithelium [67]. Following the rectal mobilisation a transverse stapler is fired across the anorectal junction, positioning transection about 2–3 cm above the anal margin or 1 cm above the dentate line. If the anastomosis is placed too high there can be resulting columnar epithelium cuffitis or a pouch rectal anastomotic stenosis. A circular stapler inserted via the anus joins the ileal reservoir to the upper anal canal. Although it has not been possible to demonstrate the clear advantage in terms of continence from a stapled compared with a hand-sewn anastomosis, this has been associated with higher rates of anastomotic disruption and pelvic sepsis.

31.8.2.2 Staged Ileal Pouch Surgery

Most surgeons favour the creation of a temporary defunctioning loop ileostomy following IPAA, since this avoids potentially catastrophic pelvic sepsis in the event of anastomotic dehiscence and also subsequent pouch dysfunction. The downside of a loop ileostomy is small-bowel obstruction. In patients who are not on steroids [68], well nourished, and of a young age and female it may be possible selectively to omit the loop ileostomy. This is more likely in those who have already had a colectomy.

31.8.2.3 Laparoscopic IPAA

In conventional open surgery a long midline incision is necessary for access to the splenic flexure and the pelvis. The laparoscopic approach would appear to be more elegant, wound-related complications such as pain and infection may be reduced, and there is some

evidence that the longer-term risk of adhesions and incisional herniation may be diminished. Whilst complete laparoscopic IPAA has been shown to be feasible, many surgeons would favour a hybrid procedure with mobilisation of the colon and intracorporeal vessel ligation followed by a pelvic dissection and creation of a pouch through a Pfannenstiel incision [69]. This is a developing theme and so far the main advantages have been cosmetic appearance and a slight reduction in perioperative stay. Functional outcomes seem to be similar.

31.8.3 Complications of IPAA

The major complications of IPAA are shown in Table 31.5.

Table 31.5 Pouch failure

Early	Late
Bleeding	Pouch cutaneous fistula
Infarction	Pouch vaginal fistula
Sepsis	Anal stricture
Leak	Long retained rectal cuff
	Efferent pouch limb
	Small-bowel obstruction
	Crohn's disease
	Pouchitis

31.8.3.1 Acute Sepsis

This is a common complication of ileal pouch surgery. Post-operative fever should be taken seriously. Septic complications usually result from an anastomotic dehiscence or the presence of an infected pelvic haematoma. Digital examination may reveal an anastomotic defect, an area of localised tenderness or an indurated or fluctuant mass. Early computed tomography (CT) scanning can gauge the extent of sepsis. A magnetic resonance imaging (MRI) scan will be useful in the more chronic cases. For a small abscess a trial of broad-spectrum antibiotics is helpful, but large abscesses may need CT-guided drainage. Where there is anastomotic breakdown an examination under anaesthesia is mandatory. Any associated abscess can be drained and the cavity cleared out and cleaned. A catheter may be placed in it for irrigation and drainage. If identified early enough, some cases may be amenable to immediate repair provided there is not too much underlying sepsis. In the Cleveland Clinic series of stapled anastomoses reviewing 1,965 ileoanal pouches, anastomotic separation occurred in 5%, pelvic abscess in 5% and fistula formation in 7% [70]. Analysis of the causes of pouch failure in the Toronto series showed that of 551 pouches, 49 (8.8%) failed and the most frequent cause of failure was anastomotic leakage in 21 (39%) [71]. Re-laparotomy is reserved for cases where CT-guided drainage and minor surgery have failed to control sepsis or for those who deteriorate quickly at the signs of generalised peritonitis. Major leaks require a proximal diverting loop ileostomy if one is not already in place. Where complete anastomotic disruption has occurred, consideration should be given to exteriorising the pouch. With gross ischaemia, the pouch should be resected and the ileum exteriorised.

The role of steroids in impairing healing of the ileoanal pouch anastomosis remains controversial, but it is customary to avoid pouch formation and instead perform a subtotal colectomy in those patients who are acutely unwell or those receiving high-dose steroids. A defunctioning loop ileostomy is considered mandatory in those on more than 20 mg prednisolone daily [10].

31.8.3.2 Haemorrhage

Haemorrhage from the pouch suture line is unusual, but treatment includes irrigation of the pouch with 1:200,000 adrenaline solution, and a return to the operating theatre with local attempts at suturing, injection or diathermy. Occasionally a pouch can be packed.

Secondary haemorrhage is usually a sign of pelvic sepsis. Intra-abdominal haemorrhage can arise from mesenteric vessels or the pelvic side walls.

31.8.4 Late Complications of IPAA

31.8.4.1 Small-Bowel Obstruction

In a large series from Toronto, the risk of small-bowel obstruction outside of the perioperative period was reported as 6% at 1 year, 14% at 5 years and 19% at 10 years [72]. One-quarter of these patients experience more than one episode. Laparotomy was required in one-third of patients, and in the majority of cases the small bowel was adherent to the pelvis or a previous stoma site. Factors predisposing to small-bowel obstruction were revisional pouch surgery and the formation of a defunctioning stoma. CT with contrast will

provide information regarding the extent and degree of obstruction. This is usually managed conservatively initially, offering a laparotomy to those who do not settle.

31.8.4.2 Fistulae and Chronic Pelvic Sepsis

Long-term manifestations of pouch sepsis include anastomotic stenosis and a variety of fistulae including pouch anal anastomotic, pouch vaginal, pouch perineal and proximal pouch cutaneous. Functional outcome is likely to be worse following pelvic sepsis that affects pouch compliance and anal sphincter competence.

31.8.4.3 Pouch-Vaginal Fistula

The incidence of pouch-vaginal fistula varies between 3 and 16%. In a study of 68 patients from St. Mark's [73] the fistula originated from the anastomosis (76%), the pouch (13%), or from a cryptoglandular source (10%). Underlying causes will include operative trauma, undiagnosed Crohn's disease and post-operative pelvic sepsis. Rates of healing are worse and pouch failure is more common in patients with an underlying diagnosis of Crohn's disease.

Initial management includes local drainage of the tract with a seton, and faecal diversion in selected cases depending on the degree of uncontrolled sepsis. Per-anal access to the fistula arising from the anal canal may be difficult and require potentially harmful anal dilatation. The transvaginal route is favoured by many. The internal opening is exposed through the posterior wall of the vagina, the pouch anal anastomosis is then mobilised, the defect closed and the vaginal wall closed over that. A first attempt can be carried out without a defunctioning stoma, but failure and further attempts require defunctioning. In some cases transabdominal advancement of the ileoanal anastomosis with closure of the defect is necessary when the pouch cannot be mobilised or adequately treated from below. Some patients with unrecognised Crohn's disease can be treated with IFX (see Chap. 30).

31.8.4.4 Anastomotic Stricture

This may result from leakage, tension or ischaemia at the IPAA and occurs in 5–15% of cases [74]. It is important to perform an adequate examination under anaesthetic prior to ileostomy closure, as well as a pouchogram. Symptoms of diarrhoea, anal or abdominal pain and straining suggest stricturing of the anastomosis. Simple digital dilatation or dilatation with Hegar's dilators may suffice. Longer strictures, or where a long columnar cuff has been left behind, may require re-laparotomy and mobilisation of the pouch and re-anastomosis.

31.8.4.5 Sexual Dysfunction

Ejaculation is a sympathetic event that is mediated by the hypogastric nerves, whilst erectile function depends on the parasympathetic erigent nerves. These structures can be damaged during pelvic dissection as they lie close to the mesorectal plane. Some surgeons advocate a close rectal dissection, but this approach is highly vascularised and many surgeons therefore prefer the more anatomical mesorectal plane [75]. Sexual dysfunction occurs in around 3% of men following pouch surgery, and for this reason sperm banking should be recommended. Sildenafil (Viagra) has been shown to help erectile dysfunction [76].

31.8.4.6 Fecundity and Pregnancy

Since UC commonly affects young females of reproductive age it is important to note that fertility rates are lower in women who have had pouch surgery compared to those who undergo purely medical management. Around 40% of women will have difficulty becoming pregnant after IPAA [77].

Vaginal delivery may cause an occult sphincter injury in 30% of patients, and females with an ileal pouch could risk incontinence following vaginal delivery. Pouch function itself changes little during pregnancy and returns to normal thereafter. There is support in North America for allowing vaginal delivery, but in Europe the potential for damage to the anal sphincter would mean that a caesarean section is usually advised for patients who already have an IPAA [10, 78, 79].

31.8.4.7 Pouch Failure

Pouch excision or the indefinite retention of a defunctioning stoma defines pouch failure. Long-term failure occurs with a frequency of 5% at 5 years and 10% at 10 years. Early pouch failure is closely associated with

perioperative sepsis, whilst late pouch failure is more often due to poor function or the unexpected diagnosis of Crohn's disease.

The success of re-do pouch surgery for UC has improved and now some three-quarters of patients retain a functional pouch in the long term [80]. The best results of re-do surgery are in those with an excessively long efferent ileal limb with a tortuous stricture and in those with a long cuff of retained columnar epithelium [81]. It is less clear whether success can be achieved in those with ongoing sepsis [82]. Re-do surgery carries an appreciable morbidity rate, but in those having the pouch completely removed this may be as high as 60%. In a recent St. Mark's series [83], salvage had been attempted in 82% of cases prior to excision. A less common complication was non-healing of the perineal wound (40% at 6 months and 10% at 12 months). Multiple procedures are often necessary. A technique of close pouch dissection was used to avoid impotence and care has to be taken over the identification and preservation of displaced ureters.

31.8.5 Pouch Dysfunction

In a cohort of a 123 symptomatic patients with pouch dysfunction, the underlying diagnosis was pouchitis in 34%, irritable pouch syndrome in 28%, unrecognised Crohn's disease in 15% and cuffitis in 22% [84]. Many patients need fine tuning of pouch function, which may require consideration of dietary factors such as lactose intolerance, wheat starch sensitivity, and treatment of upstream small-bowel bacterial colonisation. Occult sepsis diagnosed by MRI scan can be an important cause of an irritable pouch. Having excluded these other causes it is then reasonable to consider the management of pouchitis.

Prolonged faecal exposure leads to adaptive changes in the ileal pouch so that it comes to resemble colonic mucosa. Pouchitis is a relapsing acute-on-chronic inflammatory condition presenting with increased stool frequency, abdominal cramps, malaise and low-grade fever. The cause is unknown, although recurrent UC in areas of colonic hyperplasia and bacterial overgrowth are supposed possible mechanisms [85, 86]. Patients with new symptoms of pouchitis should be investigated by endoscopy and biopsy. The endoscopic appearances can be similar to UC but include either diffuse inflammation or discrete ulceration. Histologically, there are signs of acute inflammation superimposed on a background of chronic inflammatory change.

The cumulative probability of pouchitis determined on the basis of symptoms, endoscopy and pathology in one series of 468 IPAA patients was 20% at 1 year, 32% at 5 years and 40% at 10 years [87]. No pouchitis occurred following surgery for familial adenomatous polyposis. Patients with primary sclerosing cholangitis are more prone to develop pouchitis, with a cumulative probability of 79% at 10 years. First-line therapy is with metronidazole or ciprofloxacin. An algorithm for the management of pouchitis and pouch dysfunction is shown in Fig. 31.1. Oral metronidazole and ciprofloxacin resulted in clinical improvement in 96% of patients with pouchitis. A 7-day course of either metronidazole 200–250 mg three times daily or ciprofloxacin 500 mg twice daily seems to be the most effective. While ciprofloxacin has relatively few side effects, metronidazole can induce an unpleasant taste, nausea or peripheral neuropathy if treatment is prolonged. Further attacks can be treated by cycling these two antibiotics or using them in combination [88]. Maintenance therapy may be effective using smaller doses or alternate daily dosing [89]. The probiotic VSL#3 can be taken orally, with decreased relapse rates demonstrated in randomised trials. It has also been used prophylactically after pouch surgery. At 1 year, 10% of the VSL#3-treated patients experienced pouchitis, compared with 40% receiving placebo [90]. Those who fail to respond can be offered oral or rectal steroids or mesalazine. Defunctioning or pouch removal may be required for chronic pouchitis.

31.8.5.1 Cuffitis

Conventional double-stapled IPAA leaves 1.5–2 cm of columnar epithelium above the anal transitional zone. Recurrent colitis within this cuff is termed cuffitis and occurs in 10–20% of patients. It can lead to increased stool frequency, bloody discharge, urgency and discomfort. Mesalazine suppositories and topical steroids may be helpful [91]. Dysplasia or carcinoma may theoretically arise within the unresected columnar mucosa, or in islands of columnar epithelium left behind after mucosectomy. Adenocarcinomas have been reported below the level of the IPAA, but are almost invariably associated with the presence of severe dysplasia or malignancy within the original proctocolectomy specimen. Routine surveillance of the anal canal is not necessary until after the first 10 years following pouch construction, unless the patient has a previous history of dysplasia or malignancy [92].

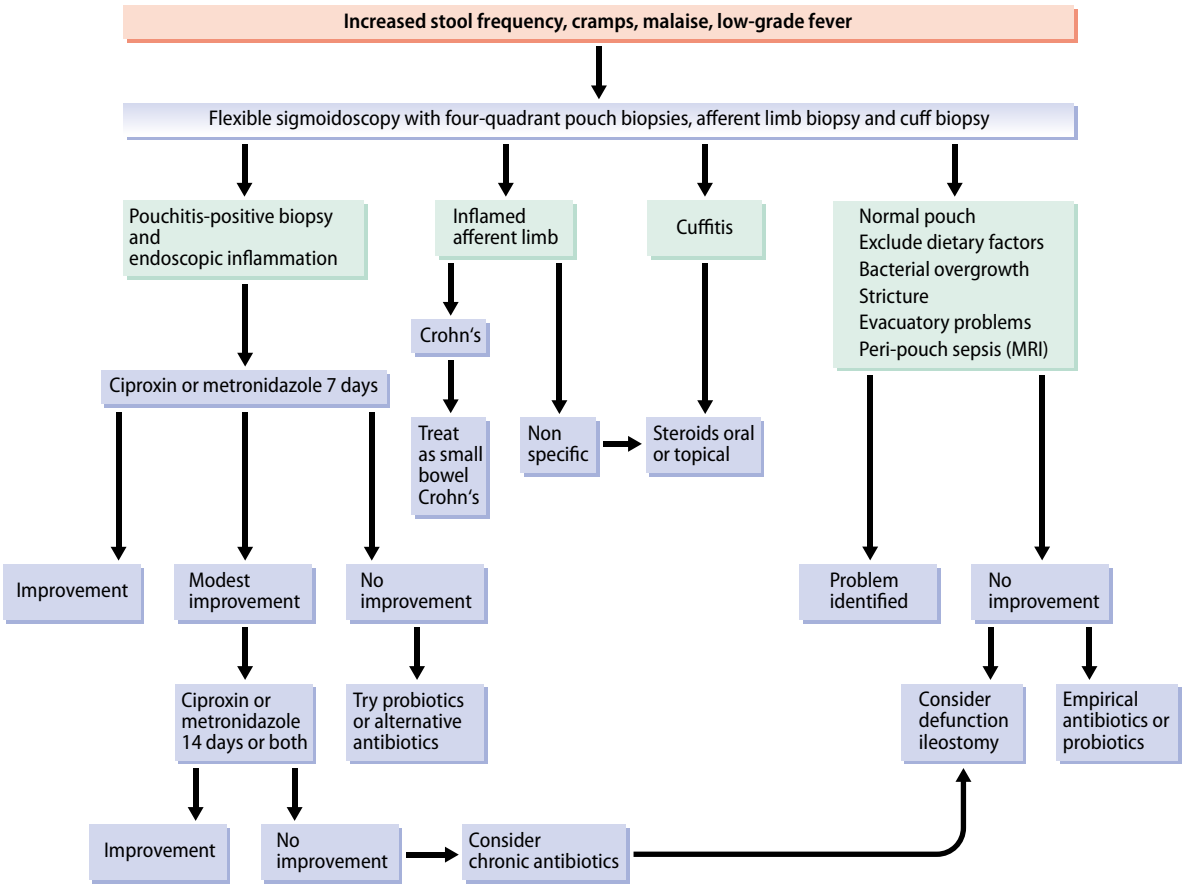

Fig. 31.1 An algorithm for the management of pouchitis and pouch dysfunction. *Q* Quadrant, *MRI* magnetic resonance imaging, *SB* small bowel, *pos* positive

31.8.6 Long-Term Outcome

Although there is a long-term attrition rate, with pouch failure occurring in 10% of patients at 10 years and probably rising to nearly 20% at 20 years, function seems to be stable in the majority of those patients who keep their pouch. Sphincter function deteriorates very slowly, with an increase in night-time soiling more marked than day-time incontinence [93]. Nonetheless, the operation is durable enough in patients who are well motivated and counselled about long-term outcomes. As a general summary, 10% lose their pouch, 10% have poor function but prefer to keep their pouch and 80% report a good quality of life.

31.9 Conclusion

Medical and surgical advances have revolutionised the management of UC in the past 20 years, but there is still a long way to go. Medical treatment with combined oral and topical aminosalicylates (mesalazine) is appropriate for mild or moderately active disease. Steroids still play an important role in treating patients whose symptoms are interfering with their lifestyle and for whom a prompt response is required, but early introduction of AZA or other immunomodulators are often necessary (40% of all patients) to maintain steroid-free remission. Anti-TNF "biological" therapy (IFX) is useful for patients who are refractory to conventional therapy, and reduces the need for surgery at 12 months, but clinical remission is still only achieved in one-third, and steroid-free remission in less than one-quarter of

patients after more than 6 months. The timing of colectomy remains the most important interface between the medical gastroenterologist and the colorectal surgeon. Careful selection of patients for ileoanal pouch surgery reduces the burden of pouch dysfunction, which substantially impairs the life of a minority of patients. The logistics of care, such as parallel medical and surgical clinics, and joint management of inpatients with acute severe colitis are important and greatly facilitate management.

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Self-Assessment Quiz

Question 1

Severe diarrhoea without visible bleeding usually occurs in:

a. < 5% patients with active ulcerative colitis
b. < 50% patients with active Crohn's colitis
c. Infective colitis caused by *Campylobacter*
d. Amoebic colitis
e. Proctitis

Question 2

A caecal patch is:

a. A process for primary culture of colonocytes
b. An indication of Crohn's disease if there is distal colonic inflammation
c. A procedure for burying the appendix stump at appendicectomy
d. A procedure for sealing a caecal perforation
e. A feature of distal ulcerative colitis

Question 3

When treating colitis:

a. Oral steroids are better than mesalazine for maintaining remission.
b. Mesalazine enemas are more effective than steroid enemas.
c. Oral mesalazine can be expected to induce remission in at least half of patients.
d. Mesalazine is best stopped when remission is achieved.
e. Azathioprine is inappropriate if steroids cannot be stopped within 2 months.

Question 4

Colectomy for acute severe ulcerative colitis:

a. Is best delayed for about 10 days to be sure that medical therapy is not working
b. Should only be performed once cyclosporin and infliximab have been tried
c. Is best combined with ileal pouch–anal anastomosis to avoid another operation
d. Should be considered with a C-reactive protein (CRP) of > 45 mg/l or bloody diarrhoea > 8 times daily on the 3rd day of intensive therapy
e. Is commonly complicated by infection if cyclosporin has been given preoperatively

Question 5

Ileoanal pouch surgery:

a. Is associated with intestinal obstruction in > 20% at 10 years and recurs in one-quarter of patients
b. Is associated with reduced fecundity in up to 40% of women
c. Is associated with pouchitis in one-third of patients within 5 years
d. Has a good or acceptable outcome in 95% of patients
e. Requires a covering ileostomy

1. Answer: a.
Comments: Bloody diarrhoea is so characteristic of ulcerative colitis (>95%) that the presence of non-bloody diarrhoea makes the diagnosis very unlikely. Similarly, bloody diarrhoea is relatively uncommon in Crohn's, so this helps distinguish the two diagnoses in clinical terms. *Campylobacter* and amoebic colitis classically cause bloody diarrhoea, and severe diarrhoea would be quite exceptional in proctitis [4, 10].
2. Answer: e
Comments: Patchy inflammation in the caecum is referred to as "caecal patch" and is sometimes observed in patients with distal colitis. The natural history of patients with patchy right-colonic inflammation seems to be similar to that for patients with isolated left-sided ulcerative colitis. All of the other answers are (entertaining) nonsense [8, 94].
3. Answer: b
Comments: Active colitis limited to the rectum should first be treated topically. Topical mesalazine is at least twice as effective

as topical steroids whether for symptoms (odds ratio, OR 2.42, 95% confidence interval, CI 1.72–3.41), endoscopy (OR 1.89, 95% CI 1.29–2.76) or histology (OR 2.03, 95% CI 1.28–3.20) [21]. Combined oral and topical mesalazine therapy is recommended for left-sided or pancolitis, with a low threshold for switching to steroids if a response (cessation of rectal bleeding) is not seen within 10–14 days. A systematic review of all placebo-controlled trials showed a remission rate on oral mesalazine of just over 20%. The response rate was of course higher. The principal role of mesalazine is in the maintenance of remission in ulcerative colitis, and in general all patients should be encouraged to take maintenance mesalazine. Oral steroids have no place in the maintenance of remission of ulcerative colitis of any extent and if steroids cannot be withdrawn within 2 months, or if there is an early relapse after stopping steroids, then azathioprine is appropriate [2].

4. Answer: d
Comments: The timing of colectomy in acute severe colitis demands the most taxing clinical judgement. Fortunately, it is possible to predict at an early stage (3rd day of treatment with intravenous corticosteroids) which patients are likely to need colectomy on that admission (CRP > 45 mg/l or bloody diarrhoea > 8 times daily). This is a signal to discuss surgical options by way of contingency planning and to make a decision about "rescue" therapy with cyclosporin *or* infliximab, but not both. Detailed appraisal of the options is given in the text. Cyclosporin does not increase the risk of septic complications after emergency colectomy; the situation with regard to infliximab remains unclear, although it does not increase septic complications after elective surgery [2, 95].

5. Answer: b
Comments: Ileopouch–anal anastomosis has transformed the surgical management of patients with ulcerative colitis refractory to medical treatment. However, only 80% have a good or acceptable outcome, two-thirds will have at least one episode of pouchitis within 5 years, and intestinal obstruction occurs in up to 20% at 10 years, which recurs in one-quarter of patients. A key factor in deciding on the timing of ileopouch–anal anastomosis in women of child-bearing age is the potential to reduce fecundity. Details are given in the text [96].

32 Diverticular Disease

Tim Brown and Alastair Windsor

CONTENTS

32.1 Introduction

The term "diverticular disease" is a generic term that is usually reserved for the condition of acquired false diverticula that affect predominantly the left sided and sigmoid colon. Right-sided diverticular disease does occur and is seen in practice, but is almost exclusively found in Oriental or Asian patients. Other diverticula exist (e.g. Meckel's diverticula) but will not be discussed in this chapter.

Diverticular disease is a common condition with a prevalence of greater than 60% in Western populations who reach the age of 70 years [1]. Autopsy studies on patients with non-gastrointestinal (GI)-related death have shown diverticula to exist within the colon of patients in their second decade. As people get older, their likelihood of having at least one diverticulum in their colon increases. The prevalence within the Western population is said to be increasing; however, an element of this increase is likely to reflect increased detection, especially as we enter the advent of bowel-cancer screening programmes. With the prevalence statistics in mind, therefore, it is perhaps surprising to reflect on the paucity with which this group of patients presents to the healthcare services.

The truth is that most people with "diverticulosis", the presence of diverticula within their colon but who lack symptoms or complications, normally manage to live in harmony with their colonic out-pouchings and die from a cause entirely unrelated to this benign condition. However, at its worst, diverticular disease is a source of much misery that can produce complications leading to the demise of its sufferer.

The great art that clinicians must practice, therefore, is one of identifying those individuals who will suffer symptoms related to their diverticula, and perhaps more importantly, identifying those who will suffer the more serious complications associated with this condition and then act in a timely manner to prevent them. This must be tempered by avoiding unnecessary investigations, interventions and consequently complications on patients who will not go on to develop these problems. Currently, good prospectively gathered evidence dealing with management issues in diverticular disease is lacking and so decision-making is based largely on the personal experience of the responsible clinician.

32.2 Historical Aspects

Diverticular disease is not a new concept and the presence of diverticula within the colon has been documented as early as 1700 by the French surgeon Alexis Littre. The presence of diverticulosis was uncommon, however, until the late 19th century, from which point the prevalence has been seen to rise steadily [2]. Denis Burkitt, an Irish surgeon working in Uganda during the 1960s and 1970s, stimulated much interest in the

condition with his observation that it only seemed to effect the expatriate population [3]. His observation was explained by the dietary difference between the two populations and led to his "dietary hypothesis for the pathogenesis of diverticulosis" [4]. He and his colleagues described an inverse relationship between colonic transit time and fibre intake. His hypothesis suggested that higher transit times are related to higher intraluminal pressures within the bowel, which cause the characteristic, acquired "blow-out" out-pouchings observed in diverticulosis.

32.3 Pathophysiology

Diverticula can be categorised as either "true" or "false" depending on the layers of intestinal wall that they are composed of. True diverticula are composed of all layers of the intestinal wall, false diverticula being composed of a proportion of these layers. They can be congenital (e. g. Meckel's diverticulum) or acquired (e. g. left-sided diverticulosis).

32.3.1 Right-Sided Diverticulosis

In the absence of left-sided diverticula, the presence of right-sided diverticula represents an entirely different condition from left-sided diverticulosis. It is common in Asia but rare in Caucasian populations. There may be a strong genetic component as migration studies show that the predominant form of diverticular disease within migrant Asians remains right-sided [5]. Diverticula can be true or false and the condition presents at an earlier age than left-sided disease. It is often complicated by bleeding rather than the inflammatory or stricturing problems that afflict those with left-sided disease. It presents a diagnostic trap to the unwary and may mimic appendicitis or the terminal ileitis of Crohn's disease.

32.3.2 Left-Sided Diverticulosis

Over 90% of diverticulosis within Western populations is left-sided. There are no reported differences in prevalence between the genders, although approximately 75% of those presenting at a young age are male who are likely to be obese.

Left-sided disease almost always affects the sigmoid colon. It never extends into the extraperitoneal rectum, but does extend proximally into the descending colon. The ascending colon and caecum are involved in less than 10% of cases.

Diverticula in the sigmoid colon are acquired, false "pulsion" or "blow-out" diverticula. Their aetiology relies on a weakness of the intestinal wall and a high intragut luminal pressure. Conditions predisposing to these two factors predominate within the sigmoid colon.

Anatomically, the large bowel consists of mucosa, submucosa, muscularis propria (consisting of inner circular and outer longitudinal muscle layer) and serosa. Blood enters the gut wall at the mesenteric border from a vessel travelling within the double-layered mesentery. Unlike the small bowel, the outer longitudinal layer of muscle of the gut wall condenses to form three band-like structures, the teniae coli that run on the inner layer of circular muscle. These can be seen traversing the entire length of the large bowel. One of these layers lies at the mesenteric edge of the bowel and the other two lie at the right and left lateral edges. Feeding vessels (the vasa recta) emerge from the mesentery and travel around the circumference of the bowel wall, running within the subserosal layer. The vessels then dive deeply to provide the mucosa and submucosa with a blood supply, simultaneously causing an anatomical defect within the circular layer of muscle, and thus a potential weakness through which the mucosa and submucosa may herniate.

The sigmoid colon contributes to the formation of "pulsion" diverticula in that it has the smallest diameter of the whole colon and so, according to the Laplace's law, will have the highest intraluminal pressure.

As well as this, to support Burkitt's hypothesis, segmentation of the colonic wall contributing to mixing of the colonic contents in those individuals with harder stool (e. g. those with lower residue in their diet) will produce high pressures within the segments and so may lead to the "blow-out" effect. Defects in connective tissue composition have been postulated; however, it is not clear whether observed changes are a response to the condition or a predisposing factor [6]. In support of the latter, diverticular disease is seen at a young age in those individuals who have inborn defects in their connective tissue composition (e. g. Ehlers-Danlos syndrome).

Macroscopically, diverticulosis has a characteristic appearance with numerous small mucosal out-pouchings from the gut wall that can be variable in position as well as in number (Fig. 32.1). The muscular layer is shortened longitudinally and causes prominent folding, giving a concertina-like appearance. Between the folds

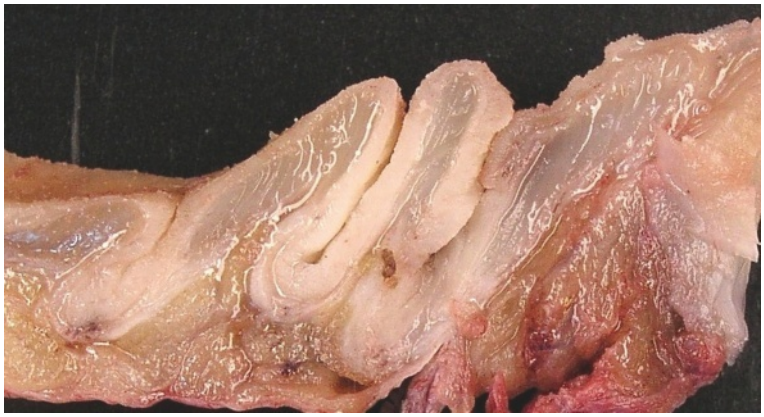

Fig. 32.1 Macroscopic section of diverticular disease

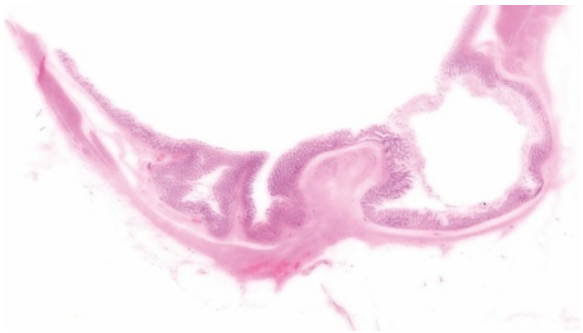

Fig. 32.2 Microscopic cross-section of diverticular disease

thrown up due to this shortening will sit the ostia of the diverticula themselves. Unless there has been inflammation or bleeding, the mucosa will appear normal. There may also be evidence of the complications of severe disease (e. g. abscess formation or haemorrhage).

When sectioned for microscopic examination (Fig. 32.2), the individual diverticula are conical in shape, consisting of out-pouchings of mucosa lying within the loose areolar tissue of the subserosa. A formal muscularis propria is always absent.

32.4 Complications of Diverticulosis

Diverticulitis, inflammation of a diverticulum (Fig. 32.3), is the commonest complication of diverticulosis. It is caused by obstruction of the neck or ostium of a diverticulum, usually by faeculent material. If this happens, the diverticulum will distend due to ongoing production of mucus remaining undrained. Much as appendicitis progresses, the diverticular mucosa will soon become gangrenous and perforate. The serosal layer or mesenteric envelope covering the diverticulum will usually contain the perforation and a local area of inflammation will arise. This inflammation may lead to formation of a peridiverticular abscess (Fig. 32.4) with concomitant serositis, or spread to involve adjacent colonic tissue. Local irritation of the parietal peritoneum will localise pain sensation to that site. It is important, therefore, to bear in mind the mobile nature of the sigmoid colon and realise that diverticular abscesses can present with localised right iliac fossa peritonism and mimic the presentation of appendicitis. The usual presentation, however, is one of left iliac fossa tenderness with associated systemic symptoms of fever and anorexia. Diarrhoea or constipation may also be present.

This will occasionally become a free perforation with direct communication between the bowel lumen and the peritoneal cavity. If the perforation is not walled off by adhesion formation, faeculent material may leak into the peritoneal cavity causing faecal peritonitis.

The natural history of the contained inflammation may progress in five ways:

1. The inflammation may resolve completely.
2. The inflammation may persist, giving rise to recurrent presentations with pain and fever.
3. The abscess may perforate into the peritoneal cavity, giving rise to purulent peritonitis.
4. The inflammation may become chronic, leading to formation of an inflammatory mass that will heal by fibrosis, leading further to stricture formation and possible colonic obstruction.
5. Chronic inflammation and serositis may lead to adhesion formation between the affected bowel and adjacent structures, eventually resulting in a fistula between these structures.

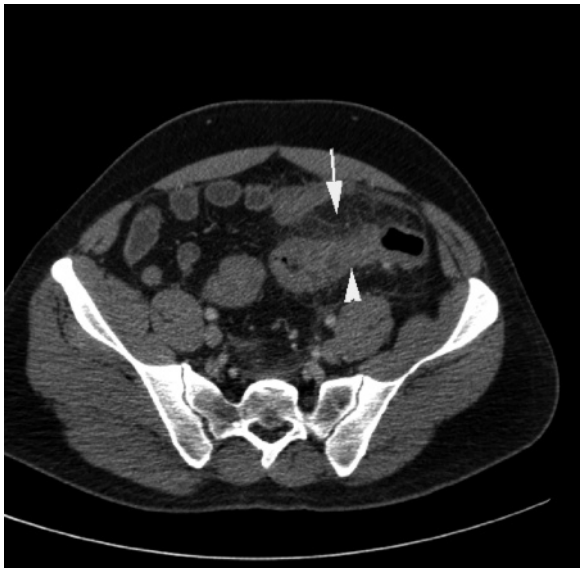

Fig. 32.3 Computed tomography (CT) abdomen. Diverticulitis with local "stranding" of pericolic fat indicating inflammatory change

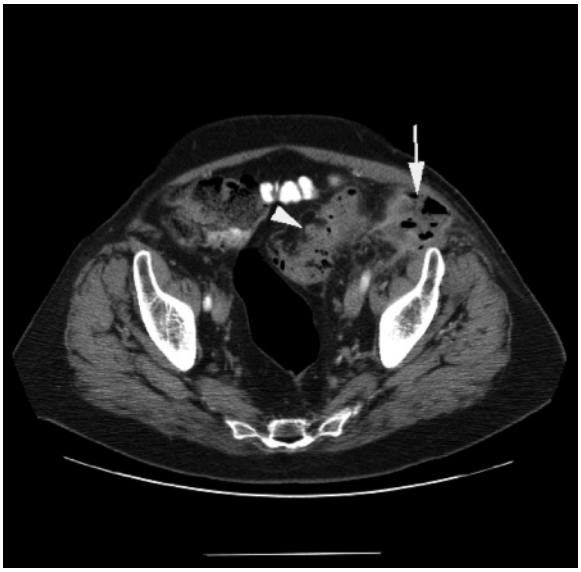

Fig. 32.4 CT abdomen. Localised diverticular abscess

Fistulae most commonly occur as colovesical or colovaginal fistulae; however, almost every other intra-abdominal viscus is at risk depending on the position of the mobile sigmoid colon. The commonest presentation of the colovesical fistula is of recurrent urinary sepsis with associated pneumaturia.

The inflammation may be extreme and lead to a systemic inflammatory response with sepsis and bacteraemia. Metastatic abscesses can form as a result of the bacteraemia (e. g. formation of a liver abscess from portal pyaemia).

A less common but serious complication of diverticulitis is haemorrhage. Mucosal ulceration from an inflamed diverticulum may erode into one of the vasa recta vessels and cause it to bleed. Characteristically, this bleeding is brisk, painless and bright red. Small bleeds may be accounted for by minor mucosal ulceration. Bleeding is an uncommon complication of diverticular disease but accounts for around 40% of cases of lower-GI haemorrhage.

32.5 Investigation

Most patients presenting with diverticular disease will present with abdominal pain that may be accompanied with GI symptoms. The goal of investigation is therefore to provide a diagnosis as a cause of the symptoms; to demonstrate any complications of the disease, and finally to guide management decision-making.

32.5.1 Contrast Enema

This was the mode of choice for the investigation of diverticulitis before computed tomography (CT) scanning became widespread. Use of water-soluble contrast instead of barium in the acute setting avoids contamination of the peritoneal cavity with barium should there be a free perforation (Fig. 32.5). There are the characteristic blow-out appearances of diverticulosis on contrast enema in addition to the saw-toothed effect brought about by the shortening of the muscularis propria. In addition, complications of the disease can be demonstrated; for example, if contrast is seen to leave the bowel lumen in communication with another viscus (e. g. colovesical fistula) or if there is communication with a peridiverticular abscess. A single-contrast enema is useful in the diagnosis of large-bowel obstruction because of its ability to demonstrate a mechanical cause of obstruction as an alternative to pseudo-obstruction. An important limitation of this technique is that on occasion the severity of the diverticular disease is such that the existence of a carcinoma within the diverticular region is hidden and will remain undiagnosed unless further investigation takes place. In this instance, mandatory luminal investigation should be undertaken.

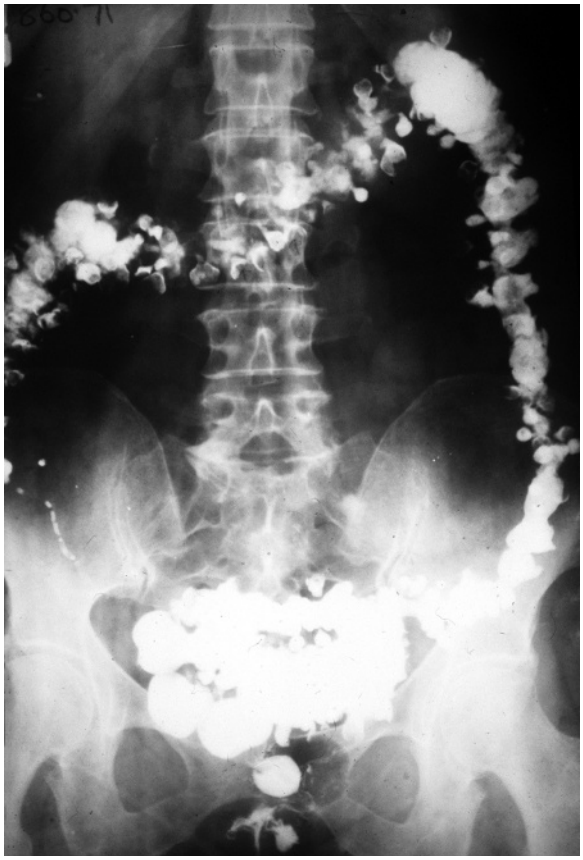

Fig. 32.5 Barium enema demonstrating widespread diverticulosis

32.5.2 CT Scanning

CT scanning has largely overtaken contrast enema as the gold standard investigation of choice in the management of diverticular disease specifically, as well as the acute abdomen in general. It has the highest specificity and sensitivity of any modality for the diagnosis of acute diverticulitis as well as providing accurate information on the associated complications of the disease [7].

The scan is usually undertaken with administration of oral and intravenous contrast to improve the sensitivity of diagnosing small perforations. Administration of rectal contrast can aid with diagnosis of fistulae as well as show communication with a peridiverticular abscess and the site of mechanical bowel obstruction.

Findings on CT that suggest acute diverticulitis include the demonstration of diverticula themselves, associated inflammation within the pericolic fat, pericolic abscesses and peritonitis as well as free perforation and distant inflammatory foci. Mechanical obstruction of the colon can be demonstrated; however, again, an underlying colorectal malignancy can be difficult to distinguish from the diverticulitis, which must be subsequently confirmed with endoscopy. This is of great importance because when colonic resection specimens are examined, diverticular disease and colorectal cancer exist in approximately one-quarter of cases.

A colovesicle fistula shows a characteristic triad on CT of colonic diverticula, a thickened colonic segment adjacent to the bladder and air within the bladder. Rectally administered contrast may present within the bladder. If there is active haemorrhage at the time of the CT scan, contrast extravasation may be witnessed; however, this is not a reliable investigation for the diagnosis of lower-GI haemorrhage.

CT has a great advantage over rectal contrast studies in that it allows for classification of diverticulitis into mild, moderate and severe, according to its appearance on the scan. Mild disease confirmed by presence of diverticula in association with bowel wall thickening and pericolic fat stranding. Moderate disease is defined as diverticula with bowel wall thickening of > 3 mm in association with a small phlegmon or abscess formation. Severe disease is present when bowel wall thickening is > 5 mm, perforation is seen as either localised or with free air under the diaphragm and an abscess > 5 cm in size is present [8].

There are few limitations in the use of CT scanning as it is well tolerated by most patients, although use of intravenous contrast should be reserved for people with good renal function.

32.5.3 Other Investigations

In the right hands, ultrasound can be a very sensitive mode of investigation in diverticulitis [9]. It is, however, operator dependent and this should be acknowledged when considering it as an investigation. It is very useful in demonstrating intra-abdominal fluid collections as well as liver abscess.

Plain-film radiography may demonstrate free air under the diaphragm in an erect chest radiograph or on a lateral decubitus film. It is, however, non-specific and has a low sensitivity. There is therefore no useful role for plain-film radiography in the diagnosis of diverticulitis and its complications [10].

Magnetic resonance scanning has not been widely used given the excellent information obtained from CT scanning. Although small studies have shown good results in the diagnosis of acute diverticulitis, magnetic

resonance imaging is poor at detecting free air, should it be present [11].

Endoscopy has a role in the diagnosis of non-specific GI symptoms and is superior to CT scanning in the differentiation between a benign and a malignant stricture. Routine endoscopic examination of patients will regularly reveal the ostia of uncomplicated diverticula, seen nestled between ridges of normal mucosa. In the acute setting, however, endoscopy must be undertaken with extreme caution due to the risk of perforation of an inflamed colon [12]. It should be reserved for examining a stricture that has been diagnosed in an acute setting (on either CT scan or contrast enema) that has subsequently settled with medical or conservative management.

32.6 Haemorrhage

In cases of large or repeated lower-GI haemorrhage, once an upper-tract lesion has been excluded, the next modality is mesenteric angiography. If the bleeding is sufficiently active, contrast will be seen to extravasate into the bowel lumen, allowing a targeted segmental resection. Alternatively, the interventional radiologist may elect to attempt to embolise the bleeding point and therefore prevent resection completely. If this fails, either preoperative or intraoperative on-table colonoscopy may aid localisation of the bleeding source, again preventing a subtotal colectomy. If the bleeding source is identified endoscopically, endoscopic haemostasis may be successful.

32.7 Classification Systems

Diverticular disease is classified as uncomplicated or complicated according to the presence of the various problems already described (e. g. formation of abscess, fistula, perforation, haemorrhage, obstruction). Hinchey and Killingback have described separate classification systems based on findings at operation (Tables 32.1 and 32.2). The purposes of developing these systems were to attempt to describe the severity of contamination secondary to the complication of perforation, either free or contained, and use this to determine or guide optimal treatment and relate this to prognosis. Their use is variable throughout the world and somewhat limited in the UK [13, 14].

Table 32.1 Adapted from Hinchey et al. (1978) [13]

Stage I – Diverticulitis associated with pericolic abscess
Stage II – Distant abscess (retroperitoneal or pelvic)
Stage III – Purulent peritonitis
Stage IV – Faecal peritonitis

Table 32.2 Adapted from Killingback (1983) [14]

Abscess
Peridiverticular
Mesenteric
Pericolic (pelvic)
Perforation
Free
Concealed
Gangrenous sigmoiditis
Peritonitis
a. Serous
b. Purulent
c. Faecal
i. Local
ii. Pelvic
iii. Generalised (diffuse)

32.8 Management

The vast majority of individuals with diverticula will never present to healthcare services as a result of this benign condition. A smaller proportion will present with a single episode of uncomplicated disease that requires no more than simple supportive management with appropriate antibiotics and bowel rest. However, a very small minority of patients will require operative intervention to resolve a complication of the diverticular disease, prevent complications of the disease, or to resolve the symptoms of the disease. Selection of this small subgroup and successful resolution of their problems is surgically challenging.

32.8.1 Elective, Uncomplicated Disease

Many patients with and without diverticular disease experience bloating, abdominal distension and colicky abdominal pain. If they subsequently undergo investigation that shows the presence of diverticular disease, then these non-specific symptoms may be attributed to the diverticulosis. If, however, no objective evidence of bowel pathology is discovered on investigation, the pa-

tient receives the label of irritable bowel syndrome or of a "functional" bowel disorder. Bowel resection for pain attributed to diverticulosis will result in improvement of pain in the initial post-operative period. However, in the longer term, the original symptoms will return in at least 25% of patients [15]. Therefore, the original diagnosis may have been one of an underlying motility or functional disorder. So, when considering an operation to resolve the pain attributed to diverticular disease, it has to be considered that there will be an unsuccessful outcome in at least one-quarter of cases.

32.8.2 Elective Resection After Diverticulitis

Only a small percentage of patients presenting with a complication of diverticulitis have ever previously been symptomatic with their disease [16]. This, then, raises the question, what is the natural history of uncomplicated disease? Will they continue to be plagued by recurrent episodes of diverticulitis? Are these patients likely to go on to develop serious complications such as perforation, GI haemorrhage, stricture formation and colovesical fistula? Bearing in mind the evidence that emergency surgery in these patients has a high associated mortality, would a "prophylactic" surgical approach confer benefit on them [17–23]?

The natural history of the disease is difficult to elucidate. Much of the data are gathered retrospectively and over a period of time in which imaging and therapeutics have changed significantly. The recognition of irritable bowel syndrome as a clinical entity that may be responsible for recurrent abdominal pain will also have played a part in previous surgical discussion. However, published data do suggest that around 15–25% of patients are readmitted with a second attack, 4–8% with a third attack and 1.6–3% with a fourth attack [24, 25]. In these series there were neither deaths attributable to recurrent diverticular disease nor increased risk of complications associated with diverticulosis in the follow-up period. In another study, Haglund et al. reported that 25% of patients required emergency surgery after the first attack, with 25% of these patients developing recurrent symptoms over the subsequent 12 years of follow-up. The risk of recurrence in the 1st year was 10%, increasing by 3% per year thereafter [26]. Most complications were associated with the first attack. In their comprehensive review of the subject, Janes et al. concluded that "offering elective resection would have little impact on the incidence of patients requiring emergency procedures", and that "for most patients, a complication of diverticular disease is the first manifestation of the disease. After the patient has definitely recovered from a first attack, their subsequent risk of developing diverticulitis approximates to that of the rest of the population [16]."

There is debate surrounding the application of this approach to younger patients (variably defined as age less than 40 or 50 years). It is suggested that patients in this age group are subject to a particularly aggressive form of the condition [12, 27–30]. This, coupled with the fact that due to their age they will have longer exposure to the risk of developing complications of the disease, has led to a more aggressive approach to prophylactic surgery in this specific group. Ambrosetti et al. are proponents of this approach and recommend an elective resection after one episode of severe (as diagnosed by CT) diverticulitis; their approach is perhaps supported by the observation that 60% of young patients with severe diverticulitis will suffer a recurrence [31]. It is not a universally held view, however, and has been questioned in a retrospective review of 762 patients by Guzzo and Hyman [32].

What does seem to be important when considering an elective resection to prevent recurrence of diverticulitis, is that the operative technique should include an anastomosis joining unaffected colon to the top of the rectum, ensuring that all of the distal sigmoid colon is excised [33]. It should also be borne in mind that elective surgery of this nature carries low, but significant morbidity and mortality rates [34].

When managing diverticular disease in the elective setting, a conservative approach may be safe. Surgical management should be approached in the knowledge that symptoms may not be resolved, that complications may never occur, and that there are potentially life-threatening complications associated with surgery. Therefore, careful selection of patients in this challenging cohort is paramount.

32.8.3 Emergency

Most patients presenting with acute diverticulitis do so for the first time and without knowing of the presence of their diverticula. The presence of a systemic inflammatory response and localised peritonitis differentiates acute diverticulitis from diverticulosis. Treatment with bowel rest and appropriate antibiotics (as dictated by local guidelines) forms the mainstay of management of these patients. In mild cases, with tenderness localising to the left lower quadrant and a mild systemic inflam-

matory response, patients can be safely managed in the outpatient setting; however, according to the severity of the sepsis and coexisting medical conditions, they may require inpatient admission and parenteral antibiotic administration. Conservative management is safe and can be successful in 70–100% of cases [26, 35–39]. If there are widespread signs of peritonitis and a significant inflammatory response, however, urgent operative management will usually be required. For those patients who present between these two extremes, conservative management and repeated assessment is a safe approach to adopt [40]. If symptoms do not resolve, then the possibility of a complication should be considered and further diagnostic imaging should be employed. If in these cases an abscess or inflammatory collection is discovered, the interventional radiologists should be consulted for consideration of percutaneous drainage of the collection. Abscesses less than 5 cm in diameter on CT can be managed with antibiotics alone, whereas more widespread contamination (Hinchey I–II) may gain rapid relief from percutaneous drainage. Drainage of purulent material also has the potential advantage of protecting an anastomosis, should the patient come to surgery and perhaps allow the surgeon the option of primary anastomosis rather than a Hartmann's procedure [41].

Operative management in the emergency situation should be reserved for the treatment of severe complications of diverticulitis, as uncomplicated disease should settle with conservative management alone.

Surgery in this context is associated with high morbidity and significant mortality. This is very often due to concomitant medical problems and occasionally, despite the presence of widespread peritonitis, patients may recover from optimum conservative treatment.

The choice of operation for these patients has recently been the subject of debate, and will remain controversial without large-scale, prospective studies. The choices of procedure are resection of the diseased sigmoid colon with closure of the rectal stump and formation of an end colostomy (Hartmann's procedure), and resection of the diseased sigmoid with primary colorectal anastomosis with or without temporary diversion. Anastomosis may or may not be accompanied with on-table colonic lavage. Patients undergoing resection with anastomosis and diversion with a temporary anastomosis seem to have a lower mortality rate when compared to patients undergoing Hartmann's procedure, even when data are corrected for coexisting comorbidities [42]. This study, however, was a retrospective meta-analysis and should be interpreted with caution. What does seem to be evident though, is that once formed, colostomy following Hartmann's procedure is only reversed 50–80% of the time [43, 44]. This may be due to comorbidity and a reluctance of the patient to undergo further major surgery. Reversal can be a difficult procedure and is associated with a high incidence of post-operative complications, resulting in a morbidity rate of between 10 and 50% and a mortality rate of 1–28% [45]. A recent meta-analysis of 6,879 patients with Hinchey III–IV peritonitis advocates a primary anastomosis and temporary diversion as the optimal strategy, representing the best compromise between adverse events, quality of life and risk of permanent stoma [46]. A prospective study of 41 patients concluded that one-stage resection, even in the presence of severe peritoneal contamination (Hinchey III–IV), was feasible and safe [47].

32.8.4 Haemorrhage

Diverticular bleeding can be brisk and life-threatening. Management should take the form of resuscitation, replacement of lost blood and clotting factors as required and identification of the bleeding site. As with all GI bleeding, an upper-GI cause should also be ruled out. Bleeding points can be localised by the interventional radiology team with digital subtraction angiographic techniques, but success of this technique depends to an extent upon the rate of blood loss, the optimum rate being 0.2–0.5 ml/min. Once identified, it is possible to embolise the bleeding point with the aim of preventing a major surgical procedure in an already compromised patient. If this service is not available, on-table colonoscopy is an alternative approach; however, vision may be obscured by blood. If these measures fail, then the patient should proceed urgently to laparotomy. In an attempt to localise the bleeding segment of colon, soft bowel clamps may be applied or the bowel divided to identify a section of bowel rapidly filling with luminal blood. If this is inconclusive, it is tempting to resect diverticular disease in the sigmoid as the likely candidate for the source of bleeding. However, "blind" sigmoid resection can miss an angiodysplastic right-sided lesion and proceeding to subtotal colectomy and formation of an end ileostomy is a radical, yet safe alternative. The rectal stump may be oversewn, with non-absorbable sutures placed to ease identification should reversal and ileorectal anastomosis be attempted at a later date.

32.9 Conclusion

Diverticulosis is a common disease and with the increasing prevalence of a Western diet, the disease and its complications may become more common. Good prospectively gathered data dealing with controversial management issues are lacking. However, there is evidence to suggest that an initial conservative approach in all but the most severe cases is safe to adopt and will often avoid the trauma of a major colonic resection with its risks of morbidity and mortality. The choice of operation in the emergency situation should be tailored on a case-by-case basis. When appropriate, however, colorectal anastomosis with temporary ileostomy may confer advantages over the traditional Hartmann's procedure.

In the elective situation, colonic resection as a prophylaxis to the development of further symptoms and complications remains controversial. Surgical management may have a role in the prevention of complications in a younger patient cohort, although this requires further consideration and clarification.

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Self-Assessment Quiz

Question 1

During emergency surgery for diverticular disease, the main intraoperative finding is of purulent fluid in the pelvis. According to the classification of Hinchey this is:

a. Hinchey stage I
b. Hinchey stage II
c. Hinchey stage III
d. Hinchey stage IV
e. Hinchey stage V

Question 2

Diverticula are:

a. Present in 20% of the population under the age of 40 years
b. Found on the left side of the colon in <50% of patients
c. True diverticula
d. Common on the right side in persons from the Far East
e. Associated with carcinoma of the colon

Question 3

Diverticular bleeding accounts for what proportion of gastrointestinal haemorrhage cases?

a. 10%
b. 20%
c. 30%
d. 40%
e. 50%

Question 4

Contrast enema investigations are useful for differentiating between mechanical and functional large-bowel obstructions. They are, however, ambiguous in the presence of diverticular disease when determining whether diverticular disease or colonic cancer is the cause of the obstruction. When examined, colonic specimens resected for mechanical obstruction of the colon show colonic cancer and diverticular disease to coexist in what proportion of cases?

a. 20%
b. 25%
c. 30%
d. 35%
e. 40%

Question 5

Diverticular disease and irritable bowel syndrome are both common conditions and coexist. Diverticular disease is commonly asymptomatic, whereas resection of the colon for an irritable bowel may not resolve symptoms. Attributing either of these to the patient's symptoms, therefore, presents a management problem to the clinician. Colonic resection for abdominal pain in the presence of uncomplicated diverticulitis is unsuccessful in what proportion of cases?

a. 5%
b. 15%
c. 25%
d. 35%
e. 50%

1. Answer: c
2. Answer: d
3. Answer: d
4. Answer: b
5. Answer: c

33 Polyposis Syndromes and Colorectal Cancer Predisposition

Christopher Cunningham, Rebecca A. Barnetson and Malcolm G. Dunlop

CONTENTS

33.1 Introduction

Colorectal polyps are common, affecting 25% of the population by age 75 years. However, the presence of multiple polyps, particularly in association with a personal or family history of colorectal cancer, should raise suspicion of a polyposis syndrome. The last decade has witnessed a dramatic increase in our understanding of polyposis syndromes and colorectal cancer predisposition. Here we discuss the polyposis syndromes that have been characterised to date and the implications for clinical practice (Table 33.1). Familial adenomatous polyposis provided the first example where the genetic lesion responsible for a dominantly inherited predisposition to cancer was elucidated, and it provided a window into the adenoma carcinoma sequence of sporadic cancer.

33.2 Familial Adenomatous Polyposis

Familial adenomatous polyposis (FAP) is an autosomal-dominant disorder (incidence of 1:10,000–15,000) that is characterised by the development of hundreds to thousands of adenomatous polyps in the colon and rectum early in life. Most carriers develop polyps around puberty and progress to cancer by middle age unless

Table 33.1 Relative contribution to colorectal cancer: incidence of genes known to cause polyposis syndromes and cancer predisposition. *HNPCC* Hereditary non-polyposis colon cancer

Polyposis syndrome	Gene	Contribution
Familial adenomatous polyposis	*APC*	0.07%
HNPCC	*MMR* genes	2.8%
Rare dominant polyposis syndromes		< 0.01%
Peutz-Jeghers syndrome	*STK11/LKB1*	
Juvenile polyposis	*SMAD4*, *BMPR1A*, *PTEN*	
Multiple adenoma phenotype	*MYH*	~0.5%

prophylactic colectomy is undertaken [1]. With greater clinical awareness and predictive genetic testing, the majority of cases are detected early and undergo prophylactic colectomy. Less than 0.07% of colorectal carcinoma incident cases are attributed to FAP [2]. Registries have been crucial in detecting at-risk individuals and offering protection by genetic investigation and clinical surveillance; however, around 25% of cancers attributable to FAP arise as new mutations in families where preceding generations demonstrate no increased risk of cancer.

FAP patients are also at increased risk of duodenal malignancy [3], and up to 32% develop desmoid tumours [4]. Although benign, these lesions cause distressing symptoms and are the most common cause of death in patients with FAP [5]. Symptomatic desmoids may be excised, but this can be challenging, particularly for those arising in the mesentery and retroperitoneum. This surgery is associated with considerable morbidity and high risk of recurrence. The growth of desmoids in the rectus sheath most often follows abdominal wall surgery. Non-surgical approaches to management have included radiotherapy, sulindac, doxorubicin and high-dose tamoxifen. Assessment of response to treatment can be difficult as desmoids may undergo spontaneous regression. Gardner's syndrome was once thought to be a separate disorder, but is now known to represent a phenotypic variation. The syndrome is associated with colonic polyposis combined with congenital hypertrophy of the retinal pigment epithelium, osteomas, dental abnormalities, epidermoid and sebaceous cysts, and neoplasms of the thyroid [6]. The cancer risk is equivalent to that in FAP, and prophylactic colectomy is recommended.

33.2.1 FAP Results from Mutations in the APC Gene

The gene responsible for FAP was identified by cytogenetics and genetic-linkage studies, which located the gene to chromosome 5q21–22 [7, 8]. The adenomatous polyposis coli (*APC*) gene was subsequently cloned and germ-line mutations identified in several FAP patients [9, 10]. *APC* is a large gene encompassing 15 exons over 250 kb, with an 8.5-kb transcript encoding 2,843 amino acid polypeptides. The vast majority of germ-line mutations reported in FAP families result in premature truncation of the APC protein [11, 12]. Around 80% of the *APC* mutations identified to date are in the large exon 15, with 2 specific mutations (codons 1061 and 1309) accounting for 15–20% of all *APC* mutations. However, the remainder are found throughout the gene with no other "hotspots". Short repeat sequences at the amino terminus of APC are predicted to form coiled-coil structures, suggesting that normal APC functions as a homodimer. Thus, mutations leading to a truncated APC protein may result in a heterodimer of the mutant/wild-type APC protein that may abrogate the function of the normal protein in a dominant-negative manner.

33.2.2 Genotype–Phenotype Correlation

Genotype–phenotype correlation can be useful in the clinical management of at-risk individuals by predicting the likelihood of extracolonic manifestations, such as desmoid disease or the extent of colonic polyps. Indeed, the common 1309 mutation is associated with a dense polyp phenotype and a high cancer risk in the retained rectum after prophylactic colectomy and ileorectal anastomosis [13], thus suggesting that proctocolectomy and ileoanal pouch reconstruction are the favoured option at initial surgery. However, the genotype–phenotype correlation can be inconsistent and identical *APC* mutations can have a diverse phenotype in terms of both colorectal polyposis and extracolonic disease [14]. Several variant syndromes are also caused by germ-line *APC* mutations. Attenuated FAP (AFAP) describes patients with later-onset disease and limited numbers of flat polyps. The mutations responsible for the AFAP phenotype tend to be in the first five exons of *APC*, exon 9 and at the 3' end of the gene [15]. Desmoid disease has been correlated with 3' APC gene mutations [16]. Although there are loose genotype–phenotype correlations, there remain many variables that impact on phenotype, even within a family, and it is likely that there are both genetic and environmental modifiers.

33.2.3 APC Gene Function

The complexities of the cellular role of APC have yet to be elucidated. The APC protein is expressed in epithelial cells in the upper portions of the colonic crypts, suggesting involvement in colonocyte maturation [17, 18]. Several functional domains are revealed in the protein sequence including the N-terminal homodi-

merisation sequences, as well as numerous other cellular processes such as cellular adhesion, cell-cycle regulation, apoptosis, differentiation and intracellular signal transduction. The central region of the protein contains β-catenin binding and regulatory domains as well as binding domains for the axin family of proteins. APC appears to influence cellular adhesion by affecting the interaction between catenins and E-cadherin, thus promoting the shedding and migration of epithelial cells. APC plays a critical role in intracellular communication by modulating the levels of β-catenin-dependent transcription [19]. β-catenin is an important transcription factor for oncogenic proteins such as cyclin D1 and c-myc [20]. APC, β-catenin and axin are central components in the Wnt signalling pathway, and the pivotal role of abnormalities in this pathway in colorectal tumorigenesis is exemplified by the presence of somatic mutations in its components in ~85% of all colorectal tumours [21].

APC also plays a key role in the microtubule cytoskeleton, binding to microtubules [22, 23], and is vital to cell division and migration. Truncated forms of the APC protein appear to be unable to bind microtubules [24] and mouse cells homozygous for a truncating mutation, *Apc*^{min}, display abnormal chromosome patterns when compared to their wild-type counterparts [22]. This suggests that APC plays an important role in maintaining the fidelity of chromosome segregation and thereby control of chromosome number. This hypothesis is supported by the observation that aneuploidy occurs in the majority of colorectal cancers with APC mutations, and underscores the complexity of the role that *APC* mutations play in suppressing tumorigenesis and tumour progression.

33.2.4 Clinical Management

The aims of clinical management are centred on carrier identification and prophylactic surgery involving removal of the majority of the large-bowel epithelium, which is highly effective in reducing colorectal cancer risk. Genetic testing should be offered around the time of puberty, although parents and child should be counselled that there is a small cancer risk even before this age [25]. There is substantial benefit from APC gene mutation analysis in FAP cases because only one gene is involved and it is relatively straightforward to survey the whole APC gene. Once a mutation has been identified, genetic testing can be undertaken in at-risk relatives, and gene carriers can be offered prophylactic surgery.

The aims of surgery are to reduce large-bowel cancer to the smallest possible level but maintain the ability for a normal life and fertility. Risk of colorectal cancer can be abolished by proctocolectomy and permanent ileostomy, and this was standard practice until the 1980s. However, patient preference and the considerable morbidity associated with such destructive surgery for young people now favours other surgical options where gastrointestinal continuity is restored. Colectomy and ileorectal anastomosis (IRA) involve reducing the surface area to only around 15 cm of rectum, and this requires at least annual surveillance for life. The primary concern with IRA centres around the residual cancer risk in the retained rectum, which ranges from 10% at age 50 years, rising to 29% at age 60 years [26]. The cumulative risk after surgery has been reported as 7.7% at 10 years, 13.1% at 15 years and 23.0% at 20 years [27]. Further studies have demonstrated similar risks of developing rectal cancer [28, 29] and have shown that this is associated with a mortality of 8% by age 55 years and 12.5% by 65 years. The risk of developing cancer in the rectal remnant has also been shown to vary according to genotype. Mutation between codons 1250 and 1464 has been associated with a nine-times increased risk of requiring rectal excision [27]. Mutations at codons 1309 or 1328 are associated with severe polyposis (>1,000 polyps) and almost all patients with these mutations who initially received colectomy and IRA required rectal excision due to rectal remnant polyposis and cancer concerns [30].

Restorative proctocolectomy (RP) and ileoanal pouch reduce substantially the risk of cancer in residual large-bowel epithelium, but this translates into an increased life expectancy of only 1.8 years over colectomy and IRA [29]. RP is technically more demanding and has some other potential disadvantages, mainly secondary to the consequences of adhesions and pelvic sepsis. These are seen in the effects of RP on fertility. Proctectomy requires more extensive pelvic dissection, whereas colectomy and IRA may minimise damage to the Fallopian tubes. A recent study of Scandinavian polyposis registers concluded that patients undergoing IRA retained fecundity in line with the general population, but ileoanal pouch reduced fertility, with a cumulative chance of pregnancy of 48% at 1 year and 61% at 2 years [31]. In terms of bowel function there is some evidence for superior function of IRA versus RP, but this fails to translate into a significant impact

in quality-of-life studies between the two groups using SF-36 [32, 33].

In summary, surgical practice and prophylaxis in FAP is largely empirical and has been guided mainly by clinician preference to date. It is essential that patients are fully informed about the possible detriments of surgery as well as the substantial benefits in cancer prevention that can be achieved. In those with a low burden of rectal polyps (<20 at the time of surgery), IRA still appears a reasonable option, particularly in women for whom fertility is an issue. However, these patients will require intensive surveillance and fulguration of rectal polyps, and are likely to require completion proctectomy in middle age if the incidence of rectal cancer is to be contained. RP offers greater protection against colorectal cancer, but exposes patients to increased risk of surgical complication, particularly pelvic sepsis and its sequelae. These patients will still require surveillance, but the need for intervention is much reduced compared to IRA. Finally, some patients still opt for proctocolectomy and ileostomy. Whilst this seems at odds with the advances in surgical prophylaxis in FAP, it may represent the best choice for a minority of individuals, particularly those with invasive disease in the rectum, mesenteric desmoid disease or in whom poor anal sphincter function is likely to compromise outcome.

Surgical prophylaxis provides considerable protection against colorectal cancer, but the risks of cancer of the upper gastrointestinal tract, particularly ampullary carcinoma, persist. Surveillance by upper-gastrointestinal endoscopy is commenced at age 25 years and undertaken 5-yearly thereafter. The presence of duodenal polyps is best assessed with a side-viewing duodenoscope, and routine periampullary biopsies should be undertaken. Endoscopic ultrasound may be helpful in identifying early invasive disease. Duodenal disease is scored according to Spigelman et al. [34], which helps to detail disease progression and guide the frequency of endoscopic surveillance (Table 33.2). Those with a stage IV Spigelman score have a high risk of underlying malignancy. Duodenal polyps may be removed by endoscopic mucosal resection, but larger lesions may require open resection; the presence of proven or suspected invasive disease warrants pancreaticoduodenectomy in fit patients. However, even in the best hands this procedure carries a mortality of around 5% and is associated with high morbidity, and so its role in prophylaxis is limited.

There has been considerable interest in the use of chemoprophylaxis in FAP. There is good evidence that sulindac reduces the size and number of colonic polyps, but this does not appear to translate into a reduced incidence of colorectal cancer [35]. More recently, the selective cycloxygenase-2 inhibitor celecoxib showed promise, but the benefits were mitigated by concerns over its side-effect profile, particularly aggravation of ischaemic heart disease.

33.2.5 Turcot's Syndrome

The hallmarks of this disorder are the development of tumours of the central nervous system, particularly cerebellar medulloblastomas or glioblastomas, and multiple colorectal adenomas. This is a rarer variant of FAP and in the majority of cases the underlying molecular defect is a germ-line mutation in the APC gene [36]. However, mutations have also been identified in the DNA mismatch repair genes, *MLH1* and *PMS2*. It

Table 33.2 Spigelman scoring system for duodenal polyposis

	Number of points		
	1	2	3
Number of polyps	1–4	5–20	>20
Polyp size (mm)	1–4	5–10	>10
Histology	Tubulous	Tubulovillous	Villous
Dysplasia	Mild	Moderate	Severe
Stage 0	0 points		
Stage I	1–4 points		
Stage II	5–10 points		
Stage IV	>10 points		

is unclear as to whether the syndrome is dominantly or recessively inherited. Turcot's syndrome is best not considered a distinct syndrome, but as part of both FAP and hereditary non-polyposis colon cancer (HNPCC) syndromes, depending on the underlying genetic defect.

33.3 MYH-Associated Polyposis

MYH-associated polyposis is a recently described syndrome with a recessive mode of inheritance and multiple polyps comprising adenomas and hyperplastic polyps. The syndrome results from mutations in the base excision repair gene, *MYH*. The disorder is autosomally recessive, and biallelic *MYH* mutations are required for the polyposis phenotype. Polyps are less numerous than in FAP and many affected families were identified on FAP genetic registries as AFAP with elusive *APC* mutations and absence of a classical dominant inheritance pattern. Since transmission is as an autosomal-recessive trait, this has substantial implications for genetic counselling, testing and surveillance. MYH gene testing is now offered to patients with a phenotype resembling FAP but no evidence of dominant transmission or causative *APC* mutation. Recent studies have established that biallelic defects in base-excision repair genes predispose to colorectal cancer [37, 38], with complete penetrance by age 60 years. It is not clear whether there is a heterozygous effect on colorectal cancer predisposition. Population frequency of heterozygous *MYH* mutations is around 0.6% and the observed contribution to colorectal cancer is 2% for patients diagnosed aged < 40 years and 0.7% for patients aged < 55 years. This has important clinical implications for the siblings of carriers, who have at least a 1:4 risk of colorectal cancer before age 60 years.

MYH is the homologue of the MutY protein in *Escherichia coli*, and functional analysis has revealed that the human MutY protein has the same role as its bacterial counterpart, in that it is involved in base excision repair [39]. The base excision repair pathway plays a significant role in the repair of mutations caused by oxidative DNA damage. The role of MYH is to remove the adenine that mispairs with 8-oxoguanine, which arises due to replication of oxidised DNA. Thus, defective MYH results in an increased rate of transversion of G:C to A:T [40], and this has been observed in human colorectal cancer. Inherited variants in *MYH* predispose to polyposis and to colorectal cancer. The two common variants have also been detected in three patients with extracolonic tumours and some of the features of FAP, including duodenal polyposis and congenital hypertrophy of the retinal pigment epithelium [41]. Further clinical studies are required to assess whether mutations in this gene predispose to other extracolonic manifestations.

33.3.1 Clinical Management of MAP

The identification of MAP is so recent that there are only limited data available, but it is clear that the risk of colorectal cancer is very high for carriers of biallelic *MYH* mutations, and intensive surveillance is appropriate. Patients shown to have multiple polyps should be referred to a regional clinical genetics centre for APC gene testing and if negative, *MYH* analysis should be undertaken. If a mutation is identified, at-risk relatives should be offered counselling and genetic testing. The cancer risk is so high that prophylactic surgery should be discussed as part of the counselling process. Incidental prophylaxis is already possible since patients who are undergoing colorectal cancer resection and who are known to carry an *MYH* mutation should have counselling about the potential benefits of subtotal colectomy, and IRA or proctocolectomy and ileoanal pouch where relevant. Although it is possible that defective base excision repair has implications for adjuvant and palliative chemotherapy and radiotherapy, at present there are no data to guide practice.

33.4 HNPCC or Lynch Syndrome

HNPCC was one of the first disorders to be recognised as a hereditary cancer syndrome. Despite the nomenclature, HNPCC is in fact associated with adenomatous colorectal polyps, and although these are found in small numbers, each has a significantly higher malignant potential than sporadic adenomas or those occurring in FAP. Initially described by Warthin [42] in the 1890s, the disease was characterised by Henry Lynch in 1962 in a family with a strong history of colorectal and endometrial cancer in a pattern suggestive of an autosomal-dominant trait [43]. Further studies refined the definition of HNPCC and showed that it was characterised by early age of cancer onset, a tendency for a greater proportion of tumours to be located in the proximal colon than in sporadic cancer, and a high frequency of synchronous and metachronous cancers [44]. Synchronous tumours are present in 5–20% of

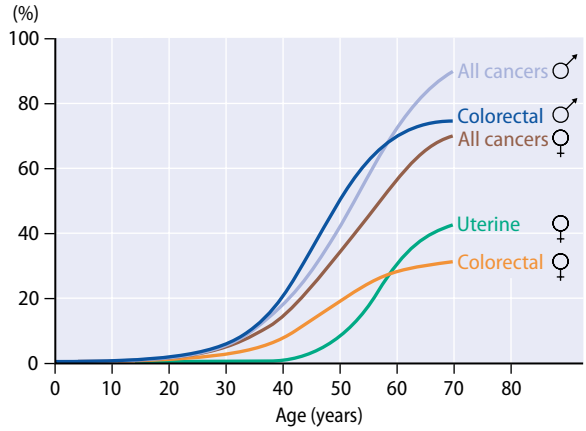

Fig. 33.1 Penetrance of mutations in DNA mismatch repair genes. Age-dependent penetrance for all cancers and for colorectal cancer in males and females, and for endometrial cancer in females. Note the substantial difference in cumulative colorectal cancer incidence between males and females

Table 33.3 Summary of Lynch syndrome (HNPCC). *MSI* Microsatellite instability

- Lynch syndrome is due to loss-of-function mutations in DNA mismatch repair genes.
- DNA mismatch repair gene defects account for ~3% of all colorectal cancer.
- Cancer risk is very high for gene carriers, especially males.
- Surveillance should be offered to gene carriers and people with a family history fulfilling established HNPCC criteria.
- Tumour MSI phenotype has implications for prognosis.
- Tumour MSI may impact on recommendations for chemotherapy in the future, but current understanding is insufficiently complete for definitive advice.

cases and metachronous tumours arise in 20–50% of cases [45]. Extracolonic tumours are also a well-recognised feature of HNPCC. Endometrial carcinomas have been reported in 20–60% of women with HNPCC [46] and the lifetime endometrial cancer risk of gene carriers is around 40% (Fig. 33.1). Cancers of the stomach, small intestine, renal pelvis, ureter and ovary are also frequently seen in HNPCC families [44]. Features of HNPCC, or Lynch syndrome, are summarised in Table 33.3. In some HNPCC families, sebaceous gland tumours and skin cancer are also a feature (Muir-Torre syndrome). Initially thought to be a distinct clinical entity, it is now clear that Muir-Torre syndrome is an allelic variant of HNPCC.

33.4.1 Diagnostic Criteria and Clinical Features

In contrast to FAP, there is no distinct premalignant phenotype in HNPCC. A set of rigorous criteria was established to identify families suitable for research studies. The Amsterdam criteria demanded the presence of at least three relatives with colorectal cancer: one individual must be a first-degree relative of the other two; at least two successive generations should be affected; at least one individual should have been affected before age 50 years. These criteria helped enrich the population for research studies, but they were too stringent for routine clinical use. Small family size, uncertain pedigree, de novo mutations or the consequences of incomplete penetrance excluded some families; there was also bias excluding those with a severe phenotype who died before childbearing age. The criteria were relaxed (Amsterdam II) to include carcinomas of the endometrium, upper gastrointestinal tract and urinary tract [47]. The Bethesda Guidelines have also been developed [48] to include individuals with extracolonic carcinomas, synchronous and metachronous colorectal cancers and right-sided cancers diagnosed before age 45 years with histology that is characteristic of HNPCC tumours. The true prevalence of HNPCC is yet to be determined in colorectal cancer cases, or indeed in the general population, but it is important to bear in mind that HNPCC alleles have been shown to be responsible for a substantial proportion of younger patients with colorectal cancer [49].

Although there are no diagnostic clinicopathological features of HNPCC, certain patterns are more frequent in HNPCC than in "sporadic" colorectal cancer. There is a greater proportion of tumours located in the proximal colon and a high frequency of synchronous and metachronous tumours. Furthermore, colorectal cancer arising in HNPCC families is more frequently poorly differentiated and exhibits a mucinous histology [50]. Tumour-infiltrating lymphocytes and a signet-ring-cell component are also more common than in sporadic carcinomas [51]. In contrast to the majority of colorectal cancers, HNPCC tumours tend to have a diploid DNA content [52].

33.4.2 HNPCC is due to Mutations in DNA Mismatch Repair Genes

In the vast majority of families, HNPCC is due to loss-of-function mutations in a class of DNA repair gene known as DNA mismatch repair genes [53]. The DNA mismatch repair system has several functions [54] including identification and repair of G:T mispairs and of insertion deletion loops that are intermediaries of DNA replication slippage. DNA mismatch repair is also involved in cellular DNA damage response and links identification of DNA damage with apoptotic pathways to drive a cell-death signal in the face of such lesions. Defective DNA mismatch repair has also been implicated in abnormalities of mitotic and meiotic recombination, resistance to anti-cancer drugs and ionising radiation, and defects in transcription-coupled repair. Tumours from HNPCC gene carriers almost universally show loss of expression of the corresponding protein due to somatic loss of heterozygosity, mutation or epigenetic silencing. Thus immunohistochemistry is useful in identifying patients who are likely to carry mutations and targeting mutation analysis to specific genes, thereby improving efficiency and reducing costs and labour.

Mutations in *MLH1* are responsible for 50% and *MSH2* for 40% of HNPCC cases identified so far [55, 56]. Less than 10% of germ-line mutations have been described in *MSH6* [57, 58] and very low frequencies of mutation have been identified in the other MutL homologues *PMS2* [59] and *MLH3* [60]. Germ-line *MSH6* mutations have a more attenuated HNPCC phenotype, with a high frequency of endometrial carcinomas, delayed age at onset and incomplete penetrance. In all, pathogenic mutations in DNA mismatch repair genes have an estimated population carrier frequency of approximately 1:3,000 [61]. However, it has also become apparent that defects in DNA mismatch repair genes are responsible for an appreciable proportion of apparently sporadic colorectal cancer arising in young patients [62] and of colorectal cancer in general [63, 64].

Systematic analysis of DNA mismatch repair mutation carriers in the population has shown that there is a 74% risk of developing colorectal cancer for males and 30% risk for females [65, 66]. In fact, female carriers have a higher risk of endometrial cancer than of colorectal cancer. Hence, preventive measures for females have to take into account the considerable gynaecological cancer risk. Many women opt for prophylactic hysterectomy because the available screening modalities are of no proven benefit and can cause considerable inconvenience and distress.

33.4.3 Microsatellite Instability in Colorectal Cancer

A particular molecular characteristic of tumours that arise in patients with germ-line DNA mismatch repair gene mutations is microsatellite instability (MSI). Microsatellites are DNA repeat sequences that are present throughout the genome. Although tumour MSI is observed in the majority of tumours from HNPCC families, this is actually a minority of all MSI tumours because MSI is detected in 15% of sporadic colorectal carcinomas [67]. A standard, validated reference panel of five microsatellite markers (BAT25, BAT26, D2S123, D5S346, D17S250) is employed to define tumour MSI phenotype [68], and tumours with instability at ≥ 2 markers are categorised as high-level microsatellite instability (MSI-H). This phenotype is frequently identified in tumours from HNPCC patients. The instability phenotype at only 1 marker is defined as low-level microsatellite instability (MSI-L), and absence of instability is defined as microsatellite stable (MSS). The significance of the MSI-L phenotype has yet to be elucidated with respect to the presence of the germ-line mutations defined earlier.

Although tumours arising in patients with germ-line mutations in DNA mismatch repair genes tend to exhibit the MSI phenotype, most MSI tumours are not due to germ-line mutations, but rather to epigenetic silencing of *MLH1* through promoter hypermethylation [69]. Indeed, 95% of MSI-H sporadic colorectal carcinomas do not express *MLH1* due to epigenetic silencing, despite having no germ-line abnormalities in this gene [70]. Thus, germ-line mutations of DNA mismatch repair genes are not the only mechanism by which loss of function of DNA mismatch repair genes is brought about. This has important potential implications for clinical management of the 12–25% of cases of colorectal cancer that exhibit the MSI phenotype because germ-line defects are responsible for only a minority of cases, the rest being due to somatic events.

33.4.4 Prognosis in HNPCC Colorectal Cancer

While there now seems little doubt that, stage-for-stage, colorectal cancers exhibiting MSI have a better prognosis than MSS lesions [71, 72], there are some important

factors to be taken into account before extending this to cancers arising in HNPCC. The age distribution of the cohorts analysed in many studies reflects the fact that the majority of patients with colorectal cancer is elderly and that most MSI tumours occur in old people, due to *MLH1* promoter hypermethylation and not to germline *MMR* gene mutations [69]. In contrast, MSI tumours observed in young colorectal cancer patients are predominantly due to germ-line DNA mismatch repair gene mutations [49, 62]. Therefore, caution is needed in applying the prognosis for sporadic MSI cancers to those arising in HNPCC in whom the MSI phenotype is a manifestation of different molecular aetiology. One study of *MLH1* mutations and another of *MSH2* and *MLH1* carriers suggested survival advantage for carriers compared to population controls [73, 74]. However, there are several important potential biases incorporated in published studies of HNPCC families, including survival bias, length-time bias, ascertainment bias and influence due to reproductive fitness. Furthermore, members of HNPCC families are much more likely to have cancer detected at an early stage as a result of screening. Three population-based studies of family history in substantial colorectal cancer patient cohorts were unable to detect any beneficial effect of cancer arising in either HNPCC [75, 76] or in familial cases in general [77]. There is insufficient evidence to make any considered judgement on the effect of "germline-attributable" MSI or germ-line *MMR* gene status in itself on colorectal cancer prognosis.

33.4.5 Cancer Control in HNPCC

There are several approaches to colorectal cancer prevention in HNPCC and the available evidence suggests that a substantial reduction in risk can be achieved. Because the cancer risk is so high [65, 66, 78], surveillance is widely employed and guidelines are well established in clinical practice [25]. Comparative studies have been undertaken and these show a substantial beneficial effect of surveillance, with a 62% incidence reduction and 65% mortality reduction [79]. Incidence reduction is most likely to be the effect of removing premalignant adenomatous polyps that are small in number but individually highly likely to progress to cancer. The surveillance interval should be less than 2 years in view of a lesser benefit with longer time intervals [80]. For clinicians managing patients with germ-line DNA mismatch repair gene mutations who have already developed colorectal cancer, it is important that the considerable cancer risk to the retained colon and rectum is understood. Following a segmental colonic resection such as right hemicolectomy, the risk is around 16% [80], while for total colectomy and ileorectal anastomosis, the risk is 3.4–12% [80, 81]. Thus, subtotal colectomy rather than a more limited resection may be the preferred surgical treatment for established colorectal cancer arising in patients with known mutations or where there is a family history fulfilling Lynch-syndrome criteria [82]. Some patients opt for pre-emptive surgery before invasive disease occurs because of concerns about the effectiveness of surveillance and the discomfort, inconvenience and potential complications of colonoscopy on at least a biennial basis until 75 years of age. However, at present there are no robust data on which to gauge advice to patients about the relative benefits of surveillance compared to the risks of major prophylactic surgery. The increasing availability of minimally invasive resection may have greater appeal to patients and it seems likely that primary prophylaxis will become more common than it has been to date.

33.5 Hyperplastic Polyposis Syndrome

Hyperplastic polyps are common and generally not considered to be associated with a significant risk of malignancy. However, the presence of multiple, large or right-sided hyperplastic polyps, particularly with a personal or family history of polyps or cancer, should raise concerns of hyperplastic polyposis syndrome (HPS). The St Mark's group first described seven cases of hyperplastic polyposis in 1980 as a differential diagnosis for FAP [83]. The World Health Organisation subsequently defined hyperplastic polyposis according to the following criteria: 30 or more hyperplastic polyps in the sigmoid colon, more than 5 polyps proximal to the sigmoid, or more than 2 hyperplastic polyps >10 mm (Table 33.4). However, many researchers are inconsistent in the application of this classification, including individuals with 20 or fewer hyperplastic polyps [84]. A familial basis for HPS is uncertain, but at least three families have been described [85, 86], and if a dominant susceptibility gene exists then it is likely to have low penetrance. Alternatively, a recessive trait requiring biallelic loss may be responsible. The most extensive genetic analysis to date examined 38 patients with HPS for molecular changes in the base excision genes *MYH* and *MBD4* [86]. One patient carried a biallelic mutation for *MYH* and six patients had single

Table 33.4 World Health Organisation definition of hyperplastic polyposis syndrome

More than 30 hyperplastic polyps
More than 5 hyperplastic polyps proximal to the sigmoid colon
Two or more hyperplastic polyps greater than 10 mm
Hyperplastic polyps proximal to the sigmoid colon in patients with personal or first-degree family history of colorectal cancer

nucleotide polymorphism for *MBD4* of uncertain significance. The underlying genetic lesion in HPS has yet to be identified and it may be that environmental factors such as smoking, alcohol and diet play significant roles.

Colorectal cancer risk is increased in HPS, with a tendency to multiple cancers. Reports are conflicting, but some suggest an incidence of 50% with protracted follow-up, although there is inevitable selection bias behind these data [84]. However, HPS certainly represents a significant predisposition to colorectal cancer and demands colonoscopic surveillance similar to HNPCC. The presence of serrated adenomas and admixed hyperplastic/adenomatous polyps are typical of HPS, and these lesions are likely intermediates in the malignant process. Although no data are available on primary surgical prophylaxis, the opportunistic secondary prophylaxis afforded by extended resection for cancers diagnosed on a background of HPS seems appropriate.

33.6 Peutz-Jeghers Syndrome

Peutz-Jeghers syndrome is characterised by multiple gastrointestinal hamartomatous polyps, and mucocutaneous melanin deposits are found on the lips, perioral and buccal regions, hands and feet in 95% of cases. This is a rare disorder with an incidence of 1:120,000 [87] and is associated with low penetrance. Affected individuals have about a 50% increased chance of developing gastrointestinal carcinomas or tumours of the pancreas, ovaries, testes, breast and uterus [88–90]. Germ-line mutations have been identified in the serine threonine kinase gene *STK11*/*LKB1* at 19p13.3 in 20–63% of patients with this disorder [91]. Large-bowel surveillance is recommended 3-yearly for affected individuals from age 18 years. Small-bowel polyps may lead to obstruction or bleeding. They may be detected by small-bowel contrast study or capsule endoscopy and are removed at laparotomy guided by on-table enteroscopy. Small-bowel imaging is performed 2-yearly and polyps greater than 15 mm should be considered for removal.

33.7 Juvenile Polyposis

Juvenile polyposis (JPS) is characterised by the development of multiple hamartomatous polyps throughout the gastrointestinal tract, usually when aged less than 10 years. Affected patients have a high risk of developing gastrointestinal cancer [92, 93] that ranges from 9 to 68% and is probably around 50%. Because it is rare, there are no reliable estimates of the frequency of JPS in the general population, but around 1:50,000 is a reasonable estimate based on population registry data. It is associated with incomplete penetrance for both polyposis and colorectal cancer; less than 0.1% of all cases of colorectal cancer are attributable to JPS.

Unlike Peutz-Jeghers syndrome, JPS exhibits genetic heterogeneity, with mutations in at least three genes being responsible. The molecular basis of JPS in around 50% of cases is germ-line mutation of *SMAD4* [94, 95]. *SMAD4* is a tumour suppressor encoding a protein that is involved in the transforming growth factor-β (TGF-β) signalling pathway, which is involved in the regulation of cell proliferation and differentiation [96]. Consistent with this, sporadic colorectal carcinomas are frequently found to have mutations in *SMAD4* or loss of heterozygosity (LOH) at this chromosome region [97]. A second locus has been identified and germ-line non-sense mutations identified in the bone morphogenic protein receptor 1A gene (*BMPR1A*/*ALK3*) and, like *SMAD4*, this gene is also part of the TGF-β superfamily [98]. In a minority of cases JPS is due to germ-line mutations in the protein phosphatase gene *PTEN* [99]. *PTEN* is also mutated in patients with Cowden disease, which is also characterised by the presence of multiple gastrointestinal hamartomatous polyps as well as benign and malignant neoplasms of the thyroid, breast, uterus and skin, but there is not an increased risk of colorectal cancer. Hence, there is a possibility of misclassification and that *PTEN* mutations are not associated with an excess colorectal cancer risk.

Estimates of cancer risk have wide confidence intervals but are around 50% lifetime risk, and so surveillance is important. Consideration should also be given to prophylactic colectomy, much in the same way as

in FAP [25]. Large-bowel surveillance for at-risk individuals is recommended 1- to 2-yearly from the age of 15–18 years or even before if the patient has presented with symptoms. Screening intervals could be extended at age 35 years in at-risk individuals. However, documented gene carriers or affected cases should be kept under surveillance until the age of 70 years and prophylactic surgery discussed.

33.8 Conclusion

Effective primary prevention of cancer in polyposis syndromes requires comprehensive genetic assessment and rigorous clinical follow-up within a disease registry. Management of these cases is challenging and benefits from a functional multidisciplinary approach. The technical aspects of disease control are already benefiting from advances in minimally invasive surgery and this will undoubtedly continue. Future studies will lead to new definition of disease aetiology, not only shedding new light on genetic contribution, but also on gene–environment interactions. This will have important implications for designing methods of chemoprevention, refining surveillance strategies, technical innovation in the removal of premalignant lesions, and targeting prophylactic surgery.

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Self-Assessment Quiz

Question 1

In hereditary non-polyposis colon cancer (HNPCC), the mismatch repair gene mutations most frequently identified are:

a. MSH2 and MLH1
b. pMS2 and MLH3
c. MSH6 and MLH1
d. MSH2 and pMS2
e. MSH6 and MSH2

Question 2

Which of the following is NOT a feature of cancer arising in HNPCC?

a. Typically display mucinous histology
b. Are poorly differentiated
c. Have diploid DNA content
d. Occur with increased incidence in the right colon compared to sporadic cancer
e. Are typically sensitive to adjuvant chemotherapy

Question 3

In HNPCC, which of the following anatomical sites is most commonly affected?

a. Brain
b. Uterus
c. Kidney
d. Stomach
e. Pancreas

Question 4

In familial adenomatous polyposis (FAP), timing of prophylactic colectomy is determined by:

a. Age of the patient
b. Age at which other family members underwent colectomy
c. Genotype
d. Polyp burden
e. Response to sulindac

Question 5

In FAP, sulindac has been demonstrated to:

a. Reduce polyp size and number
b. Reduce the incidence of colorectal cancer
c. Provide effective prophylaxis as an alternative to surgery
d. Reduce the incidence of upper gastrointestinal malignancy
e. Provide effective treatment for desmoid disease

1. Answer: a
   Comments: Over 90% of mutations in the HNPCC families characterised so far result from these mutations.
2. Answer e
   Comments: There is evidence that cancers displaying microsatellite instability are not sensitive to 5-fluorouracil. Evidence is still emerging regarding HNPCC, but on the basis of current knowledge, cancers arising in HNPCC are likely to be relatively resistant to the effects of standard adjuvant chemotherapy.
3. Answer: b
   Comments: Endometrial cancer is common in HNPCC, its incidence second only to colorectal cancer.
4. Answer: d
   Comments: Medical, social and psychological factors are important in timing prophylactic colectomy; however, polyp burden as defined by size, number and pathology is critical.
5. Answer: a
   Comments: Sulindac has been demonstrated to have a dramatic effect on the phenotype of FAP with a reduction in the size and number of colorectal polyps, but unfortunately this has not translated into effective prophylaxis against cancer.

34 Management of Malignant Colorectal Tumours

Paul Finan and David Sebag-Montefiore

CONTENTS

34.1 Introduction

The management of malignant colorectal tumours has undergone many changes over the past 25 years and, perhaps more than any other solid gastrointestinal tumour, has demonstrated the advantages to be gained by close multidisciplinary working. Significant developments in diagnostic imaging, histopathology, gastroenterology, surgery and oncology have all contributed to this progress. The aim of this chapter is to review many of these advances and, whilst not being exhaustive, should indicate the significant changes that have occurred and the opportunities that exist for improvements in the management of this common disease.

Colorectal cancer remains a major problem in the developed world. It is the second most common cause of death from cancer, and is only surpassed in overall incidence by cancer of the breast and lung. Worldwide it is estimated that there are over 650,000 new cases annually, with nearly 400,000 deaths [130, 135]. The incidence of the disease varies throughout the world, but rates of 58/100,000/year within the United Kingdom [27] and 19,000 deaths per year [126] indicate the magnitude of the problem.

The recognition of premalignant conditions and appreciation of the adenoma/carcinoma sequence has allowed colorectal cancer to be the subject for large-scale trials of population screening, with subsequent implementation at a national level. Precise preoperative staging of the tumour with transrectal and endoscopic ultrasound, and computed tomography (CT) and magnetic resonance imaging (MRI) has led to tailoring of the surgical and non-surgical treatment of these tumours. Advances in endoscopic techniques, both colonoscopic and transanal, have provided less invasive means for the treatment of appropriately selected tumours and increasingly, laparoscopic techniques are being applied to this area of surgery. Recognition of the patterns of local and distant spread has led to refinements in surgical technique. Finally, the past 15 years have seen great progress in the contribution of chemotherapy and radiotherapy to tumours of the colon and rectum, both in the adjuvant setting and for more advanced disease.

34.2 Screening

Colorectal cancer is an appropriate disease for which to contemplate population screening. It is a common dis-

ease with a well-defined premalignant phase, the colorectal adenoma. There are successful treatments following detection of a tumour and, if recognised early enough, lesions may be treated by local means. Screening techniques being considered currently are either faecal occult blood testing (FOBT) or endoscopic techniques. This subject has recently been reviewed [142, 183].

Results of randomised trials of FOBT have confirmed a positive test in 2% of screened subjects, with a positive-predictive rate for cancer of 11% and for polyps of 30%, compliance of 55–60%, and a reduction in mortality from colorectal cancer of the order of 15–18% [42, 60, 84]. The reduction is even higher when the slides are rehydrated, although in the Minnesota study rehydration increased the false-positive results and necessitated more colonoscopic examinations [102, 103]. Screening programmes are currently being evaluated addressing the issues of sensitivity, specificity and compliance [168], and a national screening programme is now being implemented within the United Kingdom.

Population screening by endoscopic techniques (colonoscopy or flexible sigmoidoscopy) is based on the premise that the recognition and removal of premalignant polyps will reduce the incidence of colorectal cancer. Case-controlled studies [115, 158] and longitudinal observational studies [6, 121] have indicated that this might be an appropriate measure to investigate further; the preliminary results of the use of a single flexible sigmoidoscopy as a screening modality have been published [7] and indicate good compliance and safety of the technique. Mortality data from colorectal cancer has still to be published from this multicentre study. Mathematical modelling of both FOBT and flexible sigmoidoscopy has suggested that both are potentially cost effective in the early detection of colorectal cancer [175].

Although population screening with colonoscopy has been recommended [143, 196], there are as yet no published randomised, controlled trials upon which to base such a recommendation. Concerns with colonoscopic screening are the resources needed together with the expected compliance rates in population screening programmes as opposed to screening in higher-risk groups. It may be that CT colonography finds a role in screening for colorectal cancer [114, 144], but this remains an unknown at present.

Finally, there are studies investigating stool markers for malignancy other than occult blood [164, 170]. Such studies remain preliminary and have not withstood the rigours of a randomised controlled trial.

34.3 Diagnosis

In the absence of a screening programme, with the associated trend towards earlier-stage disease (Dukes' stage A >50% in screen-detected lesions), colorectal tumours present either with symptoms or as an acute admission with, for example, obstruction, perforation, or bleeding. There is considerable evidence for delay in presentation and diagnosis of colorectal cancer, and this delay can occur in both primary and secondary care. Delays in reporting symptoms may amount to several months, although it is questionable whether this significantly alters the overall prognosis. There have been considerable efforts to raise awareness of the significance of symptoms of large-bowel cancer within the general population and to improve the pathway for rapid diagnosis of or exclusion of colorectal cancer [100]. Referral guidelines have been published and the issue recently reviewed [181, 182]. Once referred to secondary care, delays in diagnosis can be reduced with the introduction of systems to prioritise investigations [159], and comparisons between available systems have been published [67]. Others have adopted the principle of "straight to test" to overcome delays within the diagnostic pathway [64] or establishing "rapid-access clinics". These initiatives are likely to improve services and speed up the time to diagnosis without necessarily improving outcome.

Up to 30% of cases of colorectal cancer will present acutely and often with few symptoms prior to their admission. Advances in cross-sectional imaging in the acute patient allows for rapid diagnosis and appropriate planning of further management. Malignant large-bowel obstruction occurs in up to 20% of cases of large-bowel cancer and carries an appreciable morbidity and mortality [134, 162, 176]. Historically, contrast studies were recommended [29, 169], but these have been largely superseded with the advent of CT imaging [46, 165, 174], which confirms the diagnosis, excludes non-mechanical obstruction and contributes to staging of the disease at the same time.

34.4 Management

Although covered in other chapters, the modern management of colorectal tumours is dependent to a large degree on state-of-the art imaging (see Chaps. 8 and 9). How this is incorporated into the appropriate treatment of colorectal tumours is discussed here for sake of completeness.

Following the histological diagnosis of a colorectal primary tumour by sigmoidoscopy (rigid or flexible) or colonoscopy, or the presumed diagnosis on double-contrast radiology or CT scanning, further imaging is dictated by the location of the primary growth. For colonic tumours, CT imaging of the chest and abdomen is now almost universally adopted, with MRI of the liver reserved for further evaluation of hepatic abnormalities. There is an increasing interest in colonoscopic ultrasound, particularly for accurate staging of early colonic lesions. CT imaging is also used for staging of rectal cancer, both for assessing the primary growth and identifying secondary spread. Additionally, endorectal ultrasound and pelvic MRI has been shown to contribute to the staging of the primary rectal lesions. Positron emission tomography (PET)/CT has still to find a role in general surgical practice, but at present it should probably be reserved for staging of patients with potentially curable recurrent disease or following chemoradiotherapy for rectal cancer. The impact of these modalities will be covered within the subsequent sections. The significant advances in the management of colorectal tumours can be divided, somewhat arbitrarily, into those that apply to management of colonic tumours and those for rectal tumours.

34.4.1 Colonic Cancer

Surgical resection of colonic tumours adhering to oncological principles remains the principle modality of therapy. Within the elective setting, preoperative optimisation has received increasing attention, as has the whole subject of "fast-track" or enhanced recovery programmes [2, 43, 50, 76, 77]. There seems little doubt that such an approach will improve the recovery process, although major effects on morbidity and mortality are still to be seen. The fact that most patients are elderly with medical comorbidity demands attention to all variables within surgical care.

Colonic obstruction, as previously mentioned, is a common occurrence and management of this condition has undergone significant changes in recent years. The introduction of self-expanding metallic stents (SEMS) has achieved both palliation in patients with advanced disease and a means by which an acute obstruction can be resolved whilst the patient is appropriately prepared for an elective resection. Reviews have indicated successful placement of SEMS, with decompression in 90% of cases, a low procedure-related mortality (<1%) and migration of the stent in approximately 10% of cases [78, 157]. Stents may be placed in the rectosigmoid and left colon, but experience with more proximal placement is small. This technique is becoming more readily available, and controlled trials, particularly when used as a "bridge to surgery" are needed [129].

Immediate surgical resection of an obstructing right-sided lesion is well accepted, but left-sided colonic obstruction has attracted more varied approaches. Staged operations have been the procedures of choice, but there is abundant evidence that a single-staged procedure carries a shorter hospital stay and, under favourable circumstances, carries a low morbidity and mortality rate [99, 166, 202]. A Cochrane review of staged versus immediate resection was unable to recommend one treatment over the other in view of the paucity of controlled trial data [38].

Whether to perform segmental colectomy (SC) or subtotal colectomy (STC) has been the subject of three prospective studies [124, 180, 185], one of which was randomised [180]. Similar results were obtained with both of these procedures, with no significant differences in hospital stay, anastomotic leak rate or mortality. The main difference was the increased need for constipating agents in the STC group. The decision as to which procedure to perform may well be governed by the operative findings; caecal perforation or tear (STC), synchronous lesions (STC), rectal anastomosis (SC) and known problems with continence (SC). The use of on-table lavage has been popular but with the view that bowel preparation in the elective case may be inappropriate, its use remains optional. A controlled trial of lavage versus manual decompression alone showed no difference [96].

Perforation of colonic tumours and the associated faecal peritonitis carries a high morbidity and mortality. After initial and rapid resuscitation, surgery should be performed by experienced surgeons capable of the many procedures already outlined. In cases where the patient is unstable, a resection of the tumour with source control of the infective focus and creation of a colostomy is the main aim. An anastomosis should be avoided in these unfavourable cases. Patients who have an emergency Hartmann's procedure have a high chance of no further procedure and hence a permanent stoma [83].

Laparoscopic surgery for colonic tumours has been the subject of several randomised trials [55, 88, 178, 179] and has been reviewed recently [146]. Initial concerns with regard to adequacy of excision, and port-site recurrence have been unfounded with more experience, and histological assessment of excised specimens

has confirmed adequate lymph-node retrieval. Patients who were converted from laparoscopic to open procedures understandably had a prolonged operative time and conversions occurred in between 20 and 30% of cases. Of the trials mentioned, only one included cases of rectal cancer [55] and these were technically more challenging. Long-term results from the larger trials are awaited, but at present it would seem that there are no significant differences between laparoscopic-assisted and open resections and that the former offer some short-term benefits including reduced blood loss, reduced pain and a faster return of bowel function. Studies employing laparoscopically assisted resections and enhanced recovery programmes are under development. Appropriate training with these laparoscopic techniques is regarded as essential.

Smaller colonic tumours present particular problems and are liable to become more common with the colorectal screening project. The lesions are often detected colonoscopically and even when not pedunculated, may be removed endoscopically (see Chap. 6). Tattooing of the excision site is of considerable help if there is a need to resect a portion of the colon following histological assessment of the previously excised specimen. Marking is also of assistance for laparoscopic procedures.

34.4.2 Rectal Cancer

Rectal carcinomas present additional problems in management and because of this are discussed separately. The aim in management is to cure the disease whilst at the same time maintaining, where possible, adequate anorectal function. The location of the rectum within the bony confines of the pelvis presents particular problems, although its position and accessibility confers distinct advantages in terms of imaging and non-surgical therapeutic options. Opportunities exist to treat such lesions by surgical and non-surgical means as well as a combination of the two. This section will aim to discuss the surgical issues and a separate section will cover the topic of non-surgical therapy either as a sole treatment or in combination with surgical procedures.

34.4.2.1 Imaging

Management of rectal cancer and the decision-making process has been revolutionised by advances in imaging. The available imaging modalities include transrectal ultrasound, CT scanning and MRI of the pelvis. Many studies have shown the superiority of transrectal ultrasound over other imaging techniques in the assessment of the degree of invasion of the primary rectal tumour within the rectal wall [12, 75, 86]. In one large, single-centre report, the overall accuracy for level of rectal-wall penetration was 69%, with overstaging in 18% and understaging in 13% [49]. Most studies confirm the difficulty in distinguishing T1 from T2 tumours, although the introduction of higher-frequency probes may assist with this important distinction. T3 tumours were most accurately diagnosed (86%) in the series of Kauer et al. [75], and T4 were the least accurately diagnosed (36%). Assessment of nodal involvement is less accurate and remains a problem with all imaging techniques. Only 74% of involved nodes were detected by ultrasound in one review [86] and with only slight improvement when utilising MRI. The importance of ultrasound is when the option of local excision of rectal tumours is considered. Suitable tumours should be limited to the bowel wall and preferably not invading the muscularis propria (T1). As will be discussed later, nodal involvement with these early tumours remains a problem.

The main benefit of MRI of rectal tumours is the ability to assess the relationship between the primary growth and the proposed margin of excision in major resectional procedures. Initial experience of the value of MRI [8, 21] has been confirmed in a larger, multicentre study [110], and it is finding a valuable role in surgical practice [150]. This subject has been reviewed recently [9].

34.4.2.2 Local Excision

Local excision of rectal cancer has the advantage of retaining the majority of the rectal reservoir and hence is associated with good functional results; however, it can only be curative if the whole primary tumour is removed and there are no associated involved lymph nodes. Results in terms of cure and avoidance of local recurrence appear to be related to several features. The more advanced the T-stage of the tumour, the more likely that there is lymph-node involvement within the mesorectum, and, with low tumours, in the more laterally placed pelvic sidewall nodes. A review of the whole subject [160] notes the risk of involved lymph nodes rising from 0–10% in T1 tumours to over 30% in T3 lesions. In a study of 353 T1 tumours from the Mayo Clinic [118], the incidence of lymph node metastases was 13%. Significant factors in both univariate and mul-

tivariate analyses were lymphovascular invasion, lower-third lesions and those that had invaded the deepest third of the submucosa (sm3). It is not surprising that local recurrence rates match the T-stage of the primary tumour, and although there have been some encouraging reports [16, 53], these patients were highly selected. Local excision would appear to be an option for treatment if the lesion is T1, and reasonable results can be obtained if subsequent histological examination of the specimen shows no evidence of poor differentiation, complete excision, absence of lymphovascular invasion and preferably superficial invasion of the submucosa (sm1). These factors are only evident following excision and therefore the specimen should be pinned out to allow for good pathological examination. Larger series have cautioned extension of this means of treatment for more advanced lesions [10, 109, 132]. Overall local recurrence rates vary from 11–29% for T1 tumours to more than 30% for T2 lesions [160]. Most authorities would recommend immediate resection if the pathological examination of the locally resected specimen is unfavourable. Salvage surgery for local recurrence following local excision has been reported, but the results are not always favourable [45, 109, 193]. One study, where salvage surgery was performed in 24/27 cases identified, noted a mortality from cancer of 33% after a follow-up of less than 3 years [109]. A more recent study of salvage surgery in 49 patients noted a 5-year disease-specific survival of only 53% despite having achieved an R0 resection in 47/49 patients [193]. It has been noted that these poor salvage results come from a group of patients whose initial tumour would have been considered most favourable for long-term cure.

The reduced perioperative morbidity and mortality, however, does lead to the question as to whether local excision in combination with additional adjuvant treatment may be considered for small rectal cancers [167]. Even in this study, however, where post-operative radiotherapy and chemotherapy was given to the T2 tumours, the local recurrence rate was 20%. There is increasing consideration to preoperative therapy followed by local excision [66] or even observation alone, [57] but again, such an approach should probably be reserved for highly selected cases. Studies where there has apparently been a complete pathological response of the primary tumour, but where the protocol has included resectional surgery, have revealed viable tumour deposits within the excised mesorectum [70, 201]. In the first of these studies [201], 109 patients were given preoperative chemoradiotherapy, but the patient population included mid-rectal as well as low-rectal tumours. Of 47 who were considered to have had a complete response, 17 had no residual tumour within the rectal wall; however, 2 (12%) had a tumour within the excised mesorectum. The retrospective UK study noted complete pathological response within the rectal wall in 18% of cases, but within this group, 4 of 23 (17%) had involved lymph nodes.

An extension of local excision is the use of the transanal endoscope pioneered by Buess et al. [22]. The instrumentation allows lesions higher in the rectum to be removed. The limitations described for transanal local excision also apply to this technique, and although it is of considerable use for benign lesions, it is probably best reserved for selected T1 rectal carcinomas [119, 127, 172].

A recent review of local therapy for rectal cancer confirms the concept that careful selection of low-risk rectal tumours may be appropriate, and that any extension of the principles of this modality of treatment for more advanced lesions will necessitate consideration of adjuvant therapy. Local surgical treatment alone for more advanced T1 (sm3), and T2/3 lesions attracts high local recurrence rates [20].

The majority of cases of rectal cancer will come to some form of major resection. As will be discussed later, it is in this area where preoperative discussion will ensure that all therapeutic options are considered in the light of imaging [18, 150]. Surgical excision remains the best chance for cure in rectal cancer. Historically, rectal cancer surgery necessitated a permanent stoma, but advances in surgical techniques, understanding of the mode of spread of rectal cancer and careful auditing of results have seen a marked move towards restorative resections. The current goal of treatment is to remove the primary growth together with an intact mesorectal envelope, whilst at the same time preserving the pelvic autonomic nerves and considering surgical techniques that might preserve anorectal function.

34.4.2.3 Mesorectal Excision

It has been assumed for many years that the direction of spread from rectal cancer is in a cephalad direction, with the draining lymph nodes lying within the fatty tissue surrounding the rectum. Although there remains discussion on the precise nomenclature [30], excision of this "package", currently termed "total mesorectal excision" (TME), has been popularised by Heald et al. [63]. Coupled with this was the observation that local recurrence was likely to be due to incomplete excision

of this package, or at least presence of tumour at or within 1 mm of the circumferential margin on careful pathological examination [138]. The logical improvement to surgical practice was therefore careful removal of the rectum and the surrounding tissues and performance of a TME, with subsequent pathological examination of the excised specimen. One result of these concepts was the ability to predict threatened margins of excision preoperatively and so employ other treatments in the higher-risk cases (see later). There are no controlled clinical trials looking specifically at TME and it is unlikely that any will be forthcoming. Personal series, adopting a careful surgical technique have given rise to local recurrence rates of less than 10% [24, 41, 98], although these rates have been matched by others who have not removed the whole mesorectum [79]. The clue may be that radial dissection to the pelvic wall fascia is the important issue rather than the removal of all the mesorectum, particularly in carcinomas of the upper third of the rectum. Pathological studies, whilst showing distal spread of tumour within the mesorectum, seldom show this to be more than 3–4 cm [145, 155].

Perhaps the most compelling evidence for improved surgical techniques within pelvic surgery leading to lower recurrence rates are longitudinal observational studies where there has been a period of training in these very same techniques [5, 11, 74, 107, 194]. In an early study from Sweden [5] there was a significant fall in local recurrence rates when comparing two periods (1984–1986 and 1990–1992), the difference being a change to the surgical technique of TME in 1989. Reductions in local recurrence in Stockholm from 20 to 8% were seen after the introduction of a formal training programme [107], and similar reductions were observed in The Netherlands [74]. Although involvement of the circumferential margin may be considered a surrogate marker for quality of surgical excision [13], it is apparent that when performing TME, and if the margin is shown to be involved, one is dealing with locally advanced disease [58]. The key in such circumstances is to ensure that such cases are not considered surgical failures but are a failure if no consideration has been given in the preoperative period to other adjuvant treatments.

34.4.2.4 Functional Considerations

Although large audits still reveal permanent stoma rates of over 25% [61, 177], restoration of gastrointestinal continuity remains a goal in rectal cancer surgery. It has long been appreciated that the functional results deteriorate the nearer the anastomosis is to the anorectal junction. Following the concept of a neoreservoir in surgery for inflammatory bowel disease, there has been considerable interest in performing some form of colonic reservoir in those cases where a low anastomosis might lead to "anterior resection syndrome", with frequency of defaecation, clustering of stool and faecal incontinence. Colonic "J" reservoirs were first reported in 1986 [92, 128]. Both of these reports showed a reduction of bowel frequency, and improved continence. It became evident that the anastomosis had to be a true pouch–anal anastomosis, otherwise patients with a colonic reservoir had problems with incomplete evacuation. Randomised trials [93, 161] have confirmed the superiority of the colonic pouch over the straight coloanal anastomosis. Longitudinal studies have suggested that in most cases the benefit of the colonic reservoir is primarily in the 1st year to 18 months, after which one assumes there is adaptation of the colon used for a straight coloanal anastomosis. There appears to be no advantage in making a colonic pouch larger than 6 cm, as the larger pouches are associated with a higher requirement for laxatives and enemas [94]. These improvements in function with a colonic pouch have a demonstrable effect on the quality of life [54]. A variant on the colonic pouch is the coloplasty. This procedure enlarges the pre-anastomotic colon by incising the colon longitudinally and closing the defect transversely. Studies suggest that this procedure is a useful alternative to the colonic pouch and is an improvement over the straight anastomosis [82, 199, 200].

The identification of the appropriate planes of dissection within the pelvis is even more important when one considers that the pelvic autonomic nerves are at risk at several stages in the mobilisation of the rectum. Damage to the sympathetic chain may occur in the pre-aortic phase of the dissection or as one develops the plane within the pelvis where the hypogastric nerves divide to course around the lateral sidewalls of the bony pelvis. The parasympathetic contributions from S2, S3 and S4 join the hypogastric nerves low in the pelvis and are in danger as dissection proceeds lower within the pelvis. Pelvic autonomic nerve preservation should be considered as part of the modern TME procedure, and attention to detail can reduce the potential detrimental effect on both urinary and sexual function. A recent review of function after TME noted urinary dysfunction in 33–70% of cases, impotence rates were 20–46% and, in those men who remained

potent, 20–60% were unable to ejaculate [113]. Formal identification of the pelvic nerves can reduce this incidence. Kneist et al. [80] noted that long-term catheter drainage was more common in a group of patients who had had incomplete preservation of the pelvic autonomic nerves. In a further study comparing urinary and sexual function before and after the introduction of TME surgery, post-operative bladder function was the same in both groups but sexual function was better preserved in the TME group [108]. A large study from Japan also showed that autonomic nerve preservation did not compromise oncological outcome [163].

Two further surgical techniques can significantly affect the functional results obtained following surgery for rectal cancer. The recognition that distal intramural spread of tumours is limited has led some authors to carry the distal dissection down to include a portion of the internal anal sphincter [147, 153, 154, 184]. In the largest series reported [154], 117 patients underwent restorative resection with an ultralow anastomosis following an intersphincteric dissection. Over 40% had Dukes' A lesions; there were few complications, the local recurrence rate was 5.3%, and 86.3% were continent for solid and liquid stool and flatus. Others have reported a similar operative procedure but following preoperative radiotherapy for T3 lesions [147]. This degree of sphincter dissection may give cause for concern when one reviews the functional results. The surgical and oncological results were similar, R0 resection in 89% and a local recurrence rate at 2 years of 2%. Another paper from the same group, however, compared conventional coloanal anastomosis with intersphincteric resection and, whilst showing no difference in stool frequency or urgency, showed a significantly worse continence score with an increased need for antidiarrhoeal medication [19]. The oncological results in these selected patients seem to merit consideration of this technique when abdominoperineal excision of the rectum and anus is to be avoided, but careful patient selection is required. Although some centres are describing an increasing role for ultralow restorative resections with a reduction in the incidence of abdominoperineal excision of the rectum and anus [68, 136], further studies are needed to clarify the functional and oncological results of such an approach, in particular the role of adjuvant therapy.

The second factor for consideration, and one that is intimately associated with both lymph-node spread of rectal tumours and autonomic innervation, is that of the status lateral lymph nodes within the pelvis. There is excellent evidence from studies, principally in Japan, that rectal tumours can spread to nodes on the lateral pelvic sidewall. In a seminal paper, the relationship between the nodes and the level of the tumour within the rectum and depth of invasion within the rectal wall was described [173]. These workers showed that the incidence of positive nodes ranged from 0.6% when the tumour was over 6 cm from the dentate line, up to 29% when the lesion was within 1 cm of the dentate line. A similar increase was seen from 2.8 to 10.6% as the depth of invasion extended from the submucosal plane to the perirectal tissues. They also pointed out that these nodes lie outside the surgical planes followed in performing a TME. Similar evidence was recently reported where, in a retrospective study of 237 cases of advanced rectal cancer (T3, T4) excised for cure (R0) and having lateral pelvic lymphadenectomy, positive nodes were found in 17.3% of patients [188]. Again the incidence of positive nodes increased if the tumour was low, poorly differentiated, and when mesenteric nodes were also involved. Patients with positive lateral nodes had a shorter post-operative survival (42% versus 71.6%) and an increased rate of local recurrence (44% versus 11.7%). These findings give some cause for concern when performing any form of surgery for low rectal cancer, as some involved lymph nodes will not be removed during standard resections. Recognition of positive lateral nodes has led some workers to propose that systematic sidewall dissection should be employed for such cases, but this technique has not found favour in centres other than in Japan. Not only are the survival figures poor, a reflection no doubt of the advanced nature of the disease, but damage to the pelvic autonomic nerves is a feature in up to 30% of cases [171]. In a recent questionnaire study, sexual activity and ejaculation was reduced from 90% and 70% to 50% and 10% when lateral node dissection was added to TME and where autonomic nerve preservation techniques were employed, respectively [87]. These pelvic sidewall nodes lie within the radiotherapy field to the pelvis; a strategy for treatment will be explored later in the non-surgical section of this chapter.

34.4.2.5 Non-restorative Surgery

Although efforts have been made to attempt restorative resections in rectal cancer wherever possible and abdominoperineal excision of the rectum (APER) rates have fallen over the past 20 years, excisional surgery with a permanent stoma is still commonly performed in up to 25% of cases [61, 177]. There is increasing evidence that the adequacy of excision is poorer for cases

undergoing APER. Using circumferential margin involvement as a surrogate marker for adequacy of surgical excision, several studies have shown an increased positive rate in patients undergoing an APER [106, 117, 139, 177]. It seems likely that the anatomical limitations within the pelvis and at the outlet, particularly in male patients, may limit the margin of tissue that can be excised. Good results can be achieved from individual units [37], but others have demonstrated inferior results with APER [90]. The current view is that the coning that can occur as the mesorectal plane is followed down to the anorectal junction inevitably means that the margin is close to the rectum in the very area where the tumour is located. Efforts should be made to obtain a wider clearance and a cylindrical specimen [69]. The perineal phase of the operation can be performed in the prone position, but one problem encountered with the wider clearance is adequate closure of the perineal wound. This can be performed with a rectus abdominis or gluteal flap, or with insertion of a prosthetic mesh. It is likely that perineal herniae will become more of a problem with this form of major surgery.

The major complications encountered in surgery for colorectal tumours include anastomotic leakage, intra-abdominal collections, complications relating to stomas and failure of the perineal wounds to heal following APER. Leakage from colonic anastomosis is fortunately rare, being of the order of 5%. It has been noted, however, that the incidence rises with more distal anastomoses, and rates of 15–20% are commonly seen. The consequences of a leak are so serious that many routinely raise a stoma to protect the anastomosis. There seems little to choose between loop colostomy and loop ileostomy. One randomised trial [91] noted an increase in the incidence of intestinal obstruction and ileus, and recommended a loop colostomy. However, this same study noted that prolapse was more commonly seen with the loop colostomy, and other randomised trials have recommended creation of a loop ileostomy [39, 195]. Functional results after an anastomotic leak have been reported [120]. Of 92 patients undergoing an anterior resection, 17 (18%) had a leak. Closure of the stoma was only possible in 12 patients, and the functional results in 11 of these patients were impaired when compared with matched controls. There was a reduction in neorectal capacity, more evacuation problems and a trend to more faecal urgency. Further support for covering a low anastomosis was the observation that in those patients who were not covered and then had a leak that necessitated a stoma being raised, none of the stomas was subsequently reversed, compared with 14/23 (61%) where the leakage occurred in the presence of a covering stoma [97].

34.5 Follow-Up

Although there seem compelling reasons for follow-up of patients treated for colorectal cancer, the value has been questioned. It has been perceived that an intensive follow-up protocol will identify patients with potentially curative recurrent disease, for example hepatic and pulmonary metastatic disease, isolated local recurrence within the pelvis, or patients with asymptomatic recurrence who may benefit from additional chemotherapeutic intervention. Furthermore, follow-up of patients facilitates audit of results. This has been the subject of a Cochrane Review [72] and although supportive of the case for intensive follow-up, what constitutes the optimal follow-up remains uncertain. Their review of eight studies indicates a benefit in overall all-cause survival in those patients who are intensively followed up, some evidence for hepatic imaging in the post-operative period and an observation that more curative surgical procedures were attempted in those patients who were being followed up. The Standards Practice Workforce of the American Society of Colon and Rectal Surgeons has also addressed this issue [4] and, whilst recommending follow-up of patients with completely resected colorectal cancer, indicates those tests that would seem of value (according to the literature that was available at that time). A similar conclusion has been made by the Expert Advisory Group producing the third edition of the Association of Coloproctology – Guidelines for the Management of Colorectal Cancer (Scholefield, personal communication; www.acpgbi.org.uk).

34.6 Surgical Treatment of Metastatic and Recurrent Disease

There has been increasing interest in the role of surgery for metastatic and locally recurrent disease. Whilst avoiding the issue of how the disease is recognised (vide supra), it is apparent that improvements in technology have allowed more radical surgery to be performed and, in selected cases, cures to be achieved. For patients with hepatic metastases, resection remains the only chance of cure, and previous recommendations on margins of clearance and numbers of metastases, for example, have been challenged [190].

Of those patients who undergo an R0 liver resection, 25–40% can expect to be alive at 5 years [152]. There is also the exciting concept that neoadjuvant therapy may render hepatic metastases, previously considered unresectable, resectable [15]. The majority of hepatic metastases resected at present follow the resection of the primary tumour, but it is clear that in patients with an asymptomatic primary tumour and potentially operable hepatic disease, or those that may be rendered operable with neoadjuvant therapy, a delay in surgery of the primary tumour may be necessary. For patients who present with secondary disease within the liver (15–20%), there is some debate as to whether the hepatic secondaries should be resected synchronously or at a later stage. This subject has been discussed in a recent leading article, with a call for clinical trials to resolve many of the outstanding issues [1].

Resection of pulmonary metastases is another area that is receiving attention. Although, following National Institute of Clinical Excellence (NICE) guidance an increasing number of patients are undergoing such surgery, there are no randomised studies on which to base this decision and its wisdom has been called into question [186].

Locally recurrent rectal cancer is a distressing condition and is often incurable. Recent reviews [48, 65] have indicated that in selected cases resection and cure are possible. Success is more frequently seen with the centrally placed recurrences rather than those involving the pelvic sidewall or the sacrum. What is clear is that such cases often need a multidisciplinary team approach with neurosurgical, orthopaedic, urological and plastic surgical input. These major procedures are not without morbidity (24–44%) but 5-year survival figures approaching 30–35% are being reported [65]. Careful assessment is necessary in such cases and, although CT and MRI are commonly employed, this is one of the areas where PET scanning has found a role. These scans may identify coexisting, unrecognised recurrent and distant disease, the finding of which may avoid unnecessary extensive surgery [192].

34.7 Adjuvant Radiotherapy for Rectal Cancer

There is clear evidence that adjuvant radiotherapy reduces the risk of local recurrence when combined with surgical excision. A systemic overview was published in 2001 [31] and reviewed data from 8,507 patients who participated in 22 randomised trials that commenced recruitment prior to 1987. Fourteen of the studies evaluated preoperative and 8 of the studies evaluated post-operative radiotherapy. The risk of local recurrence was reduced from 22% with surgery alone to 12.5% with the addition of preoperative radiotherapy ($p < 0.00001$) and from 26 to 17% with the addition of post-operative radiotherapy ($p = 0.0002$). The greatest benefit was seen in the preoperative trials when a biologically equivalent dose (BED) of more than 30 Gy was given. The use of BED is required to allow the different radiotherapy dose fractionation used to be converted into a common language. For example, short-course preoperative radiotherapy (SCPRT) uses 25 Gy in five fractions, which translates into a BED of 37.5 Gy. This is similar to the Medical Research Council (MRC) CR02 [141] trial that used 40 Gy in 20 fractions with a BED of 36 Gy.

A further important finding from the overview was an excess of non-rectal cancer mortality with the use of adjuvant radiotherapy, which was greatest in the >30-Gy BED preoperative trials. This effect was largest in the European Organisation for Research and Treatment of Cancer (EORTC) 40761 and Stockholm trials. These trials used very large radiotherapy fields and simple two-field radiotherapy techniques, both of which are likely to be at least partly responsible for this finding. Current radiotherapy techniques use a minimum of three radiotherapy fields, and the target volume has been reduced, particularly the superior limit, which is now the sacral promontory.

The use of SCPRT features strongly in the trials that delivered >30 Gy BED preoperatively. This approach was developed in Sweden through the Stockholm [28, 140] and Swedish Rectal Cancer Trial (SRCT) [71], and a trial that compared preoperative short-course radiotherapy with post-operative radiotherapy [47]. One trial was also performed in the UK [52]. The most influential trial was the SRCT, as it not only showed a highly significant reduction in local recurrence, but also showed a 10% improvement in 5-year survival [71]. A further publication [35] concluded that the finding of the trial could be translated into routine practice with similar benefit through data linkage with the Swedish Cancer registries. The authors demonstrated that the local recurrence rate after surgery alone in the trial was the same as that observed in a matched population of patients who did not participate.

Two recent publications have updated the SRCT experience with a median follow up of 13 years. The benefits are sustained [44], with the incidence of local recurrence reduced from 26 to 9% and survival improved

from 30 to 38% for surgery alone and SCPRT and surgery, respectively. A second publication [14] demonstrates that late complications are increased with the use of SCPRT, with a statistically significant increased relative risk of admission more than 6 months after surgery for infection, bowel obstruction and abdominal pain.

In North America, a small but important trial [85] demonstrated that local recurrence was reduced and survival improved by the addition of systemic and concurrent chemotherapy to pelvic radiotherapy. A subsequent trial [125] also showed improved survival when infusional chemotherapy was compared with bolus 5-fluorouracil (5FU). This defined the North American "standard of care" as post-operative chemotherapy and chemoradiotherapy (CRT) for patients with T3/4 tumours or node-positive rectal cancer. The recent results of the German Rectal Cancer Group Trial [151] are likely to lead to a shift from post-operative to preoperative treatment.

Quite reasonably, the local recurrence rates after surgery alone that were seen in the previous trials were considered too high and that this was a result of poor surgical technique. Therefore, benefits from adjuvant radiotherapy required evaluation in the context of improved surgical technique using mesorectal excision.

Two important trials with similar design have tested the role of SCPRT combined with improved surgical technique. The Dutch Colorectal Cancer Group trial [73, 191] and the MRC CR07 trial [156] randomised a combined total of 3,211 patients with resectable rectal cancer, without evidence of metastatic disease, to receive either SCPRT or surgery first. If surgery was performed first, patients with involvement of the circumferential resection margin received post-operative radiotherapy (concurrent chemotherapy was used in the MRC trial). In the Dutch trial no adjuvant chemotherapy was used, whereas in the MRC trial, participating centres used adjuvant chemotherapy according to their agreed policy, thus avoiding any difference between the two treatment arms.

Both trials have demonstrated a statistically significant reduction in local recurrence with increasing absolute benefit with increasing TNM stage. The MRC trial has shown a 5% improvement in 3-year disease-free survival (DFS). Overall survival was not improved in either trial (although the MRC trial is less mature). The evaluation of the macroscopic resection specimen in both trials [116, 139] suggest that the plane of the resection specimen correlates with outcome and the MRC trial clearly demonstrates that the addition of SCPRT lowers the rate of local recurrence across all three planes of resection within the specimen [139].

These two trials provide clear evidence of benefit. At present the debate centres around which patients should now receive SCPRT. The difficulty in answering this question is multifactorial. Firstly, it is essential that the benefit that results from SCPRT be balanced against the short- and long-term risks of toxicity. Secondly, both of the aforementioned trials were performed during a time period when routine evaluation of the pelvic disease with MRI was not established in routine practice. Thirdly, it is also important to determine which patients require preoperative chemoradiation in order to define a decision-making algorithm.

34.8 Preoperative Chemoradiation

The wealth of clinical-trial data and our own clinical experience leads to the important challenge in deciding how to decide on the order of treatment for patients with rectal cancer. In the UK, the concept of multidisciplinary teams (MDTs) were developed from the Calman Hine report in 1995 [26], and this approach has continued to develop.

34.8.1 Decision Making

Today, patients with rectal cancer are routinely discussed preoperatively with review of the biopsy material, clinical details, a pelvic MRI scan and staging CT scan of the chest and abdomen. For the purposes of this chapter, patients with unresectable metastatic disease will not be discussed further. With the exception of very old, frail patients, the vast majority of patients will have a rectal cancer where the decision needs to be made between the initial surgery, SCPRT or preoperative chemoradiotherapy.

In our practice, the selection criteria for preoperative chemoradiation include primary tumours that threaten or involve the mesorectal fascia, and low rectal cancers that require an abdominoperineal excision and in which tumour shrinkage is required to maximise the chance of clear circumferential resection margins. We consider a mesorectal margin to be threatened when there is less than 2 mm from the primary tumour to the mesorectal fascia. We would also consider preoperative CRT for involved lymph nodes that are outside the mesorectal fascia and the conventional plane of surgical excision.

Prior to the results from the CR07 trial, we considered SCPRT for low mobile non-bulky tumours that required abdominoperineal excision and either initial surgery (or participation in the CR07 trial) for those patients whose margins were not considered at risk in whom an anterior resection was planned. This approach was incorporated into a decision-making algorithm to act as guide in our MDT meetings. We have recently evaluated this approach [150]. We have discussed how the CR07 results might change our algorithm within the Yorkshire Cancer Network. SCPRT would be considered for patients with evidence of nodal involvement or T3 tumours where the mesorectal fascia is not at risk. The units differ in the threshold they would apply for T3 disease extent (either >2 mm or >5 mm of extramural spread). We are adopting a standard MRI staging proforma and plan to audit our uptake of SCPRT for each unit.

There are widespread differences in adjuvant radiotherapy policy both between and within countries. We believe that it is important that MDTs agree their approach and audit the process and outcome [25, 150]. This is an essential tool for improving our routine practice.

34.8.2 Trials of Preoperative Chemoradiation

Three recent trials help to determine the role of chemoradiation. The EORTC 22921 trial [17] and the Fédération Francophone de Cancérologie Digestive (FFCD) 9203 [51] trial randomised a combined total of 1,744 patients with T3/4 or node-positive resectable rectal cancer. Both compared long-course radiotherapy alone (45 Gy in 25 fractions) with preoperative chemoradiation (45 Gy in 25 fractions with 5FU and leucovorin, LV) given during the 1st and 5thweek. Post-operatively, the EORTC trial used a second randomisation that compared no further treatment with 4 monthly cycles of 5FU/LV chemotherapy, whereas the FFCD trial recommended chemotherapy for all patients. Both trials demonstrated that the local recurrence rate was reduced from 17 and 17% with long-course RT to 9 and 8% with preoperative CRT in the EORTC and FFCD trials, respectively. Neither trial demonstrated any difference in DFS. These results provide convincing evidence that preoperative CRT is superior to long-course radiotherapy alone.

A further trial, performed with very similar entry criteria, compared preoperative CRT with post-operative CRT [151]. Post-operative adjuvant chemotherapy was recommended for all patients in both treatment arms. The German CAO/ARO/AIO-94 trial randomised 823 patients and has demonstrated clear advantages for preoperative CRT. The rate of local recurrence was reduced from 12 to 6% and there was a significant and statistical reduction in both acute and late toxicity in favour of preoperative CRT.

The recent trial results lead us to question the potential advantage of preoperative CRT over SCPRT in patients with resectable rectal cancer. One trial has compared these two treatments [23], but it should be emphasised that the trial was not designed nor statistically powered to evaluate local recurrence or survival. The Polish trial was designed to test whether the use of preoperative CRT would allow a higher rate of sphincter-preserving resections for patients with low, resectable rectal cancer. A total of 312 patients were randomised prior to surgery between preoperative CRT and SCPRT. The participating surgeons had agreed to base their decision whether a sphincter-preserving procedure could be performed on the basis of the disease extent after (chemo)-radiotherapy. However, it appears that this did not consistently occur.

There was no difference in the rate of sphincter-preserving resections between the two treatment arms. Interestingly the rate of local recurrence was 9% with the use of SCPRT and 14% after preoperative CRT [23]. Although these results are of great interest, the number of patients studied was small and further trials that formally address this question are required (there is one Australian trial that has recently completed accrual).

34.8.3 Treatment-Related Toxicity

It is most important to recognise that there are both acute and late complications that arise from adjuvant radiotherapy. There is clear evidence that there is an increase in bowel dysfunction and incontinence [34, 81, 104, 133] and sexual dysfunction [105]. Radiotherapy will also result in sterility in men and premenopausal women.

The assessment of the distal extent of the tumour by the surgeon and radiation oncologist is essential in both deciding the likely operative procedure and radiotherapy treatment planning. If an anterior resection is planned, the main bowel problems are likely to relate to a low anastomosis with avoidance of irradiation of as much of the anal sphincter as possible. If an abdominoperineal excision is planned, the main concern from radiation is the very significant delay associated with

healing of the perineal wound [104]. Possible strategies to deal with this are to minimise the amount of perineum that is irradiated, the use of a flap to cover the perineal defect, or improving the surgical technique in an attempt to avoid radiotherapy particularly in early tumours (discussed elsewhere in this chapter).

34.9 Novel Chemoradiation

There is a strong rationale to improve concurrent chemoradiation for rectal cancer. One approach is to substitute oral capecitabine for intravenous 5FU/LV during radiation. This would simplify treatment and either avoids the need for a central venous catheter and infusion pumps (using continuous infusion 5FU) or for ten intravenous injections of 5FU/LV. The use of capecitabine CRT has recently been reviewed [56] and our experience with the use of a 5 days/week schedule of capecitabine has recently been presented [33].

A large number of phase I/II studies have evaluated the addition of both irinotecan and oxaliplatin. A recent overview [62] of 3,157 patients who were enrolled in clinical trials of preoperative chemoradiation found that the pathological complete response rate was 19% when two drugs were used compared with 10% with 5FU. Although the reports from the phase II studies have reported higher partial complete response rates and high rates of clear circumferential margins, there is now a need for phase III studies to determine the benefit of adding either a second drug (irinotecan or oxaliplatin) or an antibody (cetuximab or bevacizumab).

Inevitably, intensifying CRT will increase acute and late toxicity and it is therefore important that these studies are conducted in patients with high-risk rectal cancer (e.g. tumours that threaten or involve the mesorectal fascia) before such therapy is used in patients with resectable disease with less disease extent.

34.10 Adjuvant Chemotherapy for Colorectal Cancer

The last 15 years have seen detailed evaluation of a number of important questions in the use of adjuvant chemotherapy for colorectal cancer. Most trials have been restricted to colon cancer, the main reason being simplicity. In rectal cancer there is the risk of local recurrence, which can range widely, and the difficulties of sequencing adjuvant chemotherapy with post-operative chemoradiation, both of which can confound any benefits arising from adjuvant chemotherapy.

The results of two key trials in the United States in which the combination of 5FU and levamisole for 12 months was evaluated [89, 111, 112] led to a key milestone in the use of adjuvant chemotherapy. The United States National Institutes of Health recommended adjuvant chemotherapy for stage III colon cancer patients [123].

Subsequent trials have addressed several important questions. The Intergroup 0089 trial [59] established that 6 months of 5FU/LV was as effective as 12 months of 5FU/levamisole. The QUASAR (QUick And Simple And Reliable) trial [32] demonstrated that there was no benefit from the use of levamisole and that there was no difference between the use of high-dose or low-dose LV when combined with 5FU for 6 months. A cohort of 4,927 patients was randomised in a factorial 2×2 design between low-dose and high-dose LV and between levamisole and placebo. This randomisation took place when there was a "certain" indication for chemotherapy. The same process was applied when there was an "uncertain" indication for chemotherapy, but where patients were randomised between chemotherapy (using the factorial approach) and no chemotherapy [137].

In the QUASAR trial, clinicians were allowed to use either a once-weekly administration schedule for 30 weeks or 5 days per week repeated monthly for 6 months. Although the two approaches were not a randomised comparison, there is no apparent difference in outcome between the choice of regimen used, and many clinicians in the UK prefer to use the weekly schedule as this is associated with significantly less toxicity. A 24-week schedule using a slightly higher 5FU dose has recently been evaluated [131].

34.10.1 Stage II Patients

The benefits of adjuvant chemotherapy in patients with stage II disease is less clear and still a matter of considerable debate with various pieces of conflicting evidence. A pooled analysis of four National Surgical Adjuvant Breast and Bowel Project (NSABP) studies [101] with 1,565 patients with stage II disease suggested a 32% reduction in mortality that became a 5% absolute improvement in survival. The International Multicentre Pooled Analysis of Colon Cancer Trials (IMPACT) investigators [40] combined five studies comprising 1,020 patients and found a non-significant, 1.5% im-

provement in survival. In the QUASAR trial, 92% of the patients in the uncertain arm had stage II disease and with a median follow-up of 4.6 years, the 5-year survival was improved from 77.4 to 80.3% [137].

The overall survival benefit from the routine use of adjuvant chemotherapy therefore ranges from 1.5 to 5%. However, non-randomised studies clearly demonstrate that the presence of extramural vascular invasion, peritoneal surface involvement, tumour perforation and poorly differentiated tumours in patients with stage II disease confer a survival expectation similar to that of stage III disease. This leads many oncologists to use this indirect evidence to help in the selection of patients with stage II disease and with adverse prognostic features to receive adjuvant chemotherapy.

34.10.2 DFS as an End Point

An important publication has compared the outcome of trials of adjuvant chemotherapy versus control. Sargent et al. [149] identified 18 randomised trials comprising 20,898 patients and demonstrated a convincing correlation between the 3-year disease-free and 5-year overall survival. The Spearman rank correlation coefficient between disease-free and overall survival was 0.88. This has led NICE and the US Food and Drug Administration's Oncologic Drugs Advisory Committee to accept a 3-year DFS as the primary end point of future adjuvant chemotherapy trials in colon cancer. This should significantly shorten the time interval between a positive clinical trial result(s), the granting of a license and its approval for routine use by regulatory bodies.

34.10.3 Oral Chemotherapy

Two oral fluoropyrimidines have an established role in metastatic colorectal cancer. Capecitabine is used as a single agent, whereas oral uracil and tegafur (UFT) is combined with LV. Both have recently demonstrated at least equivalence with bolus 5FU/LV as adjuvant postoperative therapy for stage III colon cancer.

The "Xeloda in Adjuvant colon Cancer Therapy" trial [187] randomised 1,987 patients between oral capecitabine and intravenous 5FU/LV in patients with stage III colon cancer. Capecitabine was given orally twice daily, at a dose of 12,550 mg/m^2 on days 1–14, every 21 days for a total of eight cycles. The 5FU/LV regimen used was the Mayo regimen, where the 5FU/LV was given as an intravenous bolus on days 1–5 every 28 days for 6 months. The trial was designed to demonstrate equivalence between the two therapies, but the capecitabine arm demonstrated a 3-year DFS of 64.2% compared with 60.6% for the 5FU/LV arm. There was no significant difference in toxicity between the two treatment arms.

The NSABP C-06 trial [95] randomised 1,608 patients with stage II and III colon cancer between oral UFT with LV, and the Mayo regimen for 6 months. There was no difference in 3-year DFS (hazard ratio 1.004) and no difference in toxicity between the two arms.

NICE has recently reviewed the available evidence for oral fluoropyrimidines and oxaliplatin [122] (see below) as adjuvant therapy for stage III colon cancer and concluded that "the choice of treatment should be decided jointly by the individual and their doctors, after they have discussed the options. This discussion should cover any contraindications to the treatments (reasons why a particular medicine might not be suitable for the person), the possible side effects of the treatments, and the different ways they can be given. It should also take into account the person's clinical condition and individual preferences".

34.11 Combination Chemotherapy

There is clear evidence that the addition of either oxaliplatin or irinotecan to 5FU increases the response rate and progression-free survival in patients with metastatic colorectal cancer. However, the addition of a second drug increases the incidence of treatment-related toxicity. Carefully designed clinical trials were therefore required to determine what, if any benefit could be achieved by post-operative adjuvant therapy after resection of colorectal cancer.

Two trials have tested the addition of oxaliplatin to 5FU. The MOSAIC (Multicentre International Study of Oxaliplatin/5-FU/LV in the Adjuvant Treatment of Colon Cancer) trial [3] randomised 2,246 patients with stage II and III colon between an infusional 5FU/LV schedule (the De Gramont regimen) ± oxaliplatin. Treatment consisted of 12 cycles at 2-weekly intervals in both arms. Oxaliplatin was given as a 2-h infusion on day 1 of each cycle. The overall trial result representing all patients demonstrated that the 3-year DFS was improved from 72.9 to 78.2% with the addition of ox-

aliplatin. When a subset analysis is performed by stage, the 3-year DFS for stage III patients was improved from 65.3 to 72.2%, whereas that for stage II patients was improved from 84.3 to 87%. The updated results at 4 years [36] demonstrate that the improvement in DFS is maintained, although there is no overall survival advantage. The 5-year results are awaited with interest.

The advantage of this combination therapy is achieved at the expense of an increase in treatment-related toxicity. A central venous catheter is required for chemotherapy, with the attendant risks of infection and thrombosis. There is a need for an ambulatory chemotherapy infusion device and an increased risk of neutropaenic sepsis and diarrhoea. The most noticeable toxicity is the reversible cold dysaesthesia that can occur for 1–2 days after each treatment and neuropathy. Grade 3 neuropathy is the most significant toxicity and was reported in 12.4% of patients during treatment, subsiding to 1% 12 months after completion of therapy.

The NSABP reported the results of the C-07 trial in 2005 [197]. In this trial, 2,407 patients with stage II and stage III colon cancer received a bolus 5FU/LV schedule given for 6 weeks, followed by a 2-week break (3 cycles) versus the same regimen plus oxaliplatin given on weeks 1, 3 and 5 of each cycle. The 3-year DFS improved from 71.6 to 76.5% with the addition of oxaliplatin. The expected toxicities include diarrhoea and neurotoxicity, although the grade 3 neuropathy rate was slightly lower (at 8%) compared with the MOSAIC trial (12%).

Oxaliplatin combined with 5FU/LV is now licensed for use in stage III colon cancer; its use has also been recently approved by NICE [122]. The increased intensity of adjuvant therapy requires careful discussion and selection of patients for the appropriate therapy.

Unfortunately, the trials that have been performed in the adjuvant setting evaluating the addition of irinotecan have been disappointing. Two trials in metastatic colorectal cancer had demonstrated an increased response rate and an improvement in progression-free survival when irinotecan was added to 5FU/LV. This led to three adjuvant chemotherapy trials. The Cancer and Leukemia Group B 90803 trial [148] studied 1,264 stage III colon cancer patients and compared an irinotecan 5FU/LV schedule (IFL) with bolus 5FU/LV. The treatment-related mortality was increased in the IFL arm at 2.8% compared with 1% using 5FU/LV. After a median follow-up of 3 years, no difference in DFS or overall survival was seen.

The Pan-European Trial for Adjuvant Treatment of Colon Cancer 3 (PETACC3) trial [189] used an infusional 5FU/LV schedule and examined the addition of irinotecan in 2,014 stage III colon cancer patients. There was no increase in treatment-related mortality, although grade 3 and 4 neutropaenia and diarrhoea were increased with the use of irinotecan. Although the 3-year DFS was improved from 60.3 to 63.3%, this did not reach statistical significance on the planned intention to treat analysis. A T-stage imbalance was present between the two treatment arms.

The third trial, the French ACCORD/FFCD trial [198] used the same treatment arms as PETACC3, but studied high-risk stage III colon cancer patients. A cohort of 400 patients was studied, and the 3-year DFS for the irinotecan 5FU/LV arm was inferior to the 5FU/LV control arm (51 vs 60%), although this difference was not statistically significant.

When the three trials are considered together, it is clear that based on the available evidence there is no justification for the addition of irinotecan to 5FU/LV schedules in the adjuvant therapy of colon cancer.

Future adjuvant chemotherapy trials are evaluating the benefit of the addition of antibody therapies directed against the vascular endothelial growth factor and epidermal growth factor receptors. Other trials are assessing whether capecitabine combined with oxaliplatin can be considered as an alternative to oxaliplatin and 5FU/LV.

34.12 Neoadjuvant Chemotherapy

At present there is no randomised evidence to support the use of neoadjuvant chemotherapy in colon cancer. Although the benefit of preoperative therapy with tumour shrinkage prior to surgery is attractive, this approach must be evaluated in well-designed, prospective, randomised controlled trials. The failure of irinotecan combination adjuvant studies to translate into a survival advantage despite very clear evidence of benefit in the metastatic disease setting is an important lesson in this respect.

34.13 Conclusion

The management of malignant colorectal tumours has clearly changed radically over the past two decades, with contributions from many disciplines. It is disap-

pointing that the combined efforts of many clinicians and researchers has led to only modest improvements in overall outcome, although there have been major advances in the local control of rectal cancers. Perhaps we are entering the most exciting times in the management of this common disease. Presymptomatic identification of malignant and premalignant colorectal lesions within population-based screening programmes offers a real hope of reducing the mortality from this disease. Whilst waiting for such programmes to be introduced, we will have to be reliant on the modest gains offered by minimal-access procedures, both endoscopic and surgical, adoption of the many changes in surgical technique that serve to improve the quality of life in patients with colorectal cancer, and by continued progress in the non-surgical management of this disease.

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Self-Assessment Quiz

Question 1

Disease-free survival is improved in comparison with 5-fluorouracil (5FU)/leucovorin by the use of which of the following chemotherapy regimens?

a. Irinotecan
b. Irinotecan combined with 5FU
c. Capecitabine
d. Oxaliplatin
e. Oxaliplatin combined with 5FU

Question 2

The German Rectal Cancer Group trial demonstrated a significant benefit in favour of preoperative chemoradiation for which of the following end points?

a. Reduction in local recurrence only
b. Reduction in local recurrence and improved disease-free survival
c. Reduction in local recurrence but no reduction in acute toxicity
d. Reduction in local recurrence but no difference in late toxicity
e. Reduction in local recurrence, reduced acute and late toxicity

Question 3

In population-screening studies for colorectal cancer, which modalities have been shown to be effective as the initial screen in controlled randomised trials?

a. Faecal occult blood testing using the guaiac peroxidase method
b. Faecal occult blood testing together with flexible sigmoidoscopy
c. Faecal occult blood testing together with colonoscopy
d. Flexible sigmoidoscopy alone
e. Colonoscopy alone

Question 4

Local excision of rectal tumours has found favour in which group of patients?

a. Resection limited to T1 and T2 tumours alone
b. T1, T2 and some smaller T3 tumours
c. Tumours of <3 cm despite a degree of differentiation
d. Selected T1 tumours not exceeding invasion of the superficial aspects of the submucosa (sm1)
e. Unselected T1 tumours

Question 5

Accurate staging of depth of penetration of the rectal wall by tumours is best performed by:

a. Computed tomography (CT) scanning
b. Magnetic resonance imaging (MRI)
c. Endorectal ultrasound
d. A combination of CT scanning and MRI
e. Positron emission tomography scanning

1. Answer: e
2. Answer: e
3. Answer: a
4. Answer: d
5. Answer: c

35 Retrorectal Tumors

Cédric Vallet and Dimitrios Christoforidis

CONTENTS

35.1 Introduction

Retrorectal or presacral tumors (RRTs) form a heterogeneous but unique group of lesions. By definition, they develop in the limited space between the sacrum and the rectum, underneath the peritoneal reflection, and medial to the ureters, iliac vessels, and rectal stalks. Their incidence is very low. Major referral centers may see up to five cases per year [1], whereas in a major metropolitan area approximately two cases per year are encountered [2]. In the newborn, sacrococcygeal teratoma is the most common neoplasm, with an incidence of 1 in 40,000 live births. The rarity of RRTs and similarities in clinical presentation with common anorectal conditions often lead to misdiagnosis and delayed treatment.

35.2 Origin and Classification

Lovelady and Dockerty [3] classified RRTs into five categories according to their origin: congenital, inflammatory, neurogenic, osseous, and miscellaneous. Other more clinically oriented classifications have recently been proposed based on the nature of the tumor (benign vs malignant, congenital vs acquired) [4], or based on anatomical relationships to the sacrum and ease of resectability [5]. A list of RRTs with an estimate of their relative incidence is presented in Table 35.1. Overall, RRTs are more common in females; the mean age of presentation is 40–50 years, and one-quarter to one-third are malignant.

35.2.1 Congenital Lesions

Congenital lesions account for approximately two-thirds of RRTs. Developmental cysts, rectal duplications, germ cell tumors, anterior sacral meningoceles, and chordomas are grouped into this category. Although congenital, the majority are diagnosed in adulthood.

35.2.1.1 Developmental Cysts

Developmental cysts originate from noninvoluted vestiges of embryonic tail elements in this area. On physical examination, developmental cysts are soft, compressible, and often ill defined. A funnel-shaped dimple on the postanal midline is found in 35–100% of cases (Fig. 35.1). This dimple is not usually associated with a sinus or a fistula to the cyst or rectum [6, 7]. Infection is common and many of these patients will be misdiagnosed as having recurrent perianal fistula or pilonidal sinus.

Tailgut cysts, also known as "retrorectal cyst hamartomas" or "postanal gut cysts," originate from the part of the primitive gut located distal to the cloaca, which normally involutes during embryonic development.

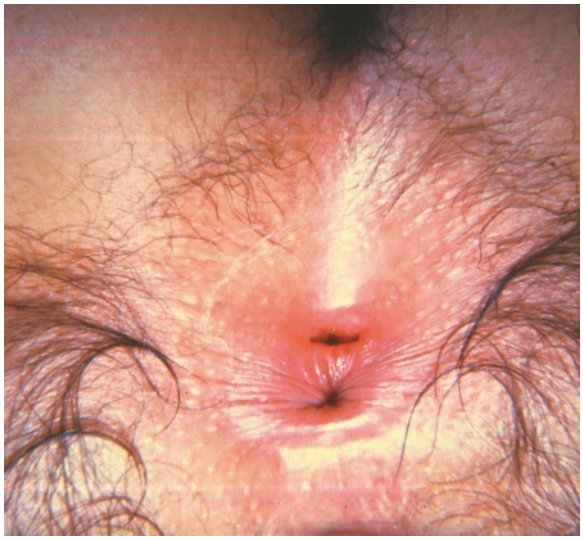

Fig. 35.1 The postanal dimple indicates a congenital cyst. It may or may not communicate with the cyst

They are uni- or multilocular cystic lesions (Fig. 35.2) that are lined by a variety of epithelial types. By definition they must contain some glandular or transitional epithelium. The lining is simple, without villi or crypts, and although smooth muscle elements may be found in the vicinity of the cysts, there is no well-defined muscular wall with a myenteric plexus. They are more common in females and are usually diagnosed in the fourth decade, but may present at any age. The risk of malignant degeneration of tailgut cysts to adenocarcinoma or squamous carcinoma is estimated to be 7% [8].

Epidermoid and dermoid cysts originate from ectoderm remnants. They are lined only by simple squamous epithelium. Dermoid cysts are rare and contain skin appendages.

35.2.1.2 Rectal Duplication

Rectal duplication is a malformation that is characterized by continuity with the rectal lumen, a wall containing two layers of smooth muscle with a myenteric plexus, and a mucosal lining that is usually similar to the rectal mucosa but frequently also contains islands of ectopic tissue (e. g., gastric mucosa, pancreatic tissue, urothelial mucosa). It may present with bleeding secondary to mucosal ulceration in the vicinity of ectopic gastric mucosa.

35.2.1.3 Germ Cell Tumors

Germ cell tumors arise from remnant totipotent cells in the retrorectal space. They are very rare in adulthood. However, the sacrococcygeal teratoma is the most common tumor diagnosed in the fetus and the infant, accounting for approximately 1:40,000 births. It has a

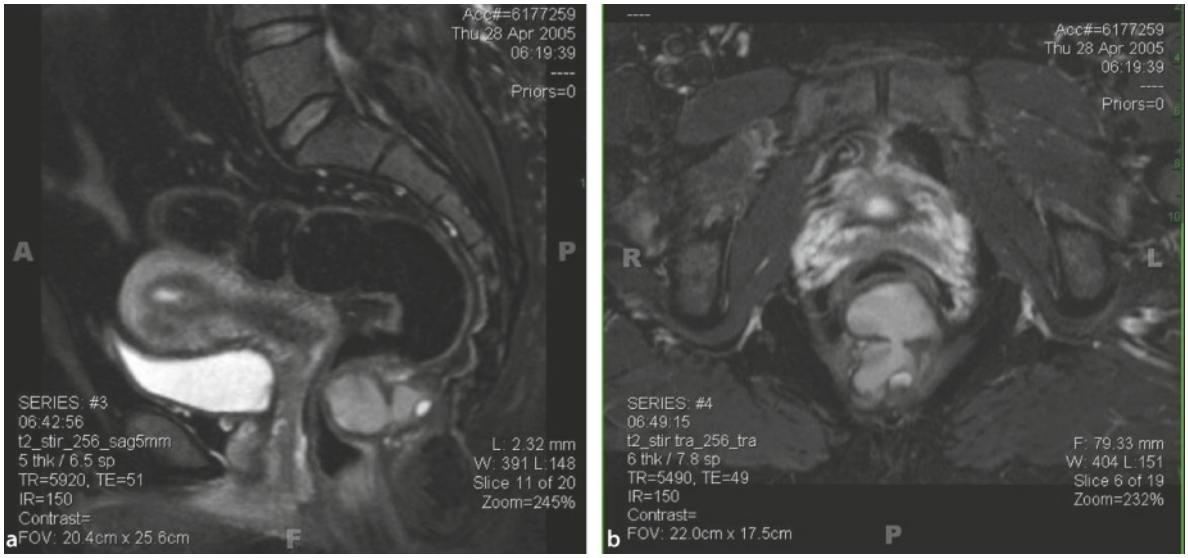

Fig. 35.2a,b Magnetic resonance imaging (MRI) sagittal (**a**) and axial (**b**) sections of a tailgut cyst. Note the mass effect on the rectum and the multiple loculations

strong female predominance and 80–90% of the lesions are benign. Malignancy is more common when the tumor is discovered after infancy and usually consists of an endodermal sinus (or "yolk sac") tumor [9]. Complete surgical resection, which may sometimes be undertaken in utero, gives excellent cure rates. Platinum-based chemotherapy is used for nonresectable lesions as neoadjuvant treatment or for metastatic disease with still-favorable outcomes. Long-term follow-up after surgery with dosage of alpha-fetoprotein is mandated for early detection of recurrence [10].

Currarino syndrome is a rare hereditary disorder associated with anorectal stenosis or low imperforated anus, a sacral bone defect, and a presacral mass. The presacral mass may be a teratoma, an anterior meningocele, a tailgut cyst, a dermoid cyst, or a combination of these. Associated anomalies of the genitourinary system are frequent.

35.2.1.4 Anterior Sacral Meningocele

Anterior sacral meningocele is a congenital herniation of the dural sac through a defect resulting from agenesis of a portion of the anterior wall of the sacrum. Associated malformations such as spina bifida, bicornuate uterus, and imperforate anus are found in approximately 50% of cases. It may contain neural (myelomeningocele) or lipomatous elements (lipomeningocele). Typical presentation is constipation with headaches upon defecation and straining, or recurrent meningitis.

35.2.1.5 Chordomas

Chordoma is the most common malignant RRT. It is believed to arise from notochordal rests and may therefore develop all along the axis of the spine. It is most commonly found in the sacrococcygeal region, but can also occur at the skull base and less frequently in the vertebral bodies. It is a lobulated, gelatinous tumor with areas of calcification, hemorrhage, and cystic changes. Microscopically, it is characterized by abundant stromal tissue, cords of cells with poorly defined boundaries, and pathognomonic large, vacuolated cells called "physaliferous cells." It is a slow-growing tumor with a low risk of metastasis; however, long-term prognosis is poor because most patients present with locally advanced disease, rendering radical surgery the only hope for cure.

35.2.2 Acquired Lesions

Noncongenital lesions that may be found in the retrorectal space include tumors of inflammatory, neurogenic, osseous, or miscellaneous origin.

Retrorectal abscesses are usually easily diagnosed considering the history and clinical presentation of the patient. Barium granulomas following traumatic barium enemas have been reported in earlier years, but are exceedingly rare nowadays.

Frequent neurogenic tumors of the retrorectal space include neurofibromas (Fig. 35.3), neurilemmomas, and ependymomas. Lesions of osseous origin arise in the sacrum and their behavior is similar to that of bony tumors in other parts of the body. Miscellaneous RRTs include benign and malignant tumors of mesenchymal origin (see Table 35.1), metastasis, lymphomas, arteriovenous malformations, extra-adrenal myelolipomas (Fig. 35.4), and even extramedullary hematopoiesis in beta-thalassemia patients [11].

35.3 Diagnostic Work-Up

Half of RRTs are asymptomatic and will be discovered incidentally either during routine physical examination or on imaging studies ordered for another reason. The most frequent symptoms are pelvic fullness and low back pain that is typically exacerbated by sitting. Mass effect can lead to incomplete evacuation, narrowed stools, increased urinary frequency, and even dystocia. Neurologic symptoms such as radicular pain, sensorimotor deficiencies, and pelvic organ dysfunction are more common with malignancy. Pain is almost always present with malignant lesions, but in only approximately 40% of benign lesions [1].

The cornerstone in the assessment of an RRT is digital rectal examination. More than 90% of RRTs are palpable on digital rectal examination. Most importantly, the digital rectal examination will help assess resectability and guide the surgical approach. Plain radiographs of the pelvis are usually of limited diagnostic value. They may identify bony destruction or deformities of the sacrum such as the so called "scimitar sacrum" with its rounded, concave border and no evidence of bone destruction (Fig. 35.5), as seen with an anterior sacral meningocele. Endorectal ultrasound can determine if there is invasion or sparing of the rectal wall and distinguish solid from cystic components. However, computed tomography (CT) scanning and magnetic resonance imaging (MRI) of the pelvis are

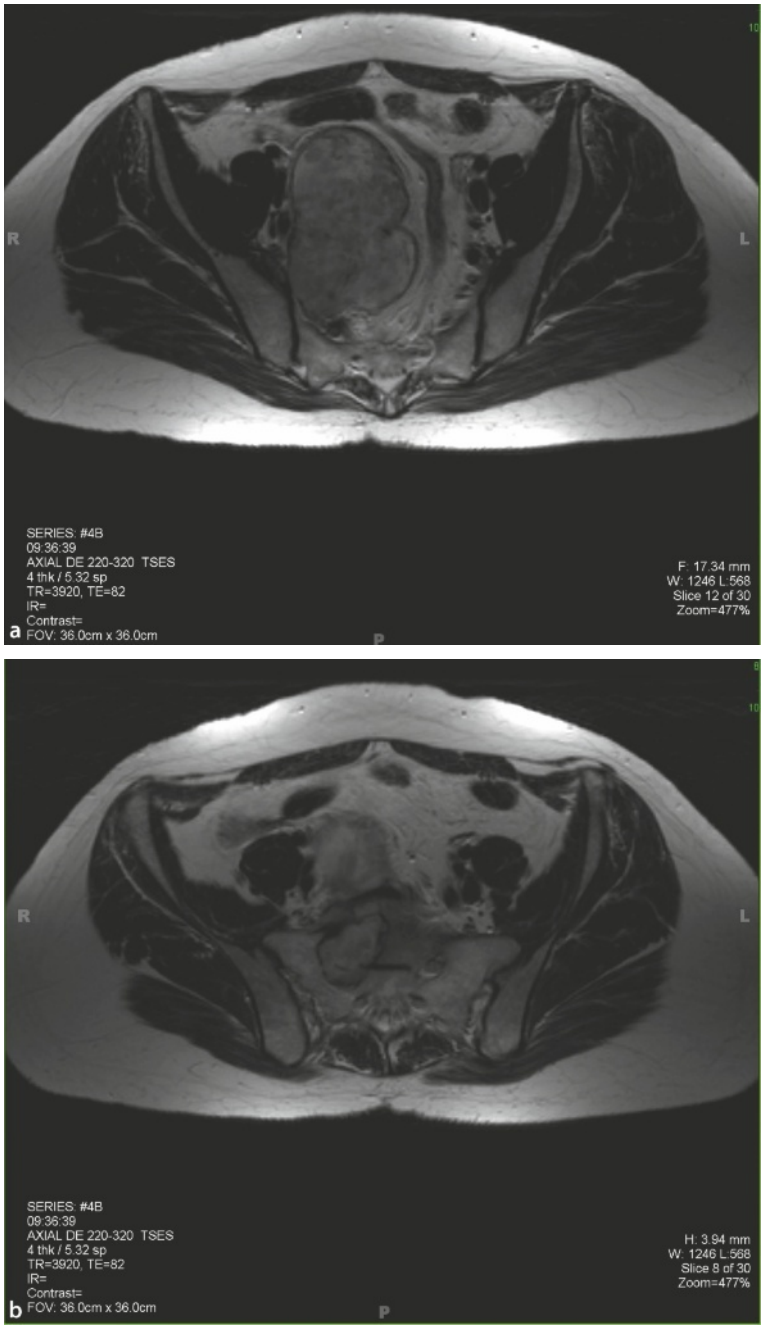

Fig. 35.3a,b MRI images of a neurofibroma arising in the right sacral foramen. Note the absence of bone destruction

Table 35.1 List of retrorectal tumors (RRTs) found in six large series published between 1971 and 2005. Numbers indicate the percentages of the total number of RRTs of the cohort. *excl* Category excluded from the study

	Freier et al. [22] Michigan	**Jao et al. [1] Mayo Clinic**	**Uhlig and Johnson [2] Portland**	**Grundfest-Broniatowski et al. [23] Cleveland Clinic**	**Glasgow et al. [21] Washington**	**Lev-Chelouche et al. [4] Tel Aviv**
Age group	Adults	Adults + Children	Adults	Adults + Children	Adults	Adults
Time span (years)	35	19	30	56	22	10
Total RRTs (*n*)	**21**	**120**	**63**	**50**	**34**	**42**
CONGENITAL						
Benign (%)	*14*	*40*	*43*	*44*	*44*	*28*
Tailgut cyst		16	16	6	2	12
Epidermoid/dermoid cyst		15	1		5	
Teratoma	2	15	2	13	8	
Rectal duplication	1		1	1		
Anterior sacral meningocele		2		2		
Malignant (%)	*47*	*28*	*11*	*40*	*12*	*21*
Chordoma	9	30	6	17	3	9
Teratocarcinoma	1	3		1	1	
Endodermal sinus tumor				2		
ACQUIRED						
INFLAMMATORY (%)	*9*	*excl*	*5*	*0*	*0*	*excl*
Barium granulomas	2					
Foreign body granuloma			1			
Perineal abscess			2			
NEUROGENIC						
Benign (%)	*0*	*8*	*6*	*0*	*15*	*7*
Neurilemmoma		7	1			
Neurofibroma		3	1			
Ganglioneuroma						
Schwannoma			2		5	3
Malignant (%)	*5*	*3*	*3*	*2*	*3*	*2*
Neurofibrosarcoma	1	2	1			
Ependymoma		1	1	1		
Neuroblastoma					1	
Malignant schwannoma						1

Table 35.1 *(continued)* List of retrorectal tumors (RRTs) found in six large series published between 1971 and 2005. Numbers indicate the percentages of the total number of RRTs of the cohort. *excl* Category excluded from the study

	Freier et al. [22] Michigan	**Jao et al. [1] Mayo Clinic**	**Uhlig and Johnson [2] Portland**	**Grundfest-Broniatowski et al. [23] Cleveland Clinic**	**Glasgow et al. [21] Washington**	**Lev-Chelouche et al. [4] Tel Aviv**
OSSEOUS						
Benign (%)	*5*	*6*	*3*	*8*	*excl*	*0*
Osteoma			1			
Aneurysmal bone cyst	1	1		1		
Simple bone cyst			1			
Giant cell tumor		5		3		
Osteochondroma		1				
Malignant (%)	*5*	*5*	*2*	*2*	*excl*	*7*
Myeloma		2				
Osteosarcoma		1	1			1
Ewing's sarcoma		3		1		
(Myxo)chondrosarcoma	1					2
MISCELLANEOUS						
Benign (%)	*9*	*5*	*2*	*0*	*20*	*17*
Hemangioma	1	1				
Lymphangioma			1			
Angiomyxoma						1
Hemangioendothelioma	1					
Lipoma		3			3	3
Leiomyoma		1				2
Fibroma		1				1
Angiomyxoma						
Malignant (%)	*5*	*7*	*10*	*2*	*6*	*19*
Plasma cell myeloma			1			
Desmoid tumor			1			2
Lymphoma		6				1
Fibrosarcoma		1				1
Liposarcoma			2			
Angiosarcoma						2
Hemangiopericytoma	1			1		
Hemangioendothelelial sarcoma			1			
Squamous cell carcinoma						1
Metastatic cancer (%)		*excl*	*14*		*excl*	
Total (%)	100	100	100	100	100	100

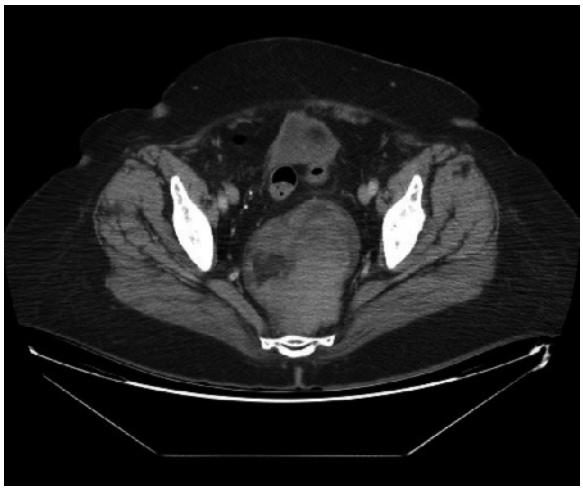

Fig. 35.4 Computed tomography (CT) scan of a retrorectal myelolipoma in an asymptomatic 78-year-old female patient

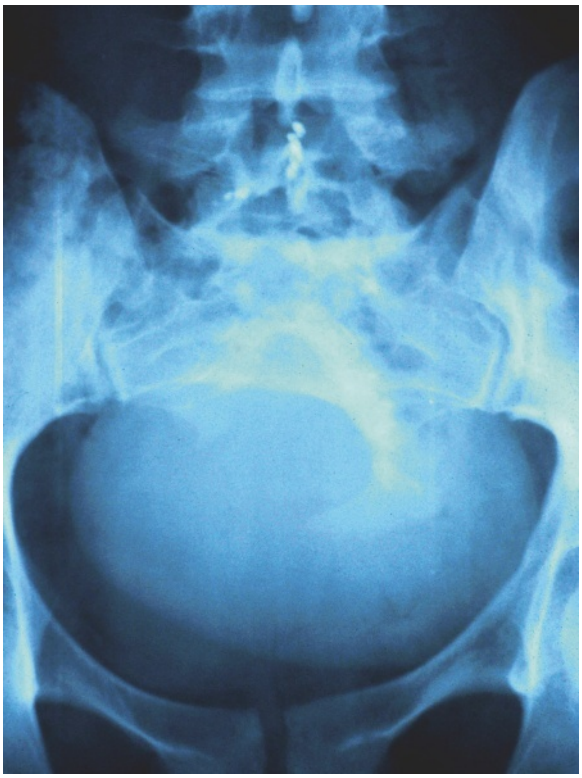

Fig. 35.5 Radiography of the pelvis showing a "scimitar sacrum," a typical finding of an anterior sacral meningocele

the most powerful imaging tools for diagnosis and preoperative planning of surgery.

Malignant RRTs generally appear as solid, bone-invading, ill-delimitated lesions as opposed to well-circumscribed benign cystic lesions. Very rarely, a sacral bone defect may be present in association with dermoid, tailgut cysts or voluminous neurilemmomas. This is usually secondary to a mass effect rather than bone invasion [1]. Developmental cysts are thin-walled and do not alter the surrounding anatomical planes. However, secondary infection, which may be chronic, will result in thicker walls and less-well-defined margins. Irregular wall thickening is suggestive of malignant degeneration. Rarely, calcifications can be present in dermoid and tailgut cysts; they are more common in teratomas. Anterior sacral meningoceles are associated with an anterior sacral bone defect and always contain clear cerebrospinal fluid. Conversely, the content of a developmental cyst is of variable thickness and may differ between loculations in the same lesion in tailgut cysts [12]. Teratomas are solid, well-circumscribed tumors that occasionally contain cystic components. Chordomas appear as a heterogenous solid mass with sacral bony destruction and extension into the soft tissues. Contrast uptake and signal intensity on CT are low, and CT scans tend to underestimate the volume of the tumor. On MRI, chordomas show a high-intensity T2-weighted signal, which allows a more accurate delimitation of the tumor (Fig. 35.6) [13].

At proctoscopy or sigmoidoscopy, in most cases the only finding will be extrinsic compression of the rectum. However, it is useful to rule out rectal mucosa involvement or communication of the lesion with the rectal lumen, as seen in rectal duplication. Sometimes, a fistulization with a cyst may be seen on proctoscopy, but contrast enema, especially when combined with a CT scan, will give the most valuable information in such cases.

Biopsy of RRTs is controversial. Since resection is indicated in most cases of RRT, the value of preoperative biopsy is questionable. It carries the potential risks of tumor cell seeding, infection, and bleeding. The magnitude of these risks is difficult to quantify. A biopsy may be helpful in the decision-making process of patients who are poor candidates for surgery either due to very large tumors or significant comorbidities. Biopsy could also help influence the choice of neoadjuvant therapy with chemo- and/or radiotherapy. When performed, the posterior percutaneous route should be chosen over the transrectal route. If possible, the needle track

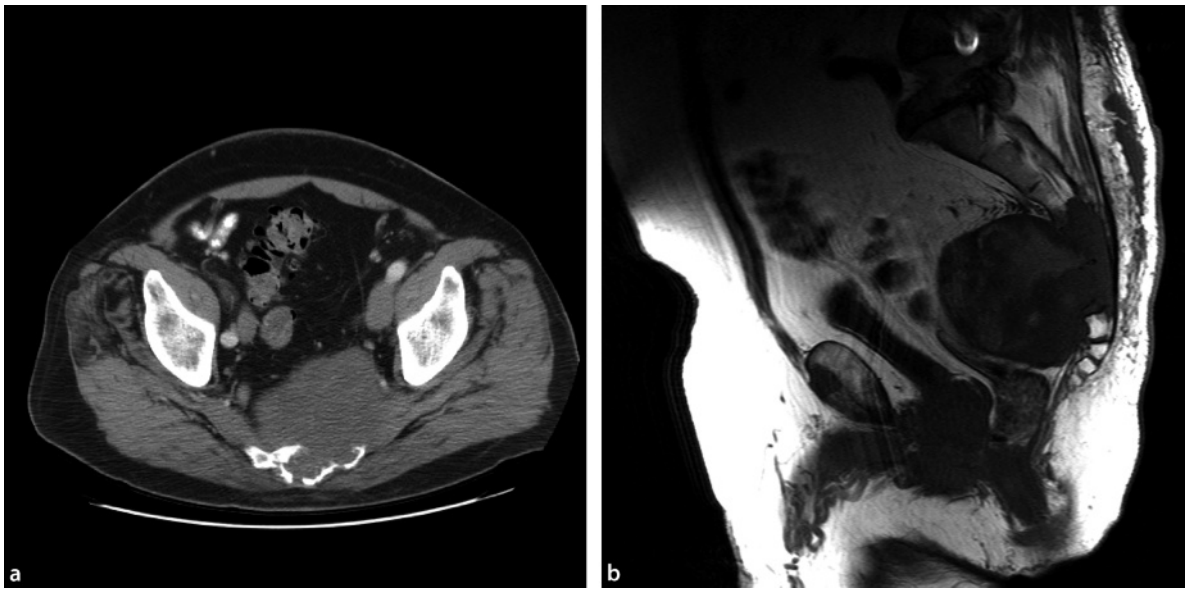

Fig. 35.6 **a** CT scan of the pelvis of a 62-year-old male patient with chordoma. Bony destruction and minimal contrast uptake are typical findings. **b** MRI sagittal section of the same patient. The level of sacral invasion is well demonstrated

should be included in the planned resection. Furthermore, the risk of tumoral cell seeding may be reduced by thermocoagulating the needle track or by using the "protected double-needle biopsy" technique as described for biopsy of hepatocellular carcinoma [14].

35.4 Treatment

Even if RRTs are frequently benign and asymptomatic, their natural history argues against conservative management except in the very sick or elderly patient. Teratomas and congenital cysts harbor a potential of malignant degeneration estimated at 5–10% [15]. Cystic lesions carry a risk of secondary infection and fistulization. In females of childbearing age, the mass effect from RRT can cause dystocia with significant morbidity to the mother and child. Although benign, sacral meningocele carries the risk of life-threatening meningitis.

For malignant RRTs, the efficacy of either chemotherapy or radiation is very limited, which is why medical treatment plays at best an adjuvant role. Hence, in the vast majority of cases, surgical resection is the most appropriate treatment for RRTs.

35.4.1 General Considerations

Resection of RRTs can be a true challenge to the surgeon. The aim is a complete, en-bloc resection, or else recurrence will occur, even with benign lesions. However, the pelvis is a fixed space with bony boundaries containing several vital structures and therefore, as the desired margins for an R0 resection are extended, the morbidity increases exponentially. Extended resections should involve a multidisciplinary surgical team comprising colorectal surgeons, orthopedic surgeons, plastic surgeons, and neurosurgeons. Precise preoperative planning based on good imaging studies is essential. The surgeon should be fully aware of the expected morbidity and inform the patient accordingly by thorough preoperative counseling.

For tumors invading the sacrum, the level of sacrectomy should be one segment above the anticipated superior extent of the tumor. When nerve resection is required, dural injuries must be meticulously closed to prevent cerebrospinal fluid leak and dural space infection. As a general rule, when unilateral resection of S1–S5 nerve roots is performed, fecal and urinary continence can be preserved. Nevertheless, this results in a hemisensory loss and leg weakness. Conservation of S1 and S2 bilaterally is not enough to preserve normal ano-

rectal function. At least one S3 nerve root is required to preserve normal continence and defecation. Sacrifice of one S3 nerve root is generally well tolerated. Resection of both S2 nerve roots results in neurogenic bladder, fecal incontinence, and impotence in male patients.

Infected cysts should be drained first, and excised electively at a later time. When infected, they become very adherent to adjacent tissues and resection is associated with a significantly higher recurrence rate and risk of postoperative urinary incontinence [16].

35.4.2 Choice of Surgical Route

There are essentially three surgical approaches to RRTs: anterior, posterior, and combined. The combined approach can be synchronous or sequential. The choice of approach should be determined by the size, the location, and whether the tumor is benign or malignant. A general treatment algorithm is proposed in Fig. 35.7.

35.4.2.1 Abdominal or Anterior Approach

High tumors (located above the level of the fourth sacral vertebra) without involvement of the sacrum itself are best resected through a laparotomy. This approach has the advantage of being familiar to most surgeons, and provides excellent exposure and control of the pelvic structures, such as the iliac vessels and ureter. It also allows ligation of the middle sacral artery and vein, which often supply the lesion.

35.4.2.2 Posterior Approach

The posterior approach is appropriate for low-lying RRTs without signs of malignancy, less than 4–5 cm in size, and that do not extend above the level of the fourth sacral vertebra. Therefore, if the superior border of the tumor can be palpated during digital examination, the posterior approach should be successful. This route has the advantage of avoiding a laparotomy, providing good access to the rectum and the lower retrorectal space, and allowing optimal visualization and preservation of the sacral nerves. However, vascular control may prove to be more difficult.

The patient is placed in a prone jack-knife position; a parasacrococcygeal, curvilinear, or horizontal incision can be used (Fig. 35.8). Division of the anococcygeal ligament allows the mobilization and resection of the coccyx classically advocated to allow access to the RRT. Abel and colleagues, however, showed that RRTs could be accessed and removed successfully through a parasacrococcygeal approach [17], thus avoiding a coccygectomy. Transverse transection of the levator ani and separation of the gluteus maximus muscle from its sacral attachments will provide further exposure to the retrorectal space and the tumor. Inserting a finger into the rectal vault can guide the dissection by pushing the tumor outwards and helping distinguish levator muscle fibers from rectal wall.

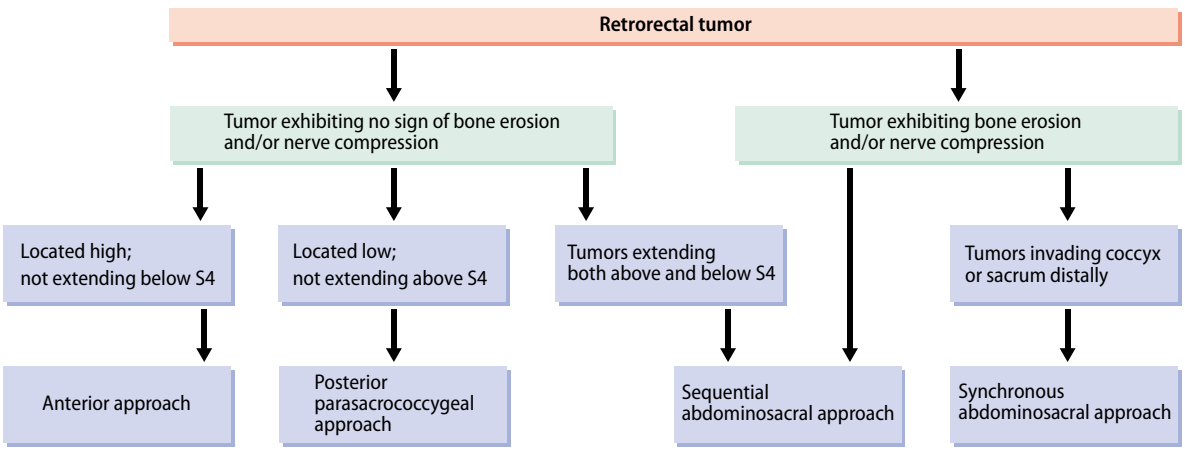

Fig. 35.7 General surgical treatment algorithm

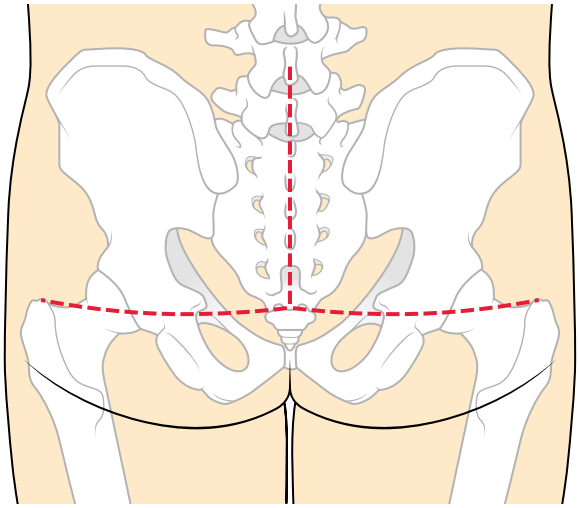

Fig. 35.8 Posterior approach to sacral and retrorectal tumors. A longitudinal incision is carried out from the level of L4 to the sacrococcygeal junction and then extended laterally toward the great trochanter

35.4.2.3 Combined Abdominosacral Approach

Tumors exhibiting bone erosion or producing symptoms of nerve compression, as well as large tumors extending both proximal and distal to the fourth sacral vertebra, should be excised via a combined abdominosacral approach. For tumors invading the lower part of the sacrum only, this can be achieved in a synchronous fashion with the patient in a lateral decubitus position [18]. An oblique left lower quadrant incision allows mobilization of the rectum and the tumor by an anterior approach. A second team works simultaneously through a posterior midline or paracoccygeal incision to widely excise the tumor one segment above any suspected bony involvement. For very large tumors, or in case of invasion of the upper sacrum, a combined but sequential abdominosacral approach with intraoperative change of the patient's position seems more appropriate.

The abdominal approach allows visualization of the full extent of the tumor, and control of the ureters, iliac vessels, and rectum. Once the rectum is mobilized out of the sacral hollow, control of the internal iliac vessels can be achieved to prevent massive hemorrhage. The middle sacral artery and vein are ligated. Rectal resection has to be done at this time for tumors invading the rectal wall or for those patients who have had a previous transrectal biopsy. Sponges are placed to protect pelvic structures and the laparotomy is closed. The patient is then placed in the prone position. A vertical incision from L4 to the level of the coccyx is performed. This incision can be extended laterally in a triradiate fashion toward the greater trochanters. To expose the sacrum and the nerve roots, gluteus maximus fibers are split, identifying the piriformis muscle. The piriformis tendon is transected, allowing good visualization of the sciatic and gluteus maximus nerves (Fig. 35.9). The gluteus maximus is then safely transected. The sacrospinous and sacrotuberous ligaments are divided as laterally as possible (Fig. 35.10). Sacrectomy is then performed. Severed nerve roots are surgically clipped to prevent spinal fluid leaks. En-bloc tumor resection can than be performed. The anterior sponges are removed through the posterior incision, and hemostasis is achieved. Lumbopelvic stabilization is obtained by using a bone allograft, iliosacral screws, or other types

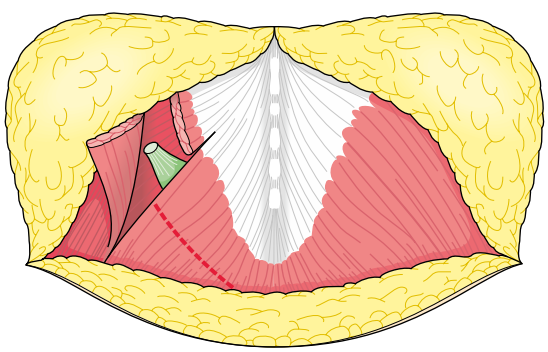

Fig. 35.9 After section of the gluteal fascia, the fibers of the gluteus maximus are divided (*dotted line*). The piriformis tendon is transected (*green*)

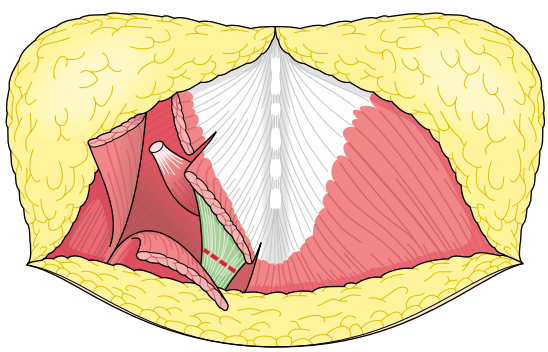

Fig. 35.10 The sacrospinous and sacrotuberous ligaments are divided under direct vision (*dotted line*)

of fixation when needed. Multiple suction drains are inserted and the muscles are reapproximated. Use of a transpelvic vertical rectus abdominis myocutaneous flap can reduce wound complications.

35.5 Prognosis

Even in benign RRTs, local control is difficult to achieve and recurrence is common, often due to incomplete resection. Nevertheless, long-term survival after surgery for benign RRTs is nearly 100%. This is not the case for malignant RRTs. In a study from the Memorial Sloan-Kettering Cancer Center [19] on malignant RRTs, the recurrence rate was 48% and the 5-year survival was a dismal 17%. More specifically, in another large study on chordomas, the 5-year and 10-year survival rates were 67% and 40%, respectively [20]. Advances in surgical technique with complete excision at the first attempt result in better local control, as documented in more recent publications [21]. However, recurrence rates are still very high and re-excision should be attempted whenever possible. Radiotherapy can provide palliation for some inoperable tumors, but no cures. High-dose radiation improves disease-free interval but with severe secondary effects. Chemotherapy for chordomas has essentially no role at this time.

35.6 Conclusion

RRTs are rare. The average practicing surgeon is likely to encounter at least one during the course of a career. Benign congenital developmental cysts and malignant chordomas are the most common RRTs in adults. The possibility of an RRT should be considered in any patient who presents with a posterior mass on digital rectal examination, or a postanal dimple, particularly in association with a fistula refractory to multiple operative interventions. Regardless of the etiology, the great majority of tumors of the retrorectal space should be treated by complete surgical excision. The choice of surgical approach depends on the size and location of the tumor, and whether it is benign or malignant. Large lesions can be a true surgical challenge and should involve a team with multidisciplinary expertise.

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Self-Assessment Quiz

Question 1

Which of the following signs is more frequently seen in malignant compared to benign retrorectal tumors (RRTs)?

a. Radicular pain
b. Dystocia
c. Pelvic fullness
d. Fistula
e. Infection

Question 2

Which of the following statements concerning tailgut cysts is correct?

a. They derive from embryological remnants of ectodermal origin.
b. They are entirely lined by a columnar epithelium.
c. They have a full-thickness muscular wall.
d. They are often multiloculated.
e. They have no malignant potential.

Question 3

Which radiological characteristics apply to a chordoma?

a. On a plain film of the pelvis it produces the scimitar sign.
b. It shows a strong contrast uptake on computed tomography (CT) scan.
c. Bone destruction is a common finding.
d. It appears as a multicystic lesion on magnetic resonance imaging (MRI).
e. It is frequently surrounded by satellite lesions.

Question 4

After resection of S3–S5 nerve roots unilaterally for a chordoma, which deficit is more likely to be found?

a. No deficit
b. Neurogenic bladder and fecal incontinence
c. Normal urinary and fecal continence with male impotence
d. Hemisensory loss and leg weakness with preservation of urinary and fecal continence
e. Fecal incontinence alone

Question 5

The combined abdominosacral approach is the preferred surgical route for:

a. Low-located tumors, not extending above the level of the fourth sacral vertebra
b. Tumors exhibiting signs of bone erosion or symptoms of nerve compression
c. Developmental cysts with a funnel-shaped dimple on the postanal midline
d. Small high-located tumors not extending below the fourth sacral vertebra
e. None of these tumors

1. Answer: a
Comments: Pain is almost always present with malignant lesions, but only in approximately 40% of benign lesions. All RRTs may be responsible for dystocia, and pelvic fullness is the most common symptom of RRTs regardless of their malignant potential. Fistulas and infection are most commonly seen with congenital cysts, which are benign in the vast majority of cases.
2. Answer: d
Comments: Tailgut cysts derive from the postanal primitive gut and therefore have an endodermal origin. Although by definition they must contain columnar epithelium, the lining of the cyst frequently contains a variety of other types of epithelia. Unlike rectal duplications, tailgut cysts lack a full-thickness muscular wall, but may contain nonorganized smooth muscle cells. They are most frequently multiloculated cystic lesions. Although rare, malignant degeneration of tailgut cysts is a well-described characteristic.
3. Answer: c
Comments: The scimitar sign is typical of the anterior sacral meningocele. The chordoma is a bone-destructive solid mass that does not show good contrast uptake on CT. It demonstrates a strong intensity signal on T2-weighted MRI images.
4. Answer: d
Comments: At least one S3 nerve root is required to preserve normal continence and defecation. Hemisensory loss and leg weakness result in injury to branches of the sacral plexus, which becomes the sciatic nerve with its cutaneous and muscular branches.
5. Answer: b
Comments: Tumors exhibiting signs of malignancy should be excised via a combined abdominosacral approach. Abdominal evaluation of tumor extension as well as control of the ureters, iliac vessels, and the rectum is mandatory prior to en-bloc resection of the tumor through a posterior approach.

36 Chronic Constipation

Cor G.M.I. Baeten and Wim Hameeteman

CONTENTS

36.1 Introduction

Constipation includes several symptoms relating to frequency of bowel movements, the consistency of stools and the ease and completeness of defaecation [1, 2]. Infrequent defaecation has long been regarded as the most important symptom of constipation. Drossman et al. [3, 4] defined constipation as when two or fewer stools per week, with or without straining, were produced for more than 25% of the time. Other symptoms, such as passage of hard stools and a feeling of incomplete evacuation have also been recognised as important symptoms of constipation.

In the Rome II criteria for functional constipation, at least two of the symptoms listed below have to be present in more than one-quarter of defaecations over a period of at least 3 months in the last year:

1. Straining
2. Lumpy or hard stool
3. Sensation of incomplete evacuation
4. Sensation of anorectal obstruction or blockage
5. Manual manoeuvres to facilitate defaecation
6. Fewer than three bowel movements per week
7. Insufficient criteria for irritable bowel syndrome

In practice, differentiation of constipation from constipation-predominant irritable bowel syndrome may be difficult, despite the criteria given in the Rome II classification. In addition, the use of different criteria for constipation over the years makes interpretation of studies concerning (conservative) treatment of constipation or irritable bowel syndrome problematic [5–8].

Before constipation can be defined as functional, and the criteria mentioned above can be applied, other conditions or diseases that may lead to constipation have to be excluded.

When secondary causes of constipation (Table 36.1) have been excluded, it is due to either a neuromuscular dysfunction of the colon (slow-transit constipation) or a neuromuscular dysfunction of the defaecation unit. Frequently, however, the distinction is not strict, as low stool volume (due to a low-fibre diet) may lead to difficulty in stool evacuation because small, pellet-like stool is hard to evacuate and no urge is felt with insufficient rectal distension.

Various descriptions are used for dysfunction of the defaecation unit, including anismus, spastic pelvic floor syndrome, pelvic floor dyssynergia, outlet obstruction and paradoxical puborectalis contraction. An expert group has proposed use of the term pelvic floor dyssynergia leading to dyssynergic defaecation.

Table 36.1 Aetiology of constipation

- Dietary (restricted fluid or fibre intake)
- Social, mental
- Immobility
- Environmental change (hospitalisation)
- Endocrine and metabolic (hypothyroidism, hypercalcaemia, hypokalaemia, uraemia, porphyria, diabetes, Addison's disease, pregnancy, lead poisoning)
- Central and peripheral nervous system pathology (spinal cord damage, spina bifida, Parkinson's disease, multiple sclerosis, aganglionosis, laxative abuse, Chagas disease)
- Autonomic neuropathy (diabetes mellitus)
- Drugs
- Psychiatric (depression, eating disorder)
- Gastrointestinal disease (structural, congenital)
- Colonic obstruction (malignant or benign tumour of the colon or adjacent organs, diverticular disease, volvulus, intussusception, inflammatory bowel disease, ischaemic stenosis, surgery)
- Anal outlet obstruction (stenosis, fissure, rectal prolapse, recto- or enterocele, surgery)
- Functional:
  - Constipation predominant irritable bowel disease
  - Slow transit constipation (colon inertia, uncoordinated motor activity, idiopathic, intestinal pseudo-obstruction)
  - Pelvic floor dysfunction (syn: outlet obstruction, pelvic floor dyssynergia; idiopathic)

36.2 Prevalence and Risk Factors

Constipation is a common problem with a prevalence of 2–28% in the Western population. American surveys reported a prevalence of 21% in women and 8% in men. Two householder surveys showed a prevalence of 3% and 28%, respectively. The variation in figures is largely caused by how the problem is defined and the way in which it is studied. An American survey found 20% of women and 16% of men reporting constipation according to the Rome criteria. Of these, 9% reported infrequent defaecation (<3 bowel movements per week), whereas 30% mentioned incomplete evacuation and 29% hard stools, suggesting that especially difficult defaecation is a major symptom in constipation [9–12]. By using the Rome II criteria in a Canadian population, a prevalence of 4.6% was found for functional constipation and 4.5% for outlet obstruction [13]. It is a common diagnosis in the practice of general practitioners as well as gastroenterologists and surgeons. The prevalence is even greater in the geriatric population, especially in nursing homes. This is not because colorectal functions exhibit an ageing process, but other factors such as immobilisation, chronic diseases, neurologic and psychiatric issues, and use of drugs contribute to constipation [12]. There seems to be a slight female predominance in some studies, where it was shown that gynaecologic surgery also increases the risk for constipation. Psychosocial factors may contribute negatively to constipation. Sexual abuse and experience of violence are also related to functional abdominal complaints, especially severe chronic constipation [12].

36.2.1 Clinical Features

Many patients often experience symptoms for years before seeking medical attention. Complaints show relapses, vary in severity, are attributed to stress and are considered part of their personality. Recent onset of complaints necessitates investigation to exclude organic illness [13]. Presenting symptoms include feeling of incomplete evacuation, excessive straining and passage of hard, pellet-like stools. The Bristol stool scale may help in the description of the problem of stool form. Blockage in the anal region and manual disimpaction and splinting of the vagina are symptoms mentioned, as well as infrequent defaecation, often less than 2 or 3 times per week, bloating and abdominal or anorectal pain and discomfort. The nature of the problem, for example when it began, whether abdominal or obstetric or gynaecological surgery has been performed, what has already been done to deal with it, what (laxative) drugs have been taken, should become clear. Drugs taken for other conditions should also be looked at; many patients are unaware of what medication they are taking and their possible side effects. It is occasionally

difficult to differentiate between upper-gastrointestinal pathology when pain is expressed more in the upper abdomen and accompanied by anorexia, nausea, fullness and a foetor ex ore, not infrequently with headache. Apart from the defaecation history, a dietary history is important concerning the time and frequency of meals, and intake of fluid and fibre. Is breakfast taken? Is time scheduled for a visit to the toilet before going to work? What physical activity does the patient engage in? At first presentation it may be difficult to do a psychological assessment to discover problems such as eating disorder, depression, anorexia nervosa or a history of sexual abuse or trauma. In a follow-up visit, however, it is important to find possible psychological reasons for constipation [14].

Suspicion of pelvic floor dysfunction is strengthened by mention of prolonged and excessive straining before passage of stool, especially when perineal or vaginal pressure or digital evacuation is needed. In case of an evacuatory problem, standard laxative programmes are not very successful, so early recognition is important.

36.2.2 Physical Examination

A good physical examination, including neurologic examination, should be performed to exclude a systemic illness. The abdomen is inspected for scars and distension; percussion may reveal air and palpation a mass or presence of stool in the left or right lower quadrant. A normal examination is not uncommon where the sigmoid colon is usually palpable. Perianal inspection follows to exclude anal stricture, fissure, fistula, skin tags and haemorrhoids. Digital rectal examination is the next step to look for stricture, fissure, mass, blood or blood in the stool. The patient, in the left lateral position, should bear down as if to defaecate so that relaxation of the external sphincter with perineal descent can be observed. If this does not occur, a functional obstruction or dyssynergic defaecation is possible [15].

36.3 Diagnostic Procedures

It is mandatory to exclude a metabolic or pathologic disorder before the diagnosis of constipation is made. This means that a complete blood count should be done with biochemical profile, serum creatinine, calcium and glucose, and thyroid function. Additional tests may be needed. When an organic disease is excluded, a functional neuromuscular disorder becomes more likely. Depending on the age of the patient, evaluation of the entire colon (older than 50 years, no recent screening of the colon done) or rectosigmoid colon should be performed.

Additional investigations are often necessary to give insight in the cause of chronic constipation. The difference between slow-transit constipation and outlet obstruction is important for selecting the right therapy.

36.3.1 Defaecography

Defaecography or proctography is a röntgenological investigation that is used to visualise various disorders. The patients receive an enema of contrast mixed with porridge to mimic the consistency of normal faeces. The paste can be so thick that normal injection into the rectum is not possible and an injection pistol is necessary. In women, a contrast marking of the vagina is necessary. Oral contrast is given a few hours prior to the procedure so that the small bowel can be visualised at the same time. The patient is then placed on a commode with a translucent toilet seat. Most of the time this is a water-filled tyre, which makes it possible to see the contrast leaving the anus. The patient is asked to contract the pelvic floor and then to uphold "stool" during a Valsalva manoeuvre. The patient must then defaecate the contrast paste. The defaecography can reveal several disorders such as rectocele, intussusception, enterocele or rectal prolapse. These disorders often result in constipation, but will be discussed further in Chap. 38. An alternative to the classical defaecography is magnetic resonance imaging (MRI)-defaecography, where all organs are visualised during defaecation. This procedure is difficult for most patients who have to defaecate in a lying position. Only a few centres have an open MRI.

36.3.2 Colonic Transit Time

Measurement of colonic transit time is often used in patients with constipation. This makes it possible to distinguish between outlet obstruction and slow-transit constipation. Radio-opaque markers are given into the stomach in the form of a dissolvable pill. The markers can be seen on daily plain abdominal X-rays, and have to leave the bowel within 4 days. When more then 80% of the markers are retained after 96 h we can speak of slow-transit passage. An alternative way to use the pellets is to give the patient different forms of pellets on

three consecutive days followed by one plain abdominal X-ray. It is also possible to divide the abdomen into three regions and to calculate the transit time for each region. One can determine whether the slowing is located in the right hemicolon, the transverse colon or the left hemicolon. With scintigraphic techniques it is also possible to determine the regional transit times of the colon. ^{111}Indium is given in a liquid or solid meal since the transit through the small bowel is equal. Scans are made at several time points. The total transit of the whole colon seems to be the most accurate, and the radioactive measurements have no benefit over conventional pellet studies [16].

36.3.3 Colonic Manometry

Colonic manometry can be performed with water-perfused systems or with solid-state catheters. It is not a normal routine investigation and these systems are currently only used in research centres. Colonic manometry provides insight into the peristaltic waves that travel over the colon, and into the possible mechanisms underlying the actions of several medications. A normal colon has three peristaltic mass movements per day [17, 18].

36.3.4 Colonoscopy

Colonoscopy is not a tool by which to determine constipation, but is used to exclude organic causes of delayed transit, like stenosis or obstructive tumours or polyps (see Chap. 34).

36.3.5 Anal Manometry

Anal manometry allows measurement of the resting pressure of the anal canal. Extremely high pressures without voluntary contraction of the anus demonstrate problems like stenosis, fissures and pain, for example, which create a fear of defaecation and a kind of constipation. Anal manometry can be performed with water-perfused or solid-state catheters. The normal values are instrument dependent and vary from institution to institution. Men have higher basic values than women. The anorectal inhibition reflex can be measured in younger patients in whom there is a possibility of Hirschsprung's disease. The Hirschsprung patient has no reflex due to the absence of intramural ganglia.

36.3.6 Balloon Distension Test

The balloon distension test provides values for pressure at first sensation, first urge and maximum tolerable volume of the rectum. For this test, a balloon is brought into the rectum and inflated until the patient indicates a feeling of substance in the rectum. With further inflation one can determine when the patient feels an urge to defaecate, and when he is no longer able to uphold this balloon. These tests tell us something about the sensibility and the capacity of the rectum. A more accurate measurement is performed with barostat equipment. This is done with noncompliant plastic bags and allows calculation of the compliance of the rectal wall.

36.3.7 Balloon Expulsion Test

The balloon expulsion test is used to see whether patients are able to expel an intrarectal balloon. Dyssinergia patients are not able to do this. One has to be careful in the interpretation of this phenomenon, because psychological factors also can play a role in defaecating a balloon when others are present in the same room.

36.4 Medical Management

The first step in the medical management of constipation is to exclude any pathological disorder that causes secondary constipation, as mentioned above. It is important that special attention be paid to the use of drugs when diagnostic procedures have revealed no abnormality.

36.4.1 Lifestyle Measures

Although no validated data exist on the benefit of lifestyle measures, it is generally recommended that the patient take regular physical exercise, drink a fair amount of fluid (2 l daily) and increase their natural fibre intake. Time should also be taken for regular toilet visits, where excessive time and straining should be avoided. A diary, not only concerning food and fluid intake, but also containing a registration of stool habits, may help in giving advice. Consultation with a dietician explaining the amount of dietary fibre in common foods may be helpful.

36.4.2 Fibre Supplementation

It is generally believed that when it seems that the constipation is not caused by an outlet problem, a trial with fibre supplementation should be considered. A daily intake of 20–30 g should be given, along with a fluid intake of at least 2 l. Bran is first choice, but commercial preparations containing psyllium may be better alternatives. Sachets containing fibre can be taken to work and the office to improve fibre intake. When after 4–6 weeks no improvement is seen, additional investigations such as measuring oroanal transit should be considered, and when slow transit seems to be present, additional medical therapies come into view.

Recent reviews on medical therapy by Jones et al. [20] and by Ramkumar and Rao [21] showed that only a few trials exist that support the prescription of laxatives and other drugs for chronic constipation. Medical therapy was reviewed systematically by Ramkumar and Rao [21], and levels of evidence given (level I – good evidence, to level III – poor evidence) as well as a classification of recommendations (grade A – good evidence in support of the use of the drug, via grades B and C – poor evidence to support the use of the drug, to the lowest grade E – good evidence to support against the use of the drug) [21, 22].

With regard to medical therapy, the following categories of drugs have been used: bulk or hydrophilic laxatives (psyllium, bran, methylcellulose), surfactant or softening or wetting agents (docusate, poloxalkol), osmotic laxatives (lactulose, sorbitol, magnesium hydroxide, polyethylene glycol (PEG) solutions), peristaltic stimulants (senna, bisacodyl, erythromycin, misoprostol), and others such as prokinetics or prosecretors (tegaserod, colchicine).

36.4.2.1 Fibres

Studies with increased dietary fibre suggest this to be beneficial. Studies with bran also suggest benefits with improvement of consistency and frequency. Side effects are mainly bloating and flatulence. More data exist on the use of psyllium, which improves stool frequency and consistency. Transit time may also improve. Combinations of psyllium and senna increase stool frequency. Phylum therapy was considered effective with level II evidence and grade B recommendation [21]. Only a grade C recommendation was given in this review for the use of methylcellulose [21].

36.4.3 Stool Softeners

Decussate sodium and decussate calcium are the major drugs in this category. Studies are few, and in several, decussate was combined with other laxatives. In comparison with phylum, the latter appears to be better. Decussate studies resulted in level III evidence, grade C recommendation by Ramkumar and Rao [21].

36.4.4 Hyperosmolar Agents

Lactulose is a non-absorbable disaccharide that functions as an osmotic laxative. Compared with placebo it improves constipation; side effects are mainly bloating, flatulence and loose stools. Lactulose was given level II evidence and grade B recommendation by Ramkumar and Rao [21]. PEG is a large polymer that is not degraded by bacteria. Various molecule sizes are used. Apart from use as a lavage solution for gut cleansing prior to colonoscopy and surgery, it has been used in chronic constipation. Various preparations exist in sachet formula, combined with electrolytes, which make PEG an easy-to-use laxative that can be taken on journeys. PEG has been compared with placebo and lactulose and although the studies used various definitions to score constipation, PEG was found to be an effective treatment with few side effects, and was preferred above lactulose. Level I evidence and grade A recommendation were given [21].

36.4.5 Saline Laxatives

Saline laxatives all have the same mechanism of action: osmotic retention of fluid in the lumen of the gut. The choice of the agent is largely arbitrary (e. g. magnesium hydroxide, magnesium sulphate, sodium phosphate). In patients with renal insufficiency, a risk of hypermagnesaemia may exist. In cardiac failure, sodium intake should be taken into account.

36.4.6 Peristaltic Agents

Senna, bisacodyl and sodium picosulphate have a beneficial effect on stool frequency. Bisacodyl can be given orally and as a suppository. A combination of psyllium and two doses of senna were effective, the best result being obtained with the higher senna dose. Senna may give rise to damage to the enteric nervous system,

although this remains to be proved [5]. Other laxatives are preferred for long-term use and several authors prescribe senna only when other medical alternatives are insufficient and where surgery might become indicated. Cleaning the bowel with large-volume enemas should be considered as another alternative.

36.4.7 Prokinetics and Others

Various placebo-controlled studies have been performed with cisapride. Although cisapride appeared to be a useful agent, availability is very limited at present due to its side effects; it is no longer marketed in the USA and many European countries.

Tegaserod, a partial 5-hydroxytryptamine receptor 4 agonist, has been studied in a large placebo-controlled trial in patients with chronic constipation [23]. Two doses, 2 mg and 6 mg twice daily, given for 12 weeks, proved better than placebo. No serious side effects were seen. Although tegaserod is only available in a few countries, a grade A recommendation and level I evidence was given [21].

The usefulness of colchicine in chronic constipation is unclear. Data for the use of misoprostol data are also scarce.

A review of medical therapy for chronic constipation has shown that the use of PEG, lactulose, psyllium and tegaserod was supported by good evidence [21]. Laxatives in recommended doses are safe and usually well tolerated. Laxatives should only be given when investigation has ruled out conditions or disease that need other treatment but present with constipation.

36.4.8 Bowel Lavage

Severe constipation that is no longer treatable with laxatives can be treated by cleaning the bowel with enemas. Enemas such as sodium phosphate and sodium docusate are commercially available; they soften the faecal mass and by osmotic action keep the water in the bowel lumen. Cheaper is the use of a water enema, which can be introduced with the help of a 60-cm³ syringe with a catheter tip. The commercial enemas have a volume of 120 cm³. This low volume reaches only the rectum and it is possible that this is not enough.

There is also experience with large volumes of water that can be introduced with a 2-l bag. This bag can be hung onto a wall and is connected to a hose that has a cone-shaped end, which the patient can press into the anal canal. The speed of water induction in the bowel is dependent on gravity and thus on the height of the bag attachment to the wall. The water is normal tap water, and can be used everywhere where drinking tap water is allowed. In places where tap water is unsafe for consumption, bottled water is advisable. The temperature of the water has to be around 37°C. The same effect can be obtained with a water pump. The introduction speed of the water can be modified by the pump (Fig. 36.1). Patients may experience cramps during the introduction. It is better not to let the water and stool

Fig. 36.1 Irrigation pump for irrigation of the large bowel

go but to slow down the introduction until the bowel is filled with 1.5–2 l. In this way, almost the whole colon is filled with water and stool. This will induce a strong urge to defaecate. The duration of the procedure is on average 30 min. This very old method, which has been used for millennia, seems to have been almost forgotten, but is highly effective [24]. The same method can also be used in case of faecal incontinence or a combination of constipation and incontinence because one cannot lose faeces from an empty bowel.

The water normally softens the faeces, but when it is not softened enough, one can add some liquid soap to the water (one tablespoon in 1 l of water). It is also possible to add some laxative to the water to enhance the cleaning of the bowel. There are only a few reports in the literature about this high-volume lavage of the colon. All give an acceptable success rate.

Bowel lavage can be given in a retrograde way, as described earlier, but can also be administered from above by the antegrade route through a caecostomy, appendicostomy or another antegrade colonic enema (ACE) procedure. The antegrade direction is more successful than the retrograde one (see Chap. 36.4.11).

36.4.9 Physiotherapy

Physiotherapy is another treatment option for constipation. It has no influence on slow-transit constipation but can be of help in patients with pelvic floor problems. Biofeedback therapy has to be given by specially trained physiotherapists who have the knowledge and the equipment to do this. Biofeedback means that the muscles can be trained under visual guidance from manometric instruments, or via electromyographic guidance. This makes the training much more meaningful. Biofeedback therapy is indicated for patients with an inadequate squeeze technique or a paradoxical reaction of the pelvic floor. Physiotherapists also use the balloon test as a training facility to help the patients to learn to expel faeces in the form of a balloon. The results are not always good, but it is safe and in many cases it prevents surgery [25, 26].

36.4.10 Surgical Treatment

Surgical treatment of intractable constipation can be divided in surgery for slow-transit constipation and for outlet obstruction [27].

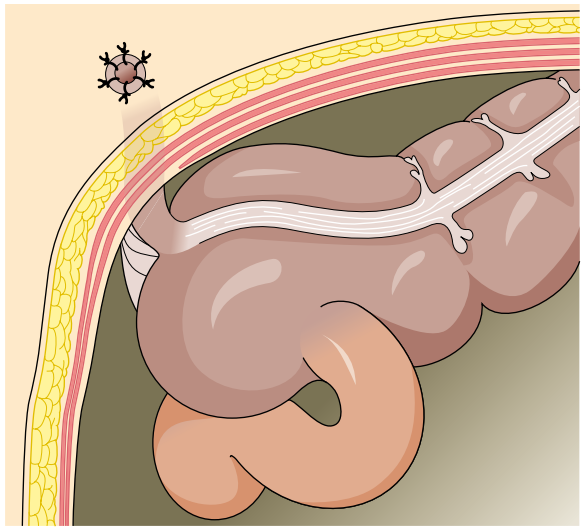
36.4.11 Antegrade Colonic Enema Procedures

As mentioned before, slow-transit constipation can be treated with large-volume irrigation of the colon. This is always first tried in a retrograde way, but the results are not always good. It is well known that the antegrade route is often more successful. What possibilities do we have to create an introduction opening in the proximal colon? The first-described stoma is the Malone appendicostomy. This is created with the appendix, which is picked up laparoscopically and pulled through the shaft of the trocar. At the outside, the tip of the appendix is removed and a slit is made at the end and sutured to the skin. The location is under the bikini line in the right lower abdomen. To prevent leakage from this appendicostomy, it is wise to lead the appendix with a Z-shaped route through the abdominal wall. An indwelling urinary catheter is brought through the appendix and the balloon is filled in the caecum [28, 29].

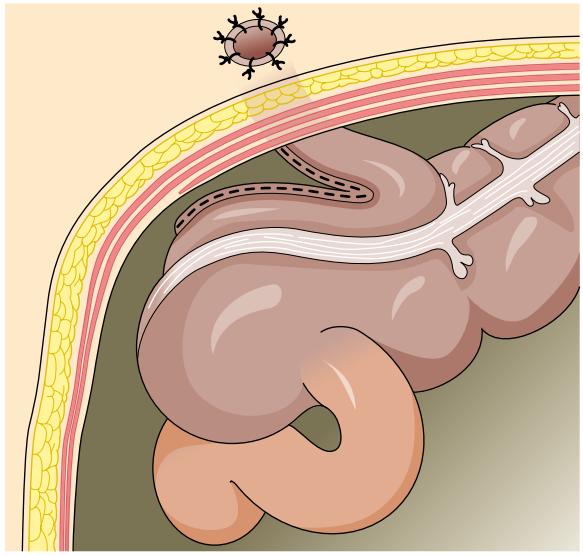
At the outside, the catheter is taped to the skin and the irrigation can start immediately. The catheter has to be left in place for at least 2 weeks until the appendix is properly fixed in its surroundings. The catheter can then be removed and hopefully there will be no backflow of irrigation water and faeces. The catheter has to be reinserted every day for cleaning the bowel. In case of leakage, it can be better to leave a catheter or a button in place to prevent backflow. A surgical solution for backflow is to wrap the appendix with a "Nissenlike" fundoplication of the caecal wall around the appendix. Another problem with appendicostomy is the formation of a stenosis of the opening. Therefore, it is good to advise the patient to dilate the entrance daily with a dilator [30].

In many cases patients have had an appendectomy in the past and there is no appendix available for antegrade irrigation of the bowel. In these cases one has to be innovative to create another entranceway for this procedure.

It is possible to create a neoappendix with a flap of caecum. One has to select a well-vascularised part of the caecum, create a small opening and bring in a urine catheter. Along the catheter one can partly divide the caecum with a gastrointestinal anastomosis stapler. The neoappendix can than be brought through the abdominal wall as described earlier. Another possibility is to create a neoappendix with the last part of the ileum. The ileum can be divided approximately 10 cm from the end; the proximal part is anastomosed with the ascending colon. This can be done in an inverted way to



a



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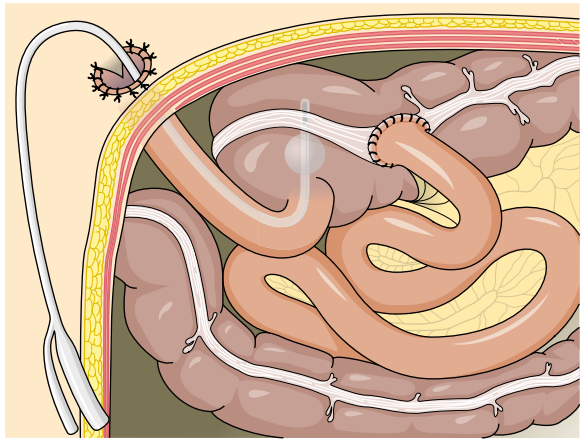

c

Fig. 36.2a–c Three different techniques for creating a stoma for antegrade bowel lavage. With appendix (**a**), caecal flap (**b**) and ileum (**c**)

mimic the ileocaecal valve. The distal part can be used as a neoappendix and be sutured to the skin [30]. The ileum is normally too wide for this procedure and has to be tapered with a length resection at the antimesenterial side (see Fig. 36.2).

Other techniques have been described by using the descending colon as an introduction conduit for antegrade cleaning of the bowel. The descending colon has to be brought into the sigmoid with a fixed intussusception to prevent backflow of the water. The proximal part of the descending colon has to be anastomosed to the sigmoid distal to the conduit.

A procedure for administering fluid into the bowel without the use of body tissue is an endoscopically placed colostomy. This technique is identical to the well-known gastrostomy. A colonoscope is brought into the caecum and with a hollow needle; the caecum is punctured transcutaneously in the right lower abdomen, under visual guidance. A guiding thread is introduced and grasped by a forceps through the colonoscope. The colonoscope is then withdrawn through the anus and the guide wire is connected to a gastrostomy catheter. The gastrostomy catheter is the pulled from the anus through the whole bowel by traction on the guide wire at the abdominal site. The "colostomy" catheter will follow and is placed from inside out. The catheter is ready for induction of water. This procedure is more risky than the gastrostomy since the catheter is contaminated and can create infections along its route outside the bowel.

All of these procedures are called ACE procedures and are based on the same concept of administering fluid high in the large bowel to change the consistency of the stool and to enhance the transit through the colon.

36.4.12 Resections

When irrigation of the bowel is too difficult, it is possible to resect a part or the whole large bowel. This is only done when there remain no other possibilities.

Resection of the sigmoid can be done when there is a long redundant sigmoid and the transit study indicates that the sigmoid is the slowing factor. This operation often leads to a suboptimal result and most surgeons will make a choice for a subtotal colectomy with an ileorectal anastomosis. In most cases this allows restoration of normal transit and the possibility of defaecation. However, one can never be sure whether the constipation will change into diarrhoea. In this operation there is no way back and the patient must be informed about this possibility before the decision is made. Informed consent is very important!

In patients who have a combination of slow-transit constipation and outlet obstruction it is possible that they will experience problems of defaecation even with a watery stool. Therefore, I always give the patients an enema before making the decision to proceed to a subtotal colectomy. When patients cannot empty their bowel after subtotal colectomy it is possible to resect the rectum and to perform an ileal pouch–anal anastomosis. This operation can eventually cure the problem but is really the last resort [31].

36.4.13 Sacral Nerve Stimulation

Sacral nerve stimulation (SNS) is a very new treatment that was originally invented by urologists to treat patients with urinary incontinence. They found that patients with combined incontinence also reacted very well with regard to their faecal incontinence. Based on this finding, colorectal surgeons adapted this method for faecal incontinence. During this treatment patients with a combination of incontinence and constipation experienced a better and more frequent defaecation. At the same time, urologists found that patients gave good reactions with regard to retention of urine. This led to the thought that SNS could probably be used for patients with exclusively faecal constipation. So far only incidental observations have been mentioned in the literature, but larger prospective studies have recently been undertaken. These studies have not been published yet but there are interesting findings. It seems that not only does defaecation frequency increase, but also there is a diminution of abdominal pain, bloating, fullness and incomplete evacuation, and there is an improvement in quality of life. Of importance is the fact that it is not necessary to operate immediately, but one can do a percutaneous stimulation test by inserting a hollow needle into the foramen of S3. By electrical stimulation of the needle it is possible to find the optimal location. This can be seen when the anus contracts. An electrode can be introduced through the hollow needle; after removal of the needle the electrode is glued to the buttock and connected to an external stimulator. The patient can go home after this and has 3 weeks in which to judge whether this stimulation improves his situation. When this is the case the patient can proceed to the real operation where a definitive electrode is inserted and connected to an implanted stimulator. This procedure can be done under local or under general anaesthesia. The longevity of the stimulator will be around 8 years with the currently used amplitude of 2.2 mV. When the battery is completely discharged, the stimulator can be exchanged during a minor procedure under local anaesthesia [32, 33].

36.4.14 Stoma

The last resort for patients with intractable constipation is the creation of a stoma. A distal colostomy on the sigmoid is used in patients with untreatable outlet obstruction. The anorectum is bypassed in this way and the constipation is changed into an involuntary loss of stool at the abdominal side.

A proximal colostomy or an ileostomy can be created for patients with intractable slow-transit constipation. One has to be careful since it is possible that even with such a draconian operation patients can experience constipation in their stoma. In patients who want to have the possibility to go back to their original problem, it is better to make a loop colostomy or ileostomy. During the making of these stomas it is important to clean out the distal part of the colon, since faeces will stay in this part "forever" and creates faecalomas, which are impossible to evacuate.

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Self-Assessment Quiz

Question 1

After previous appendectomy, a Malone stoma is:

a. No longer a possibility
b. Possible with a caecal tube
c. Always giving reflux
d. Laparoscopically impossible
e. None of these

Question 2

Sacral nerve stimulation (SNS) is:

a. A treatment for faecal incontinence
b. A treatment for urinary incontinence
c. A treatment for constipation
d. All of these (1, 2 and 3 are correct)
e. None of these (1, 2 and 3 are incorrect)

Question 3

Defaecography is a diagnostic tool that:

a. Gives information about enterocele
b. Gives information about slow rectal transit
c. Shows cystocele
d. Is safe in women at reproductive age
e. Can not be used in males

Question 4

The drugs/substances given here are used in the medical therapy of chronic constipation. Evidence is lacking for which kind of therapy?

a. Lactulose
b. Psyllium
c. Tegaserod
d. Polyethylene glycol solution
e. Bran

Question 5

Treatment of chronic constipation and dyssynergic defaecation have a lot in common. Which of the following is effective for only one of the two?

a. Toilet training
b. Diet
c. Laxatives
d. Biofeedback therapy
e. Bulking agents

1. Answer: b
   Comments: It is possible to create a neoappendix from a caecal flap that can be sutured to the skin and can be used for antegrade bowel lavage [28, 30].
2. Answer: d.
   Comments: SNS started as a treatment for urinary incontinence and proved to be beneficial for faecal incontinence and for constipation [32–34].
3. Answer: a
   Comments: It is the only investigation that can give information about enterocele. Defaecography can be performed with thickened barium contrast or with magnetic resonance imaging (MRI) or computed tomography (CT) scan. MRI and CT scans are only possible in institutions where they have open equipment since a patient that has to defaecate in the lying position can sometimes have difficulties expelling the bolus [35–37].
4. Answer: e [20].
5. Answer: d [38].

37 Pelvic Floor Dysfunction

Michael E. D. Jarrett

CONTENTS

37.1 Definition

Pelvic floor dysfunction is the inability of the pelvic floor to fulfil its supportive role to the pelvic organs and/or its inability to allow these organs to function normally. The dysfunction may be limited to a single organ, but more often involves more than one of the urinary, genital and anorectal organs to some degree. This chapter will only discuss pelvic floor disorders involving the anorectum, leaving aside specific urogenital troubles. Rectal prolapse and solitary rectal ulcer syndrome are discussed in Chap. 38.

37.2 Anatomy

This area is often confused by controversies surrounding nomenclature and complicated by differences in the morphological interpretation of the pelvic muscles. The pelvic floor stretches across the pelvis and divides it into the main pelvic cavity above, which contains the pelvic viscera, and the perineum below. The pelvic floor or diaphragm is not a flat structure but a funnel-shaped one formed by the levator ani muscles and the small coccygeus muscles and their covering fascia. It is incomplete anteriorly to allow for the passage of the urethra, and in the female the vagina. Fibrotic attachments bridging this area prevent protrusion of the pelvic organs. The levator ani muscle is a wide thin sheet that has a linear origin from the back of the body of the pubis, bilaterally from tendinous arches, formed by a thickening of the pelvic fascia covering the obturator internus muscles, and from the ischial spines. From this extensive origin, groups of fibres sweep downward and medially to their insertions. Anterior fibres form a sling around the prostate or vagina and insert into the perineal body. Intermediate fibres consist of the puborectalis, which forms a sling around the junction of the rectum and anal canal, and the pubo-, ilio- and ischiococcygeus muscles, which pass posteriorly to insert into a median raphe between the tip of the coccyx and the anal canal (the anococcygeal body) and the coccyx itself.

The different pelvic organs are fixed to the pelvis by their lateral ligaments, by fibrotic reinforcement of the pelvic aponeurosis and related fascia. Cohesion of the different organs is secured by the pre- and retrovaginal fascia in women and by the retroprostatic fascia of Denonvilliers in men, as well as by the fatty tissue of the different pelvic spaces.

The deep part of the external anal sphincter is continuous with the levator ani muscle as the "steep" part of the funnel descends almost vertically around the rectum.

The innervation of the levator ani muscles is not constant, but is via the pudendal nerve (S2, S3, S4) and a direct innervation from the sacral plexus (S3, S4). The external sphincter is innervated by motor fibres travelling in the pudendal nerve (S2, 3) and the perineal branch of S4.

37.3 Action

The levator ani muscles on the two sides form an efficient muscular sling that supports and maintains the pelvic viscera in their position. They resist rises in intrapelvic pressure during straining and expulsive efforts of the abdominal muscles (as occurs in coughing). Furthermore, they have an important sphincter action with regard to anorectal function, and in the female they also serve as a sphincter of the vagina.

The puborectalis maintains the anorectal angle, and its stimulation pulls the rectum forward and upward, hence closing the angle.

37.4 Aetiology

Stretching, laxity, abnormal relaxation or paralysis, and rupture and tears of the muscular components, ligaments, fascial and fibrotic structures increase the risk of pelvic floor dysfunction. The main cause is pregnancy and childbirth [22]. Excessive straining, surgery in the pelvis or surgical removal of any component [20], and old age may also contribute [29].

37.5 Classification

With regard to the pelvic floor disorders, one can divide the female pelvis anatomically into anterior, central and posterior sections. Disorders may primarily affect one section or globally affect the perineum (Table 37.1). Traditionally the anterior, central and posterior sections have been managed by urologists, gynaecologists and colorectal surgeons, respectively. The conditions, however, tend to have a related aetiology and hence rather than presenting with a discreet problem, patients tend to present with coexisting pathologies across two or three compartments. Surgery to one compartment may have implications for the others [34]. It is important, therefore, that each speciality has a working knowledge of the other and that these patients are discussed and managed in a multidisciplinary manner.

Table 37.1 Disorders affecting the different divisions of the female pelvis

Anterior	Anterior colpocoele Cystocoele (+/– stress urinary incontinence)
Central	Uterine prolapse Posterior colpocoele
Posterior	Rectocoele Rectal intussusception Rectal prolapse
Global	Perineal descent (descending perineum) Perineal herniation

37.6 History and Examination

Patients may complain of one or more of the following: pain, incomplete evacuation, the need to digitate, tenesmus, a pelvic mass or prolapse, protrusion of a pelvic organ, mucus and/or blood being passed, constipation, and urinary and/or faecal incontinence. A full obstetric history should be elicited (including number of pregnancies, birth weights, instrumentation and mode of delivery [57, 74], presentation and tears) as well as any history of pelvic or perineal surgery. The chronological relationship between onset of symptoms and any traumatic incident should be established.

Clinical examination should include inspection of the perineum for scars and for protrusion of vaginal or anorectal mucosa and asymmetry of anal folds. If the history is suggestive of a rectal prolapse, straining over a toilet or commode is a necessary part of the examination. Rectal examination should be carried out to assess sphincter tone and ascertain whether a rectocoele is present.

37.7 Additional Investigations

Evacuation proctography (defaecography) with small-bowel contrast is essential in the evaluation of pelvic floor disorders (see Chap. 8). Concomitant cystography can be carried out in selected patients for evaluation of bladder dysfunction [47]. Video defaecography is a dynamic investigation that gives information on the anorectum, the anorectal angle, the rectovaginal septum and the depth of the pouch of Douglas and its contents, and provides information on changes resulting from straining and stool retention as well as the quality and completeness of bowel evacuation [3, 77].

Similarly, dynamic magnetic resonance defaecography appears to be an accurate imaging technique for assessing clinically relevant pelvic floor abnormalities [26, 67, 88].

Perineal, introital and endoanal ultrasound can provide information on associated sphincter lesions and

has become an indispensable diagnostic procedure in urogynaecology for determining the localisation of the bladder neck and vesicourethral junction, as well as for pre- and post-operative comparisons [18].

Ultrasound scanning and magnetic resonance imaging, of course, negate the need to expose the patient to harmful ionising radiation and allow control groups to be more easily examined from an ethical point of view. This is important, as the clinical significance of supposedly abnormal findings is not always immediately evident [26, 89].

Rectal manometry and cystomanometry should be performed in the case of associated faecal and/or urinary incontinence in conjunction with assessment of rectal sensation with an intrarectal balloon.

Pudendal nerve terminal motor latency (PNTML) may be measured, as a significant relationship between perineal descent and PNTML has been shown in some studies [41, 52, 56, 83], although one large study did not confirm this [43]. Colonic transit may be measured to rule out colonic inertia.

37.8 Descending Perineum

Descending perineum syndrome is said to be present if the anocutaneous junction descends by more than 3 cm in relation to the ischial tuberosity during a maximum straining effort. Measurement may be performed using a perineometer [36], or more commonly now using defaecating proctography [42].

The anorectal junction should normally lie above the pubococcygeal line (a line drawn from the lower border of the symphysis pubis to the tip of the coccyx). If the anorectal junction only descends below this line on straining it is termed a descending perineum, and if it lies below the line at rest it may be described as a descended perineum that may descend further on straining.

Traumatic or multiple deliveries may result in descent of the perineum either at rest or on straining, and pelvic floor muscles may also become progressively neuropathic following years of constant straining during defaecation [8, 32, 38]. As such, descent of the perineum is most common in women. The problem may be complicated by faecal and urinary incontinence, although observed symptoms are more often due to associated lesions and many patients are asymptomatic despite severe pelvic floor failure [96].

The first step of treatment is re-education, biofeedback and medical therapy, as there is no consensus for surgical treatment [11, 96]. Various surgical options have been proposed for use mainly in patients with associated incontinence. These include postanal repair, preanal repair and total pelvic floor repair. Total pelvic floor repair appears to give better results than posterior or anterior repair alone [78]. Sphincterotomy and haemorrhoidectomy should not be undertaken in this patient group, as there is a high risk of them becoming faecally incontinent [98].

37.9 Rectocoele

Rectocoeles are hernias of the rectum anteriorly through the rectovaginal septum. They usually result from damage during childbirth or from excessive straining, and small ones can be found in nulliparae [23]. Rectocoeles may be classified according to their position: low, middle or high [59]; and/or their size: small (< 2 cm), medium (2–4 cm) or large (> 4 cm) [69]. Size is measured anteriorly from a line drawn upward from the anterior wall of the anal canal on proctography. They can also be classified into three clinical stages at straining during defaecating proctography (Table 37.2, Fig. 37.1).

Small rectocoeles rarely produce symptoms [89, 97]. The larger ones, however, may cause obstructed defaecation, constipation, pain (often in the lower back) and bleeding due to ulceration [99], and may interfere with sexual function. Perineal pressure or vaginal digitation is often described as a measure taken by the patient to aid defaecation. Incomplete evacuation of the rectocoele on defaecating proctography is an important finding. Posterior rectocoeles are less common and are

Table 37.2 Classification of rectocoeles

Type	Features
I	Digitiform rectocoele or single hernia through the rectovaginal septum
II	Big sacculation, lax rectovaginal septum, anterior rectal mucosal prolapse, deep pouch of Douglas, frequently associated with an enterocoele
III	Rectocoele associated with intussusception and or prolapse of the rectum

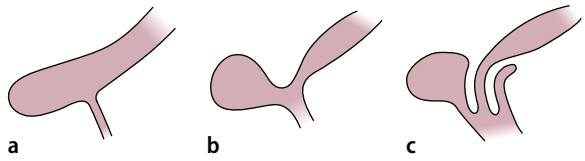


Fig. 37.1a–c Types of rectocoele. **a** Type I. **b** Type II. **c** Type III

caused by a weakness in the supporting pelvic floor muscles [33].

Conservative methods of treatment such as pelvic-floor exercises, electrical stimulation of the pelvic floor muscles and the use of supportive devices such as pessaries within the vagina are of limited use [92].

Surgical repair should only be carried out on carefully selected patients and in the context of any coexisting pelvic floor abnormality. The best results seem to be gained in patients who need to vaginally digitate [12] rather than in those needing to apply pressure to the perineum or digitate rectally [45]. Barium trapping on defaecography is also often used as a selection criterion [63], although it is not felt to be directly associated with defaecatory dysfunction [33]. An abnormal transit study might have a less favourable outcome from rectocoele repair with respect to constipation [63].

Several techniques have been employed to attempt to surgically repair rectocoeles:

1. The endoanal approach [12, 48, 85–87, 93]
2. The endorectal stapled approach [6, 14–16, 60, 61, 81]
3. The transvaginal approach [50, 58, 70, 72]
4. The transperineal approach [53]
5. The abdominal approach

The surgical treatment should be tailored to the extent of the rectocoele, the symptoms associated with it and any other concomitant pelvic floor deficiency.

Type I and II rectocoeles lend themselves to the endoanal, transvaginal or transperineal approaches, with or without the use of prosthetic materials to support the repair. The endoanal approach was described by Sullivan et al. [93] and Sarles et al. [85, 86], and is usually carried out with the patient in the prone jackknife position. The anterior rectal mucosa above the dentate line is infiltrated and lifted with a solution of local anaesthetic and a vasoconstrictor. A flap of mucosa is raised off the rectal circular muscle to expose the rectal wall over a distance of 6–10 cm above the dentate line or as far as the apex of the rectocoele. The rectal muscle is then plicated, usually with a series of five to eight vertically placed sutures to reinforce the rectal wall and the rectovaginal septum. Redundant mucosa is excised and the defect closed [85]. Some surgeons prefer to plicate the muscle with horizontal mattress sutures (Fig. 37.2) [68].

If the sphincter is weak and if the anterior anal canal is short and without a lesion in the external sphincter, the longitudinal plication can be completed by two or three double-U transverse sutures to lengthen the anal canal (Fig. 37.2d, e). This reinforces the occlusion mechanism and improves incontinence. If there is an associated vault prolapse, a sacrospinal fixation may also be performed [7, 40, 69].

An anterior Délorme's procedure has been described as a further anal approach to rectocoeles, especially with associated mucosal prolapse [54] or rectal intussusception [95].

If a transverse perineal incision is used, the whole of the rectovaginal septum is exposed, separating each structure to demonstrate the levator ani, which is plicated using a series of horizontal mattress sutures. The interposition of mesh at this site has been reported [73]. It has been proposed that this approach is limited as it does not allow enough access to the upper part of the rectovaginal septum and to the pouch of Douglas.

The transvaginal approach with an extensive posterior colpomyorrhaphy is a technique that has traditionally been preferred by gynaecologists and performed in the lithotomy position. A Lone Star retractor is useful and following local anaesthetic and vasoconstrictor infiltration the vaginal mucosa is incised transversely and mobilised as far as the cervix or pouch of Douglas. The peritoneum at this point is mobilised and pushed up, and a Douglassorhaphy may be performed. The levator ani and puborectalis muscles are dissected out and approximated at the midline with sutures. If the sutures include the rectal muscle superficially 1–1.5 cm below, the rectal wall is lifted and a rectal mucosal prolapse is prevented.

A sphincteroplasty may also be performed if there is sphincter rupture or distension. If the patient presents with a vaginal vault prolapse, a culpopexy to the sacrospinal ligament may also be carried out.

Direct comparison of the transanal and transvaginal approaches in a prospective study of 30 female patients with symptomatic rectocoeles, excluding patients with compromised anal sphincter function or other symptomatic prolapse, was carried out by Nieminen et al. [70]. There were 15 patients in each study group. At 1-year follow-up, 73% (11/15) showed improvement

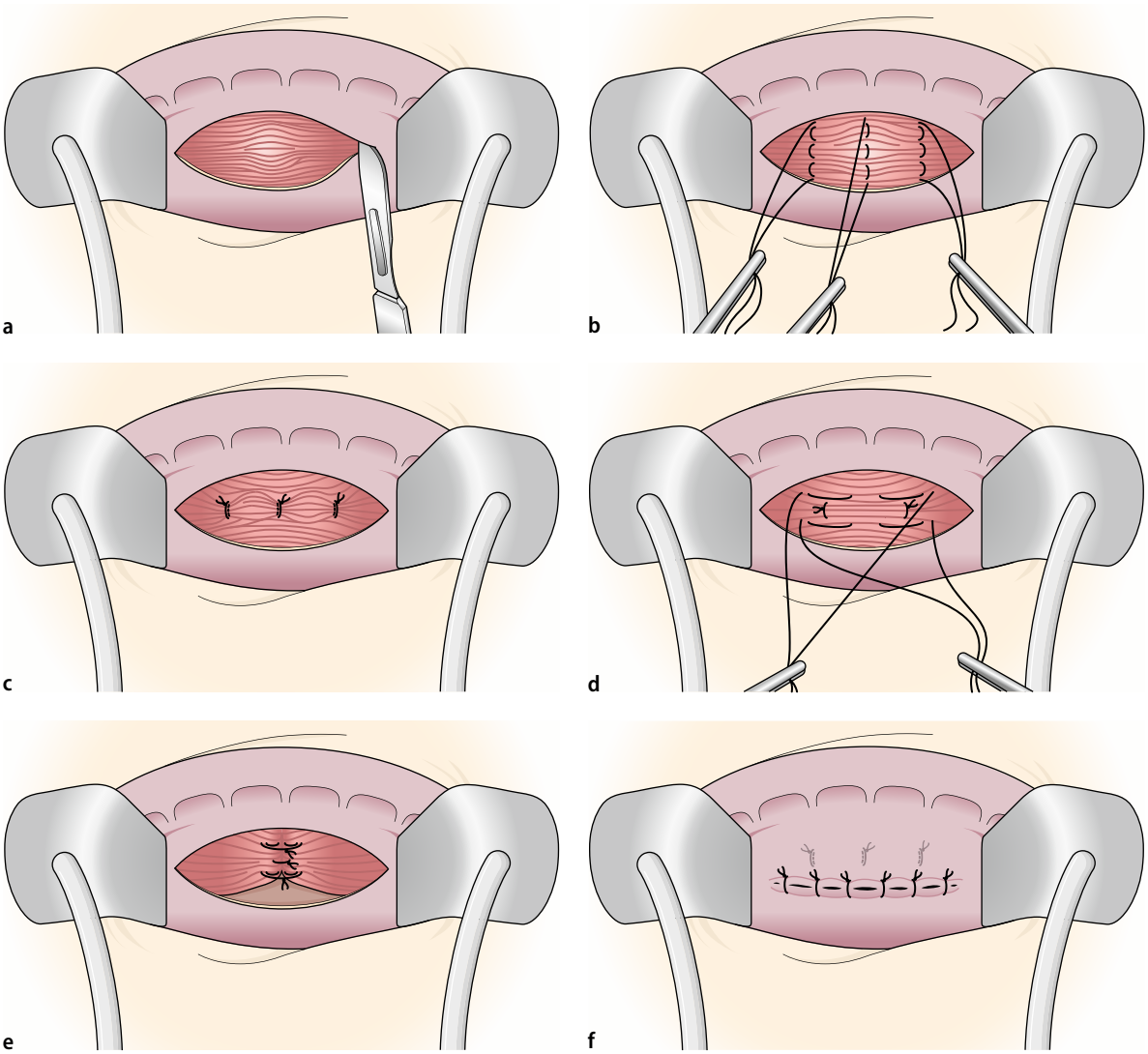


Fig. 37.2a–f Endoanal approach to rectocoeles. **a** Incision 0.5 cm above the pectineal line. **b** Plication of the anterior rectal wall. **c** Sutures are tightened. **d**,**e** Transverse plication in the case of incontinence. **f** Mucosal suture

in the transanal group as opposed to 93% (14/15) in the transvaginal group. The need to digitate decreased significantly in both groups, from 93% (14/15) to 27% (4/15) in the transanal group and from 73% (11/15) to 7% (1/15) in the transvaginal group. Clinically diagnosed recurrence rates, however, showed a significant difference, with 40% (6/15) in the transanal group and 7% (1/15) in the transvaginal group ($p = 0.04$). There were no adverse effects on sexual function in either group, but 27% (8/30) reported improvement.

In terms of functional results, the endoanal and transanal approaches appear similar, but data of long-term follow-up are largely unavailable (Tables 37.3 and 37.4). The use of mesh implantation again suffers from short follow-up times and/or small numbers, with the pervading worry of prosthetic material erosion or infection and de novo dyspareunia (Table 37.5). The clinical use of prosthetic materials in this area remains unknown and there is a need for further study [4, 39, 55].

An abdominal or combined abdominoperineal approach is most often necessary for type III rectocoeles (Fig. 37.1c, Table 37.2) or those with an accompanying enterocoele or vault prolapse. The abdominal part

Table 37.3 Success and recurrence rate of transvaginal approach in rectocoeles

Reference	Patients (*n*)	Follow-up (years)	Success rate (%)	Recurrence (%)	De novo dyspareunia (%)
Nieminen et al. [70]	15	1	93	7	0
Maeda et al. [58]	10	7.5	100	–	–
Lamah et al. [50]	60	3.5	82	–	–
Smirnov and Khvorov [90]	22	–	–	27.3	–
Paraiso et al. [72]	37	1	–	14	0
Mellgren et al. [63]	25	1	84	–	–
Abramov et al. [2]	183	>1	–	22	17

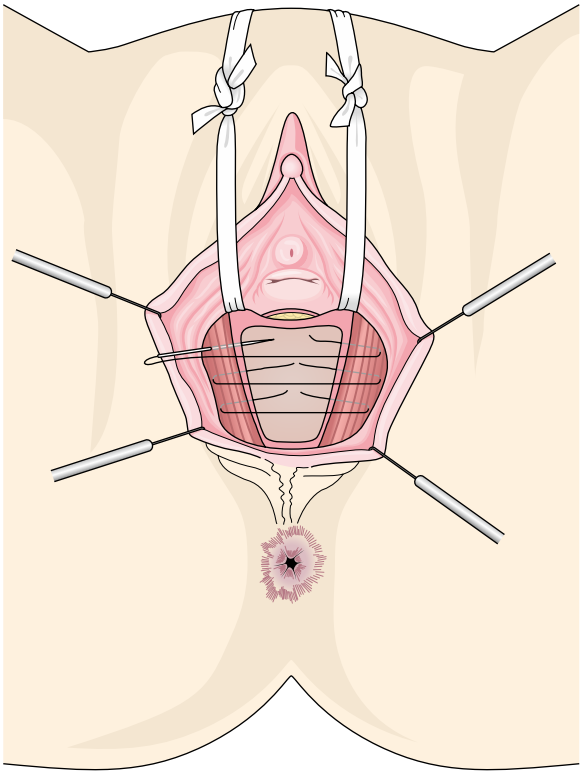
Table 37.4 Success and recurrence rate of transanal approach in rectocoeles

Reference	Patients (*n*)	Follow-up (years)	Success rate (%)	Recurrence (%)	De novo dyspareunia (%)
Nieminen et al. [70]	15	1	73	40	0
Heriot et al. [37]	45	2	78	–	0
Sullivan et al. [93]	151	1.5	79.5	–	–
Sehapayak [87]	355	–	98	–	–
Khubchandani et al. [48]	59	1.5	80	–	–
Sarles et al. [85]	20	3	94	–	–
Marti (unpublished, from 1990)	33	1	90	–	–

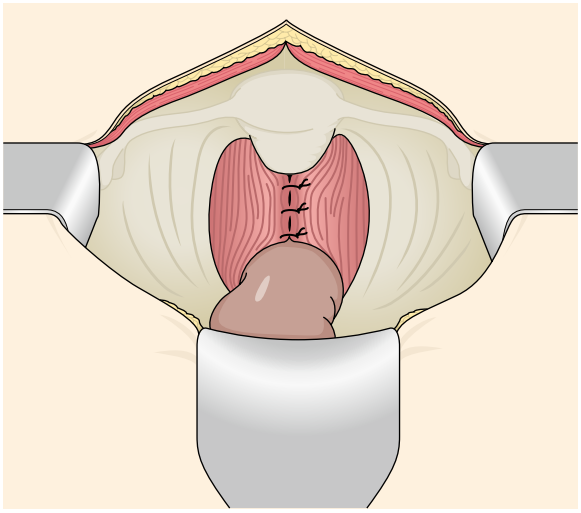
Table 37.5 Success and recurrence rate of prosthetic material use in rectocoele repair

Reference	Patients (*n*)	Prosthetic material	Follow-up (years)	Erosion of material (%)	Success rate (%)	Recurrence (%)	De novo dyspareunia (%)
De Tayrac et al. [21]	132	Prolene mesh	1	6.3	92.3	2.6	12.8
Smirnov and Khvorov [90]	20	Prolene mesh	–	–	–	5	5
Lim et al. [55]	37	Vypro Mesh	3	30	–	22	27
Kobashi et al. [49]	62	Cadaveric fascia lata	1	–	93.6	–	10.3
Paraiso et al. [72]	26	Porcine xenograft	1	–	85	–	46
Altman et al. [5]	23	Porcine xenograft	3	0	<50	41	–

of the operation may be open or laparoscopic and the procedure may or may not involve the placement of prosthetic material. The principle of the surgery is to perform a rectopexy to deal with the intussusception and/or prolapse of the rectum, to repair the rectocoele, and to perform a Douglassorhaphy to obliterate an excessively deep pouch (if one is present). If necessary, a correction of bladder or uterine prolapse may be carried out and in the case of a previous hysterectomy, the upper part of the vagina may be secured to the upper part of the levators or fixed to the sacrospinal ligament to prevent a vaginal vault prolapse.



a



b

Fig. 37.3a,b Abdominovaginal approach according to Zacharin. **a** Perineal view. **b** Abdominal view

An abdominoperineal approach was described by Zacharin [100] in which the pouch of Douglas and the rectovaginal septum are opened. Two strips of gauze are placed from the abdomen through the pouch of Douglas down to the perineum, where they are secured over the pubis, essentially dividing the anterior and middle compartments from the posterior compartment. A rectopexy of choice is performed and the pelvic hiatus closed with three to four sutures placed through the levators on both sides (Fig. 37.3). The gauze strips are then removed and a posterior colpomyorrhaphy performed (Fig. 37.4).

For large type III rectocoeles with intrarectal intussusception and/or prolapse (<3 cm) and a history of obstructed defaecation syndrome (inability to expel faeces, vaginal or rectal digitation, defaecation only with the aid of laxatives/enemas), the stapled transanal rectal resection (STARR) procedure has been proposed (Fig. 37.5). Intrarectal intussusception can be seen on defaecating proctography and may suggest a mechanical obstruction to defaecation. Resection of the prolapsing rectum in this group of patients may represent an effective treatment. The objective of the STARR procedure in these patients is:

1. Removal of the prolapsing rectum and restoration of the normal anatomy
2. Re-establishing the continuity of the rectal muscular wall with reaquisition of normal rectal capacity and compliance
3. Anatomical correction of the rectocoele with regression of the posterior colpocoele, if associated

Early results are encouraging [27, 71, 75], with the largest prospective multicentre trial containing 90 patients undergoing the STARR procedure for treatment of outlet obstruction caused by the combination of intussusception and rectocoele. All patients had significant improvement in constipation symptoms without affecting continence, and post-operative defaecating proctography showed the disappearance of both the intussusception and rectocoele [14]. Complications, however, have been reported, including bleeding, faecal urgency, incontinence, pain, constipation [24] and rectovaginal fistula [9, 13]. The presence of an entero- or sigmoidocoele at rest is a contraindication to the use of this technique; however, it can be performed after the correction of these pathologies or with concomitant laparoscopic surveillance [76].

Laparoscopic ventral mesh rectopexy is another technique described for rectal prolapse repair [17] that may be tailored to achieve Douglassorhaphy and rectocoele repair with or without perineal intervention.

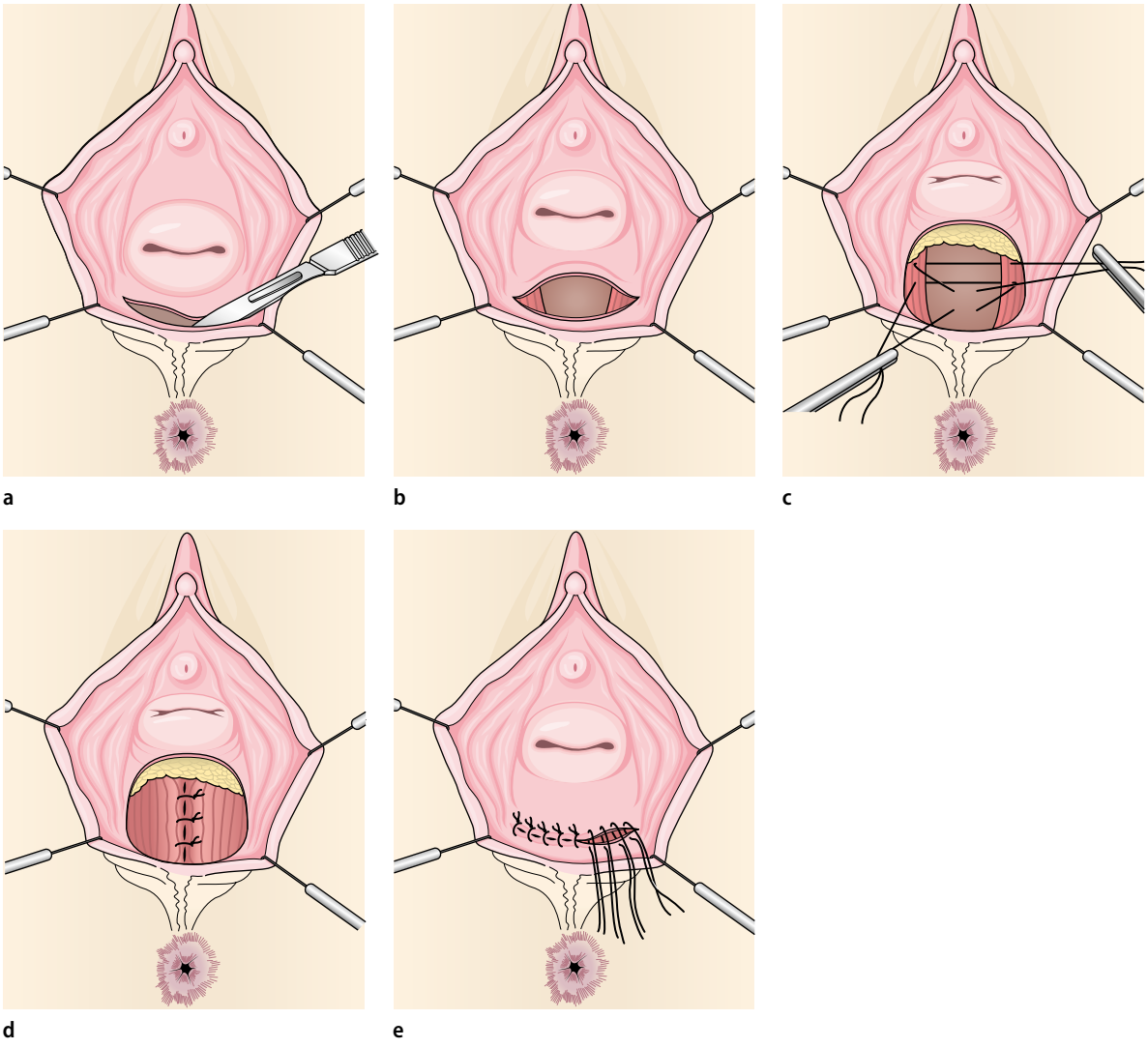


Fig. 37.4a–e Posterior colpomyorrhaphy. **a** Transverse vaginal mucosa incision. **b** Mobilisation of the mucosa up to the level of the cervix. **c** Approximation of the levator ani and puborectalis muscles with inclusion of the anterior rectal wall 1–1.5 cm below. **d** Sutures are tightened. **e** Closure of the mucosal incision

37.10 Enterocoele

An enterocoele is defined as a herniation of the peritoneal sac between the vagina and rectum that may contain small bowel or sigmoid colon (sigmoidocoele). These may occur as a result of vaginal hysterectomy performed without reconstruction of the rectovaginal septum and without correct suspension of the vaginal vault or adequate support of the pouch of Douglas [46, 51, 62]. There is also a high incidence following cystopexy [51]. It is a rare condition and the implications of an enterocoele remain unclear. They will only be clearly noted if small-bowel contrast is used at defaecating proctogram, and are noted in between 11 and 19% of these studies for defaecatory disorders [64, 94]. Concomitant abnormal findings are common [66], such as perineal descent, rectocoele and rectal intussusception, and were encountered in 76% of patients. Reported symptoms include obstructed defaecation (59%), post-defaecation discomfort (52%) and pelvic pain (27%) [94].

The role of surgical intervention in these patients remains unclear due to small numbers. Operations have been undertaken in selected patients to obliterate the

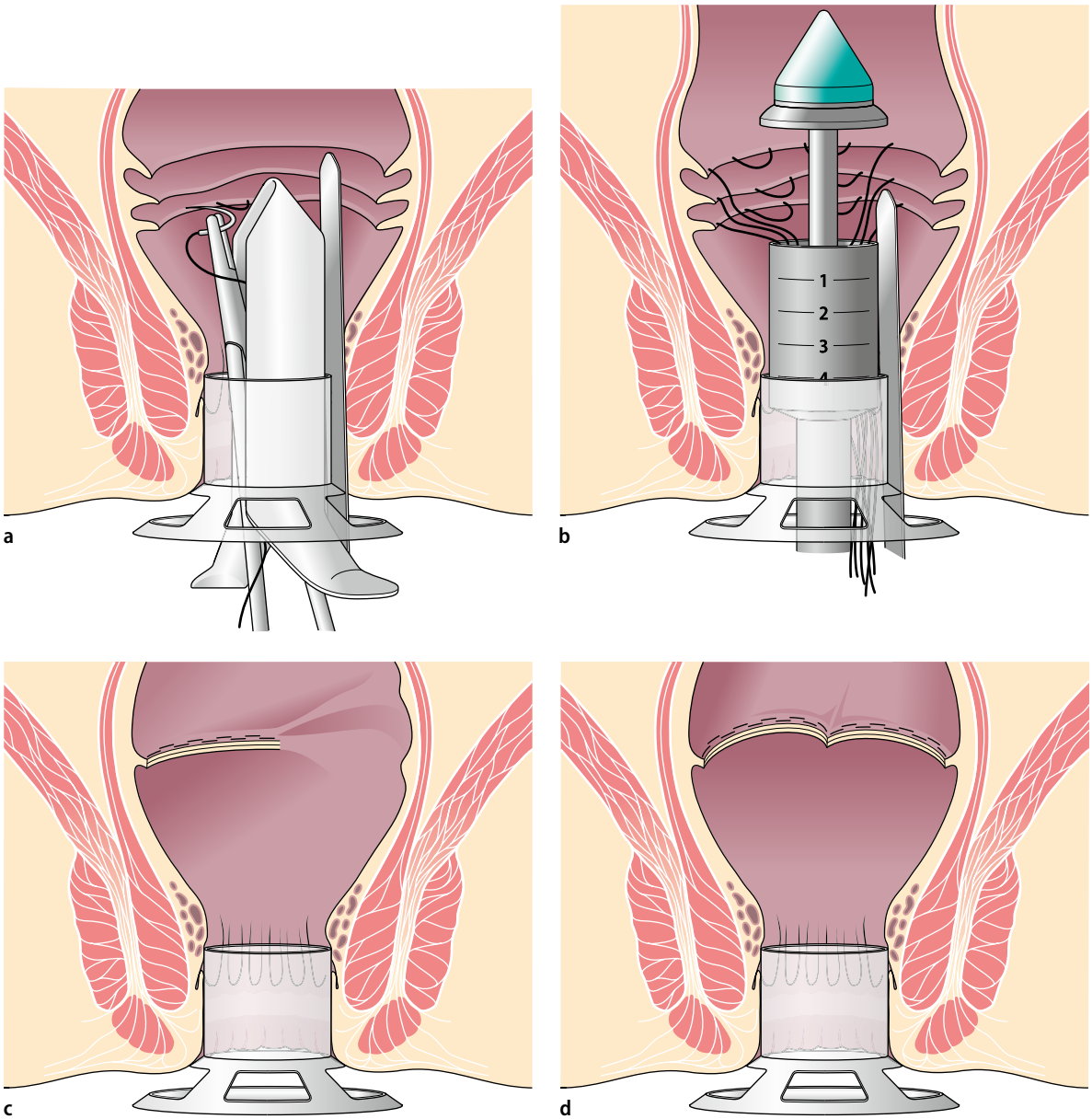


Fig. 37.5a–d Stapled transanal rectal resection – STARR – procedure. **a** A semicircular full-thickness purse-string is performed on the prolapse anteriorly. The posterior rectum is protected with a spatula. **b** Three purse-strings are placed 2 cm cranially above one another; the staple device is inserted. The tails of the suture threads are pulled through the stapler ports and held with a clamp to apply traction whilst the stapler is closed and fired. **c** Post-anterior firing of the stapler. **d** The same procedure is repeated posteriorly and haemostasis gained prior to completing the procedure

pelvic inlet or reduce the herniation of the pouch of Douglas either with a transabdominal or perineal approach, with [28, 31] or without [94] the use of synthetic material. Results suggest that symptoms of pelvic pain and heaviness are improved with enterocoele repair, but that evacuation difficulties tend to remain [31, 94]. With other associated pelvic-floor abnormalities being common [28, 94], any operation being considered also needs to attempt to correct these, as it is likely that these contribute to the defaecatory dysfunction experienced by this patient population.

Table 37.6 Sigmoidocoele classification system from defaecating proctography

1st degree:	Above the pubococcygeal line
2nd degree:	Below the pubococcygeal line
3rd degree:	Below the ischiococcygeal line

37.11 Sigmoidocoele

The descent of a loop of sigmoid colon through the pouch of Douglas leading to obstructed defaecation is rare. Straining, bloating and a feeling of rectal fullness and pain are most often associated. Jorge et al. (1994) suggested a classification according to the degree of descent of the lowest part of the sigmoid (Table 37.6) and noted a sigmoidocoele in 24 of 289 (8%) defaecating proctogram studies for constipation [44]. The most severe cases may be treated surgically. This usually involves rectopexy and resection of the upper rectum, sigmoid colon and distal descending colon as an extended resection rectopexy, with colposuspension and obliteration of the pouch of Douglas; good results have been reported in selected patients [65].

37.12 Perineal Herniation

Perineal herniation is a rare condition, being observed in only 37 out of 800 patients examined by defaecating proctography [79]. It results from a levator ani defect caused by traumatic childbirth or chronic straining to pass stool. The levator ani muscles in these patients are so weak that any rise in pelvic pressure is exerted downwards to create a perineal hernia rather than anteriorly to form an anterior rectocoele. Such a herniation may be associated with faecal incontinence due to the weakness in the pelvic floor and poor sphincter control.

Perineal herniation may also occur following proctectomy. Historical data suggest prevalences ranging from 0.6 to 7%, although retrospective data from the Mayo clinic (1990–2000) states that only 8 of 3,761 patients undergoing an abdominoperineal resection developed a perineal hernia [1]. With the push towards a "cylindrical" rather than "hour-glass-shaped" specimen at abdominoperineal resection, morbidity in this regard may increase, although further studies will be required [19].

The literature reports many different approaches for the treatment of perineal hernia including open or laparoscopic mesh repair [25, 30], and perineal, abdominal [10] or combined approaches [84, 91]. Particularly in the cases following previous surgery, the use of autologous tissue may be employed [35, 80, 82].

37.13 Rectal Prolapse

For details on rectal prolapse, see Chap. 38.

37.14 Conclusion

Pelvic floor dysfunction covers a variety of pelvic pathologies that are largely attributable to obstetric trauma. All organ systems in the pelvis need to be taken into account in the investigation and management of these patients. This requires a close multidisciplinary and cross-speciality approach in order to avoid substandard results in this difficult area.

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Self-Assessment Quiz

Question 1

Which of the following statements is true? The stapled transanal rectal resection (STARR) procedure:

a. Can be used for all rectal prolapse
b. Can be combined with other pelvic floor procedures including hysterectomy, colposuspension and procedures for urinary incontinence
c. Can be used to correct all rectocoeles
d. Involves full-thickness stapling of the anterior rectal wall only
e. Can be used in patients with an anatomical enterocoele

Question 2

When investigating the pelvic floor, which of the following is incorrect?

a. Rectocoeles are often found on defaecating proctography in asymptomatic patients.
b. Endoanal ultrasonography can determine internal and external anal sphincter defects.
c. Perineal descent, rectocoeles and internal intussusception are best evaluated by defaecating proctography.
d. Findings on defaecating proctogram are closely related to patient symptomatology.
e. The internal anal sphincter appears as a distinct hypoechoic band on endoanal ultrasound.

Question 3

Which of the following is true?

a. Innervation of the levator ani muscles is predominantly from S1 and S2.
b. The longitudinal muscle of the rectum thickens to form the external anal sphincter.
c. The levator ani muscles encircle the urethra, vagina and lower rectum as support for these organs.
d. The pudendal nerve is formed from the anterior divisions of S1 and S2.
e. Puborectalis and external anal sphincter contraction at defaecation lead to functional obstructive defaecation symptoms.

Question 4

Which of the following is incorrect? Rectocoeles:

a. Require surgery
b. Are found in nulliparae
c. May require vaginal digitations to aid evacuation
d. Are predominantly anterior
e. Can be seen well on defaecating proctography

Question 5

Which of the following is false?

a. Pudendal nerve terminal motor latencies are measured using a St. Mark's glove electrode.
b. Defaecating proctography ought to be carried out with small-bowel, vaginal and bladder contrast in order to gain the most information about the pelvic floor as a whole.
c. Endoanal ultrasound and anorectal physiology give information regarding the anal sphincter's structure and function, respectively.
d. Perineal descent is most commonly measured using a perineometer.
e. An abnormal transit study may have a worse outcome following rectocoele repair with regard to symptoms of constipation.

1. Answer: b
   Comments: STARR can be used in patients with obstructive defaecation symptoms who have rectoanal invagination associated with a full-thickness rectal prolapse of less than 3 cm, or rectocoele. The procedure involves full-thickness stapled resection of both the anterior and posterior rectal wall and as such an anatomical or stable enterocoele/sigmoidocoele is a contraindication to STARR, although a combined approach with laparoscopy has been proposed [76]. STARR can be undertaken alongside other operations on the pelvic floor, necessitating good interspecialty communication and discussion, but care should be taken to avoid procedures requiring opening of the posterior vaginal wall.
2. Answer: d
   Comments: Defaecating proctography can reveal several abnormalities, with rectocoeles being one of the more common findings. Findings at defaecating proctography may not always mirror the patient's symptomatology and indeed many patients have been found to have asymptomatic rectocoeles [89]. The internal anal sphincter appears as a distinct hypoechoic band in endoanal ultrasonography, and defects in either the external anal sphincter or internal anal sphincter can be determined on these scans.
3. Answer: e
   Comments: The levator ani muscles have a dual nerve supply with direct innervation from the perineal branch of the third and fourth sacral nerves, the peripheral part being supplied by the pudendal nerve. The pudendal nerve is formed from the anterior divisions of S2–S4. The levators form a sling around the lower rectum, which is incomplete anteriorly to allow for passage of the urethra and vagina in the female, with fibrotic attachments bridging this gap to prevent protrusion of the pelvic organs. Longitudinal muscles of the rectum extend to form fibrous attachments to the perianal skin between the internal and external anal sphincters. The puborectalis and the external anal sphincter should relax during defaecation. If they do not, functional obstructive defaecation syndrome or anismus are present.
4. Answer: a
   Comments: Rectocoeles usually result from trauma during childbirth but small ones can be found in nulliparae [23]. They are predominantly anterior and digitations vaginally may be required to empty the rectocoele and aid complete evacuation. Rectocoeles can be readily seen on defaecating proctography, but their presence does not mean that surgery is necessarily required.
5. Answer: d
   Comments: Perineal descent is more commonly measured these days using defaecating proctography [42] rather than the perineometer, as described by Henry et al. [36].

38 Total Rectal Prolapse, Internal Prolapse – Solitary Rectal Ulcer Syndrome and Rectocele

André D'Hoore

CONTENTS

38.1 Introduction

Surgical treatment of rectal prolapse remains one of the most controversial topics in colorectal surgery. Different views and a large number of (named) operations are described in the surgical literature. For no particular reason, different operations have been in vogue in different continents and surgeons base their choice merely on anecdotal personal experience. There is a lack of randomized trials comparing different techniques and approaches. This chapter aims to critically describe the most frequently applied perineal and abdominal techniques. Surgeons should master both approaches to allow a surgical approach that is tailored to the individual patient. The introduction of laparoscopy has significantly reduced the morbidity of an abdominal approach. Newer techniques focus on a less extensive mobilization of the rectum to avoid cumbersome postoperative constipation. Evaluation of surgery for rectal prolapse should not only focus on recurrence, but should also include functional aspects.

Whether surgery is indicated in obstructed defecation syndrome (ODS) is a matter of debate. The introduction of the stapled transanal rectal resection (STARR) technique and the finding that some laparoscopic rectopexy techniques improve rectal emptying have fueled this debate. Understanding the multifactorial pathogenesis of ODS is a prerequisite to appropriate patient selection for surgery on a sound scientific basis.

38.2 Total Rectal Prolapse

Rectal prolapse is defined as a full-thickness rectal intussusception protruding through the anus. With the aid of cinedefecography, Broden and Snellman [1] were able to demonstrate that in fact the prolapse is an intussusception rather than a sliding hernia through a pelvic fascia defect, as was proposed by Moschcowitz [2].

Untreated rectal prolapse will inevitably lead to sphincter insufficiency. In the elderly patient, total rectal prolapse can be part of a more complex pelvic organ prolapse.

Functional outcome should be included in the assessment of postoperative success along with the rate of anatomic recurrence.

38.2.1 Epidemiology

External rectal prolapse is an uncommon but disabling condition. Rectal prolapse is predominantly a female pathology (gender ratio 10:1) and the finding of two

ages of peak incidence may well reflect the underlying pathophysiology. In the younger group of patients, a history of obstructed defecation and prolonged straining seems to precede rectal prolapse. In the aged patient, rectal prolapse is often part of a more complex pelvic organ prolapse related to a weakened pelvic floor (Fig. 38.1). Childbearing can certainly contribute to the development of pelvic floor laxity; however, half of women with rectal prolapse are nulliparous.

In males, the condition is unrelated to age. There is a variable association with psychiatric illness [3].

38.2.2 Clinics

Symptoms include the sensation of a lump protruding during defecation with the need to reposition the prolapsed rectum manually. Mucous discharge and soiling is common. Anal bleeding with tenesmus and pain are associated with a "solitary rectal ulcer."

Symptoms related to anorectal dysfunction are common and differ with age: constipation predominantly in the younger patient, fecal incontinence in the aged patient. Some degree of fecal incontinence is noted in about 60–80% of patients. The dilating effect of the prolapse, pudendal neuropathy, and repetitive stimulation of the rectoanal inhibitory reflex all result in a low resting anal pressure [4].

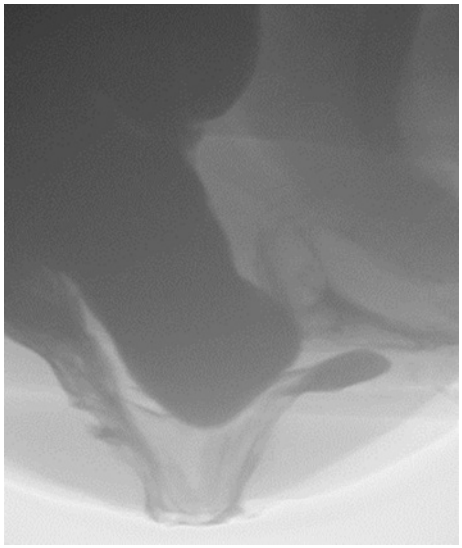


Fig. 38.1 External rectal prolapse at strain. After emptying the bladder an impressive enterocele enters the anal canal

Constipation is present preoperatively in up to 60% of patients. Most patients have a pattern of obstructed defecation. Slow-transit colonic constipation (STCO) occurs only seldom in this clinical setting [5].

Rectal prolapse should be differentiated from mucosal anal prolapse, anterior mucosal prolapse, and prolapsing hemorrhoids (Fig. 38.2).

A complete examination of the pelvic floor should be performed to assess the degree of descent of the middle and/or anterior compartment. A pathologic descent of the pelvic floor (descending perineum syndrome) should be noted, as this can contribute to persistent postoperative dysfunction. If the prolapse is not visible at clinical examination, the patient should be asked to sit on a commode and bear down to reproduce the prolapse.

A clinical assessment of patient's fitness to undergo surgery is indicated in the elderly.

38.2.3 Technical Investigations

In general, a flexible endoscopy is advisable to exclude a neoplasm or a lead-point lesion as a cause for the prolapse. The finding of extensive diverticular disease could also influence the type of surgery.

Isolated erythema or ulceration of the rectal wall is the cardinal feature in solitary rectal ulcer syndrome (SRUS) and biopsy can reveal a typical histology with fibrous obliteration of the lamina propria.

Colpocystodefecography should be performed if more information on the middle and anterior pelvic compartments is necessary. Furthermore, this can reveal functional information as a nonrelaxing sphincter syndrome in patients with internal rectal prolapse. Table 38.1 provides an overview of the radiologic grading of rectal prolapse [6].

Manometric tests (anal pull-through, balloon retention test, and balloon evacuation test) are useful to objectify anorectal function, especially a sphincter deficit in patients with total rectal prolapse, and dyssynergia (obstructed defecation) [7] in patients with internal prolapse and/or rectocele.

A radio-opaque marker study is appropriate in patients with a history suggesting STCO; however, nearly one-third of the patients with outlet delay constipation will present with a delayed overall large-bowel transit [8].

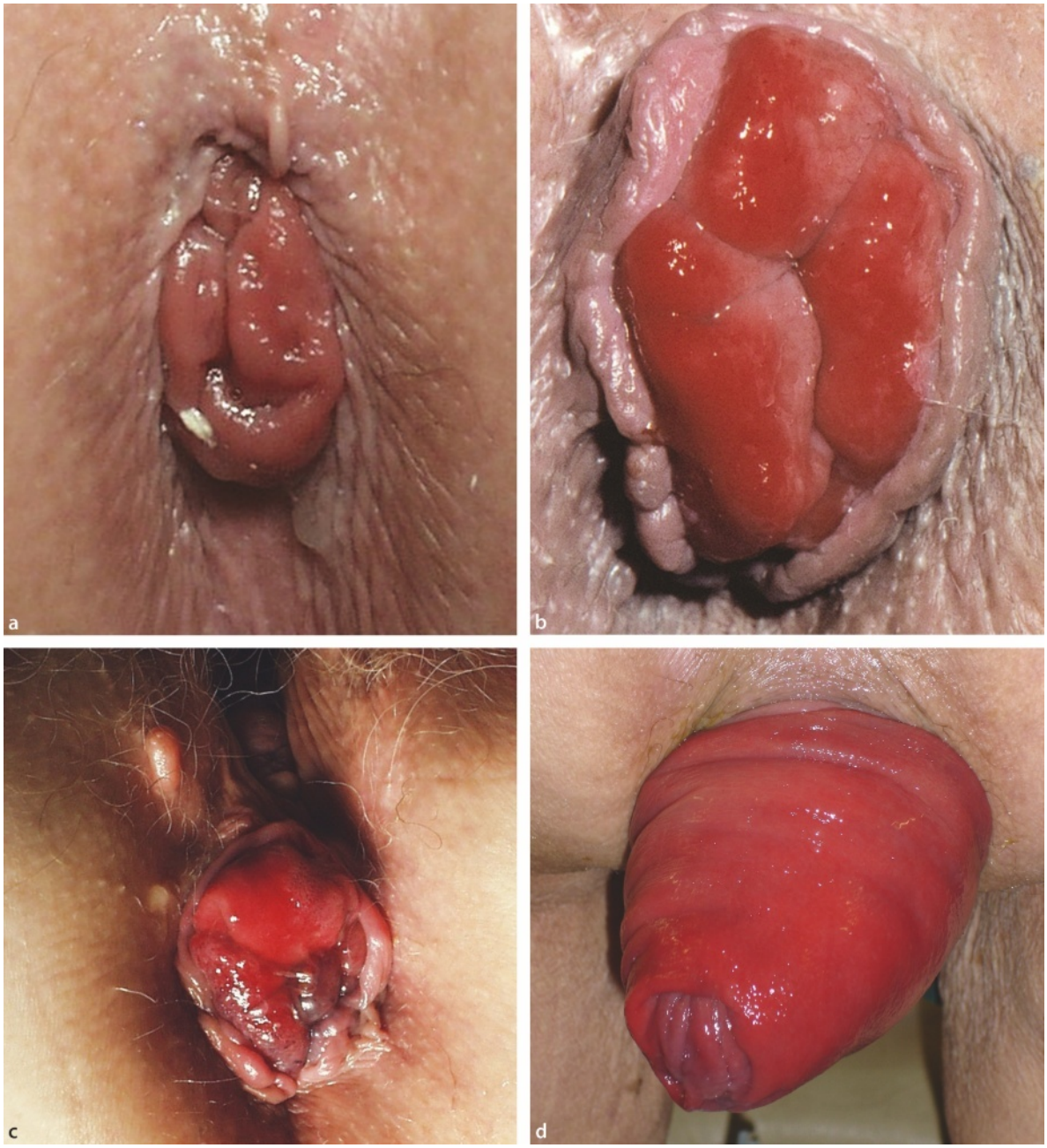


Fig. 38.2a–d Differential diagnosis. **a** Circular mucosal prolapse. **b** Internal hemorrhoidal prolapse. **c** Anterior mucosal prolapse and prolapsing hemorrhoids. **d** Total rectal prolapse

Table 38.1 Defecographic grading of rectal prolapse

	Grade I	Grade II	Grade III
Rectocele	< 2 cm	2–4 cm	> 4 cm
Enterocele	Proximal third of the vagina	Middle third of the vagina	Lower third of the vagina
Intussusception	Above the puborectal line	At the puborectal line	In the anal canal
Sigmoidocele [63]	Above the pubococcygeal line	At the pubococcygeal line	Below the pubococcygeal line
Descending perineum		>4 cm descent at strain	

38.2.4 Anatomic Features of Rectal Prolapse

Some anatomic features are rather constant findings in rectal prolapse patients and can explain different surgical approaches to correct the prolapse: intussusception, deep cul-de-sac or pouch of Douglas, absent fixation of the rectum to the sacrum, redundant sigmoid colon, and weakness of the pelvic floor and anal sphincter muscles.

38.2.5 Surgical Repair

The aim of surgical treatment is to correct the prolapse, restore continence, and prevent impaired evacuation. A large number of operations for rectal prolapse has been described, reflecting their defectiveness. There is no particular scientific reason to explain the popularity of a specific approach, and the choice of an individual surgeon is based mostly upon anecdotal personal experience. These operations can be categorized as either abdominal or perineal. Table 38.2 provides an overview of the techniques that are currently used.

Based upon a Cochrane Database Systematic Review, it can be proposed that abdominal approaches result in a reduction of recurrences. Residual incontinence is less frequent after abdominal approaches. Postoperative constipation, on the other hand, seems to be linked to mesh rectopexy, especially when lateral ligament ligation (read: extensive rectal mobilization) is performed. Bowel resection during rectopexy is associated with lower rates of postoperative constipation. Nevertheless, the limited number of relevant trials, their small sample sizes, and other methodological weaknesses severely limit the usefulness of this review for guiding practice [9].

It seems appropriate that surgeons master both a perineal and an abdominal technique. All abdominal procedures can be performed laparoscopically, which can result in a reduced hospital stay and a cost reduction [10].

38.2.5.1 Perineal Approaches

Perineal approaches are generally reserved for patients with multiple comorbidities who are too frail to withstand an abdominal approach or general anesthesia. Perineal procedures can be performed under regional anesthesia (spinal or sacral block) and with the patient in a lateral decubitus position.

Table 38.2 Surgical techniques to restore rectal prolapse

Perineal approach	• Thiersch repair (silver wire, polypropylene tape) = obsolete • Delorme mucosectomy • Altemeier perineal rectosigmoid resection
Abdominal approach	• Suture rectopexy • Mesh rectopexy – Teflon or Marlex sling repair: Ripstein – Ivalon sponge: Wells – Lateral fascial lata (Mersilene strips): Orr- Loygue – Ventral recto(colpo)pexy • Anterior resection: Muir • Suture rectopexy + sigmoid resection: Goldberg-Frykman • Pelvic floor restoration: Roscoe Graham = obsolete

Thiersch Wiring

Anal encirclement was first described by Thiersch in 1891 [11]. Originally, a silver wire was used to narrow the anal canal and to prevent externalization of the prolapse. Since then, different materials have been used. This procedure is outdated; it fails to correct the prolapse and subsequent anal erosion is common (Fig. 38.3).

Delorme Mucosectomy

This technique was described as early as 1900 and became popular in the 1980s [12]. The procedure involves stripping of the mucosa of the prolapsed rectum, sparing the muscular tube. The circular incision starts about 1 cm cephalad of the dentate line. Infiltration of the submucosa with a diluted epinephrine solution facilitates the dissection. By placing interrupted sutures around the circumference, a plication of the muscle layer is performed; this reduces the prolapse above the anal canal. The mucosal sleeve covers the plication and is anastomosed to the anal canal (Fig. 38.4). The major advantage is the avoidance of a full-thickness resection and the risks linked with a coloanal anastomosis. This technique is more appropriate for the treatment of smaller rectal prolapses.

Perineal Rectosigmoidectomy (Altemeier Procedure)

In contrast to the Delorme procedure, the Altemeier procedure involves a full-thickness resection of the prolapse (rectum, rectosigmoid) with a coloanal anastomosis [13, 14]. To avoid damage to the internal anal sphincter, the incision is started at 1.5 cm above the dentate line (Fig. 38.5). The opening of the fold of Douglas allows the surgeon to palpate, and thus decide whether a redundant loop of sigmoid colon should be resected. Despite coloanal anastomosis, septic complications and suture-line dehiscence are rare, probably due to the weakness of the remaining sphincter.

Outcome of Perineal Procedures

Recurrence

Recurrence rates after Delorme mucosectomy vary from 4 to 38%, reflecting the length of follow-up and patient selection. Watts and Thompson [15] showed that in a large series of 101 primary procedures, a cumulative recurrence rate of about 40% at 5 years could be expected. An even higher incidence of recurrence (60% at 2 years) was recorded for repeat Delorme's.

The incidence of recurrence rates after Altemeier is lower and varies between 0 and 15%. Recurrence probably reflects inadequate resection [16].

Functional Outcome

Perineal procedures have yielded poor functional outcome with respect to fecal incontinence and urgency.

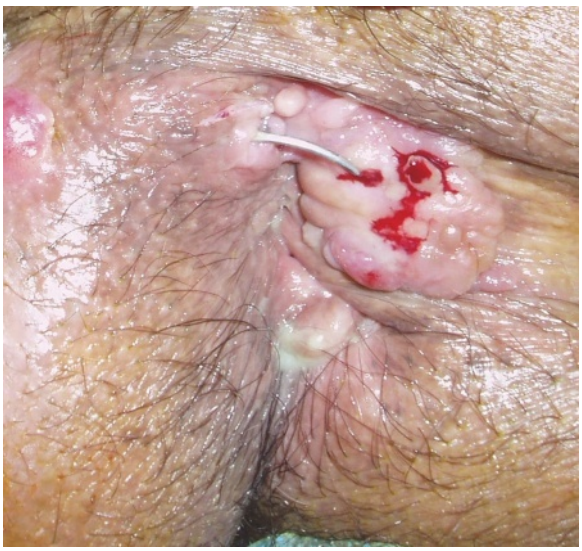


Fig. 38.3 Erosion of metallic wiring with localized anal sepsis

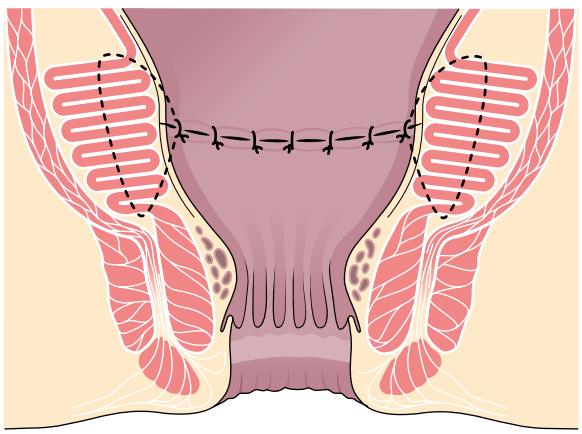


Fig. 38.4 Schematic representation of a Delorme mucosectomy and rectal muscle wall plication. Taken from Mann and Glass [68]

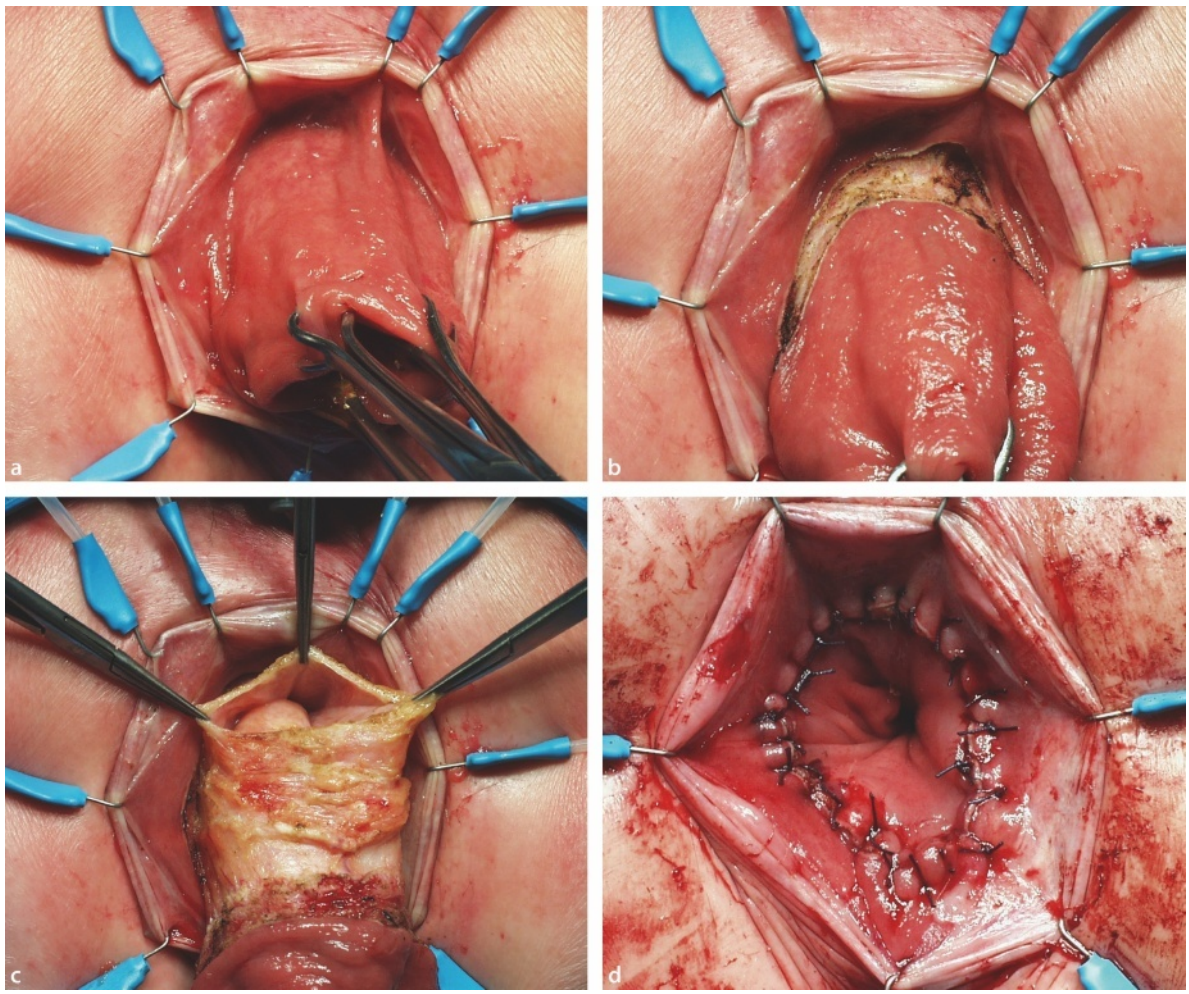


Fig. 38.5a–d Peroperative steps of the Altemeier procedure

The resection or plication of the rectal reservoir (and this in a situation of already reduced sphincter function) further jeopardizes fecal continence [17].

Perineal Colonic Pouch

To overcome this problem, Yoshioka et al. [18] suggested the construction of a colonic J-pouch of the peranally mobilized sigmoid (Fig. 38.6). However, this is only seldom possible and depends directly upon the length of the prolapse.

Additional Levatorplasty

In addition to the classical Altemeier procedure, posterior or anterior buttressing has been proposed. The muscular edges of the puborectal muscle can be identified, allowing the performance of either a posterior or anterior levatorplasty using nonabsorbable sutures. Some authors favor the posterior buttress, as it also restores the anorectal angle. A double levatorplasty is not advisable as it can result in stenosis. In an interesting study, Agachan et al. demonstrated that after perineal rectosigmoidectomy with levatorplasty, not only were incontinence scores improved, but recurrence was also reduced (Fig. 38.7) [19].

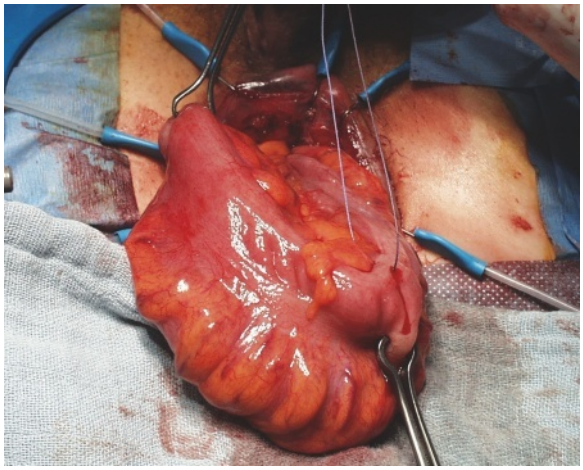


Fig. 38.6 Perineal pouch procedure to reconstruct a neorectum after Altemeier's procedure

Choice of Perineal Operation

Perineal procedures are indicated in frail, old patients with extensive morbidity. Smaller prolapses can be treated by Delorme's mucosectomy. In larger prolapses a perineal resection with dorsal levatorplasty is advisable. In the seldom-seen scenario of an incarcerated and gangrenous rectal prolapse, a perineal resection is indicated, whereas abdominal rectopexy cannot be performed. In young, fit male patients, a Delorme's procedure is certainly debatable as it avoids the risk for pelvic autonomic nerve injury.

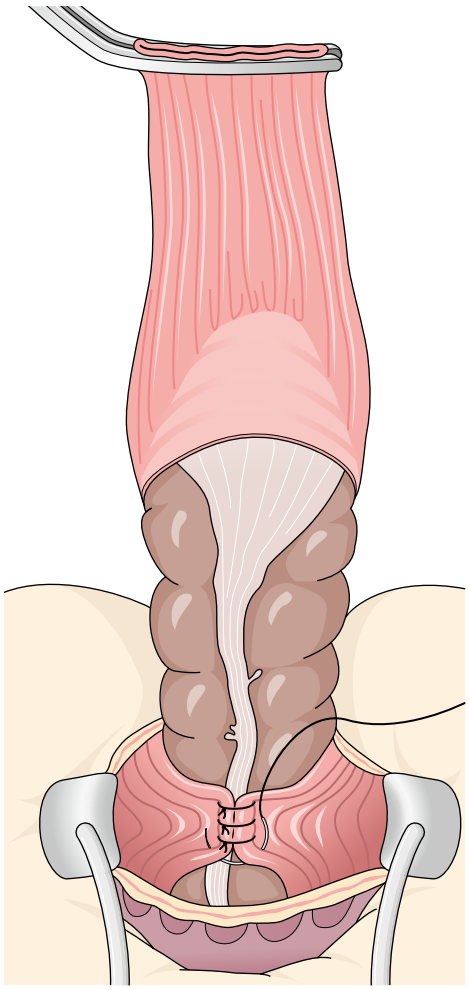


Fig. 38.7 Dorsal levatorplasty in the modified Altemeier perineal rectosigmoidectomy. Taken from Mann and Glass [68]

38.2.5.2 Abdominal Approaches

Preservation of the rectum is important to obtain a satisfactory functional outcome with regard to fecal continence. Most suspension techniques rely on the same surgical principle: mobilization of the rectum, reduction of the prolapse, and fixation of the elevated rectum to the sacrum.

Suture Rectopexy

The technique was first described by Cutait in 1959 [20]. Nonresorbable sutures are used to fix the mesorectum of the elevated rectum to the presacral fascia and sacral promontory.

Posterior Mesh Rectopexy

In the original Wells procedure [21], Ivalon (polyvinyl alcohol sponge) was inserted posterior to the mobilized mesorectum to stimulate inflammatory adhesion-fixation of the bowel to the presacral fascia. Later, the same procedure was performed using polypropylene or Teflon meshes (Fig. 38.8).

Anterior Sling Rectopexy

In the Ripstein procedure [22], an anterior sling of fascia lata or synthetic material is positioned in front of

the rectum and sutured to the sacral promontory. To overcome the risk of bowel obstruction, a modified technique (McMahan-Ripstein) [23] includes a posterior fixation of the mesh to the presacral fascia and the lateral mesh is anteriorly sutured to the rectum, deliberately leaving an anterior gap (Fig. 38.8).

Lateral Mesh Rectopexy

In the so-called Orr-Loygue procedure [24, 25], lateral fixation (using either fascia lata strips or synthetic material) between the elevated rectum and the sacral promontory is achieved at both sides of the rectum.

Outcome of Classical Rectopexy

Recurrence

Any abdominal procedure that involves extensive rectal mobilization and fixation appears to be more effective than perineal procedures, with recurrence rates in most series varying between 0 and 5% [26, 27].

Functional Outcome

Certainly abdominal rectopexy provides the patient with the best chance of maintaining or regaining fecal continence. Unfortunately, postoperative constipation is a significant problem and has consistently been reported to occur in up to half of patients [28]. Different mechanisms can contribute to this phenomenon (mesh obstruction, rectal wall fibrosis), but autonomic nerve damage secondary to the full mobilization of the rectum may result in disturbed rectosigmoid motility [29–32]. The extrinsic sympathetic innervation of the rectosigmoid (S2–S4) is interrupted if deep (antero)lateral dissection (transection of the so-called lateral ligaments) is performed.

Suture Rectopexy with Sigmoid Resection (Frykman-Goldberg Procedure)

The procedure was initially intended to reduce the recurrence rates of suture rectopexy by resecting the redundant sigmoid colon [33]. It significantly reduces the incidence of postoperative constipation as the "denervated" segment of colon is resected. Adding a resection potentially increases the morbidity.

Ventral Recto(colpo)pexy

In ventral rectopexy as described by D'Hoore and Penninckx [34], dissection is limited to the anterior aspect of the rectum (rectovaginal septum), avoiding the risk of autonomic nerve damage.

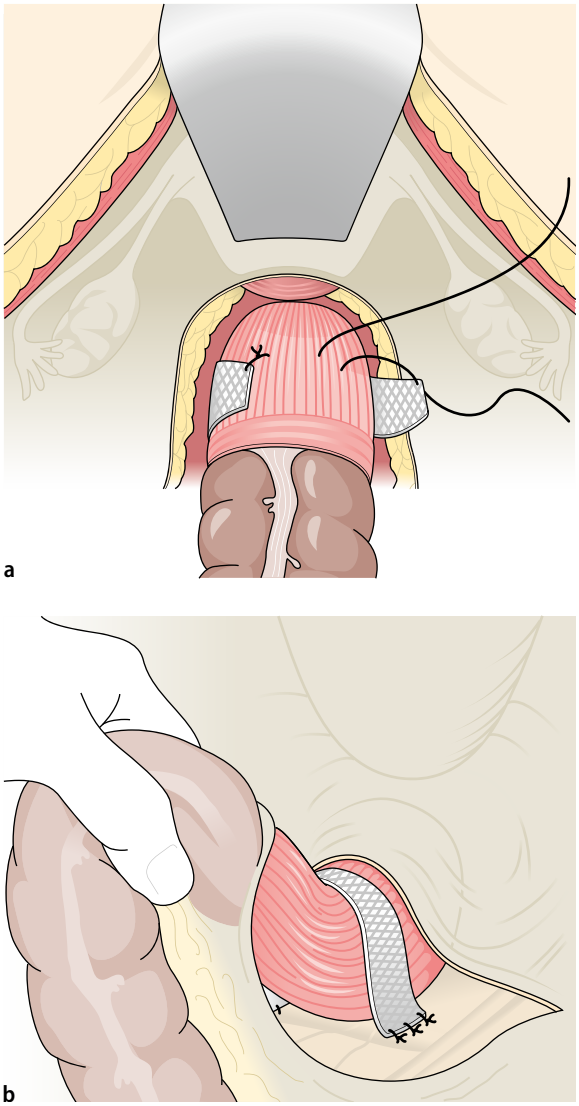


Fig. 38.8 Classical mesh rectopexy: **a** Wells procedure; **b** Ripstein. Taken from Mann and Glass [68]

Laparoscopic Technique

Patients are placed on a moldable "bean bag" in a modified lithotomy position. A 30° optic is introduced at the umbilical site and three additional ports are placed: a 12-mm port in the right lower quadrant and 5-mm ports in the left lower quadrant and right lateral wall, respectively. A peritoneal incision is made over the sacral promontory and extended caudally over the deepest part of the pouch of Douglas. The right hypogastric nerve is spared. Denonvilliers' fascia is incised and dissection is performed on the muscular wall of the rectum, opening the rectovaginal septum. Occasionally, a redundant pouch of Douglas can be resected. No rectal mobilization is performed. A strip of Marlex (Bard, Crawley, UK) trimmed to 3×17 cm is sutured to the ventral aspect of the distal rectum and fixed upon the sacral promontory using either sutures or an endofascia stapler. The posterior vaginal vault or fornix is elevated and sutured to the same mesh, resulting in a colpopexy. The lateral borders of the incised peritoneum are then closed over the mesh, resulting in an elevation of the neo-Douglas (Fig. 38.9).

The same procedure can be performed in male patients. Dissection is limited to the level of the seminal vesicles and no attempt is made to dissect posterior to the prostate.

Results

Recurrence

After a mean follow-up of 49.3 months (range 12–110 months), a recurrence occurred in 3 out of 109 patients (2.75%). A detachment of the mesh at the site of the promontory fixation was the cause in all three of these patients. In one patient a dehiscence of the colpopexy resulted in a recurrent enterocele.

Functional Outcome

Long-term functional results showed an improvement of continence in 90% of the patients and postoperative constipation was avoided. Moreover, constipation (obstructed defecation) resolved in 84% of patients [35]. These results were confirmed recently by Collinson et al. [36]. A summary of outcome results after laparoscopic ventral rectopexy is given in Table 38.3.

Different mechanisms probably contribute to the improved emptying of the rectum:

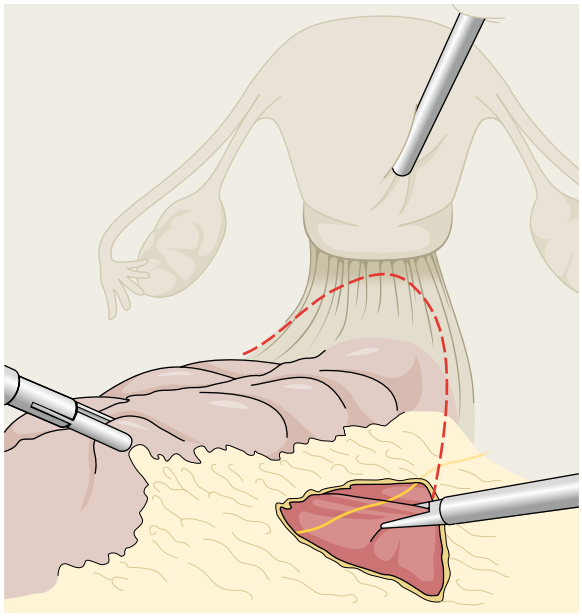
1. Autonomic nerve integrity avoiding rectosigmoid dysmotility
2. The position of the mesh reinforces the rectovaginal septum
3. Correction of the intussusception
4. Correction of an enterocele

Advantages compared to classical rectopexy include:

1. Limited dissection, laparoscopic technique
2. Nerve-sparing

Table 38.3 Updated outcome results after laparoscopic ventral rectopexy for total rectal prolapse

	Patients *(n)*	Follow-up (months)	Hospital stay (days)	Morbidity (%)	Recurrence (%)	Constipation improved (%)	Incontinence improved (%)
Collinson et al. [36] Oxford	63	18	3	11	2	78	90
Slawik et al. [64] Bristol *(mixed series +internal prolapse)*	73	54	3	21	0	80	91
Leuven *(unpublished data)*	147	85	4.8	8.1	3.4	54	90



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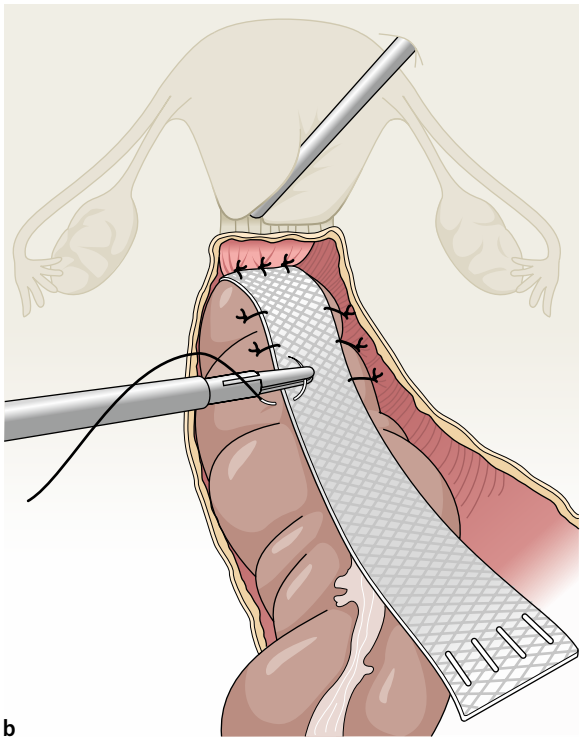

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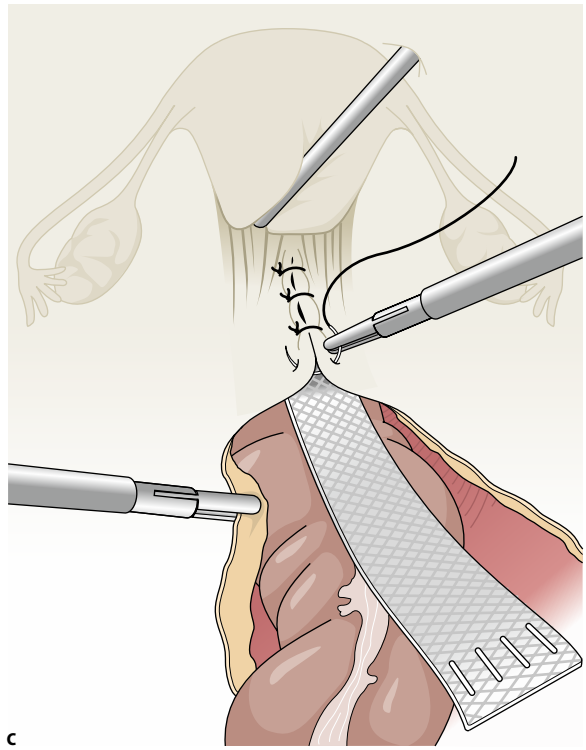

c

Fig. 38.9a–c Different steps in laparoscopic ventral rectocolpopexy

3. Sacral promontory fixation avoiding the risk of troublesome bleeding from the presacral venous plexus
4. Simultaneous correction of enterocele

Choice of Abdominal Operation

Laparoscopic ventral rectocolpopexy has become the procedure of choice in our department to treat most patients with rectal prolapse. Resection rectopexy (Frykman-Goldberg) is performed in those patients with extensive diverticular disease.

Most patients with rectal prolapse have outlet obstruction constipation. STCO is seldom seen in this setting. In the case of STCO, adding a sigmoid resection will not avoid postoperative constipation. In this situation we perform a laparoscopic ventral rectopexy in a first step. We reevaluate the patients at 6 months and especially document residual sphincter function. With acceptable sphincters and a residual problem of resistant STCO, a subtotal colectomy will be performed with an ileorectal anastomosis on the superior part of the rectum above the neo-Douglas (Fig. 38.10).

38.3 Internal Rectal Prolapse and SRUS

Controversy over the significance of internal prolapse and the role of surgical correction is still ongoing. Rectal intussusception or internal rectal prolapse is a common finding at evacuation proctography in normal volunteers. During defecation, a limited degree of intussusception may occur as a mechanism of rectal emptying [37].

In contrast, a circumferential full-thickness intussusception into the anal canal (grade III internal prolapse; Fig. 38.11) can be the cause of obstructed defecation (incomplete evacuation, excessive strain, sensation

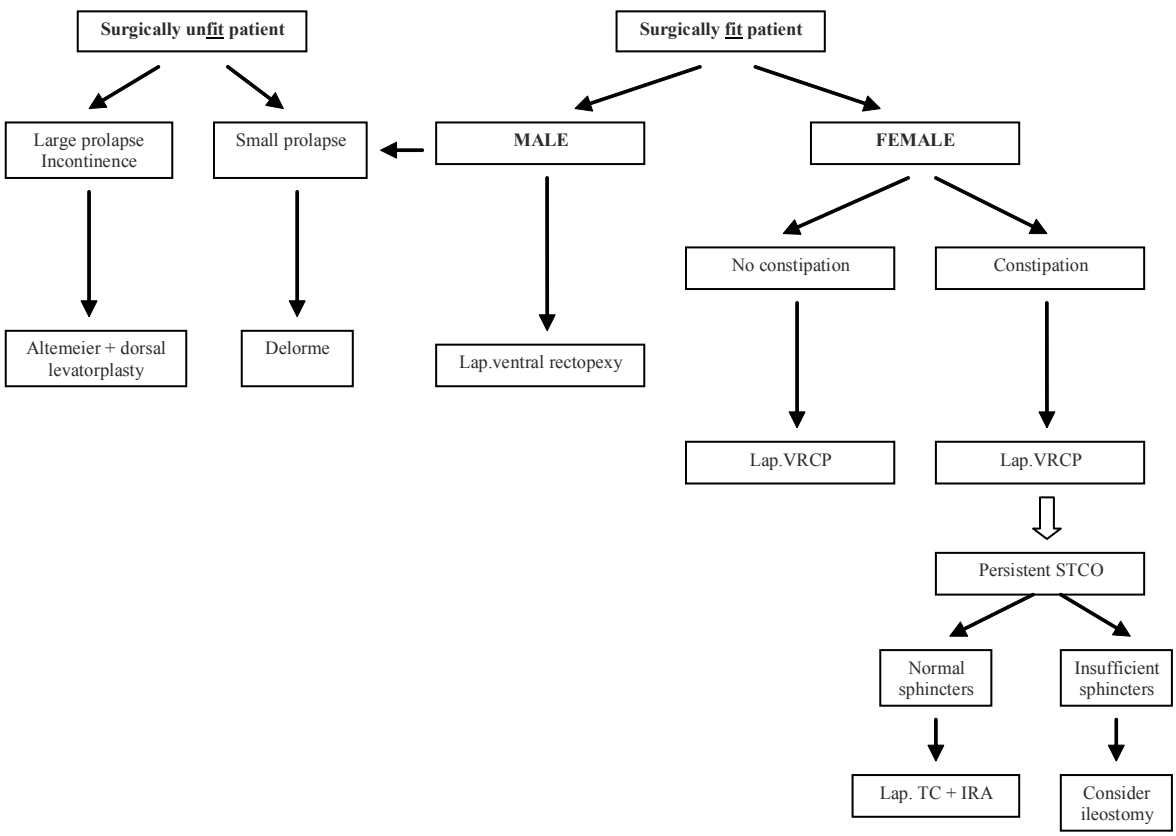

Fig. 38.10 Current treatment algorithm for total rectal prolapse at the University Hospital Leuven. *LAP* Laparoscopic, *VRCP* ventral rectocolpopexy, *STCO* slow colonic transit constipation, *TC* total colectomy, *IRA* ileorectal anastomosis

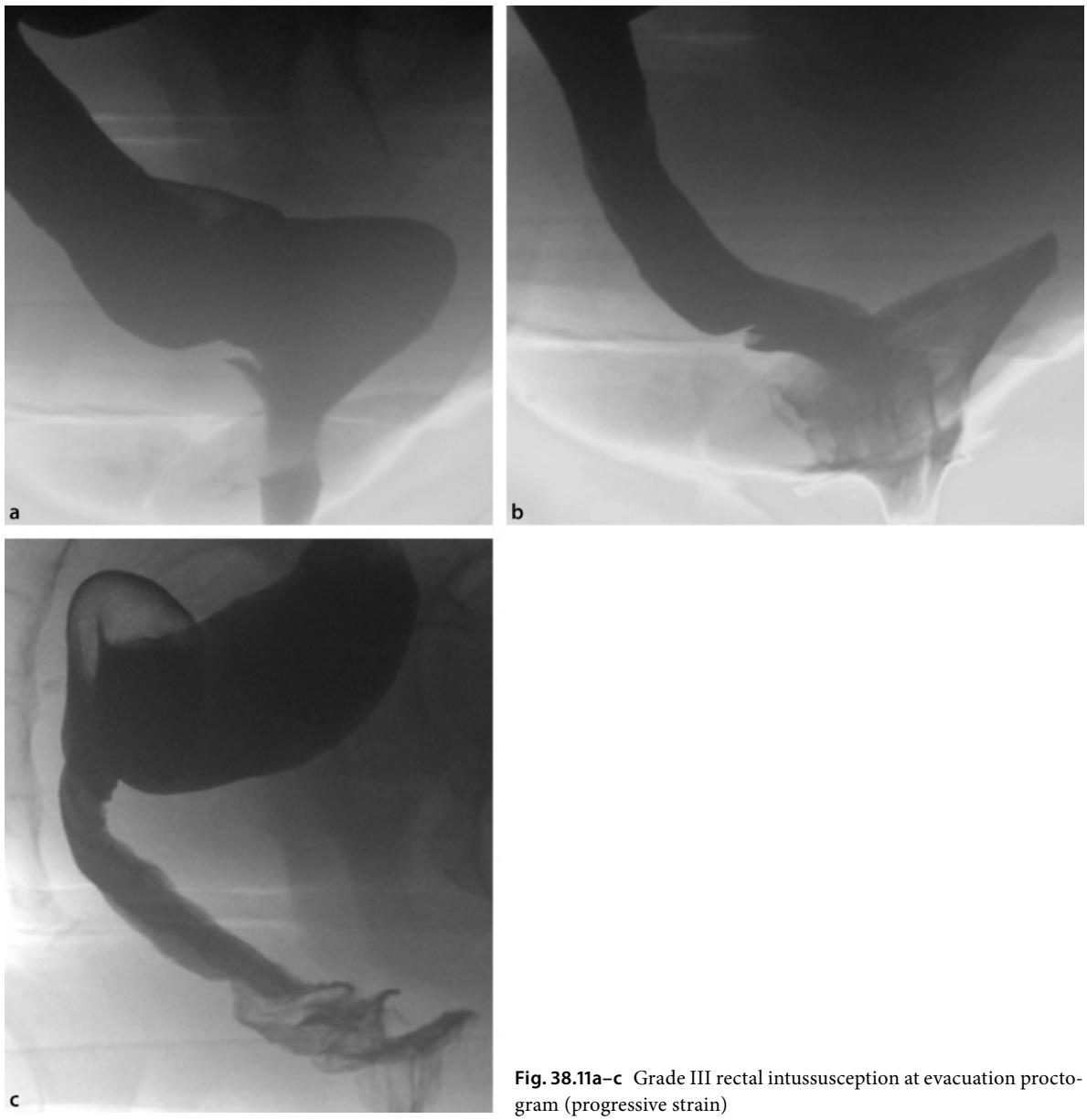

Fig. 38.11a–c Grade III rectal intussusception at evacuation proctogram (progressive strain)

of anorectal blockage), incontinence, and mucous discharge [38]. The trauma at the site of the intussusception may lead to a rectal ulcer (SRUS), causing anal pain and bleeding [39]. Internal prolapse and anismus contribute to the development of SRUS.

Debate also continues regarding the concept of rectal intussusception being a precursor of total rectal prolapse [40]. This was recently challenged by Collinson et al., who showed a slow chronological progression along the spectrum from internal to external prolapse over a timeframe of 10–15 years [41].

38.3.1 Technical Investigations

Patients with a defecatory dysfunction (obstructed defecation) deserve a thorough evaluation that includes:

1. Dynamic imaging (RX-colpocystodefecography; Fig. 38.12)
   a. Grading of the internal prolapse
   b. Unsuspected prolapses (enterocele, rectocele)
   c. Features of a nonrelaxing pelvic floor (anismus): insufficient increase or decrease in the anorectal angle during straining, and/or a persistent puborectal notch
2. Extensive manometry including a defecometry (Fig. 38.12)
   a. Balloon expulsion test (screening for dyssynergia)
   b. Defecometry [42]: analysis of manometric profiles during attempted defecation recording rectal pressure and anal canal pressures simultaneously allow the distinction between different forms of dyssynergic defecation [43]
3. Neurologic investigation if needed
4. Rectoscopy with biopsy. Misdiagnosis of SRUS is frequent leading to inappropriate medical and or surgical treatment [44]

38.3.2 Treatment

In spite of the well-defined anatomical deficit, a conservative treatment is indicated as a first-line for most patients. For the clinician it is rather impossible to judge the relative impact of the anatomical defect and the common anorectal dysfunction causing the patient's symptoms.

1. Conservative dietary therapy – a high-fiber diet with biofeedback (certainly in case of documented "anismus" or dyssynergia) – is the mainstay of treatment

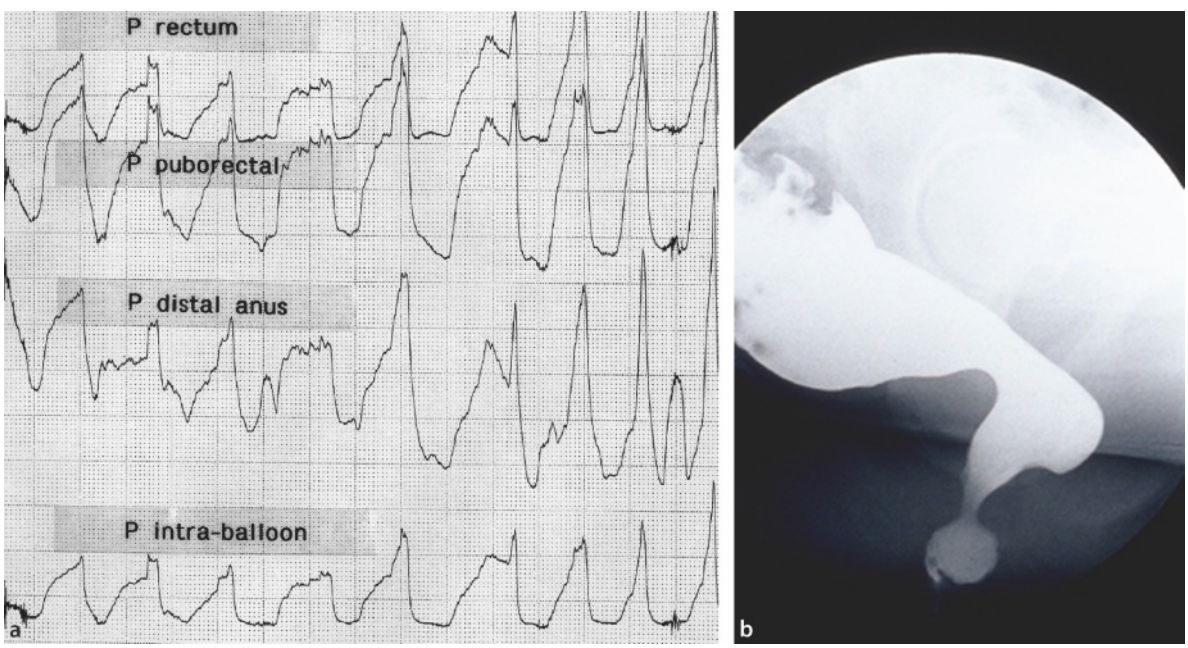

Fig. 38.12a,b Classical "anismus" on defecation proctogram (**a**) and defecometry (**b**)

[45]. Topical treatment often fails to heal the rectal ulcer.
2. Surgery can be considered in patients who fail after a prolonged period (6 months) of optimized conservative therapy. "Prophylactic" surgery seems inappropriate in view of the actual data of the natural history of the condition.

38.3.2.1 Endoanal Delorme

Berman et al. [46] reported successful results after endoanal Delorme for rectal intussusception; however, technical difficulties have limited its implementation. Since the introduction of the STARR procedure, the endoanal Delorme technique has become obsolete.

38.3.2.2 Classical Mesh Rectopexy

As mentioned above, classical posterior rectopexy results in denervation of the autonomic nerve supply of the rectosigmoid, resulting in constipation in about half the patients, and is therefore considered an ineffective treatment for internal rectal prolapse [47].

38.3.2.3 Laparoscopic Ventral Recto(colpo)pexy

After laparoscopic ventral rectopexy for total rectal prolapse, a significant improvement in symptoms of obstructed defecation has been noted in about 80% of patients. Our own experience (D'Hoore, Penninckx) in internal prolapse is limited to a small series of 20 selected patients (15 female). In 14 patients, the leading symptom was obstructed defecation. This resolved in almost all of the patients ($n = 13$) after a mean follow-up of 30 months. One patient developed fecal urge. Healing was obtained in all seven patients with a documented rectal ulcer (unpublished data). Others reported a similar functional outcome in carefully selected patients [48].

38.3.2.4 STARR Procedure

This new technique consists of a STARR, which allows resection of the rectal intussusception as well as correction of the rectocele (Fig. 38.13) [49]. It is less invasive than a laparoscopic procedure and can eventually be performed in a day-case setting. Promising results have been reported [50, 51]; however, severe complications can occasionally occur, as partial resection of the rectal reservoir may induce or worsen symptoms of fecal urge and urge incontinence [52]. Recently, a modified STARR procedure was developed using a new dedicated device, CCS-30 Transtar (Ethicon-Endosurgery; Fig. 38.14) [53].

The emergence of laparoscopic ventral rectopexy and STARR will certainly lead to a reappraisal of the role of surgery in the treatment of patients with internal rectal prolapse. Nevertheless, extensive clinical and technical evaluations of the patient are essential to obtain a successful outcome. There is certainly a lack of prospective and prospective randomized data, which hinders definitive conclusions. There is also a lack of useful validated questionnaires by which to score patient symptoms and to allow a meaningful comparison between different therapeutic approaches.

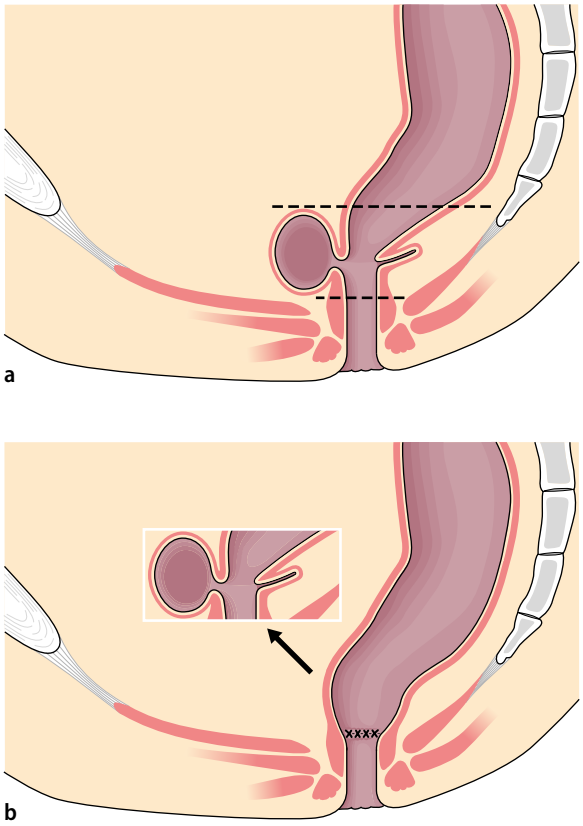

Fig. 38.13a,b Stapled transanal rectal resection (STARR) procedure

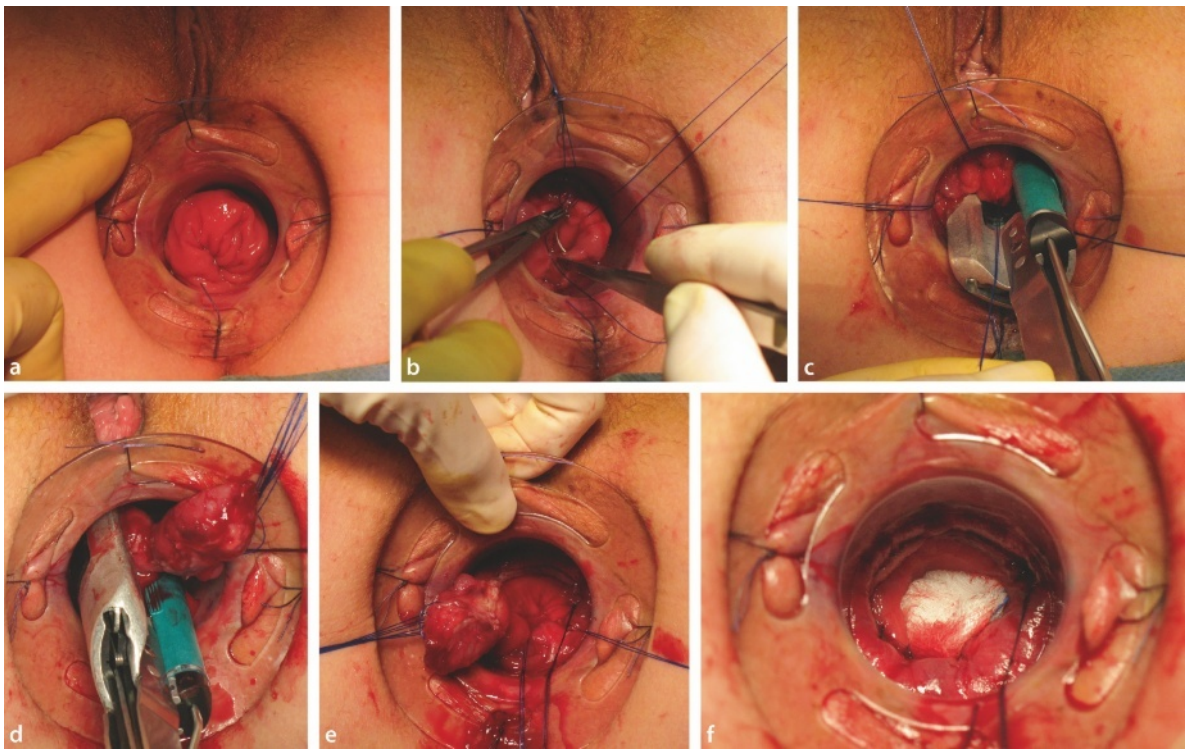

Fig. 38.14a-f STARR procedure using the Transtar-Contour. **a** Exposure of the prolapse. **b** Traction sutures. **c** Opening of the prolapse. **d** Progressive stapling. **e** Control of hemostasis **f** Final appearance of the staple line

38.4 Rectocele

A rectocele is a bulging of the anterior rectal wall into the vagina. Trauma at vaginal delivery is a major cause. Many rectoceles are asymptomatic and do not require surgical treatment. Symptoms can be related to the prolapse (feeling of a lump at Valsalva) or related to pelvic floor dysfunction. Most patients referred to a colorectal practice have symptoms of obstructed defecation (difficulty emptying the rectum and the need to support the posterior vaginal wall to facilitate defecation) [54].

Different mechanisms can contribute to ODS in patients with a rectocele: trapping within the herniation, dissipation of the evacuation force vector, mechanical outlet obstruction by the presence of intussusception and/or an enterocele, functional outlet obstruction in case of dyssynergia, and a deficient rectal filling sensation.

38.4.1 Classification

From a clinical point of view, rectoceles can be classified as being low or high. According to the study on the structural anatomy of the vaginal support in relation to the posterior pelvic compartment, De Lancey described three separate levels of relevant support [55]. Deficiencies can lead to different clinical manifestations of the rectocele.

1. Level I: the paracolpium: cardinal and uterosacral ligaments
2. Level II: the endopelvic fascia and rectovaginal septum
3. Level III: the perineal body

Deficiency at level I can result in a high rectocele, occasionally with an enterocele, peritoneocele, sigmoidocele, vaginal prolapse, or rectal intussusception.

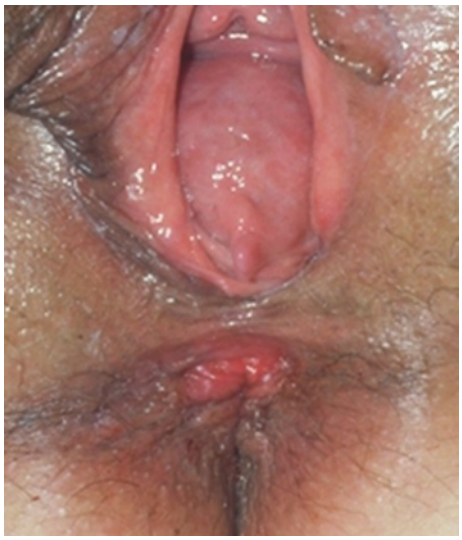

Fig. 38.15 Low rectocele with anterior sphincter defect

Deficiency at level II can result in a middle rectocele with or without rectal intussusception. Deficiency at level III can result in a perineocele or low rectocele. An anterior sphincter defect is common.

38.4.2 Clinics

As stipulated above, clinical examination should guide the surgeon to distinguish a simple rectocele from more complex descent of the middle and posterior pelvic compartments. In the presence of a perineocele, an occasional sphincter defect should be noted (Fig. 38.15). An anterior mucosal prolapse can be the clinical manifestation of a small, low rectocele. In the presence of a middle or high rectocele, the presence of a rectal intussusception and/or enterocele should be explored. In the older patient in particular, a three-compartment prolapse (including a cystocele or bladder prolapse) can be present and will guide further investigations.

38.4.3 Technical Investigation

38.4.3.1 RX-Colpocystodefecography

A defecation proctogram is necessary to obtain a complete view of the complexity and the level of the prolapse. Four-contrast defecography with small-bowel opacification has significantly improved diagnostic accuracy [56]. It has to be taken into account that a full bladder can mask a prolapse of the middle compartment. The significance of the finding of barium trapping in the rectocele remains a matter of debate (Fig. 38.16) [57].

38.4.3.2 Anal Endosonography

Anal endosonography is indicated in patients with a perineocele and clinical suspicion of an anterior sphincter defect.

38.4.3.3 Manometry

Functional evacuation tests (balloon expulsion test, defecometry) are indicated in patients with obstructed defecation to exclude dyssynergia (anismus), which could postpone surgical correction of the rectocele.

38.4.3.4 Urologic Investigation

Depending upon the clinics and urologic complaints (dysuria, urinary incontinence), a urologic consult should be obtained.

38.4.4 Tailored Surgical Treatment for Symptomatic Rectocele

Main indications for surgery in patients with a rectocele are symptoms related to the prolapse itself and obstructive defecation. Surgery only corrects the mechanical aspect of the outlet obstruction and will not always alter the functional problems (dyssynergia). In patients with a documented dyssynergia, biofeedback should precede a surgical approach.

Different options are available to correct rectoceles, including transvaginal, transanal, transperineal, transabdominal, and laparoscopic approaches. Based upon the aforementioned classification, a more tailored approach could be appropriate:

1. Level III (perineocele): colpoperineorraphia posterior ± sphincter repair, or STARR
2. Level III + rectal intussusception: STARR, Transtar, laparoscopic ventral rectopexy with perineotomy [58]

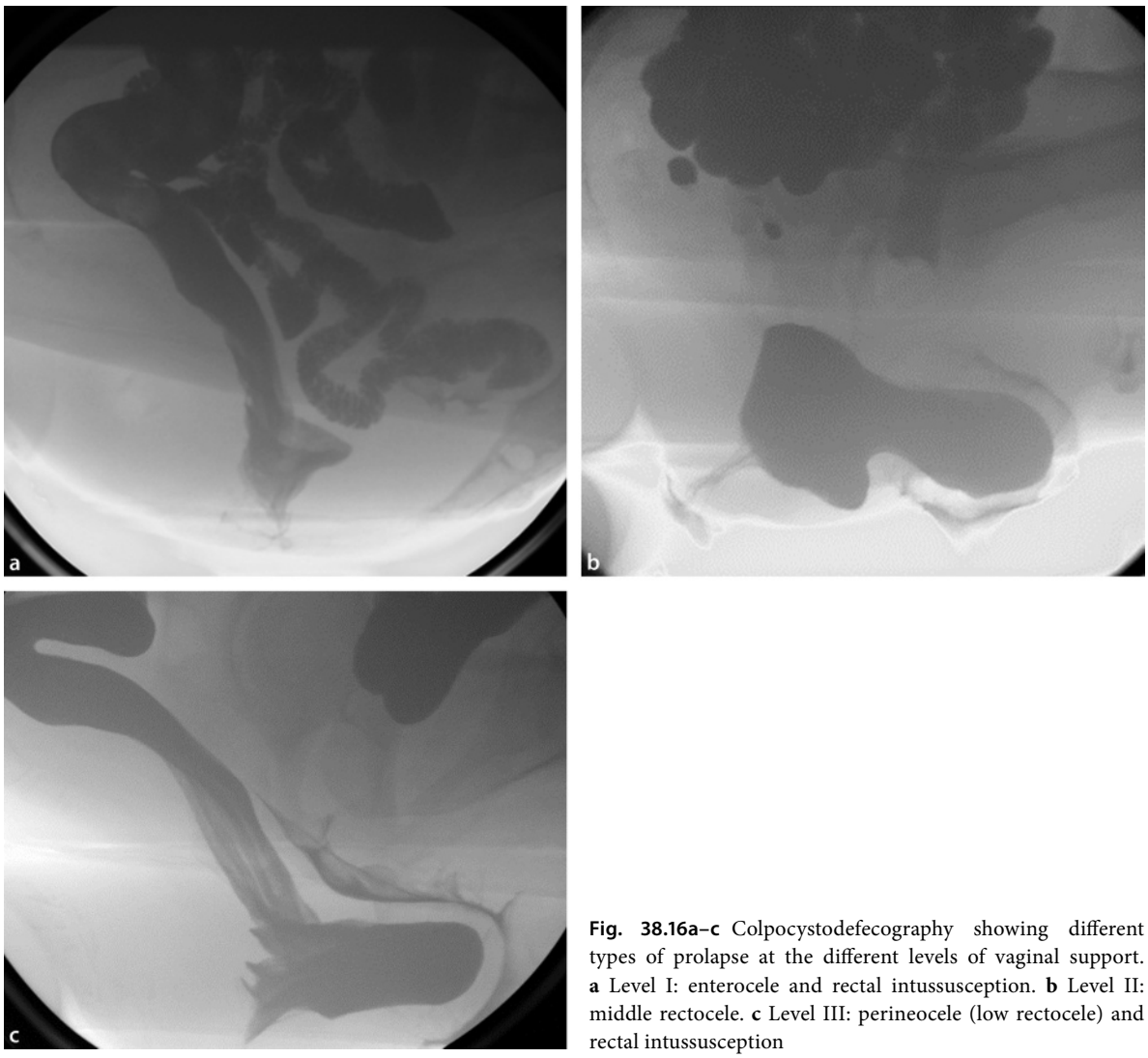

Fig. 38.16a–c Colpocystodefecography showing different types of prolapse at the different levels of vaginal support. **a** Level I: enterocele and rectal intussusception. **b** Level II: middle rectocele. **c** Level III: perineocele (low rectocele) and rectal intussusception

3. Level II: STARR, Transtar, laparoscopic ventral rectocolpopexy, external pelvic rectal suspension (Express procedure) [59]
4. Level II – level III + enterocele (level I):
   a. Fixed enterocele – no reduction at the end of straining: laparoscopic ventral rectocolpopexy, laparoscopic colpopexy + STARR
   b. Nonfixed enterocele: STARR, laparoscopic ventral rectocolpopexy

Colporraphia posterior can be performed through a transperineal or transvaginal approach. It allows the opening of the rectovaginal septum, reeving of the anterior rectal wall, and plication on the midline of the puborectal muscles. Suturing too high, however, may lead to postoperative dyspareunia. This approach is appropriate in combination with (overlapping) sphincter repair to restore (prolong) the perineal body (Fig. 38.17).

The STARR procedure has replaced other transanal approaches [60, 61] and has been used for low rectoceles, especially in combination with (anterior) mucosal prolapse. It corrects not only a low or middle rectocele, but also the rectal intussusception. Recently, Lehur et al. in a multicenter, randomized, controlled trial demonstrated a significantly higher success rate after

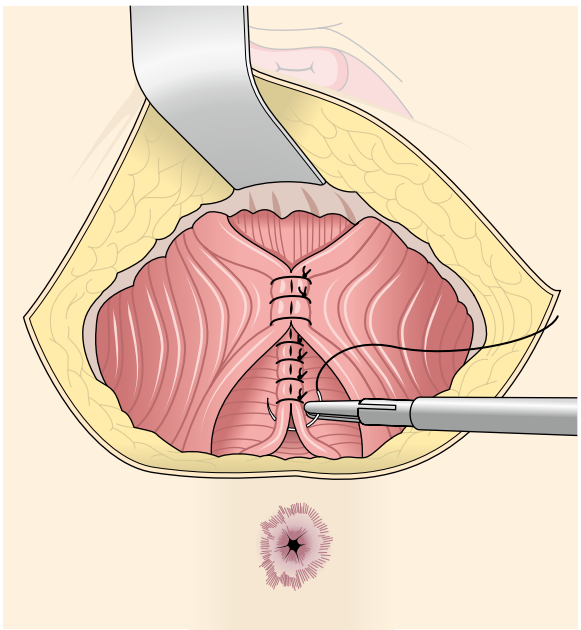

Fig. 38.17 Colpoperineorraphia posterior in combination with a sphincter repair. Taken from Mann and Glass [68]

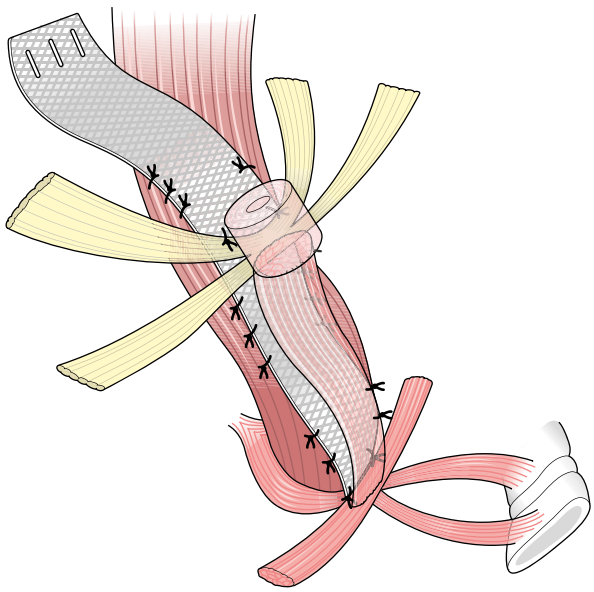

Fig. 38.18 Schematic view of the mesh position in laparoscopic ventral rectocolpopexy with perineotomy

treating obstructed defecation with the STARR procedure compared to with biofeedback alone (81.5% vs. 33.3%, $P < 0.0001$) [62].

It is important to exclude the presence of a "fixed" enterocele (i. e., where the enterocele does not reduce spontaneously at the end of straining), which may lead to an inadvertent small-bowel lesion if STARR is performed. To overcome this difficulty, a laparoscopic colpopexy (suspension of level I) should precede the STARR procedure.

The Express procedure was recently developed by Williams et al. [59]. A Permacol (collagen) mesh is inserted via a perineal approach to correct the rectal intussusception and rectocele. The mesh is fixed to the periostium of the pubic bone. In a small series of 13 patients, 2 patients developed a pelvic sepsis that necessitated surgical drainage, and a temporary stoma was required in 1 patient.

The technique of laparoscopic ventral rectocolpopexy was originally designed to correct total rectal prolapse. The unique position of the mesh in front of the rectum allows the correction of a middle and high rectocele. The fixation of the mesh to the anterior aspect of the rectum restores rectal intussusception. As a colpopexy can be performed to the same mesh, it allows the surgeon to restore a deficiency in level I (enterocele). Recently, D'Hoore et al. [58] modified this technique by combining the laparoscopic approach with a small perineotomy; this allows the position of the mesh to be extended to the level of the perineal body. As such, a complete rectovaginal septum reinforcement with mesh can be achieved (levels I–III; Fig. 38.18). In a pilot study including 20 patients, no major perioperative morbidity was noted. At a mean follow-up of 24.2 months (range 13–35 months), no recurrent rectocele occurred. Symptoms of obstructed defecation resolved in 14 of 17 patients.

The surgical treatment of rectocele is complex. Descensus of the posterior pelvic compartment will inevitably change the stability of the middle and anterior pelvic compartments. Vice versa, a surgical correction of rectal prolapse syndromes may alter urogenital function. Aging of the population is the main reason for a steep increase in the prevalence in pelvic floor dysfunction. The (colorectal) surgeon has an important role to play in its diagnosis and treatment; however, understanding the complexity of pelvic floor dysfunction is essential to obtaining a good surgical outcome. The advent of new, minimally invasive techniques has revitalized pelvic floor surgery.

38.5 Conclusion

Aging of the female population will lead to an increase in pelvic floor descensus, rectal prolapse syndromes, and related functional problems. Different surgical techniques have proven their efficacy to correct rectal prolapse and to improve rectal function. A laparoscopic approach is preferred for most other patients. From a functional point of view it seems important to avoid extensive rectal mobilization. Furthermore, laparoscopic ventral rectopexy allows the correction of a level I defect (enterocele, vaginal vault prolapse). Recent data demonstrate that this approach avoids postoperative constipation and hence may improve rectal evacuation. The reason for combining a sigmoid resection with the rectopexy procedure therefore becomes questionable. Further clinical research is needed to look into whether we can expand the indications for surgery to patients with rectal intussusception, rectocele, and obstructed defecation. Whether to resect (STARR procedure) or to suspend the prolapse will become a "hot topic" in the near future. Less efficient perineal procedures still play a role in the treatment of the frail and unfit patient suffering from rectal prolapse. In these cases, an Altemeier procedure with a levatorplasty is the procedure of choice if the prolapse is consequential.

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Self-Assessment Quiz

Question 1

Suture rectopexy with sigmoid resection is indicated in:

a. Every patient with total rectal prolapse
b. Every patient with total rectal prolapse and constipation
c. Patients with total rectal prolapse and extended diverticular disease
d. Patients with total rectal prolapse and a redundant sigmoid colon
e. Only in patients with rectal prolapse and a delayed colonic transit time

Question 2

Which of the following statements is not true?

a. Altemeier resection is better adapted than Delorme to treat larger total rectal prolapse.
b. Delormes can result in urge and urge incontinence.
c. Adding a levatorplasty in Altemeier resection can improve functional outcome.
d. The coloanal anastomosis in Altemeier resection is risky, as each low anastomosis has a substantial leak rate.
e. Perineal procedures should be mainly restricted to surgically unfit patients.

Question 3

Anismus is a possible confounder in patients with obstructed defecation (ODS). Diagnosing anismus is therefore important. Which of following statements is wrong?

a. Clinical examination has a high negative predictive value.
b. Defecometry can objectify anismus.
c. A failed balloon expulsion test demonstrates anismus.
d. A combination of different diagnostic tests will improve diagnostic accuracy.
e. Objectifying adequate strain is a prerequisite for the diagnosis of anismus.

Question 4

There is a renewed interest in a surgical approach for patients with intussusception and ODS. Which of the following statements is wrong ?

a. The stapled transanal rectal resection (STARR) procedure has been shown to be more effective than biofeedback.
b. Laparoscopic nerve-sparing rectopexy techniques seem to avoid postoperative constipation.
c. There has been an overall increase in the interest in ODS in "pelvic floor clinics."
d. The new transanal stapling techniques appear to be effective (STARR, Transtar).
e. Internal prolapse is the only cause for ODS and should be treated as such.

Question 5

Which of the following is not correct?

a. Classical transanal approaches (Sullivan – Kubchandani) only allow the resolution of a level III defect.
b. Transperineal approaches resolve level II and III defects.
c. Transtar, in contrast to STARR, also corrects a level I defect.
d. Laparoscopic ventral rectopexy corrects level I and II deficiencies.
e. STARR can be indicated if the intussusception is complicated by an enterocele, but this has to reduce at the end of straining.

1. Answer: c
   Comments: Certainly not all patients deserve an abdominal approach. Up to 70% of patients with total rectal prolapse have constipation. Outlet obstruction can be caused by the prolapse itself. All patients with a rectal prolapse have a redundant sigmoid colon. Whether a resection should be added in case of delayed colonic transit (slow colonic transit constipation, STCO) is debatable; total colectomy rather than a segmental colectomy is indicated in patients with STCO. Sigmoid resection nevertheless seems appropriate in patients with a history of diverticular disease. Certainly any mesh repair (adjacent to the diseased colon) should be avoided.
2. Answer: d
   Comments: Especially with the advent of laparoscopic approaches, the indication for a perineal approach has been merely restricted to the surgically unfit patient. From a technical point of view, a resection is more adapted than a plication for large prolapse. The Delorme and the Altemeier procedures will result in better reduction of compliance of the remaining reservoir, which in some patients can result in urge and urge incontinence. Adding a levatorplasty to the perineal resection procedure has been shown to improve postoperative incontinence. Although a low coloanal anastomosis has to be performed in the Altemeier procedure, an anastomotic leak in this setting is rare and leak rates are not comparable to the higher leak rates observed in restorative rectal resections for cancer.
3. Answer: c
   Comments: Anismus is a disturbed relaxation of the striated pelvic floor and/or external anal sphincter. Clinical examination has proven to be very accurate to rule out anismus [65]. To overcome the artifacts of the laboratory setting it has been suggested that it is best to combine different diagnostic tests [66]. According to the diagnostic criteria for function bowel disorders [67], there should be evidence of adequate expulsion force during attempted defecation to allow the diagnosis of anismus. Defecometry, in contrast to a "simple" balloon expulsion test, does demonstrate the expulsion force.
4. Answer: e
   Comments: There has certainly been a huge increase in interest in ODS in pelvic floor clinics. Different reports on the effectiveness of STARR in the treatment of ODS are promising. Also, laparoscopic nerve-sparing rectopexy has been shown to improve rectal emptying and avoid postoperative constipation. Recently, Lehur et al. [62], in a prospective multicenter study, demonstrated the superiority of STARR in comparison to biofeedback. However, in most patients, ODS has a multifactorial pathogenesis and the anatomical finding is only part of the picture. This explains the clinical difficulty of selecting patients with ODS who will benefit from a surgical approach.
5. Answer: c
   Comments: Level III defects are perineoceles and can be corrected by a transanal or transperineal approach. Level I defects (vaginal vault prolapse, enterocele) can only be corrected by a colpopexy during laparoscopic rectopexy. A STARR procedure is only indicated if the enterocele is "not fixed," to avoid any inadvertent perforation at the Douglas fold. The difference between Transtar and STARR is basically the stapling instrument that is used. STARR and Transtar procedures correct level II and III defects and resect the intussusception.

39 Anorectal Stenosis

Myles Joyce and P. Ronan O'Connell

CONTENTS

39.1 Introduction

Anorectal stenosis is a relatively uncommon problem that occurs most often as a complication of previous anorectal surgery [11]. Stenosis is clinically significant if symptomatic, due to malignancy, or if it prevents passage of a 12-mm colonoscope. Symptoms vary with the aetiology and degree of stenosis, but may include tenesmus, pain and bleeding on defaecation, faecal impaction or overflow incontinence, abdominal pain and large-bowel obstruction. The underlying cause dictates management.

39.2 Aetiology

The aetiology is usefully discussed with reference to the level of the stricture. Strictures of the anal canal and anorectal junction most commonly occur following haemorrhoidectomy, perineal trauma, anorectal sepsis, anal fistula surgery, malignancy or radiotherapy. Other unusual causes include hidradenitis suppurativa and giant condylomata acuminata (Buschke-Lowenstein tumour). A stricture arising de novo should raise suspicion of malignancy; however, the antecedent history usually indicates the cause. Symptoms from birth indicate a congenital aetiology and in the absence of atresia are most often associated with an ectopic anus with, in females, a low vaginal fistula [3].

Strictures above the anorectal junction are most commonly due to malignancy, inflammatory bowel disease or the complications of treatment for either. The incidence of anastomotic stenosis following coloanal or colorectal anastomosis varies from 3 to 30% [20]. Risk factors include preoperative radiation, tissue ischaemia, sepsis and the presence of a defunctioning stoma. Unusual causes of rectal stricture include melanoma, lymphoma and other rare malignancies, endometriosis, Crohn's disease and long-term use of rectal suppositories [1, 22].

Malignancies arising from the prostate, bladder, uterus and vagina may infiltrate the rectum. While Denonvilliers' fascia forms an effective barrier, extension of a prostate cancer may affect the rectum in 4% of cases [2]. Transcoelomic spread of tumours of the stomach, pancreas, ovary or colon may give rise to peritoneal metastases in the rectovesical or rectouterine (Douglas) pouch. The rectouterine pouch is a frequent location for endometriosis, which is often associated with a dense fibrotic reaction and stricturing of the rectum or distal sigmoid colon [16]. Sacral or presacral masses may also impinge on the posterior rectal wall and present with symptoms of rectal stenosis [7].

39.3 Clinical Presentation and Diagnosis

39.3.1 Anal Stenosis

The most common presentation of anal canal stenosis is pain and bleeding on defaecation. The symptoms are similar to those of anal fissure and the patient may have a fear of passing stool. Constipation requiring laxative use is the rule. The duration of symptoms and antecedent history give a strong indication of the diagnosis, although many patients complain that the anal opening is too tight or too narrow in the absence of any discernible stricture. In such cases, functional causes of obstructed defaecation should be sought.

The diagnosis is usually apparent on clinical examination, although formal assessment under anaesthetic may be required to distinguish stenosis from spasm associated with an acute fissure and to allow biopsy of areas suspicious for malignancy. Investigations must include appropriate endoscopy and imaging when a diagnosis of malignancy or inflammatory bowel disease is considered. Appropriate bacteriological and serological investigations should be undertaken if an infective cause is suspected.

Anal stenosis is the most difficult long-term complication of conventional haemorrhoidectomy when performed for circumferential prolapsed or thrombosed haemorrhoids. The Whitehead circumferential haemorrhoidectomy has a particularly unhappy association with post-operative anal stenosis, ectropion and entropion [26]. As much anal canal skin and mucosa as possible should be preserved at haemorrhoidectomy, with submucosal excision of haemorrhoidal tissue if required [17]. That being said, there seems little difference in long-term outcome between open (Milligan-Morgan) and closed (Ferguson) techniques with regard to stenosis.

While rare, stenosis has been described following stapled haemorrhoidectomy or procedure for prolapse and haemorrhoids (PPH). The narrowing occurs most often at the anastomotic line at or above the anorectal junction. Patients will present with pain and symptoms of obstructed defecation. The only predictive factor is severe pain in the post-operative period. Risk factors include low placement of staples to include squamous mucosa, full-thickness excision of the rectal wall and previous sclerotherapy [25].

Excessive use of diathermy in the management of anal condyloma may result in scarring and contracture, with subsequent stenosis.

39.3.2 Rectal Stenosis

Narrowing of the rectal ampulla gives rise to alteration in bowel habit, particularly urgency, frequency and fragmentation of stool due to loss of rectal compliance. It is rare for rectal stenosis, even when due to malignancy, to cause large-bowel obstruction, except for tumours of the upper third, close to the rectosigmoid junction.

Anastomotic strictures in the rectum are relatively frequent following low colorectal, coloanal or ileoanal anastomosis (Fig. 39.1). The lower the pelvic anastomosis, the greater is the potential for stenosis [13]. The problem may not present for several weeks or may become evident during reversal of a defunctioning stoma. A radiological report of an intact anastomosis prior to stoma closure does not exclude a potentially clinically significant anastomotic stricture. Digital rectal examination and rigid endoscopy is important before stoma closure.

In a patient without a defunctioning stoma, the anastomosis may feel narrow in the early post-operative period, but the passage of faeces is often sufficient to dilate the lumen. Strictures identified at the time of stoma closure are usually short (< 1 cm) and give way on digital examination or with careful passage of Hegar dilators. Some strictures may be sufficiently narrow to cause symptoms, and usually occur following post-operative pelvic sepsis, anastomotic leakage or radiotherapy. Such strictures require more definitive management [5]. Local recurrence of malignancy must be ruled out.

Radiation proctitis is an inevitable side effect of radiotherapy for pelvic malignancy. While the small bowel may be excluded from the radiation field, the rectum and bladder are fixed. Early manifestations of radiation injury include tenesmus, frequency and bleeding. Late manifestations including fistulation and stenosis may occur several years post-radiation [6].

Both ulcerative colitis and Crohn's disease may cause rectal narrowing. In ulcerative colitis the major risk factor is long-standing severe proctitis. The rectum is affected in up to 50% of patients with Crohn's disease and is typically associated with perianal disease. Long-standing strictures have an increased risk of ma-

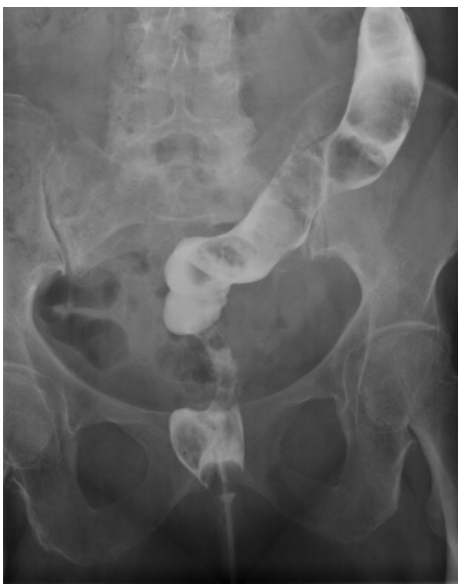

Fig. 39.1 Symptomatic rectal stricture after anterior resection

lignancy and must be biopsied as part of any treatment. Strictures in the anal canal will usually respond to minimally invasive techniques. Significant rectal strictures in Crohn's disease often require proctectomy [4]. Following ileal pouch–anal anastomosis in patients with ulcerative colitis, a cuff of inflamed rectal mucosa may be retained. This may contribute to an anastomotic stricture. The more usual cause is partial dehiscence of the anastomosis with fibrosis and scarring.

Rectal stenosis may occur secondary to the long-term use of non-steroidal anti-inflammatory drugs per rectum. Suppositories containing paracetamol and acetylsalicylic acid are particularly implicated. The potential for stenosis is correlated with the duration of treatment rather than the dose. The proposed mechanism is recurrent mucosal ulceration with fibrosis and eventual stenosis [23].

Radiological imaging plays an important role in diagnosing the nature and extent of rectal stenosis. The suspected diagnosis will dictate the order and timing of imaging modalities. Barium and gastrografin enema will determine the luminal component of the stenosis, including length, location and the presence of associated fistula (Fig. 39.2). Computed tomography and magnetic resonance imaging are beneficial in determining the mural and extra-mural components of the disease. Endoanal ultrasound is a useful adjunct but may be limited by rectal narrowing. Luminal narrowing in combination with rectal wall thickening, ulceration or polypoid growth is more characteristic of malignant than benign stenosis [24].

39.4 Treatment of Anal Stenosis

Conservative treatment of anal stenosis centres on the use of laxatives and enemas to prevent impaction and facilitate defaecation. Regular self-dilation using anal canal dilators may be of use, and in time, scar tissue in the anal canal may mature and the degree of stenosis stabilise [15]. Repeated dilation does not, however, restore elasticity, and surgical excision of the scar with or without anoplasty may be required.

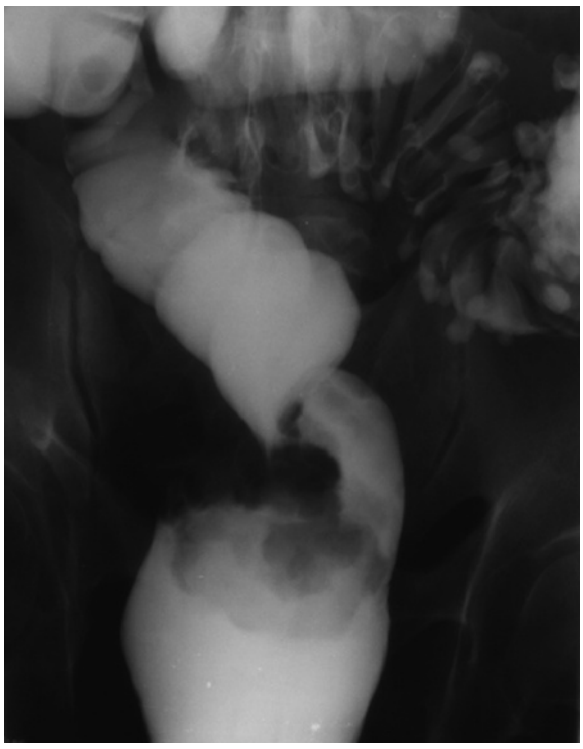

Fig. 39.2 Stricture at mid-rectal level secondary to neoplasm

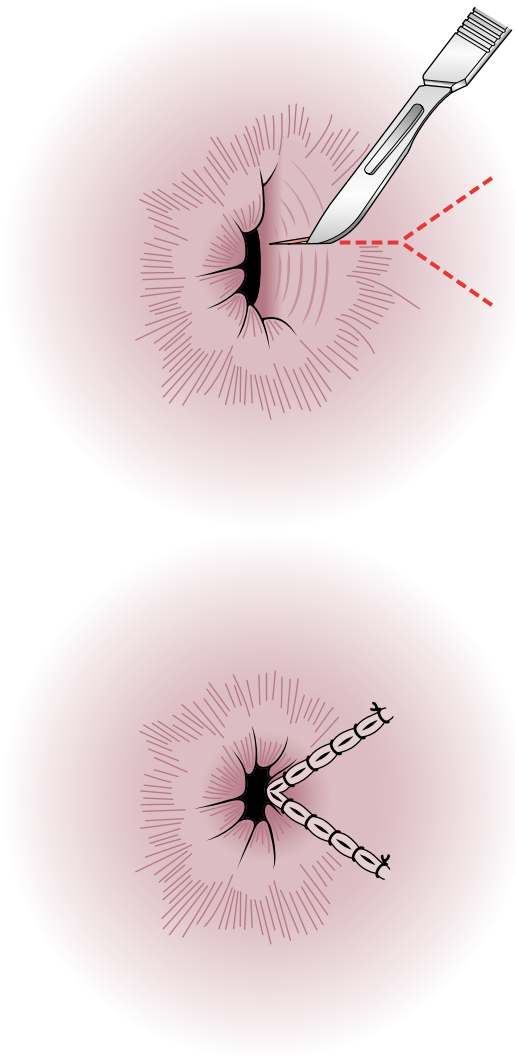

Fig. 39.3 Y-V flap

Excision of the scar is occasionally useful when adequate bridges remain and the scar is confined to one, or at most two, quadrants of the perianal skin. The technique resembles anal fistulectomy and is usually performed in conjunction with internal sphincterotomy. Healing is by secondary intention. Although there may be a recurrence, most patients are improved. Sphincterotomy may affect continence.

Anoplasty is used for more severe stenosis of the anal canal [14]. The scar in one quadrant is excised, an internal sphincterotomy is usually performed and a Y- or V-shaped flap of perianal skin and subcutaneous fat is raised (Fig. 39.3). The flap is advanced into the defect and sutured to the underlying sphincter and rectal mucosa. The lateral edges are usually undermined to reduce tension. The procedure is often repeated in the opposite quadrant.

An alternative technique is to mobilise a diamond-shaped flap of perianal skin, which is undermined as little as possible to maintain vascularity. The flap is advanced to fill the defect in the anal canal resulting from

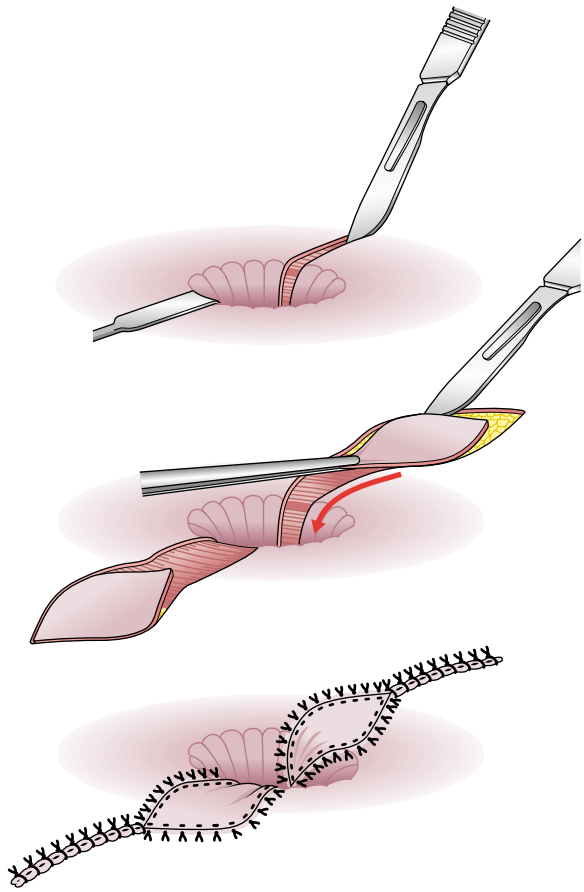

Fig. 39.4 Diamond-shaped flap

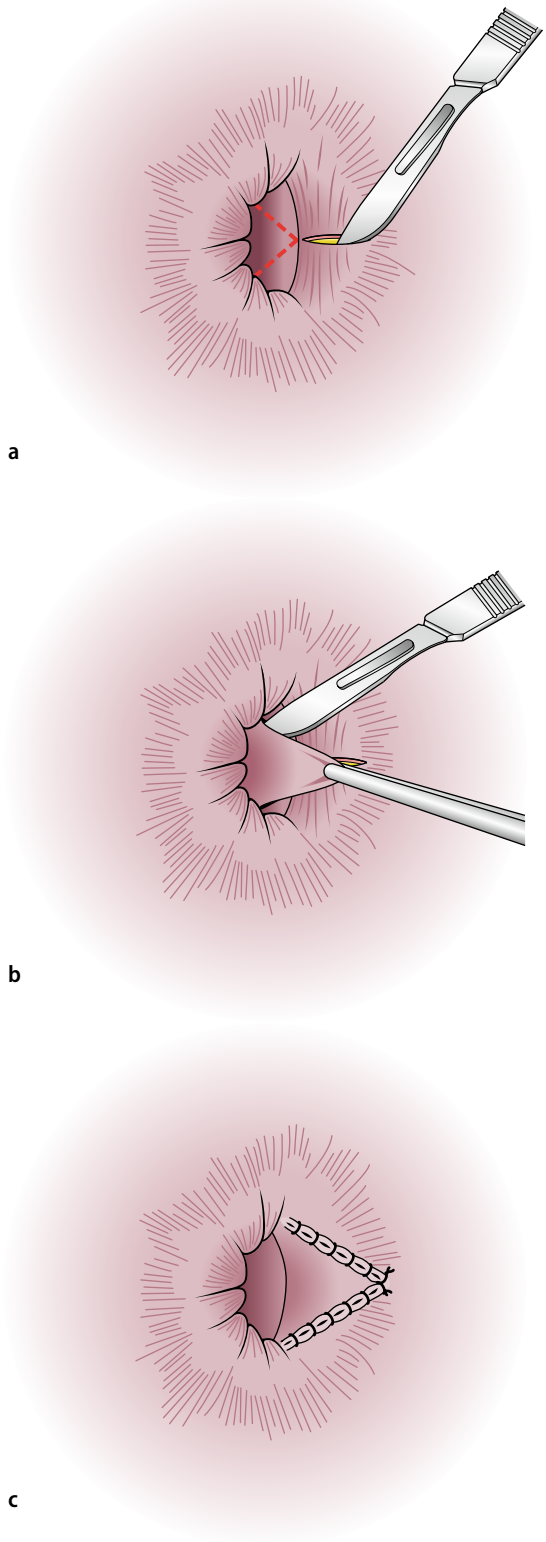

Fig. 39.5a–c Mucosal flap for stenosis

excision of the scar. The flap and donor defect are sutured (Fig. 39.4). Entropion is treated by mucosal flap advancement, but care must be taken to avoid suturing the mucosal flap below the dentate line, as an ectropion may result (Fig. 39.5).

Circumferential anal stenosis is more difficult to treat and may require bilateral rotation "S" flaps. A circular incision is made to excise all scar tissue or ectropion as far as the healthy rectal mucosa. Two or three rotation flaps are then created and rotated into the anal canal to cover the defect (Fig. 39.6). An alternative is four-quadrant sphincterotomy with perianal skin-flap advancement (Fig. 39.7). A defunctioning stoma can be appropriate in such circumstances.

The so-called Whitehead deformity is characterised by anal stenosis and ectropion formation. The Sarafoff

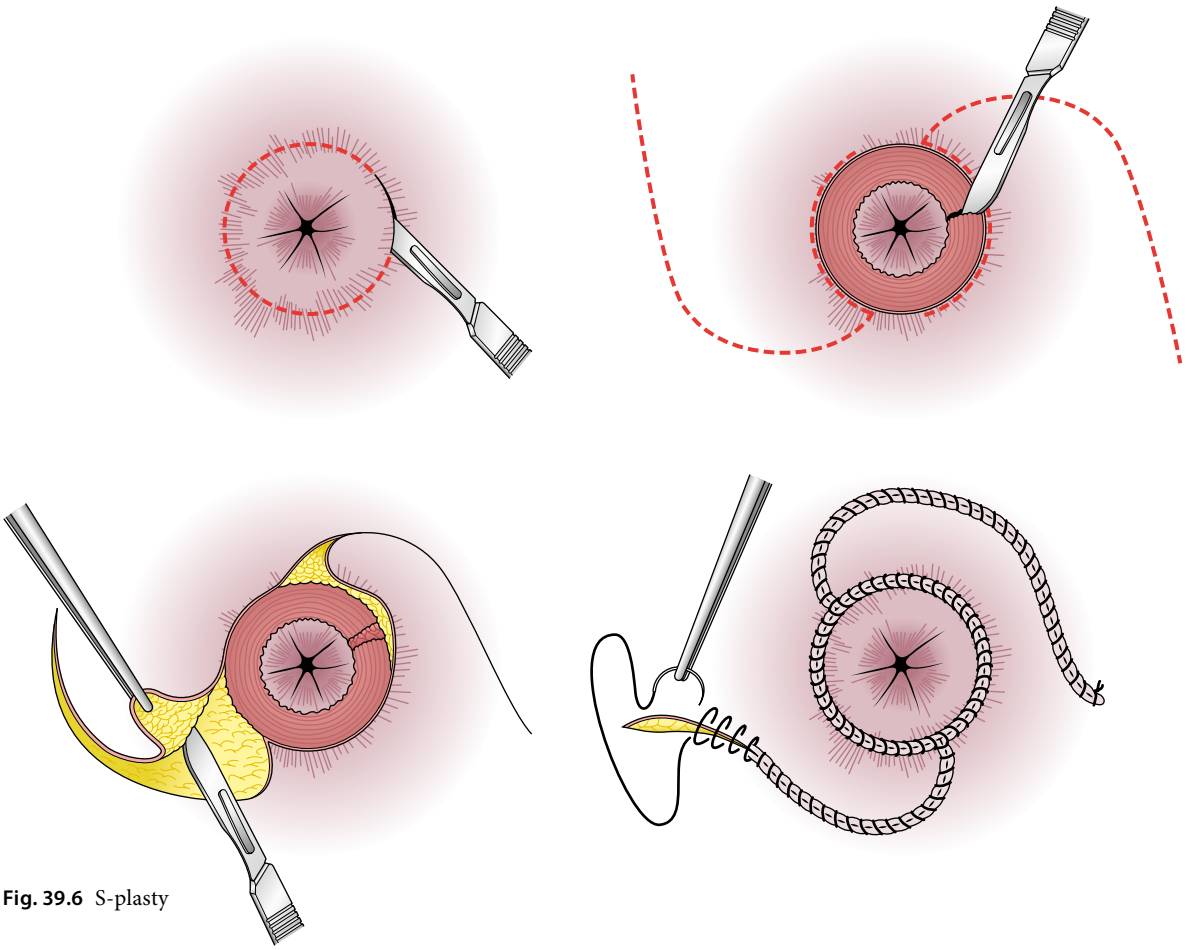

Fig. 39.6 S-plasty

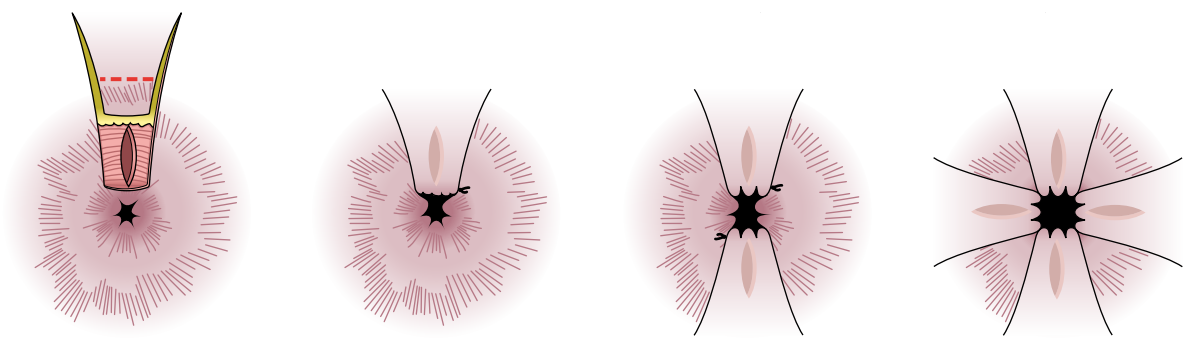

Fig. 39.7 Four-quadrant sphincterotomy with skin flaps

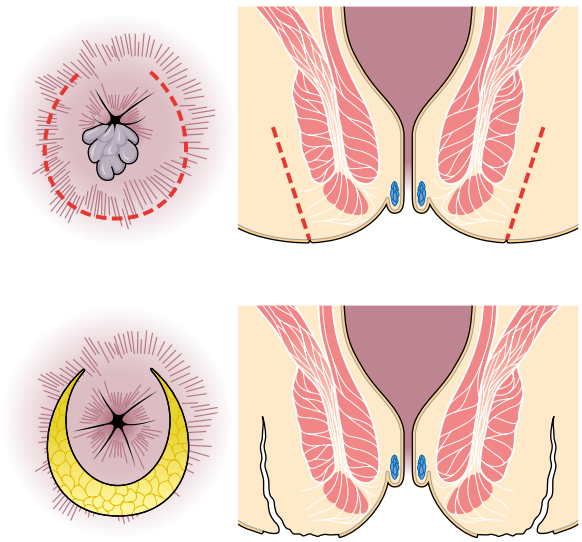

Fig. 39.8 Sarafoff procedure

procedure can be useful in overcoming the ectropion. A deep circular incision is performed 2 cm away from the anal canal and the defect allowed to heal by secondary intention over 4–6 weeks (Fig. 39.8). The ectropion disappears following retraction of the anal canal mucosa [19].

39.5 Treatment of Rectal Stenosis

If tolerated by the patient, digital dilation is the simplest technique for treating low rectal strictures. This may be supplemented in the lower rectum by use of Hegar or mitral valvotomy dilators. Endoscopic mechanical dilation is required for higher strictures and is most commonly performed with hydrostatic balloon dilation under intravenous sedation and fluoroscopic guidance [9]. Full bowel preparation is usual. Complications include localised perforation, which may be managed conservatively, bleeding, transient septicaemia and failure. Repeat dilations may be required. Lucha et al. described the use of long-acting corticosteroid injections (triamcinolone acetate 10 mg/quadrant) in combination with dilation to treat rectal strictures that are refractory to serial dilation [12].

Rectal stenosis due to malignancy is usually treated by surgical excision. A defunctioning stoma may be constructed to allow neoadjuvant therapy, if considered appropriate. A self-expanding metal stent, placed endoscopically, may be used to palliate malignant strictures or as a temporary measure to prevent obstruction prior to definitive management [21]. Stents are of more value in the sigmoid and rectosigmoid colon than the rectum, as migration of the stent occurs more frequently in the rectum.

Palliation of a malignant rectal stricture can be obtained by transanal resection of the tumour (TART). This can be achieved using a urological resectoscope; however, customised equipment for rectal tumour resection is available [10]. Even reducing the volume of the tumour by 5–10% can produce symptomatic relief. The procedure may be repeated and it is always wise to err on the side of removing too little rather than too much. An alternative to TART is neodymium:yttrium-aluminium-garnet laser photocoagulation of the tumour through a proctoscope or flexible sigmoidoscope [18].

Anastomotic or short benign strictures may be suitable for transanal strictureplasty using a standard circular stapler. The lumen must be of sufficient calibre to allow the anvil of the stapler to be passed. The stapler is then closed against the rectal wall encompassing the strictured tissue, which is resected. This procedure may be repeated on the contralateral side until the calibre is satisfactory [8]. A similar procedure may be performed using a linear stapler with stay sutures placed into the stricture, allowing the fibrotic tissue to be brought into the jaws of the stapler and resected.

Selected patients may be suitable for formal resection of the stenosed rectum with reanastomosis. Such a patient would typically have experienced pelvic sepsis with anastomotic stenosis following curative anterior resection, ileal pouch–anal anastomosis or closure of Hartman's procedure. The operation is complex and should only be performed by those with considerable experience in dealing with the problem. Mobilisation in a fibrosed, previously operated pelvis is difficult. It may prove impossible to mobilise healthy rectum below the anastomosis. In this circumstance, mucosal proctectomy and a Soave-type pull-through coloanal anastomosis is appropriate.

39.6 Conclusion

The causes of anorectal stenosis are various, but a comprehensive knowledge of pelvic anatomy will help in delineating the differential diagnoses. Anal stenosis is most commonly iatrogenic following haemorrhoidectomy. Simple measures may suffice, but moderate-to-

severe stenosis requires anoplasty. Rectal stenosis is most commonly anastomotic and the majority respond to dilation. A de novo rectal stricture or stenosis raises suspicion of malignancy and necessitates tissue diagnosis. Palliative measures include transanal resection, stenting and defunctioning stoma construction. Rectal stricturing in Crohn's disease often requires proctectomy.

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Self-Assessment Quiz

Question 1

The most common cause of a rectal stricture in the absence of preceding surgery or intervention is:

a. Crohn's disease
b. Adenocarcinoma
c. Carcinoid tumour
d. Rectal invasion by prostate cancer
e. Endometriosis

Question 2

A benign stricture in the upper rectum, less than 1 cm in length, is best managed by:

a. Surgical resection
b. Defunctioning colostomy
c. Balloon dilation
d. Self-expandable metallic stent
e. Transanal strictureplasty

Question 3

Self-expanding metallic stents have a role in:

a. Benign rectal stricture
b. Endometriosis
c. Rectal Crohn's disease
d. Non-steroidal-anti-inflammatory-drug-induced rectal stenosis
e. Palliation of rectosigmoid carcinoma

Question 4

In patients with a colorectal or coloanal anastomosis, prior to reversing the defunctioning stoma, one should perform:

a. Pelvic magnetic resonance imaging scan
b. Pelvic computed tomography scan
c. Gastrografin or barium enema
d. Imaging proximal to the stoma
e. Endoanal ultrasound

Question 5

A permanent stoma may be required when the stenosis is associated with:

a. Recurrent cancer
b. Perianal Crohn's disease
c. When the stenosis is long and irregular
d. Anorectal melanoma
e. All of the above

1. Answer: b
2. Answer: c
3. Answer: e
4. Answer: c
5. Answer: e

40 Anorectal Traumatic Injuries

Nicolas C. Buchs, Joan Robert-Yap, and Bruno Roche

CONTENTS

40.1 Introduction

Injuries of the colon and rectum are common surgical problems. They result from penetrating and blunt abdominal trauma, pelvic fractures, anal erotism, barium enema, and colorectal endoscopy.

Mortality from anorectal trauma has decreased during the past century. Knowledge acquired during wartime and applied in civilian practice has contributed to this outcome improvement. Before World War I the mortality was 90% with nonoperative management, decreasing to 67% during this war when the primary suture technique was introduced. During World War II the mortality decreased to 30% with the use of fecal diversion and presacral drainage. During the Vietnam conflict, primary repair was performed when possible along with distal rectal washout, with a mortality of 15% [1–3]. Improvement in resuscitation, quick evacuation of the wounded soldier, and widespread use of antibiotics resulted in a further decrease in mortality to less than 6% [3, 4].

Multisystem injuries are common, and these patients are best served by a multidisciplinary team that includes visceral surgeons, urologists, orthopedic surgeons, and plastic surgeons [4].

40.2 Etiology

War injuries are nowadays the result of high-velocity weapons with associated damage. In civilian practice they are the result of blunt abdominal trauma due mainly to road accidents, impalement, endoscopic injuries, sexual behavior, foreign bodies, bullfighting injuries, and gunshot lesions. Motorcycle accidents are responsible for about 20% of anorectal traumatic lesions; they result in severe perineal injuries involving the anal canal, sphincters, urogenital tract, and pelvic bone.

Thermometric ulceration is one of the most common rectal injuries, resulting in acute and massive bleeding, and is located nearly always on the anterior rectal wall.

Colorectal perforations occur in 0.1–0.42% of colonoscopic examinations, more frequently after therapeutic interventions such as polypectomy [4].

During barium enemas, the risk of a rectal injury is less than 1%, and the lesions are due to forceful insertion of the cannula or to overinflation of air. If perforation is discovered early and the examination discontinued, extravasation is reduced and the mortality is low, whereas if extravasation is extensive, the mortality may be high. The mortality rate is lower in cases of extraperitoneal perforation than after intraperitoneal perforation.

During anal sexual intercourse, multiple lesions are possible and infections may develop. Manual or fist anal intercourse may result in mucosal tears, rupture of the sphincter, and sometimes perforation of the rectosigmoid.

40.3 Diagnosis

Although details may be difficult to obtain, especially in cases of special sexual practice, a detailed history is necessary. Therapeutic or diagnostic procedures (endoscopy, biopsy, enema, or bowel preparation) should be searched in the anamnesis. Rectal injury should be suspected if there is an entry or an exit wound through the upper thigh or the lower abdomen, and in cases of pelvic fracture with penetrating or blind trauma [5]. Diagnostic evaluations include digital examination, cystourethrography, rectosigmoidoscopy, X-ray, peritoneal lavage, water-soluble contrast study, and computed tomography (CT) scan [4].

The presence of blood in the anal canal or rectosigmoid may suggest intestinal injury. Intraperitoneal perforation is usually apparent earlier than extraperitoneal perforation. However, extraperitoneal rectal injuries are more frequent than intraperitoneal ones. Abdominal X-rays are necessary to demonstrate air in the peritoneal cavity or in the retroperitoneum. A CT scan may be performed to assess the exact location of the injuries [6]. Water-soluble contrast studies may show contrast extravasation. In the absence of radiological evidence of intestinal injury, a rigid rectoscopy must be performed by the surgeon [4].

The sphincters should be assessed, especially in cases of impalement. Physical examination must be performed initially before anesthesia to determine the resting tone as well as voluntary and reflex contraction. Endoanal ultrasonography may be useful. The extent of the injury will be checked again under general anesthesia later.

The size of the lesion, the extent of soft-tissue damage, and the degree of contamination will determine the treatment strategy. If extrarectal damage is severe, as after high-speed weapon injuries, the risk of uncontrolled sepsis and bleeding is increased dramatically.

40.4 Classification

Lesions can be classified into four groups according to the site of damage and the presence of sphincter tears:

1. Intraperitoneal perforation without sphincter damage
2. Intraperitoneal perforation with sphincter damage
3. Extraperitoneal perforation without sphincter damage
4. Extraperitoneal perforation with sphincter damage

40.5 Associated Lesions

Associated lesions in cases of anorectal traumatic lesions must be searched. Blunt injuries of the rectum are associated with high morbidity and mortality rates because they are associated with injuries to the pelvic vasculature, nerves, bladder, and urethra. Complex pelvic, perineal, and gluteal injuries often result in hemodynamic shock from massive hemorrhage, and difficulty controlling blood loss from injured pelvic arteries, veins, muscles, and bony fractures [4].

The genitourinary tract must always be checked in front of a perineal wound. A swelling or a hematoma of the penis or the scrotum should alert the physician, as should cases of blood at the urethral meatus or a high-riding prostate.

40.6 Treatment

The choice of treatment depends on the following factors:

1. Whether it is an intra- or extraperitoneal lesion
2. The size and the depth of the lesion
3. The associated lesions
4. Whether or not the sphincters are intact
5. The etiology and the ballistic properties of the injury
6. The degree of fecal contamination
7. The delay between the trauma and the treatment
8. The general condition of the patient

But first of all, patients who present to the emergency room should be evaluated by Advanced Trauma Life Support (ATLS) criteria with adequacy of the airway, breathing, and circulation (ABC). Fluid resuscitation is commenced and life-threatening injuries, as determined by ABC or the ATLS criteria, should be addressed before evaluating less life-threatening anorectal injuries [7].

40.6.1 Treatment of Intraperitoneal Perforation

A laparotomy is mandatory in cases of intraperitoneal perforation, as the abdominal cavity is usually contaminated with fecal material. Preoperative broad-spectrum antibiotics are also necessary. The patient is placed in the lithotomy position, allowing simultaneous access to the rectum, the anus, and the abdominal cavity.

A simple tear may be excised and sutured. Multiple perforations or severe lacerations, as after gunshot wounds, may need a segmental resection. If contamination is severe or if the delay between injury and surgery is long, Hartmann's procedure is mandatory. The rectum must be washed out, especially in high-energy pelvic trauma, via the efferent limb of a diverting stoma combined with washout per anum [8], or just removing gross stool per anum [5].

If continuity has been restored, a total diverting colostomy should be performed to avoid any further contamination of the abdominal cavity (Fig. 40.1).

The entire cavity must be checked during the laparotomy because in penetrating trauma, the "rule of two" should be followed. Ignorance of a second perforation results in severe complication.

Drainage should be envisaged in every case through the anterior abdominal wall. If extensive mobilization of the rectum has been necessary, the presacral space should be drained through the perineum, and the drain is typically removed in 4–5 days [5].

40.6.2 Treatment of Extraperitoneal Perforation

The rectum should be washed out in every severe case [8] and drained per anum. Broad-spectrum antibiotics must be administered. Minor lesions, such as after endoscopy, can be left open for secondary granulation, as after transanal tumor excision [9], without drainage or rectal washout.

Subperitoneal tears without injury to the ischio- or pelvirectal space may be sutured through the anal canal. A colostomy is not always necessary [3]. The depth of the wound and the degree of soft-tissue contamination may be difficult to evaluate. If there is doubt about the presence or extent of a rectal injury, then fecal diversion without repair would be prudent (Fig. 40.1) [5].

A laparotomy may be required in the face of postoperative infection or pelvic hematoma, with total diverting colostomy and drainage.

In cases of severe extraperitoneal rectal lesions, an emergency laparotomy is necessary. The rectum should

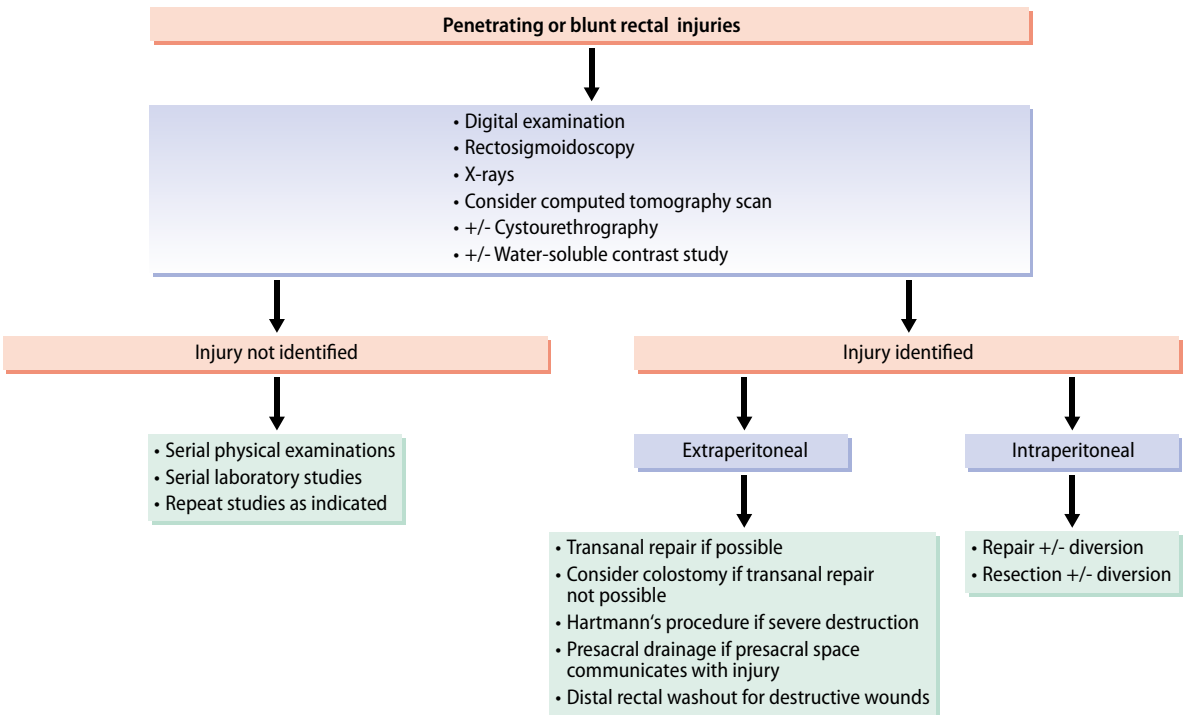

Fig. 40.1 Algorithm for the treatment of penetrating or blunt rectal injuries (modified from Cleary et al. [4]). *CT* Computed tomography

be fully mobilized and the lesion repaired. A proximal left-end colostomy is established. Severe devitalizing injuries of the rectum may require an extended low anterior resection [4] or a Hartmann's procedure.

Continuity can be restored after the rectal wounds have healed and the inflammation has resolved (2–3 months). Sphincter function should be assessed first (e.g., digital examination, endoanal ultrasonography, manometry) [4]. However, for some selected patients with a contrast enema that appears normal at 10 days, thus confirming healing of rectal wounds, early colostomy reversal had been done with good results [10].

40.6.3 Treatment of Perineal Injuries and Sphincter Lesions

Perineal injuries may occur in association with penetrating and blunt pelvic lesions. Life-threatening injuries should be addressed first, including laparotomy for hemorrhagic solid organ and major arterial injuries, and hollow viscous lesions [4].

Disruptive sphincter injuries associated with other injuries may not be amenable to immediate repair and may require fecal diversion [4].

Most perineal injuries involving the anal sphincter mechanism warrant debridement of all devitalized tissue to viable tissue with bright red bleeding, broad-spectrum antibiotic coverage, and irrigation of wounds that are then left open with delay in definitive repair [6, 11].

Soft-tissue coverage of extensive wounds can be considered when life-threatening injuries are stabilized, hemodynamic stability is assured, and wounds are clearly clean and granulating [6].

Endoanal ultrasonography may be performed before repair in those in whom the nature and the degree of the injury are not clear. Anal manometry and pudendal nerve motor terminal latency may be helpful in assessing sphincter muscle and pudendal nerve function before colostomy closure [4].

Anal sphincter injuries (Table 40.1) not associated with other injuries, especially those caused by sexual practice or abuse, may be repaired primarily without fecal diversion [4].

Significantly, anal sphincter muscle lesions are probably best treated by fecal diversion, especially if there are associated injuries and if incontinence is likely with subsequent contamination of perineal wounds [4].

Very disruptive injuries with significant tissue loss may not be amenable to repair. Some of these patients may be candidates for sacral nerve stimulation, stimulated gracilis or gluteus muscle transposition, or an artificial sphincter [4, 11, 12], with a risk of mucosal erosion.

After repair of the sphincter, biofeedback and physiotherapy should be proposed to all patients.

40.6.4 Treatment of Associated Lesions

Patients with significant associated pelvic or perineal injuries should be diverted [13, 14] because of the risk of sepsis. Severe bleeding and sepsis may occur in cases of pelvic fractures with injury of the rectum. A pelvic strap belt is a good way of providing temporary hemodynamic stabilization [15]. External fixation, like pelvic clamp, for unstable pelvic fracture takes precedence over the repair of anal lesions [4], thus minimizing blood loss. The rectum should be repaired if possible using an intraluminal approach, and a colostomy must be performed, with a clearing of the rectum through a sigmoidoscope. Severe perianal laceration and pelvic fractures can induce massive and uncontrollable bleed-

Table 40.1 Treatment of anal sphincter injury (modified from Cleary et al. [4])

Presentation	Treatment
No associated injuries No delay in treatment	Primary repair
Significantly associated injuries Minor sphincter injury	Delayed repair
Significantly associated injuries Major sphincter injury	Fecal diversion followed by delayed repair
No significant associated injuries Delayed presentation (inflammation and edema)	Fecal diversion followed by delayed repair

ing. Arterial embolization can be effective [16, 17], and if it is not successful, an emergency abdominoperineal excision may be necessary to control the bleeding by packing [18, 19].

Injuries to the genitourinary tract may require a suprapubic catheter [6], especially in the case of blood at urethral meatus. A urethroplasty is feasible at a second stage. Trauma of the penis or the testis necessitates a first-stage revision with debridement and closure if possible, with skin graft at a second stage.

40.6.5 Treatment in Special Cases

Some colonoscopic burn injuries can be managed conservatively without operation. When surgery is required for diffuse peritonitis on examination or failure of conservative management, primary repair is often possible [4].

Colorectal perforation may result from the anal insertion of foreign bodies (see Chap. 41 for management).

40.7 Conclusion

Anorectal trauma is seen frequently in emergency room. Although before 1914 the associated prognosis was very poor, knowledge acquired during wartime and applied in civilian practice has contributed to an improvement in outcome. The patient should be managed initially according to ATLS principles. After addressing life-threatening injuries and fluid resuscitation, attention should be directed to other injuries, including other hollow, viscous lesions. For the patient with intraperitoneal rectal perforation, a laparotomy remains mandatory, sometimes associated with a colostomy. In cases of extraperitoneal perforations, a transanal repair may be performed, if possible. Decisions regarding fecal diversion, presacral drainage, and distal rectal washout are based on whether the injury is amenable to repair by a transanal approach, how destructive the injury is, and whether it communicates with the presacral space [4].

Because of the multisystem injuries that are commonly seen in cases of perineal trauma, these patients are the best served by a multidisciplinary team. Great attention should be paid to hypothetical associated lesions, which carry a high rate of morbidity and mortality.

Anal sphincter lesions should be repaired primarily if there is not a significant delay with inflammation and edema and if there are no significant associated lesions that need a fecal diversion.

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Self-Assessment Quiz

Question 1

In the management of intraperitoneal perforation, what is the incorrect answer?

a. A laparotomy is necessary.
b. A Hartmann's procedure must always be performed.
c. A diverting colostomy should be considered.
d. A small lesion can be only sutured or excised.
e. Drainage should be considered in each case.

Question 2

In cases of anorectal lesions associated with a pelvic fracture, what is the correct answer?

a. The initial treatment concerns the anorectal repair.
b. A colostomy should not be done because of the risk of sepsis.
c. An arterial embolization is one of the treatments of choice for uncontrollable bleeding.
d. The pelvic strap belt is the definitive treatment for pelvic bleeding.
e. The rectum should not be washout in cases of pelvic fracture.

Question 3

Concerning sphincter damage, what is the incorrect answer?

a. Endoanal ultrasonography, anal manometry, and pudendal nerve motor terminal latency may be helpful in assessing sphincter muscle before repair.
b. Primary repair should not be done in the presence of a delayed sphincter lesion.
c. Physiotherapy is very important after sphincter repair.
d. Debridement of all devitalized tissue is mandatory.
e. Fecal diversion must be considered for all sphincter damage.

Question 4

What is the difference between extraperitoneal and intraperitoneal perforation?

a. Extraperitoneal perforation is usually apparent earlier than intraperitoneal perforation.
b. Intraperitoneal perforation is more frequent than extraperitoneal perforation.
c. Computed tomography scan may be necessary to assess the location of the perforation.
d. Thermometric ulceration is usually located above the rectosigmoid junction.
e. The treatment for extraperitoneal and intraperitoneal peritoneal is the same.

Question 5

For the treatment of extraperitoneal lesions, the following answers are true, except:

a. Minor lesions can be left open for secondary granulation.
b. Laparotomy is necessary for severe rectal lesions.
c. Diverting colostomy should be envisaged for cases with extended rectal injury.
d. Sphincter function should always be checked after restoration of continuity.
e. A transanal suture can be attempted for selected cases with subperitoneal tears.

1. Answer: b
2. Answer: c
3. Answer: e
4. Answer: c
5. Answer: d

41 Colorectal Foreign Bodies

Nicolas C. Buchs, Joan Robert-Yap, and Bruno Roche

CONTENTS

41.1 Introduction

Colorectal foreign bodies can result from a variety of etiologies, the most common being insertion of foreign objects into the anus and rectum, which is a well-described phenomenon and can no longer be considered rare [1]. Lesions due to ingested bodies, however, are not common, and even rarer are migrations from the peritoneum, which have been reported on occasion.

Management involves the safe retrieval of the offending object. It is essential to exclude associated colorectal injuries, which if left undetected may be lethal. Extraction can be difficult due to the size, shape, and migration of the foreign body [1]. Furthermore, the patient's imagination must be surpassed by the physician's ingeniousness to withdraw the various offending foreign bodies. Indeed, even in experienced hands, the treatment of patients with retained colorectal foreign bodies can be challenging [2].

41.2 Ingested Foreign Bodies

Ingested foreign bodies that occur in natural food, such as pips, thorns, seeds, and soft bones, are normally totally digested by the time they reach the lower intestinal tract. However, chicken and rabbit bones, toothpicks, shells, pieces of glass, plastic, and metallic clips used in food wrapping can pass through the intestinal tract without being digested and may cause rectal or anal injury. Infants, children, or mentally handicapped adults may ingest foreign bodies of various sizes and forms such as batteries, forks, toys, knives, keys, nails, screws, and spoons. Pieces of denture are among the most dangerous foreign bodies, as they can easily perforate the bowel. Narcotics wrapped in condoms have been swallowed to avoid detection by customs authorities and may result in acute obstruction or acute toxicity if absorption occurs after rupture [3]. Even prosthesis displacements (duodenal stents, for example) have been known to cause rectal obstruction, if only rarely [4]. The clinical signs include rectorrhagia, mucosal tears, abscesses, bowel perforation, and sometimes death [5, 6].

Seventy-five percent of perforations occur at the level of the ileocecal valve and appendix [6], but swallowed objects may lodge in the rectum or in the anal canal and cause traumas such as lacerations, abscesses, or Fournier's gangrene [7].

For the surgeon, the key point is to decide whether it is better to wait for the foreign body to pass or to perform an endoscopy to remove it within the first hours after ingestion. Even large objects can be spontaneously eliminated. Transanal extraction under sedation or general anesthesia is sometimes necessary [5]. Surgery is required only in 1% of cases. Anorectoscopic removal may be necessary if the foreign body is impacted in the rectal wall or creates symptoms of obstruction.

41.3 Migration from the Peritoneum

In rare cases of gallbladder rupture, gallstones may be eliminated through the rectum. The peritoneal extremity of ventriculoperitoneal shunts has been spontaneously extruded through the rectum [8]. Furthermore, a forgotten vaginal pessary may erode the vaginal wall and create a rectovaginal fistula. A vaginal pessary has been reported to be retrieved from the rectum [9].

Migration from the peritoneum is extremely rare, and management of these cases is similar to that for an introduced foreign body. However, the origin of the foreign body should be clarified and sometimes surgery is necessary.

41.4 Introduced Foreign Bodies

A very large variety of objects can pass through the rectum. Injury can result from the introduction itself, decubital lesions, penetration of the bowel wall, perforation, and impaction when lost inside the rectum. The list of foreign bodies that have been introduced into the rectum is very long [10–12]:

1. For sexual stimulation and autoeroticism [10, 12–14] (mainly in men) [1]: vibrators, plastic phalluses and sticks, bottles, baby powder cans, batteries, flashlights, light bulbs, baseballs, cucumbers, bananas, carrots, grapefruits, oranges, stones, and screwdrivers. Cases of manual anal intercourse resulting in mucosal lacerations or even perforation of the rectosigmoid have been reported [15].
2. During diagnostic and therapeutic procedures: thermometers, rectal tubes, enema tips and irrigation catheters.
3. To self-treat and to alleviate symptoms of anorectal diseases: broomstick handles to relieve itching or to reduce prolapsed hemorrhoids.
4. In criminal assaults or to avoid detection by prison authorities [1]: sticks, glass bottles, tips of air compressors or bicycles pumps, and knives.

Accidental introduction with loss inside the rectum is very rare. The delay prior to seeking assistance is wide: from hours to 55 days [1, 2]. The reasons given are often vague, but a detailed history asking specifically about rectal insertion is essential in all patients presenting with atypical rectal symptoms [1, 5, 16]. Even if no foreign body is found, atonic anal sphincters, as well as bloody or mucoid rectal discharge, should alert the clinician [5].

41.4.1 Treatment

Extraction may be difficult for several reasons:

1. The foreign body is large in size [1].
2. The foreign body has a smooth surface that is difficult to grasp.
3. The foreign body is friable or hard and unyielding.
4. Vision may be obscured by mucus and blood.
5. The rectal mucosa may be edematous and bulging.
6. Negative pressure above the foreign body may hold it by suction and interfere with the traction [17].
7. The curve of the sacrum tends to hold the lower end away from the anus.
8. The anal sphincter may be in spasm.
9. The foreign body lies too high [2].

The following principles should be observed whenever possible:

1. A digital rectal examination should allow the emergency physician to confirm the presence of a foreign body. Low-lying foreign bodies are distal to the rectosigmoid junction, whilst high-lying foreign bodies lie above it [1]. An atonic anal sphincter may be a clue for the physician [14].
2. Abdominal and pelvic plain and lateral radiographs should be performed to determine the type, number, size, and location of foreign bodies and to exclude signs of peritoneal perforation [1, 14]. The abdominal radiograph will demonstrate a radio-opaque foreign body (Fig. 41.1); however, vegetables and rubber objects may not be visible [1].
3. Extraction should always be tried with the patient in the lithotomy position to allow simultaneous access to the anorectum and the abdomen [1]. If surgery is mandatory, the same position is necessary.

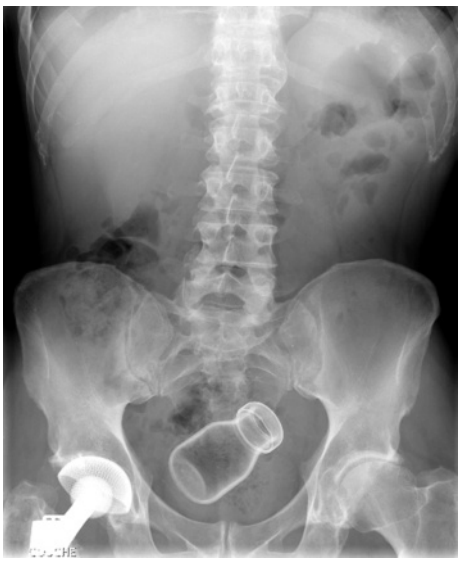

Fig. 41.1 A plain pelvic X-ray showing a bottle in the rectum, which had been inserted several hours earlier by a man for sexual stimulation

4. Local, locoregional, or even general anesthesia may be required to ensure sphincter relaxation or dilatation. Sphincterotomy is rarely necessary [1].
5. The anal canal should be lubricated. Air should be inflated within the rectum through catheters or sigmoidoscopes to minimize the effect of suction or negative pressure created above the foreign body by withdrawal [17, 18].
6. Maneuvers for extraction should be very gentle to avoid worsening the lesions [14].

Numerous techniques for extraction exist:

1. Colonoscopic or sigmoidoscopic extraction [1, 19], taking care to avoid pushing the foreign body proximally
2. Use of clamps and forceps, even obstetrical forceps [1, 18], or using a delivery vacuum extractor [20]
3. A corkscrew to remove a rubber ball or a corn cob
4. Slings of mesh placed around the foreign body or stuck to it with superglue [1]
5. A Foley catheter inserted above the object to pull it down and out, or through a rigid sigmoidoscope [21]
6. Insertion of a Sengstaken-Blakemore tube within a hollow object [22]
7. Using a magnet for metallic objects [22]
8. Filling a hollow object with plaster of Paris and gauze: when the plaster sets, extraction is facilitated by the gauze [1, 13]
9. Using the transsphincteric approach [23]

Laparotomy should be used only as the last resort after failure of transanal manipulations [1, 2, 12, 13]. Intra-abdominal manipulation should help the perineal surgeon without opening the colon. Recently, laparoscopically assisted removal of a foreign body was reported to be useful in especially difficult cases [24]. In cases of active rectal bleeding caused by a foreign body, it may be challenging to locate and control the hemorrhage with endoscopy. Arterial embolization could be an alternative, as reported recently [25].

Colostomy should be used only when necessary. In cases of perforation or tears, defunctioning colostomy or a Hartmann's procedure may be required [1, 5, 16, 18].

After extraction, a rectosigmoidoscopy must be performed in each case to ensure that there are no mucosal tears [2, 5, 14, 16]. Psychological assessment and support must be offered in all cases [1]. A hospital stay of at least 24 h should be organized to rule out bleeding or delayed perforation [16]. Figure 41.2 shows an algorithm for the management of colorectal foreign bodies.

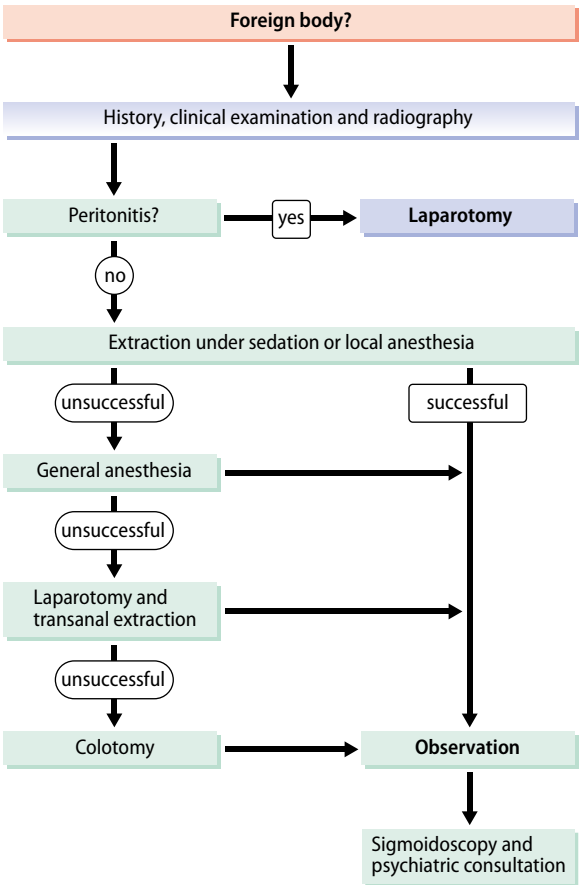

Fig. 41.2 Algorithm proposed for the management of colorectal foreign bodies

41.5 Conclusion

The insertion of foreign objects into the anus and rectum is a well-described phenomenon and can no longer be considered rare. Foreign bodies entering the colorectum through migration from the peritoneum are very rare; however, ingested and introduced foreign bodies present themselves relatively frequently in emergency rooms and surgeons must be familiar with the management of this pathology. The treatment, even in experienced hands, can be challenging. An extraction under sedation is recommended, and if it is not possible, a general anesthesia must be performed. Transanal extraction is preferred in all cases, except if a colonic perforation is suspected; a Hartmann's procedure may be necessary in these conditions. After the extraction, it is essential to exclude associated colorectal injuries, which if undetected may be lethal.

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Self-Assessment Quiz

Question 1

In the diagnosis of a colorectal foreign body, what is the correct answer?

a. A plain X-ray must always be done, because all foreign objects can be seen.
b. An atonic sphincter is suspicious of a retained foreign body.
c. The initial physical examination should always be done under sedation.
d. The history is always clear.
e. Pain is the principal symptom observed.

Question 2

In the treatment of a colorectal foreign body, what is the incorrect answer?

a. In all cases, an exploratory laparotomy is necessary to rule out any colonic perforation.
b. Hartmann's procedure is reserved for colonic perforation.
c. An endoscopy must be performed after the extraction to ensure that there are no mucosal tears.
d. Sphincterotomy is rarely necessary.
e. Laparoscopically assisted removal is an alternative in the treatment of colorectal foreign bodies.

Question 3

Extraction may be difficult because:

a. The anal sphincter may be atonic.
b. The curve of the sacrum tends to hold the higher end away from the anus.
c. Negative pressure under the foreign body may hold it by suction.
d. The rectal mucosa may be edematous and bulging.
e. Vision may be obscured by stool.

Question 4

Several complications exist after removal of a colorectal foreign body, except:

a. Hemorrhage
b. Colonic perforation
c. Dyspareunia
d. Anal incontinence
e. Mucosal lesions

Question 5

Which of the following does not belong to the usual follow-up after removal of a colorectal foreign body?

a. Sigmoidoscopy
b. Proposition of a psychiatric consultation
c. Barium enema
d. Blood count
e. Clinical follow-up for 24 h

1. Answer: b
2. Answer: a
3. Answer: d
4. Answer: c
5. Answer: c

42 Abdominal Catastrophes and Intestinal Failure

Antje Teubner and Iain D. Anderson

CONTENTS

42.1 Introduction

Defining an abdominal catastrophe is difficult, but the nature of colorectal surgery means that we encounter them regularly. Many relate to emergency surgery, anastomotic leakage or re-operative surgery, and most involve abdominal sepsis. Many will involve multiple organ failure, re-operation, bowel loss or damage, an open abdomen, multiple stomas or fistulae, nutritional dependence and prolonged debility. While simple cases may be readily managed, severe, complex and prolonged cases are not uncommon and pose greater challenges and a significant risk of death. Over the last 25 years, our institution has acted as a national referral centre for complex cases from around the UK and from Europe, and managed well over 1,000 cases. With experience, we have established principles of successful management, which will be discussed herein.

Intestinal failure (IF) can be defined as a reduction of the amount of functioning gut beneath that necessary to maintain nutrition or fluid balance. This happens commonly after emergency colorectal surgery, but usually resolves very quickly. In a few cases, this state continues for weeks or months because of complications or a short gut. The surgical team must then manage the complications or disease causing the IF and seek to resolve them, but they must also manage the associated problems, which commonly include ongoing sepsis, nutritional and fluid problems, high-output stomas or fistulae and complex abdominal wounds.

In this chapter we will consider the causes, assessment and management of abdominal sepsis in colorectal surgery, the management of the complex case with organ failure and the management of intestinal fistulae and IF.

42.2 Causes of Abdominal Catastrophes and IF

Colorectal surgery carries high risks; for example, the risk of death after elective anterior resection is greater than after coronary bypass grafting, and the likelihood of complications is at least 30%. Emergency surgery is generally associated with risks 5–10 times greater than the elective counterpart. Not surprisingly, many abdominal catastrophes follow emergency admission or operation: bowel infarction, massive resection, pancreatitis, complicated diverticulitis, even neglected appendicitis to name but a few. Organ failure, prolonged recovery or death is not unexpected in these circumstances, but is devastating after elective surgery that goes wrong. Medical comorbidity or bleeding can lead to unexpected catastrophe, but the commonest problem remains anastomotic leakage. Any anastomosis can (and does) leak, but the left-sided colocolic or colorectal anastomosis comes under most suspicion. In general terms, the nearer the anastomosis lies to the pelvic floor, the greater the risk. Many surgeons defunction low anastomoses with a loop ileostomy, either selectively or routinely. This does not prevent leakage, but it does significantly diminish the consequences.

By following appropriate principles, the colorectal surgeon can often manage the catastrophic event, such as severe diverticulitis, anastomotic leakage or

intra-abdominal abscess, satisfactorily. Our experience shows that it is at least as common for a sequence of events rather than a single one to lead to a true catastrophe culminating in death or IF. The precise factors and sequence differ in each case, but there are common features that merit discussion (Table 42.1). Once post-operative surgical sepsis occurs, there is typically a delayed, inadequate or inappropriate attempt to deal with it, not infrequently on more than one occasion. Some surgeons are reluctant to exteriorise a leaking bowel, or further problems with nutrition or sepsis can precipitate too early an attempt to re-anastomose the bowel. Each operation becomes more challenging and the patient's physiological reserve dwindles in the face of continuing sepsis. The issues are neatly summarised by a study of Crohn's patients with IF: two-thirds developed IF as a result of catastrophe rather than as a result of multiple resections [1].

Thus, while abdominal catastrophes and IF do occur more commonly among patients with complex Crohn's disease, radiation enteritis or multiple previous operations, operative factors contribute in a high proportion of cases. This in turn means that abdominal catastrophes can and do occur after almost any laparotomy.

Table 42.1 Factors contributing to abdominal catastrophe

Failure or delay in identifying occurrence of sepsis
Unsuccessful first salvage operation
Unrecognised enterotomies
Failure to control sepsis
Inexperienced surgeon operates/re-operates
Failure to exteriorise bowel ends
Multiple unsuccessful re-operations
Inappropriate anastomosis: septic, malnourished, persisting distal obstruction
Too early corrective surgery
Failure to anticipate difficulty
Problems with management of open abdomen
Problems with enteral nutrition (intolerance, tube leakage or blockage, abscess)
Problems with parenteral nutrition (line infection, blockage, jaundice),
Problems with stomas, tubes and drains (leakage, erosion)
Pressure from patient or family (to re-operate too quickly)
Surgeons desire to correct problems quickly
Expertise of hospital exceeded

42.3 Presentation and Resuscitation

Most catastrophes present with acute deterioration on the surgical unit: rapid diagnosis and adequate resuscitation is essential. Patients with abdominal sepsis who deteriorate to the point where they have established septic shock by the time they reach an intensive care unit (ICU) have at least a three-fold greater mortality than those who are managed at an earlier stage. If unexpected complications are to be diagnosed early and managed effectively, then junior surgeons must be trained to assess and manage post-operative patients systematically. The Royal College of Surgeons of England has a training course and manual for this: Care of the Critically Ill Surgical Patient Course [2]. Another import aspect of care is the communication of risk to the on-call team. Informing them about unfit patients and those who have had more risky procedures will enable a heightened index of suspicion and thus possibly an earlier diagnosis.

Sepsis can present in many ways and surgical patients can suffer a wide range of complications, both medical and surgical; hence, the importance of a systematic method of assessment that incorporates early resuscitation. A rapid immediate assessment of the airway, breathing and circulation will usually be accompanied by administration of high-flow oxygen and an intravenous fluid challenge. Any obvious bleeding should be controlled and basic monitoring commenced. A few unstable patients will need rapid transfer to a critical-care area or the operating room, but most will respond sufficiently for a detailed assessment to be undertaken, the aim of which is to identify and treat the underlying cause of deterioration as quickly as possible. A wide initial range of potential differential diagnoses should be considered, in part depending on the presenting features. In general, however, complications can be predicted from the underlying disease process, the operation undergone and the presence of comorbid illnesses.

Personally examining the patient and reviewing the case notes and available blood, microbiology and radiology results in detail is fundamental. With complex patients, particularly those on the ICU or who have had multiple previous operations in another hospital, note review will take some time. It is essential that the senior surgeon creates time to do this, as further intervention will be compromised if the previous procedures and current state are not clearly understood. With complex and critically ill patients, a team approach is essential: different members can resuscitate and arrange transfer

or investigations while others consider the strategic surgical issues.

The severity of physiological derangement associated with sepsis is an important factor in determining outcome, and therefore the urgency and magnitude of treatment that the surgeon will want to carry out. With a relatively well patient, there may be time for conservative management or detailed investigation, whereas with a patient succumbing rapidly with multiple organ failure, the surgeon has a single opportunity to salvage the patient. The spectrum of severity of sepsis can be defined (Table 42.2). This is useful not only for audit or research, but also in clinical practice as a marker of severity, urgency and prognosis.

Systemic inflammatory response syndrome (SIRS) is the earliest defined state in which there are markers of systemic inflammation. Sepsis is defined as being present when a source of infection is confirmed. The next level of severity is where there is associated organ dysfunction. This is known as severe sepsis (when a source of infection is confirmed) or sepsis syndrome (when a source has not been defined). Although there are precise numerical values that define organ dysfunction, in clinical practice the presence of clinical signs of organ dysfunction (e. g. hypoxia, confusion, coagulopathy, hypotension) will suffice.

Importantly, the stage beyond organ dysfunction is organ failure, which still carries a mortality of at least 25%, rising with the number of failed organs. The importance of SIRS, particularly when persistent in the face of treatment, is thus that it is an early marker of impending severe illness, the onset of which can be sudden. Treatment at an early stage is much more effective.

As the response to initial resuscitation becomes clear during the 1st h or so, the need for further investigation will also likely become clear. While many diagnoses are possible and while other sources of sepsis (urine, chest, intravenous lines most commonly) are common, further abdominal investigation will often be needed to confirm or exclude signs of abdominal sepsis. Occasional patients may be so unwell or will have such a clear indication for surgery that further imaging will not be indicated, but in most patients, a computed tomography (CT) scan, preferably with both intravenous and oral or rectal contrast, will help. The CT scan can not only confirm or refute diagnosis, but can also help to identify parts of the abdomen that may not require exploration. In a difficult and adherent repeat operation, this can reduce the risk of collateral visceral damage. Single collections can be drained radiologically, the urgency depending on the severity of sepsis. Specialised radiologists can place larger drains and even drain more than one collection. Double drains permit subsequent flushing of any cavity.

42.4 Deciding to Operate

Patients with generalised peritonitis, multiple collections or dead tissue, or who fail to respond to percutaneous drainage need a laparotomy if they are to survive. The timing of the most recent operation will influence the ease of a further procedure and hence the

Table 42.2 Definitions of sepsis severity. *WCC* White cell count, *CVS* cardiovascular system, *CNS* central nervous system, *GCS* Glasgow Coma Scale, *SVR* systemic vascular resistance, P_aO_2 arterial oxygen tension, F_iO_2 fraction of inspired oxygen

Systemic inflammatory response syndrome (SIRS)	Two of: • Pyrexia (> 38°C) or hypothermia (< 36°C) • Tachycardia (> 90 beats/min in the absence of beta blocker) • Tachypnoea (> 20 breaths/min or a requirement for mechanical ventilation) • WCC (> 12,000 or < 4,000) Sepsis = SIRS + documented source of infection
Severe sepsis	SIRS + altered organ perfusion or evidence of dysfunction of one or more organs. Almost any organ or system can be involved. For example: • CVS: lactate >1.2 mmol/1 or SVR < 800 dyne/s/cm^3 • Respiratory: P_aO_2/F_iO_2 < 30 kPa or P_aO_2 <9.3 kPa • Renal: urine output <120mls over 4 hrs • CNS: GCS 15 in the absence of sedation/neurological lesion
Septic shock	Refractory hypotension in addition to the above, in the presence of invasive infection. This is almost always part of multiple organ failure.

risk of future complications. Within 3 days or so, further surgery will usually be relatively straightforward, but beyond this stage, adhesions will make surgery increasingly difficult and pose greater risks of bowel damage in particular. This potential difficulty may influence the decision in a borderline case. However, in a patient with abdominal sepsis, it is essential that the underlying cause (or source) of sepsis is dealt with by some means, and the sicker the patient, the less time the surgeon has to achieve this aim.

In many cases there may not be a clear indication for surgery at a particular time; in this situation, the surgeon has to weigh up the risks on either side. These include the likelihood of each possible diagnosis and the risks of delaying treatment of each. For example, a patient with possible intra-abdominal sepsis might also have signs of pneumonia. On the one hand, neglecting intra-abdominal pathology will be deleterious, yet carrying out a non-therapeutic laparotomy in a patient with pneumonia will likely result, at best, in prolonged ventilation. Reaching the right decision not only requires senior assessment and careful consideration of the most likely cause, but also other possible causes and the likelihood of each. This, in turn, requires a detailed knowledge of the complications of any recent operation and of any comorbid conditions that the patient may have. In each individual case, the risks of surgical activity and inactivity will vary, but if there is significant abdominal sepsis, then adequate definitive treatment will be needed.

42.5 Patients in ICU

Many of these considerations also apply to patients with organ failure in the ICU. The surgeon may have to assess his own patients or, when on call for emergencies, patients previously unknown to him. Both can cause difficulties. With a patient on whom he has previously operated, the surgeon has the advantage of knowing precisely how straightforward or hazardous the first procedure was. Conversely, surgeons can sometimes find it difficult to be as objective about the diagnosis or management of surgical complications in their own patients as in others.

When another surgeon's patient is referred from ICU, the surgeon may be presented with a complex and seriously ill patient whom he does not know and in whom he is being asked to undertake a risky procedure. In these cases, the surgeon must again be sure to satisfy himself that the diagnosis is secure and that surgery is the best course of action. After making his own assessment, the surgeon and intensivist should discuss the case in detail together before recommending a jointly agreed plan to the patient or their relatives.

Table 42.3 Signs of deterioration in patients in the intensive care unit

Increase in inspired oxygen requirements
Increase in ventilation requirements
Increased fluid requirements
Reduced cardiac function
Vasodilatation
Increased inotrope dependence
Need for renal replacement/haemofiltration
Coagulopathy
Thrombocytopaenia
Acidosis
High lactate level

The sedated patient may not show typical abdominal signs, although occasionally a dramatic finding such as enteric content in the drain may be found. The diagnosis usually rests on clinical suspicion plus evidence of deterioration in vital functions (Table 42.3).

Once organ failure is present, the need to eradicate abdominal sepsis becomes paramount. Patients with surgical abdominal sepsis and organ failure do not survive if the source is not dealt with adequately and promptly. Immediate resuscitation and correction of coagulopathy are essential, but often the general condition will not improve until the sepsis is drained. Deferring surgery in the hope of an improvement in the patient's condition is often the wrong approach: these patients are sometimes described as being too sick **not** to have an operation.

42.6 Operating on the Abdominal Catastrophe

Having made a decision to operate in the light of the risks and often with aid of preoperative CT scanning, the surgical team will approach the operating table with a clear provisional plan. That plan may well be changed in the light of operative findings, but the surgeon should be cautious about subjecting an ill patient to a long and complex procedure. If reconstruction failed under ideal circumstances, why should it succeed in an ill patient? In a patient who already has incipient or established organ failure in particular, the simplest and safest procedure will be best. This usually means

draining sepsis, debriding any necrotic tissue and exteriorising any leaking bowel or anastomoses as stomas.

Even with the recent trends towards resection and primary anastomosis in diverticulitis, most surgeons still opt for a Hartmann's procedure in a patient with faecal peritonitis and septic shock. The same considerations apply with the abdominal catastrophe, typically from a leaked anastomosis. In a well patient who is diagnosed early and has a stable circulation, a small leak and minimal contamination, preservation of a repaired anastomosis with proximal defunctioning may be appropriate; however, it is often foolhardy in the critically ill. Preserving the anastomosis might work, but there is a significant risk of further peritonitis. Since that patient has already had two operations, it then becomes unlikely that they will survive further sepsis and organ failure. The difficulty of diagnosing further peritonitis in a patient with established organ failure other than at a late stage compounds the problem.

In a multiply operated septic abdomen, other strategies may be needed. It may not be possible to take down and exteriorise the prime source of sepsis because of dense adhesions. If the sepsis is primarily pelvic, then it may be possible to identify and exteriorise a proximal loop of jejunum without entering and damaging the matted pelvic loops. This should ameliorate the sepsis, but will likely result in a high-output stoma and create the need for prolonged intravenous feeding. A third option is simply to drain locules of pus or enteric content and then to leave the abdomen open (laparostomy): with time, any leaking bowel will usually find its way to the surface, allowing the sepsis to resolve.

Not infrequently, creating a stoma in the ideal site is not possible. Avoiding damage to the stoma from excessive tension is important, and making a large stoma wound can help. An oedematous bowel may refuse to evert, and leaving an un-everted tube spout can be acceptable. Sometimes all that can be achieved is to tack the stoma to the edge of a laparostomy. A final option is to intubate the bowel within the abdomen with a large Foley catheter – perhaps most effective when the fourth part of the duodenum needs exteriorisation – although the wound will stenose if the catheter is removed.

Circumstances not infrequently influence the operation. Incomplete operations lead to continuing problems, but sometimes the ideal full laparotomy to ensure that no collections are overlooked may have to be curtailed, either because the patient is too unwell or because the risks of further dissection causing bowel damage are too great. In curtailing a procedure, the reassurance of a preoperative CT scan is invaluable. However, in deciding not to dissect a difficult area, the surgeon should be aware that adhesions are often most dense around areas of sepsis.

In severe situations, a policy of damage-control surgery can be adopted. The critically ill patient will be acidotic, hypothermic and coagulopathic – or will rapidly become so. Prolonged surgery in this circumstance will often be fatal and it can be better to make an active decision to quickly drain pus, remove dead tissue, stop bleeding by packing and staple closed a leaking bowel (without resection) before terminating the operation. The patient is then resuscitated on ICU for 24–36 h before returning for more definitive surgery.

When recovery of gut function is likely to be prolonged, the placement of a gastrostomy tube can be worthwhile. It can be used initially for drainage then for enteral feeding without the discomfort of prolonged nasogastric intubation. Similar considerations can apply to jejunostomy tubes, and sometimes both can be helpful, for example when a duodenal fistula is present. However, each tube carries a small risk of leakage, which brings its own problems.

Drains have their advocates and opponents, but certainly have a role in some cases. When further leakage is likely (e. g. duodenal or pancreatic leaks) or when a deep cavity exists (e. g. psoas abscess), the placement of a drain will initially help control sepsis and in time will create a track. Sizeable (24-Ch) tube or sump drains are effective. However, drains of any size will not usually protect adequately from further colorectal leakage.

It will occasionally be necessary to pack an area, usually the pelvis, to obtain haemostasis. Especially when the patient is shocked and coagulopathic, a point will be reached where further attempts at control only do more harm. Packs should generally be removed as early as possible once clotting is restored, and usually the next day. After this, the small bowel will become adherent and more likely to be damaged by removal of the packs. Packs should be removed cautiously under direct vision.

Closing the septic abdomen requires some thought. Avoiding tension is always important. Ideally, the fascia should be closed in the usual way with a mass closure, but not with tension sutures. Leaving the skin open in a septic abdomen is often recommended to reduce the frequency of wound infection. However, oedema, bowel distension, bleeding or packing can all make closure difficult and increase the intra-abdominal pressure. This can result in abdominal compartment syndrome, where the abdominal pressure prevents normal venous return and normal ventilation, amongst other

effects. This syndrome is increasingly recognised in patients with organ failure and can require later decompression.

When the abdomen is difficult to close, several options exist. Our preference in abdominal sepsis is to close each end primarily (fascia and then skin) and leave the centre of the wound open, covering it with an absorbable mesh (e. g. Vicryl), which is sutured to the fascia. Placement of a non-absorbable permanent mesh at this stage can result in fistulation, which is extremely difficult to manage subsequently. When a source of sepsis cannot be exteriorised and the abdomen is intentionally left open as a laparostomy, we would again favour the placement of a Vicryl mesh, as this restrains the viscera, is easier to manage and may reduce the rate of secondary enteric fistulation. Occasionally, in a severely contaminated abdomen, placing the mesh may be deferred for several days while further washouts are carried out. When the abdomen is left open in some form, the exposed bowel must be dressed carefully to minimise further trauma from dressing changes. Gauze will control bleeding but will adhere rapidly and must be removed carefully and within 24 h. If further lavage is planned, a non-adherent silastic sheet can be used to cover the bowel, as can a Bogota bag – a 3-l sterile intravenous fluid bag emptied and cut open and used as a temporary abdominal cover.

42.6.1 Post-operative Care on ICU

Most patients suffering an abdominal catastrophe will be managed on the ICU after their further surgery. For the patient to recover optimally, continued daily surgical input will be needed. Nutritional needs may be altered by sepsis (where delivering a greater proportion of calories as fat is beneficial), but also by intestinal anatomy. Short bowel, insecure anastomoses, a fistula or a suboptimally sited stoma can all be pointers towards parenteral feeding, to prevent recurrent abdominal sepsis, to facilitate wound and stoma care or to ensure nutritional intake. Tube gastrostomies or jejunostomies may need to be used for drainage for a while before feeding through them becomes appropriate as the drainage reduces. Each case is different and direct guidance from the operating surgeon is important.

The surgeon will need to advise on wound management, particularly when the abdomen has been left open as a laparostomy. Even without fistulation, the laparostomy will initially produce large volumes of fluid. If this is purulent, then copious daily saline lavage of the exposed bowel loops may be carried out. The wound can be covered with the largest fistula bag. Many wounds are too big for this, in which case a sandwich dressing is useful, preventing bowel adherence but providing a simple and reliable method. The sandwich dressing begins with a sheet of semipermeable transparent dressing placed sticky-side up (non-adherent side on the bowel). Then moist gauze rolls and pads are placed. Finally, the dressing is retained with a larger sheet of semipermeable transparent dressing placed sticky-side down to hold the rest in place. This dressing needs to be changed daily. It can be placed on top of a Vicryl mesh or bowel loops. If there is copious effluent of serum or bowel contents, then low-grade suction catheters can be placed at the dependent corners of the wound. This is simply to collect effluent and help keep the dressing on. We avoid suction with healthy granulating laparostomies because in our experience it predisposes to fistulation. With sepsis eradicated and nutrition in place, a laparostomy will granulate remarkably rapidly.

Recurrent sepsis remains a threat in the critically ill, and the surgeon will frequently be asked to re-evaluate such complex patients. Although the underlying principles remain unchanged (identify the source and deal with it as quickly, simply and securely as possible), there are certain issues of debate. Given that recurrent abdominal sepsis can be difficult to diagnose promptly and that it carries a high mortality, there was a fashion some years ago for carrying out planned relaparotomy on a 24- to 48-hourly basis. This was eventually shown to cause more harm than good in most cases and was largely discounted. Planned relaparotomy is necessary after damage-control surgery (to complete the operation) and is still of value in ischaemic bowel (at 48–72 h to reassess the progression of ischaemia). Otherwise, it is still used in isolated cases to re-inspect or re-lavage specific areas of concern.

The process now used is termed "laparotomy on demand". Deciding to re-operate requires careful assessment of both the problem and the prognosis. In ICU patients, the likelihood of eradicating sepsis diminishes with each operation, and with it the chance of survival [3]. Patient age is also a key determinant of survival, hence the importance of creating as safe an abdomen as possible at the first operation for catastrophe, as described earlier. If a further operation for sepsis is needed, the aforementioned approaches apply, but with greater emphasis on appropriate defunctioning and a greater likelihood of an open abdomen resulting. The appropriateness of subjecting an elderly patient to several months with a laparostomy, more months perhaps with a high-output stoma and nutritional dependency before another major reconstructive procedure needs

to be considered before advising further operations on the elderly patient with recurrent sepsis.

Sepsis can occasionally recur behind a granulating laparostomy. An anterior approach would be impossible and the options lie between radiological drainage and a retroperitoneal or flank approach. Laparostomies occasionally bleed significantly from the granulating wound or a stoma edge. Anticoagulation often plays a part. Pressure, topical haemostatic gauze and suturing may all be needed.

There are numerous other possible surgical complications. For example, stomas or gastrostomies may retract or leak intra-abdominally or interparietally, causing sepsis or necrotising fasciitis. If re-siting is unsafe or impossible, then laying the wound open, lavaging daily, aspirating effluent and reducing bowel effluent may help. New leaks or fistulae may develop in the exposed bowel or within the abdomen. The bowel may herniate through a laparostomy even with a mesh in place. New Vicryl mesh can help and care will be needed in dressing the exposed loops.

42.6.2 Post-operative Fistulae

Intestinal fistulae cause particular problems in the management of the abdominal catastrophe: nutrition, wound care, recurrent sepsis and prolonged hospitalisation are all typical accompaniments of post-operative fistulation. There are many types and causes of intestinal fistulae, but we will restrict our consideration here to the more commonly seen post-operative ones and general principles of their management. Primary fistulae related to Crohn's, diverticular and other fistulising diseases, and upper gastrointestinal fistulae are beyond the scope of this chapter.

While post-operative fistulae can occur as a result of the small bowel being trapped in the abdominal closure in a straightforward laparotomy, many of the conditions that predispose to fistulation occur in re-operations for abdominal sepsis or obstruction (Table 42.4).

Table 42.4 Factors predisposing to post-operative intestinal fistulae

Inadvertent enterotomy or serotomy
Intestinal anastomosis in unfavourable conditions
Unrelieved distal intestinal obstruction
Subsequent obstruction from adherence to an abscess cavity or phlegmon
Open abdomen

Avoiding fistulation depends on adequate but judicious surgery, especially in terms of repairing or creating a new anastomosis under unfavourable circumstances. Once a fistula is identified, the first priority is to deal with any associated sepsis, as discussed earlier in this chapter. A full clinical assessment and early CT scanning would be the norm, with further drainage or surgery as indicated. Initial wound sepsis associated with a new fistula will usually resolve rapidly once free drainage is established. Most experienced fistula surgeons would advocate fasting the patient initially and resort to total parenteral nutrition (TPN). This limits the effluent and is helpful for four reasons:

1. Initial wound management is easier for the patient and the nursing staff.
2. Control of local sepsis will be facilitated.
3. Adequate nutritional intake is more certain.
4. The scene is set for spontaneous closure, if that is possible.

Fistulae are termed low output (< 500 ml/24 h) or high output. Low-output fistulae will usually have little effect on fluid and nutritional status, but higher-output fistulae will impair nutritional or fluid balance or both, and replacement will be needed. TPN brings its own risks; the risk of line sepsis can be minimised by using a dedicated line solely for feeding. The advice of a nutrition team is also very useful.

The factors that discourage spontaneous fistula closure include distal obstruction, an associated abscess cavity, mucocutaneous continuity and the presence of an underlying bowel disease or a complex fistula involving more than two epithelial surfaces. Reducing fistula output with constipating drugs is often helpful but does risk constipation. In the presence of an open abdomen, mucocutaneous continuity occurs readily, and effectively prevents fistula closure.

If sepsis can be treated and nutrition maintained, the commonest type of wound fistula, where there is a side hole in the bowel, stands a reasonable chance of closing spontaneously within a few weeks. However, once a fistula has been present for 6 weeks, closure is less likely and it may be better to accept this and permit the patient oral nutrition. Contrast studies of the entire gastrointestinal tract will be needed to delineate the anatomical picture accurately.

Surgical repair is best delayed until the patient is well nourished, sepsis-free and psychologically ready for further major surgery. Another important consideration is allowing the peritoneal cavity to recover and become less hostile. This takes several months, and we do not usually advocate further surgery (unless forced

to operate for sepsis) until at least 6 months has elapsed from the last laparotomy. A detailed account of reparative fistula surgery is beyond the scope of this chapter, but the surgeon must be aware of previous operative and pathological findings, have a detailed picture of current anatomy and anticipate difficulty. If multiple anastomoses are required then a staged approach with a proximal defunctioning jejunostomy can be safer.

It can often be difficult to decide whether to resect a further modest portion of small intestine or carry out a further anastomosis. This decision must be taken as part of the overall operative strategy. Where the extra length will likely make a significant difference, then the surgeon will have a pointer. Measuring the length of small bowel remaining is a useful discipline. With less than 100 cm of small bowel, long-term nutritional support becomes likely. When the colon is also absent, the length of small bowel needed for nutritional independence will more often be nearer 150 cm. If there is intrinsic bowel disease then a greater length is generally required. When these critical points are being approached, the surgeon should preserve all the small-bowel length he reasonably can. Even if the patient ends up on long-term parenteral feeding, the social impact of feeding three nights each week is considerably less than a requirement to feed nightly. Preserving a modest length of bowel can make a difference.

Closure of the abdomen is difficult, especially when a previous central defect has healed secondarily, and several techniques are described. Separating the components of the abdominal wall is an important first step, and further tissue width can be gained by unfolding the rectus sheaths or making a lateral releasing incision. Using a double near-and-far suture technique helps close the rectus sheath, but often a residual central defect remains. We avoid permanent mesh placement (e. g. polypropylene or collagen) at the same time as anastomoses are made, as leakage will be catastrophic. We favour placement of an absorbable mesh (e. g. Vicryl). An incisional hernia will develop in two-thirds of these patients, but if necessary this can be dealt with definitively some months later.

42.6.3 Chronic IF

While patients are waiting for reparative fistula surgery, when they elect not to undergo more surgery or when they are left with a short-bowel syndrome, they effectively enter a state of chronic IF. Three types of IF are described:

1. Many surgical patients need TPN or enteral nutrition (EN) when perioperative or in the ICU for a limited period of time (days/weeks), before recovering.
2. After complicated major surgery with resection, surgical sepsis, fistulation or obstruction, support will typically be needed for weeks or months.
3. As sepsis subsides and a steady state is entered, some require long-term support, depending on the length and type of bowel remaining and functioning. The intestine adapts with time and the need for support often diminishes.

Chronic IF can be permanent, but patients can live active, good-quality lives, work, and raise families on self-administered home parenteral nutrition. This potential outcome should be borne in mind when deciding whether or not to resect an extensive intestinal infarction, although clearly, the patient's age, wishes and general condition must also be considered.

The IF patient may need all or part of their nutrition to be delivered artificially, depending on their anatomy. Safe TPN is the cornerstone of a successful IF service, although with special dietetic support many patients can adapt to specialised EN. At least as many patients can nourish themselves but cannot maintain fluid balance; these patients require parenteral fluids and often magnesium supplementation. Whether with a short bowel or a high-output proximal stoma, the fluid losses can be restricted by suppressing gastric acid production and by slowing intestinal function with codeine and loperamide. As the patient stabilises and as wounds and fistulae become more easily managed, the likelihood of them tolerating and being nourished effectively by EN becomes greater. If the patient has a proximal stoma or established fistula with an intact distal intestine, then the distal gut can be used for enteral feeding. Establishing this technique requires a skilled stoma therapist and dietetic support, but with a distal bowel length of greater than 75 cm, perhaps 75% of patients can have their parenteral requirements either significantly reduced or removed [4].

42.7 Conclusion

Unfortunately, abdominal catastrophes are an integral part of colorectal surgery. Some can be prevented or minimised by planning complex elective procedures carefully and by considering the role of defunctioning, especially when circumstances are less than ideal.

When things do go wrong, having a mechanism with which to diagnose problems and begin effective management rapidly is important. This will involve assessment by senior surgeons. With critically ill patients, the best (and sometimes only) opportunity for effective salvage is at the first re-operation, where defunctioning and exteriorisation are a cornerstone of management. Surgeons need to remain involved with care on the ICU, as recurrent problems are frequent. It is usually unwise to plan reconstructive surgery until the patient is not just stable, but also well, and preferably 6 or more months on from their previous laparotomy. Almost all units see cases beyond the expertise of their surgeons or their particular hospital; discussing or referring these on is good practice.

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Self-Assessment Quiz

Question 1

An abdominal catastrophe such as open abdomen with multiple small bowel fistulae is:

a. More commonly seen after elective than emergency surgery
b. Usually the result of a single adverse event in the clinical course
c. Only seen with rare and unmanageable underlying disease processes
d. Caused by most surgeons during their working life
e. Associated with an average 30-day mortality greater than 75%

Question 2

A 73-year-old patient develops generalised faecal peritonitis due to a leaking colorectal anastomosis 4 days after high anterior resection. In the anaesthetic room she has a temperature of 35°C, thrombocytopaenia, renal impairment and is inotrope-dependent. Do you:

a. Defer surgery until tomorrow for further resuscitation
b. Take down the anastomosis and exteriorise the bowel ends
c. Repair or refashion the anastomosis
d. Washout obvious collections then leave the abdomen open
e. Repair or refashion the anastomosis and create a proximal stoma

Question 3

A patient from the intensive care unit (ICU) with abdominal sepsis and multiple organ failure is undergoing a third laparotomy in 8 days and you are about to close the abdomen. With full muscle relaxation, the abdominal wall still seems too tight for the oedematous bowel. Modern options *do not* include:

a. The placement of double polypropylene tension sutures
b. The placement of an absorbable mesh
c. The use of a Bogota bag
d. The placement of a temporary non-adherent (silastic) sheet
e. Packing the abdomen open

Question 4

During your duty weekend, you are asked to assess a colleague's patient on ICU for possible abdominal sepsis. The patient had a Hartmann's procedure for perforated diverticulitis 6 days ago but remains septic and has organ failure (ventilated, inotropes, haemofilter). The stoma is healthy but non-functional. Regarding further investigation and treatment, which statement is true?

a. Clinical assessment of the abdomen for signs of peritonitis is usually of value.
b. The inotrope dose and recent changes in ventilatory support are of value to the surgeon in identifying deterioration in overall condition.
c. A negative abdominal ultrasound scan is sufficient to reasonably exclude sepsis.
d. A contrast-enhanced computed tomography (CT) scan is no longer the optimal investigation.
e. A second-look laparotomy at day 2 would have prevented the situation arising and remains good practice for all patients with severe abdominal sepsis.

Question 5

A patient develops a jejunal fistula in an open abdomen. The fistula is seen to come from a failed anastomosis 100 cm below the duodenojejunal flexure. Regarding the fistula, which statement is true?

a. The patient will not need total parenteral nutrition (TPN) at this stage.
b. The patient will not be able to eat until reparative surgery is carried out.
c. Reparative surgery should be carried out in the next month.
d. The fistula has a fair chance of healing spontaneously.
e. The first management step is to exclude abdominal sepsis.

1. Answer: d
   Comments: Abdominal catastrophes are more common after emergency surgery and usually occur in typical surgical patients with common conditions but in whom a series of mishaps have occurred. Most surgeons will have to manage one during their life and with simple, safe management principles, an acceptable mortality rate is within reach.
2. Answer: b
   Comments: This patient has multiple organ dysfunction or failure and now has more limited capacity for recovery than before. If the bowel is repaired rather than exteriorised, then the risk of further bowel leakage is considerable. A further operation will then carry a high mortality and little chance of technical success – an abdominal catastrophe is likely if the patient survives. So in this already compromised patient, the time for salvage is now and the best way to achieve this is to exteriorise the ends and retreat to fight another day. If the patient has had reasonable resuscitation, then deferring surgery would likely only lead to further deterioration, although this needs to be a joint decision depending on what further improvement can be achieved. Hopefully, an open abdomen would not be needed, as it carries its own problems, and eradicating the source of sepsis (by exteriorisation in this case) is a fundamental principle.
3. Answer: a
   Comments: Pulling the oedematous wall together with greater force with tension sutures will probably cause harm. The abdomen will be too tight and an abdominal compartment syndrome may result: this can impair respiration, and cardiovascular and renal function. The tight sutures may well cause tissue necrosis locally and put the patient at risk of necrotising infection as well as wound failure. With an infected abdomen in an unstable patient, any of the rapid temporary means of closure indicated above (b–e) can be appropriate depending on the individual circumstances (degree of oedema, chronicity, contamination, likelihood of re-operation). Placement of a permanent mesh is not advised at this stage, as infection or bowel fistulation in conjunction with it will be a disaster.
4. Answer: b
   Comments: ICU patients with organ failure show deterioration through the need for changing degrees of support (inotropes, ventilation), acidosis, coagulopathy, hypoalbuminaemia or renal failure. These features plus clinical suspicion about the abdomen and a lack of evidence for other sources of sepsis (chest, urine, lines, fungi) indicate the need for further intervention. A contrast-enhanced CT scan remains the optimal investigation. Clinical abdominal assessment is necessary but often adds little in the ventilated patient with recent surgery. A negative abdominal ultrasound scan has too high a false-negative rate to reasonably exclude sepsis. Routine second-look laparotomy carries a higher mortality rate than laparotomy on demand and is no longer widely practised.
5. Answer: e
   Comments: The first and vital step when fistulation occurs is to identify and deal with any abdominal sepsis. This sets the scene for stabilisation and recovery. A fistula at 100 cm will need TPN at least initially, and probably for several weeks at least. A few patients might cope with this length of time, as adaptation occurs, but most will not. Fistulae in open abdomens almost never heal, as mucocutaneous continuity rapidly occurs. This does have the advantage of making it safe for the patient to eat at a relatively early point. Reconstructive surgery should preferably be delayed until the abdomen has become less hostile, usually at about 6 months. Earlier surgery has a higher failure rate, sometimes with catastrophic consequences.

Section IV Specialist Conditions

43 Paediatric Colorectal Surgery

Blaise J. Meyrat

CONTENTS

43.1 Introduction

Many of the colorectal conditions encountered in children are the same as those found in the adults. The focus of this chapter is thus pathologies found specifically in childhood, which include acquired as well as congenital disorders.

43.2 Polypoid Diseases

Polyps are common in childhood and occur in approximately 1% of preschool- and school-aged children. Because of this incidence, they represent the most frequent cause of gastrointestinal (GI) bleeding in toddlers and preschoolers [1, 2]. They are classified according to histological type into hamartomas (juvenile polyps and Peutz-Jeghers polyps) and adenomas (familial adenomatous polyposis, FAP). A third type of polyp, the hyperplastic polyp, is now gaining increased

recognition. They are usually encountered in patients over the age of 40 years and may be a precursor for colorectal carcinoma [3].

43.2.1 Juvenile Polyps

The most commonly used classification is based on the studies of Jass and Sachatello [4, 5]:

I. Isolated juvenile polyps:
   a. Fewer than five.
   b. Confined to the colon.
   c. No family history.

II. Juvenile polyposis syndromes:
   a. Juvenile polyposis in infancy: widespread polyposis of the entire GI tract in children younger than 6 months.
   b. Generalised juvenile polyposis: multiple polyps throughout the GI tract, mostly in the stomach, the distal colon and the rectum in children aged between 6 months and 5 years.
   c. Juvenile polyposis coli: polyps of the distal colon and rectum in children aged between 5 and 15 years.

43.2.1.1 Isolated Juvenile Polyps

Isolated juvenile polyps are also known as retention, inflammatory or cystic polyps. They represent 80% of polyps found in childhood. Solitary juvenile polyps are not considered as precancerous lesions [6]. Grossly, they range in size from 2 mm to several centimetres, and have a glistening, smooth, spherical reddish head (Figs. 43.1 and 43.2). They are often ulcerated on their surface (resulting in bleeding) and their stalk is covered with colonic mucosa.

Microscopically, they are hamartomas in colonic tissue, arranged in a haphazard manner (Fig. 43.3). The surface of the polyp is covered with a single layer of colonic epithelium that is sometimes ulcerated or replaced with granulation tissue. When inflammation occurs, the epithelium may show a reactive hyperplasia that can mimic dysplasia or adenomatous changes.

Isolated juvenile polyps are found in about 1% of all preschool children; 40% are found in the rectum and the sigmoid colon and 60% are evenly distributed in the proximal colon. They are rarely seen after adolescence. The clinical presentation is rectal bleeding (93%), abdominal pain (10%) and rectal prolapse (4%). The diagnosis is based on the history, rectal digital examination, sigmoidoscopy, colonoscopy and air-contrast barium

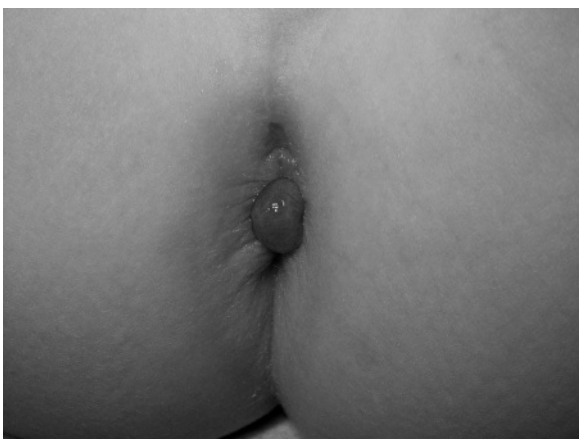

Fig. 43.2 Anus with a prolapsing juvenile polyp. Compare with Fig. 43.47

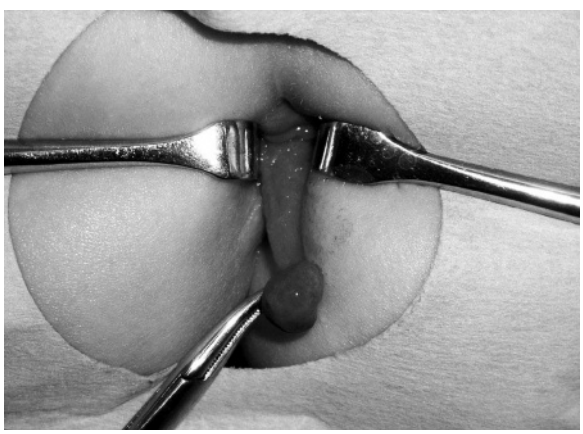

Fig. 43.1 Rectal juvenile polyp with an attached stalk

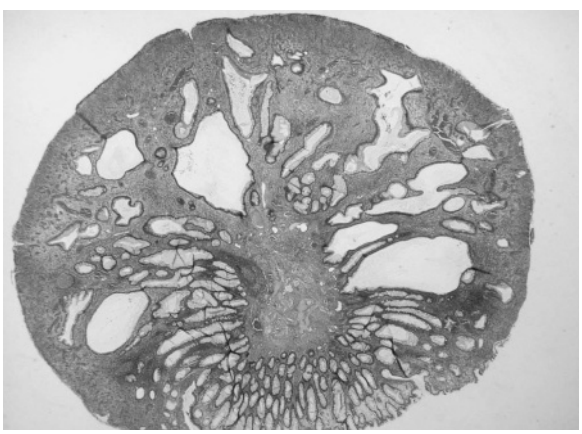

Fig. 43.3 Photomicrograph of a juvenile polyp

enema. The treatment includes removal of the polyps found in the distal colon and rectum.

As multiple juvenile polyps are associated with a higher risk of colon neoplasia, finding a polyp in the rectum does not obviate the need for a pancolonoscopy. The entire colon should be surveyed for the presence of more than five polyps, which could lead to the diagnosis of juvenile polyposis syndrome.

43.2.1.2 Juvenile Polyposis Syndromes

Juvenile polyposis syndrome is an autosomal dominant condition with incomplete penetrance. Two specific gene changes causing disruption of transforming growth factor β have been identified: *SMAD4* and *BMPR1A* [7].

Juvenile Polyposis in Infancy

This condition is seen in the first months of life and is not accompanied by a familial history of polyposis. Diarrhoea, rectal bleeding, intussusception, protein-losing enteropathy, macrocephaly, clubbing of fingers and hypotonia are the most common signs of clinical presentation. Most commonly the entire GI tract is involved.

Generalised Juvenile Polyposis

The disease is encountered is children aged from 6 months to 5 years. The main clinical presentations are diarrhoea, mild rectal bleeding, intussusception and rectal prolapse. For this age group, it is important to distinguish juvenile polyposis from FAP. Polyps are found throughout the bowel, mostly in the stomach, the distal colon and the rectum. The treatment comprises endoscopic resection of the polyps, but may require segmental bowel resections and may need recurrent therapy.

Juvenile Polyposis Coli

This condition is occurs in children between 5 and 15 years of age. The disorder is characterised by rectal bleeding, anaemia and rectal prolapse. The polyps are limited to the distal colon and the rectum. About 50% of patients have a familial history, indicating an autosomal-dominant pattern of inheritance. Associated defects like cleft palate, malrotation and polydactyly have been described.

43.2.1.3 Pathology

Children with five or more polyps, polyps throughout the GI tract or even one polyp with a familial history should be considered to have a juvenile polyposis syndrome. This implies a long-term surveillance of the patient because of the high risk of carcinoma occurring at an early age [8]. The gross appearance of polyps in juvenile polyposis is the same as that for isolated juvenile polyps, but they may present as a multilobular mass resembling a cluster of polyps attached to a stalk. Microscopically, these polyps show more epithelium with a villous or a papillary configuration. Epithelial dysplasia may occur in juvenile polyps and in coexisting adenomas found in conjunction with juvenile polyps. Severe dysplasia, which may be carcinoma in situ, have been seen in juvenile polyps associated with juvenile polyposis syndrome. Lobular polyps have a higher propensity for severe dysplasia than non-lobular polyps.

43.2.2 Peutz-Jeghers Syndrome

43.2.2.1 Pathology

Peutz-Jeghers syndrome is characterised by multiple gastrointestinal hamartomatous polyps and is usually accompanied by melanotic spots ranging in colour from brown to black, occurring on the lips, around the mouth and on the buccal mucosa (Fig. 43.4). They can also be found on the hands, feet, nasal mucosa, conjunctivae and in the rectum. They are usually present in infancy and fade at puberty. Polyps may be found throughout the GI tract from the stomach to the rectum, although they occur most frequently in the small intestine (55%), the stomach (30%) and the rectum (15%) [9]. Grossly, polyps range in size from a few millimetres to several centimetres and are present as smooth, firm, pedunculated lesions that are lobulated (Fig. 43.5). Histologically, they are hamartomas of the muscularis mucosae with strands of muscle fibres. The proportion of epithelial elements to lamina propria is greater in Peutz-Jeghers polyps than in juvenile polyps (Fig. 43.6). Another distinctive feature of Peutz-Jeghers-type polyps is arborising bands of smooth muscle, unassociated with blood vessels, extending into the fronds of the polyp.

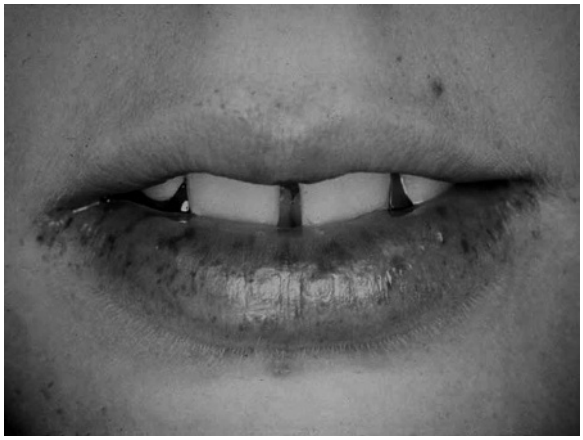

Fig. 43.4 Eight-year-old child with Peutz-Jeghers syndrome: melanotic spots on the inferior lip

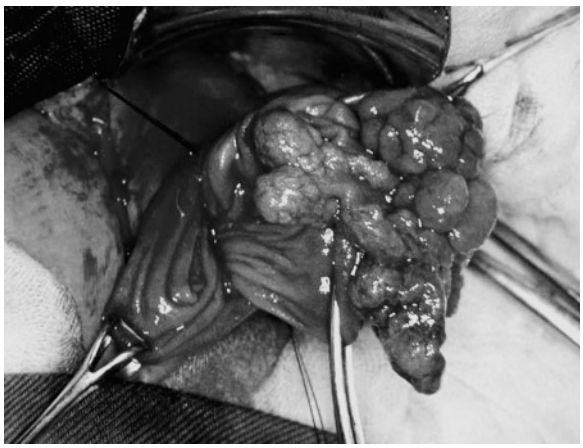

Fig. 43.5 Peutz-Jeghers syndrome. Opened transverse colon showing numerous polyps

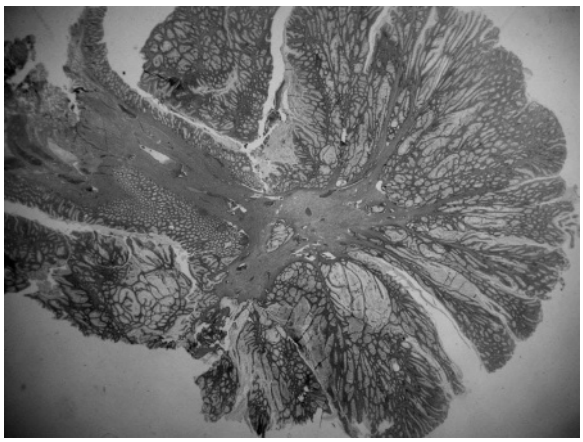

Fig. 43.6 Photomicrograph of a Peutz-Jeghers polyp

Retention cysts are not seen. Adenomas can occur concurrently with Peutz-Jeghers polyps.

43.2.2.2 Aetiology and Genetics

There is an equal gender distribution. Most cases of Peutz-Jeghers syndrome are inherited in an autosomal-dominant pattern, but some may develop de novo; family history is negative in 45% of cases [9]. Peutz-Jeghers syndrome is caused by germ-line mutations of suppressor genes [10].

43.2.2.3 Clinical Presentation

Because of the familial association of Peutz-Jeghers syndrome, the disease is often revealed through screening programmes in patients with a history. Otherwise, recurrent abdominal pain related to intussusception, anaemia from blood loss or a malignant condition can be the first clinical signs. Thirty percent of patients present signs and symptoms in the first 10 years of life, and 50% by 20 years of age. There are several reports of intestinal tumours in Peutz-Jeghers syndrome [9] and malignant changes in the hamartomatous Peutz-Jeghers polyps have been reported. Extraperitoneal tumours associated with Peutz-Jeghers syndrome include ovarian, cervical and testicular neoplasms as well as cancer of the breast, thyroid, bile duct, pancreas and gallbladder.

43.2.2.4 Treatment

A management protocol should include an annual evaluation of the symptoms related to the polyps, blood count to evaluate blood loss related to the polyps, breast and pelvic examination with cervical smears in girls, testicular examination in boys and pancreatic ultrasonography. All polyps larger than 0.5 mm found at endoscopy should be removed. Laparotomy with intraoperative endoscopy is recommended for all polyps larger than 15 mm in diameter.

43.2.3 Familial Adenomatous Polyposis

FAP is defined as the presence of more than 100 visible polyps in the large intestine. The presence of polyps in the colorectum is the hallmark of FAP and polyps

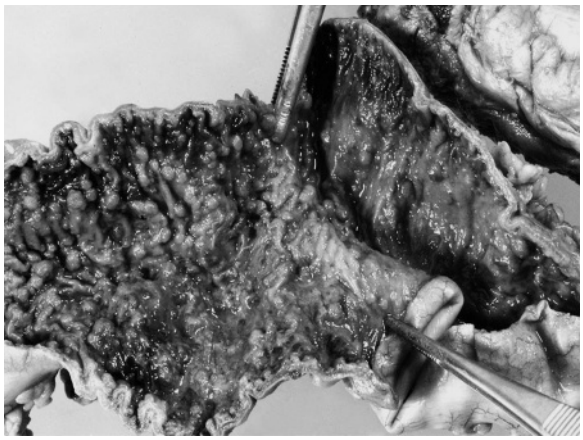

Fig. 43.7 Familial adenomatous polyposis. Opened descending colon showing multiple polyps

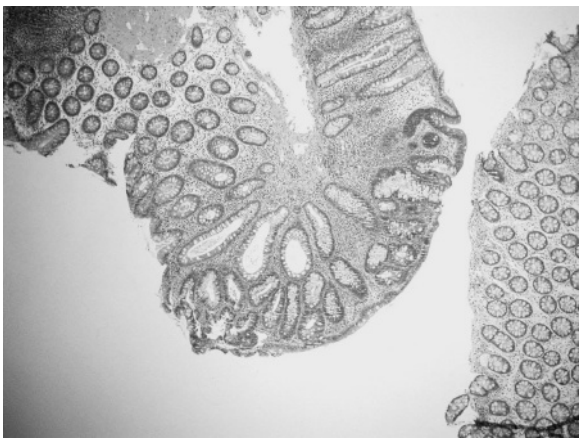

Fig. 43.8 Photomicrograph of an adenomatous polyp

are usually scattered throughout the colon. Polyps may vary in size from 1–2 mm to pedunculated tumours of 1 or more centimetres (Fig. 43.7).

43.2.3.1 Pathology

FAP results from neoplastic transformation of epithelium cells in the proliferation zone of a crypt (Fig. 43.8). As neoplastic cells extend to the basement membrane, they represent carcinoma in situ, and when they extend beyond the basement membrane, the tumour becomes microscopically invasive. Adenomatous polyps can be found in the small bowel and more rarely in the stomach.

43.2.3.2 Clinical Presentation and Genetics

The incidence of FAP lies in the range 1:6,000–1:12,000 births. It is an autosomal-dominant trait with 10% of new mutations [11]. It is caused by a germ-line mutation in the adenomatous polyposis coli gene, on chromosome 5q21. Most patients present at adolescence, but FAP can also be found in infancy and early childhood. Most cases are identified by routine surveillance because of a familial history of adenomatous polyps, otherwise patients can be free of symptoms or present with an increased frequency of defaecation, abdominal pain, rectal bleeding or anaemia.

Polyps are found by sigmoidoscopy and occasionally by air-contrast enema. Polyps can be found in the stomach in up to 60% of patients [12], but they are usually hamartomas and only 6% are adenomatous polyps. They can also be found in the duodenum where they are more likely to be adenomatous polyps.

43.2.3.3 Treatment

A malignant condition will develop in all patients with FAP if it is left untreated, and surgical removal of the entire colon will prevent colon carcinoma. Although different procedures have been proposed, most include an ileorectal anastomosis, which mandates surveillance of the rectum [13, 14]. We now prefer a total colectomy, performed laparoscopically, with an endorectal pull-through (PT) of the ileum after a rectal mucosectomy, and an ileoanal anastomosis (see transanal endorectal PT for Hirschsprung's disease, HD).

43.2.3.4 Gardner's Syndrome

Gardner's syndrome is the association of FAP with extracolonic skin and soft-tissue tumours including desmoids and thyroid tumours, and with osteomas of the mandible, the skull or the long bones.

43.2.3.5 Turcot's Syndrome

Turcot's syndrome refers to the occurrence of primary central nervous system tumours, mainly medulloblastomas, ependymomas and astrocytomas, in association with colorectal FAP.

43.3 Anorectal Malformations

43.3.1 General Considerations, Incidence and Classification

Anorectal malformations (ARMs) occur in 1:4,000–1:5,000 live births. The rectum or the anal canal can be blind-ending in the atresia or can communicate through a fistula with adjacent structures like the skin, the vulva or the vagina in girls, and the skin, the urethra or, more rarely, the bladder in boys. The Wingspread classification (Table 43.1), which is based on radiological analysis and on anatomical details, has been used widely but has little value in the prognosis of the postoperative results of continence. In this classification, defects can be classified as low or infralevator, and high or supralevator (Figs. 43.9–43.17). A more recent and consensual classification has replaced all others [15].

43.3.2 Associated Malformations

ARMs are frequently associated with malformations of the urinary tract, the spine and the spinal cord as well as cardiac, oesotracheal and bowel malformations. These associated malformations should be carefully ruled out as they have important consequences on the morbidity and the mortality of the patient. Spine and spinal-cord malformations have been found in about 50% of patients [16], independent of the severity of the anorectal defect. Most patients with spinal defects have dorsal stigmata-like dimples (Fig. 43.18), hypertrichosis, skin appendix or midline naevi. Associated upper or lower urinary tract malformations have an incidence of about 50%, including malformations of the kidneys and ureters, vesicoureteric reflux and malformations of the internal and external genitalia. These malformations occur more frequently in association with high ARMs.

Table 43.1 Wingspread classification of anorectal malformations

Level of anomaly	Female	Male
High anomalies	Anorectal agenesis · With rectovaginal fistulae · Without fistula · Rectal atresia	Anorectal agenesis · With rectoprostatic or rectobladder neck fistula · Without fistula · Rectal atresia
Intermediate anomalies	Rectovaginal fistula Rectovestibular fistula Agenesis without fistula	Rectobulbar fistula Agenesis without fistula
Low anomalies	Anovestibular fistula Anocutaneous fistula Anal stenosis	Anocutaneous fistula Anal stenosis
Particular anomalies	Persistent cloaca Rare anomalies	 Rare anomalies

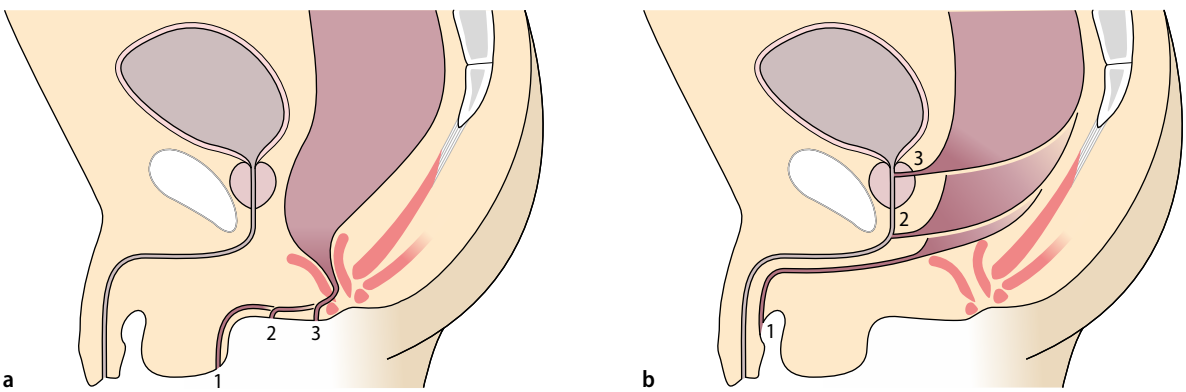

Fig. 43.9a,b Diagrams showing the different localisations of fistulae in anorectal malformations in the male. **a** Low defects with anoperineal fistulae (*1–3*). **b** Intermediate defects with a long trans-scrotal (*1*) and with a rectobulbar fistula (*2*), and a high defect with a rectoprostatic fistula (*3*)

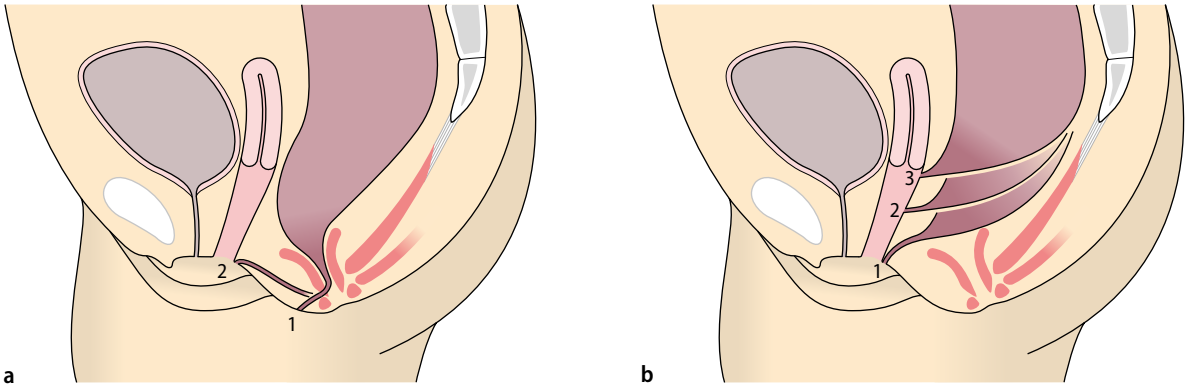

Fig. 43.10a,b Diagrams showing the different localisations of fistulae in anorectal malformations in the female. **a** Low defects with an anoperineal (*1*) and an anovestibular (*2*) fistula. **b** Intermediate defects with a rectovestibular (*1*) and a rectovaginal fistula (*2*), and a high defect with a rectovaginal fistula (*3*)

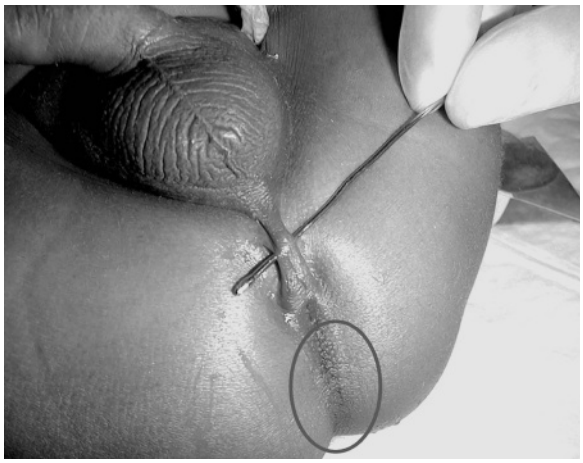

Fig. 43.11 Bucket-handle malformation typical of a low-defect anorectal malformation in boys

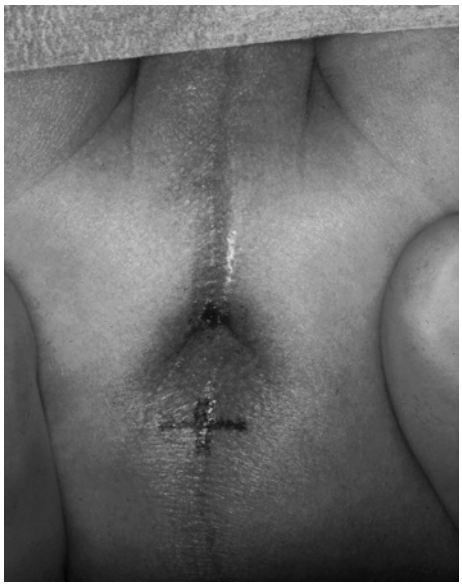

Fig. 43.12 Boy with an anoperineal fistula. A skin mark shows the centre of the sphincter contraction

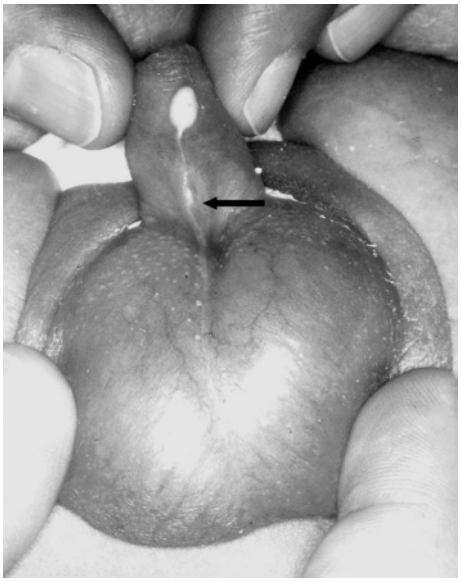

Fig. 43.13 Intermediate type of anorectal malformation with a long trans-scrotal fistula. The *arrow* indicates the tip of the fistula

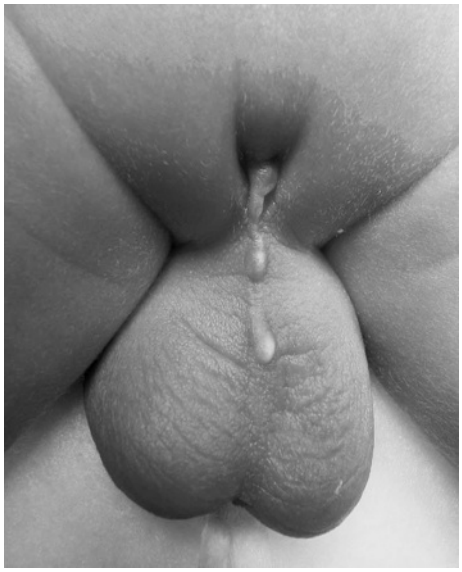

Fig. 43.14 Boy with an anal atresia. The pearls of meconium on the raphe are typical of a low defect

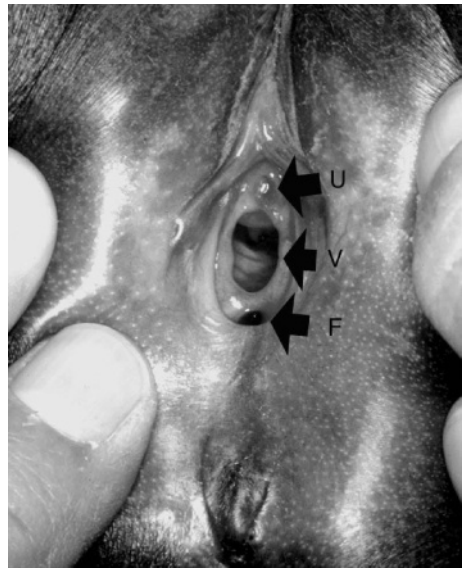

Fig. 43.15 Girl with an anorectal malformation with a vestibular fistula (*F*). *U* Urethra, *V* vagina

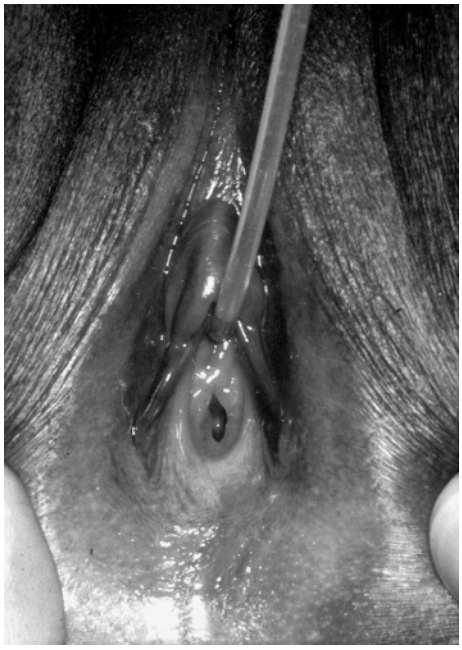

Fig. 43.16 Girl with an anorectal malformation with a rectovaginal fistula. A bladder catheter has been inserted

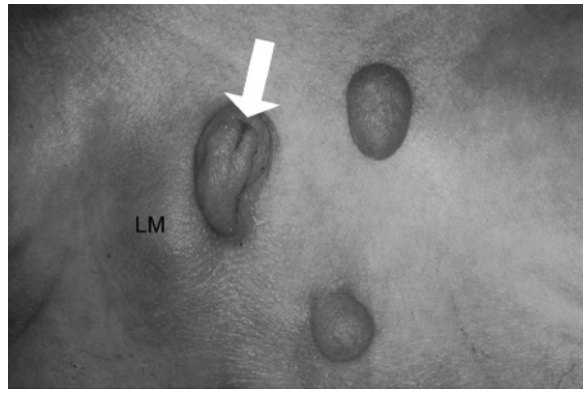

Fig. 43.17 Persistent cloaca. The *arrow* indicates the single cloacal channel. Note the abnormal divided left labia majora. *LM* Right labia majora

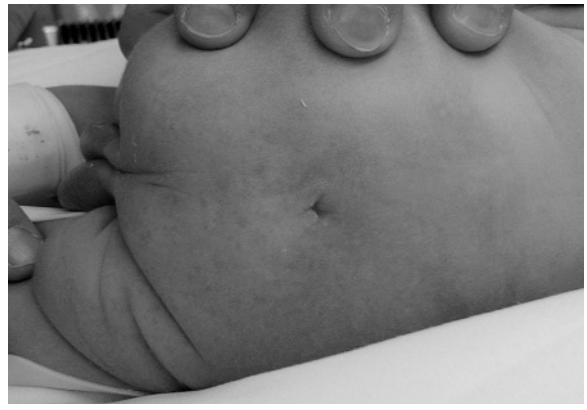

Fig. 43.18 Dorsal stigmata in a boy with a high type of anorectal malformation. The patient also has a partial sacral agenesis and a spinal lipoma with a tethered cord. Note the flat perineum and the divided scrotum

In 1987, McLorie reported 20% and 60% of associated malformations of the urinary tract in low and high anorectal defects, respectively [17]. Unfortunately, no series of patients has been studied prospectively. In our own series of 50 patients with ARMs, we found an overall incidence of 22% urinary tract malformations. In the same series of patients, 28% had cardiovascular defects like atrial or septal defects, patent ductus arteriosus, pulmonary sling, arterial pulmonary stenosis and defect of the right ventricle. Because of this high incidence of congenitally associated malformations, we believe that magnetic resonance imaging of the spine, cardiac ultrasound, ultrasound of the kidneys and a voiding cystourethrogram are mandatory in the work-up of patients with an ARM, whatever the height of the defect.

43.3.3 Initial Management

Three considerations should be taken into account in the initial management of a newborn with an ARM: the diagnosis of the defect, the need for a colostomy and the search for associated malformations (Table 43.2 and Figs. 43.19 and 43.20).

Newborns with an ARM should have a nasogastric suction tube and be fed intravenously. We advise prophylactic antibiotics because of the high incidence of associated urinary tract malformations. With the exception of girls with a persistent cloaca, no surgery is performed in the first 2 days of life. In the case of persistent cloaca, hydrocolpos can be present in patients with a common channel of more than 3 cm, and these patients often require a bladder catheter, a vesicostomy or even a vaginostomy in order to avoid anuria. In all other patients, the height and the type of defect will become apparent within the first 18–24 h of life. The aspect of the perineum, the presence and the localisation of a fistula, and the analysis of urine for the presence of meconium allow classifying the ARM into a low or a high defect in about 80–90% of patients. If no fistula is found or if doubt exists concerning the level of the rectal pouch, an invertogram should be performed, with measurement of the distance between the rectal pouch and the skin that has been marked at the level of the anal dimple (Fig. 43.21).

The cystourethrogram doesn't always allow the disclosure of a fistula in boys. In these cases, as well as in girls with a rectovaginal fistula, only the colostography will show the level of the rectal pouch and the rectourethral or the rectovaginal fistula (Fig. 43.22).

All newborns with a perineal fistula (i. e. to the skin) and those with a distance between the anal pouch and the skin of <1 cm in the invertogram are considered to have a low defect and do not require a colostomy. Boys with a urethral or a bladder fistula, girls with a vestibular or vaginal fistula, and patients with a distance between the rectal pouch and the skin of ≥ 1 cm are considered to have a high defect and need a colostomy. We

Table 43.2 Radiological techniques used for the diagnosis of the type of anorectal malformation and associated malformations. *MRI* Magnetic resonance imaging

Technique	Aims	Tips
Cardiac ultrasound	Rule out cardiac malformations	
Abdominal ultrasound	Rule out renal malformations Rule out malrotation	
MRI of spine	Rule out spinal and spinal cord malformations	
Voiding cystourethrogram	Bladder morphology Rule out vesicoureteric reflux Study of micturition Morphology of urethra	Study micturition for voiding disorders and urethral malformations No help for visualisation of urethral fistula
Invertogram	Distance between rectal/anal pouch and skin	Prone position with hips raised for 5 min Lateral radiograph Place opaque mark on skin at anal dimple Use opaque ruler for measurement of distance
Colostography	Define type of defect Visualisation of fistula	Distal loop filled under pressure (use balloon catheter) Wait for relaxation of perineal muscles

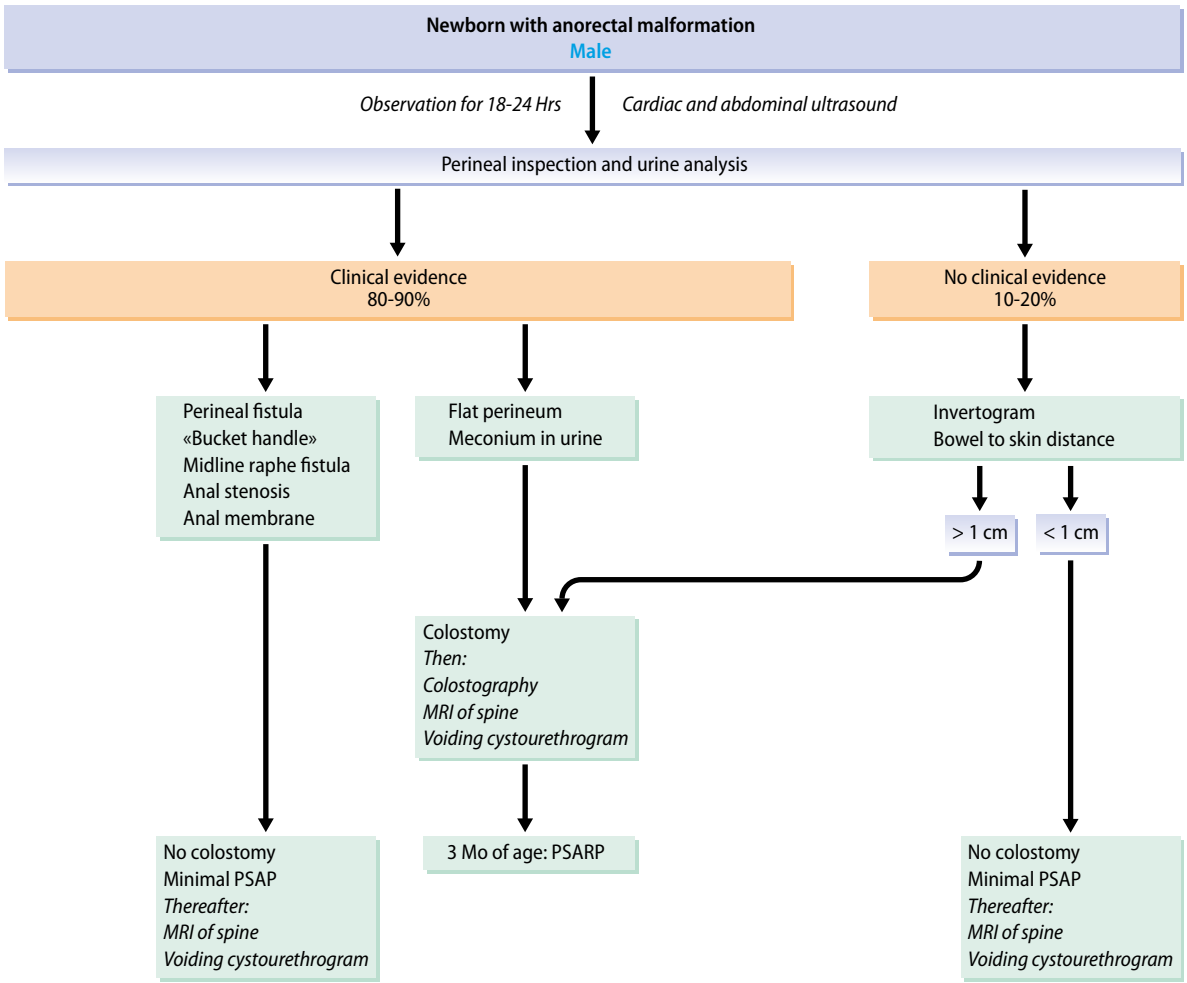

Fig. 43.19 Management of boys with an anorectal malformation. *MRI* Magnetic resonance imaging, *PSAP* posterior sagittal anal pull-through, *PSARP* posterior sagittal anorectal pull-through

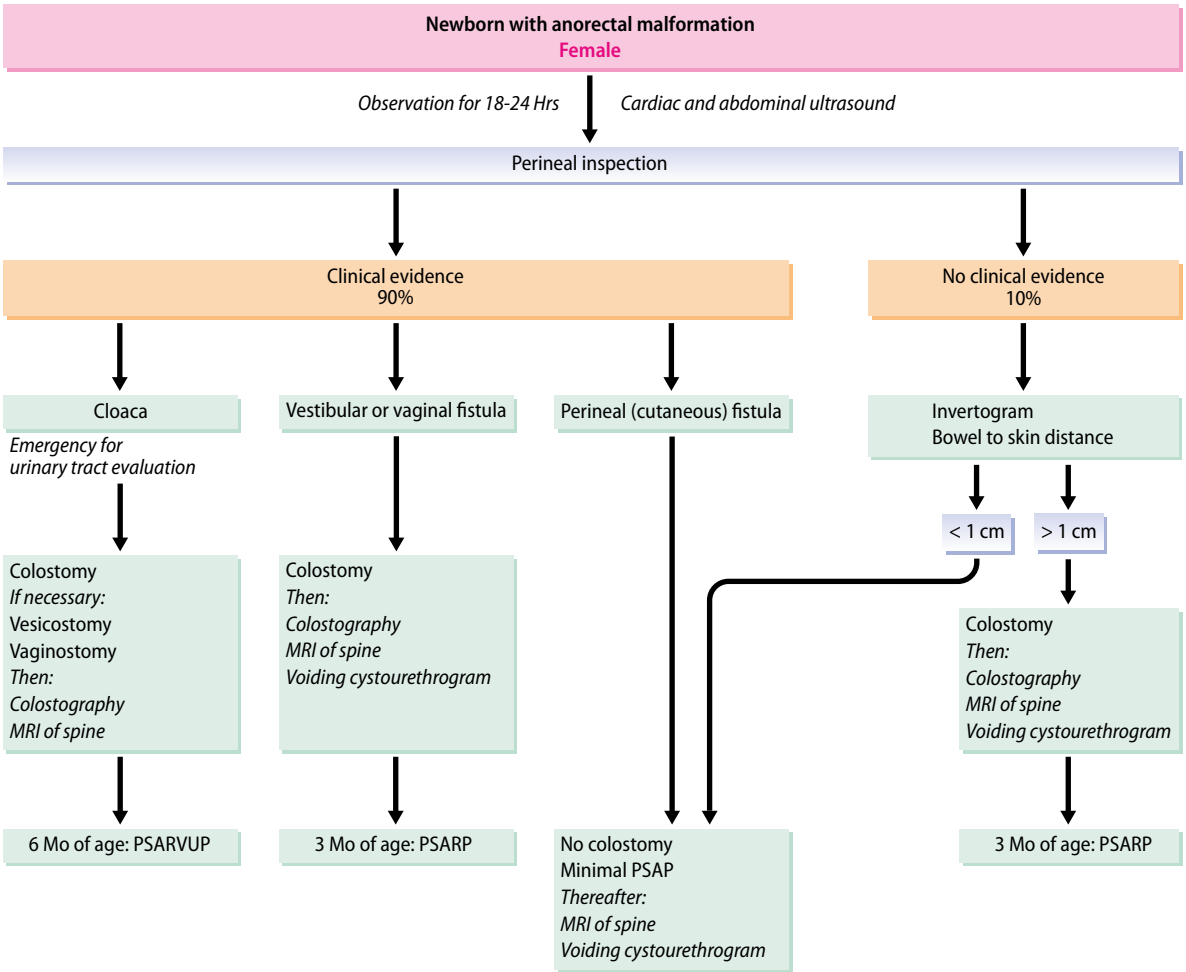

Fig. 43.20 Management of girls with an anorectal malformation. *PSARVUP* Posterior sagittal anorecto-vagino-urethral pull-through

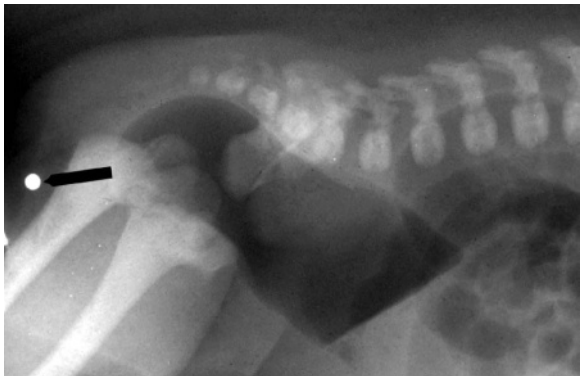

Fig. 43.21 Invertogram in a child with a rectal agenesis. The distance between the air bubble in the rectal pouch and a mark placed on the perineum must be measured (*arrow*)

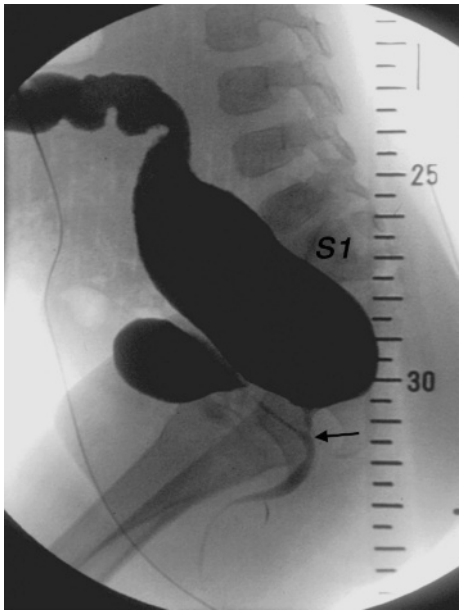

Fig. 43.22 Colostography in a boy with a high type of defect with a partial sacral agenesis. The *arrow* indicates a rectobulbar fistula

Table 43.3 Indications for a colostomy according to the type of anorectal malformation

Major clinical groups	Indication for colostomy
Males	
Perineal (cutaneous) fistula	No
Rectourethral bulbar fistula	Yes
Rectourethral prostatic fistula	Yes
Rectovesical fistula	Yes
No fistula (atresia) with gap <1 cm	No
No fistula (atresia) with gap >1 cm	Yes
Anal stenosis	No
Females	
Perineal (cutaneous) fistula	No
Vestibular fistula	Yes
No fistula (atresia) with gap <1 cm	No
No fistula (atresia) with gap >1 cm	Yes
Anal stenosis	No
Cloaca	Yes
Rare or regional variants	
Rectovaginal fistula	Yes
H fistula	Yes

also perform a colostomy in patients with rare defects (e. g. H-fistula or fistula to the distal penis), those with an unclear type of malformation and, of course, in girls with a persistent cloaca (Table 43.3).

43.3.3.1 Colostomy

When performing the colostomy, it is important to remember that it will remain in place for about 6 months and that its aims are to avoid stool spillage from the distal colon, allow colostography and protect the anal region after the PT procedure. We prefer to perform a left pararectal laparotomy and place a double-loop colostomy with a distance of about 4 cm separating the stomas at the junction between the descending and the sigmoid colons. This localisation prevents a prolapse of the proximal loop, avoids lesions to the blood supply of the distal loop and allows a sufficient length for the PT procedure (Fig. 43.23).

43.3.3.2 Anorectal Reconstruction

Although many techniques have been used for the reconstruction of ARMs, we prefer the posterior sagittal approach described by Peña [18] for all types of defect. The reconstruction can be performed in the newborn patient in the case of a low defect. The technique is called minimal posterior sagittal anal PT (minimal PSAP). For higher defects, we perform a posterior sagittal anorectal PT (PSARP) at the age of 3 months, and

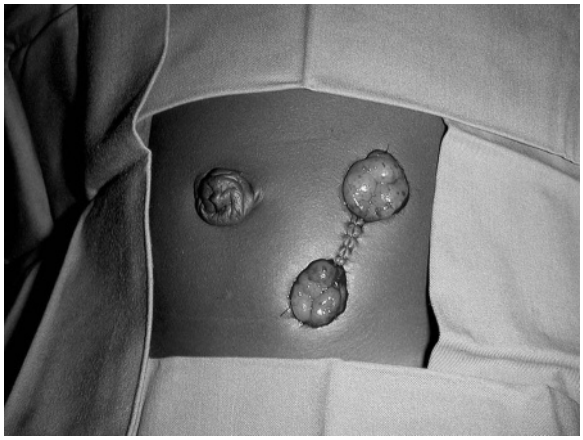

Fig. 43.23 Colostomy with separated stomas

in cloacal anomalies, the reconstruction, a posterior sagittal anorecto-vagino-urethral PT (PSARVUP), is performed when the child is 6–12 months old [19].

A bladder catheter is always inserted before starting the procedure, when necessary with the help of a cystoscopy. In boys, this catheter will help the localisation of the urethra in most instances. The patient is then placed in a prone position with the pelvis elevated. Two bolsters can be placed under the shoulders to prevent hyperextension of the neck. During the whole procedure, muscles are identified with the help of a muscle stimulator. Stimulation of the external sphincter (called the parasagittal fibres) causes a concentric contraction, stimulation of the muscle complex makes the anal dimple more prominent, pulling the skin deeper into the perineum, and stimulation of the levator muscle pushes the rectum forwards. The crossing of the muscle complex with the parasagittal fibres represents the margins of the anus. It is important to stay strictly in the midline during the dissection to avoid lesions of the urethra or the vagina and to the muscles. The rationale for this is also that nerve fibres and blood vessels do not cross the midline. A midline incision will be created from the tip of the coccyx to the perineum or to the vestibula. In case of an ARM with a perineal or a vestibular fistula, the skin incision continues around it and multiple silk sutures are placed around the fistula to allow traction during the rectal preparation. In low defects, the dissection of the parasagittal fibres and the muscle complex is sufficient to allow sufficient length for the PT of the rectum. In higher defects, the levator muscle has to be divided to reach the rectal pouch. In very high defects such as those found in boys with a rectobladder neck fistula and in girls with a high rectovaginal fistula, it is sometimes impossible to visualise the rectum through a sagittal approach, and a laparotomy is mandatory to visualise the fistula and mobilise the rectum. When there is no fistula, or in case of a rectovaginal or rectourethral fistula, the rectal pouch is first localised (Fig. 43.24), then opened medially until the fistula is reached on the distal part of the rectum (Fig. 43.25), separated, and then sutured close to the urethra or to the vagina. Multiple silk sutures are placed on the opened part of the rectum to allow traction during its preparation. The dissection of the anterior aspect of the rectum must be very careful, even in low defects, because the rectum and the urethra or the vagina share a common wall without any plane of dissection (Fig. 43.26). Once the rectum has been separated from the vagina or the urethra, its mobilisation is made circumferentially by dissecting in its wall in order to avoid provoking lesions to the perineal nerves. When a laparotomy is needed, muscles are separated, the urinary tract is exposed and a rubber tube is placed on the anterior aspect of the levator muscle, simulating the presence of the rectum. The patient is then turned face up and the entire lower

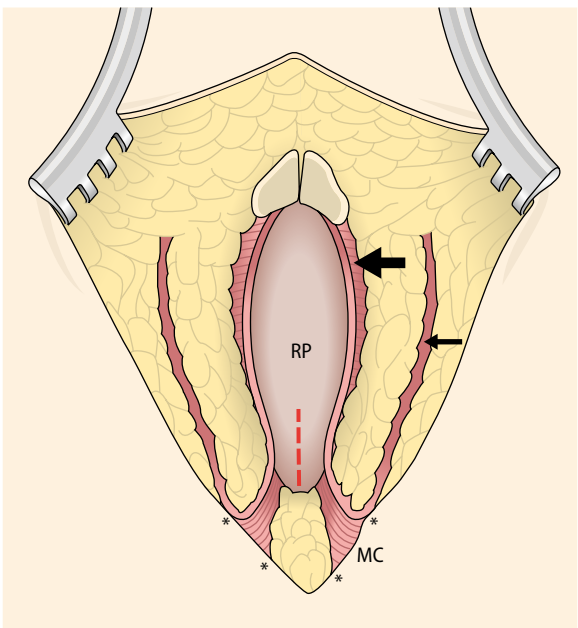

Fig. 43.24 PSARP in a boy with an anorectal malformation with a rectourethral fistula. The skin, the subcutaneous tissue, the parasagittal fibres (*small arrow*), the muscle complex (*MC*) and the levator ani (*thick arrow*) have been divided, showing the rectal pouch (*RP*). *Left- and right-side anterior and posterior aspects of the anus. The *dotted line* indicates the rectal pouch incision

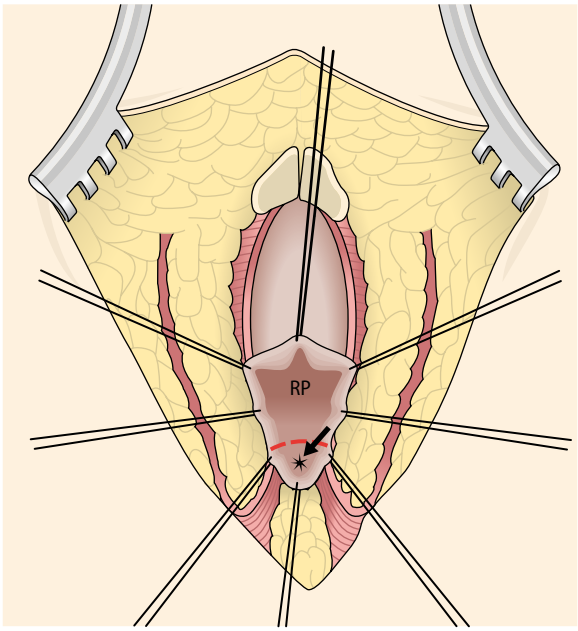

Fig. 43.25 PSARP in a boy with an anorectal malformation with a rectourethral fistula. The rectal pouch (*RP*) has been opened, showing the rectourethral fistula

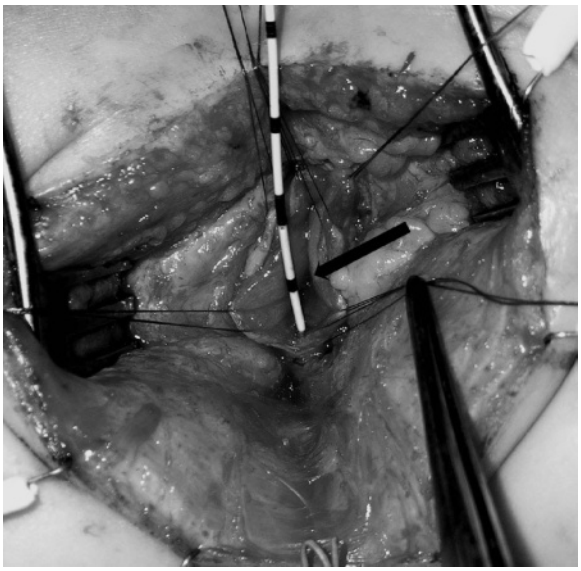

Fig. 43.26 PSARP in a boy with an anorectal malformation with a rectourethral fistula. The rectal pouch (*arrow*) has been opened. A catheter has been inserted into the urethral fistula

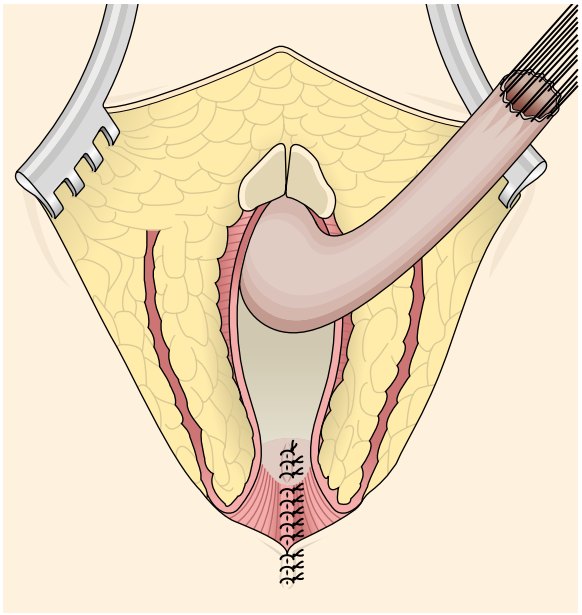

Fig. 43.27 PSARP in a boy with an anorectal malformation with a rectourethral fistula. After the closure of the urethral fistula and the approximation of the perineal body, the anterior aspect of the muscle complex and the skin are approximated

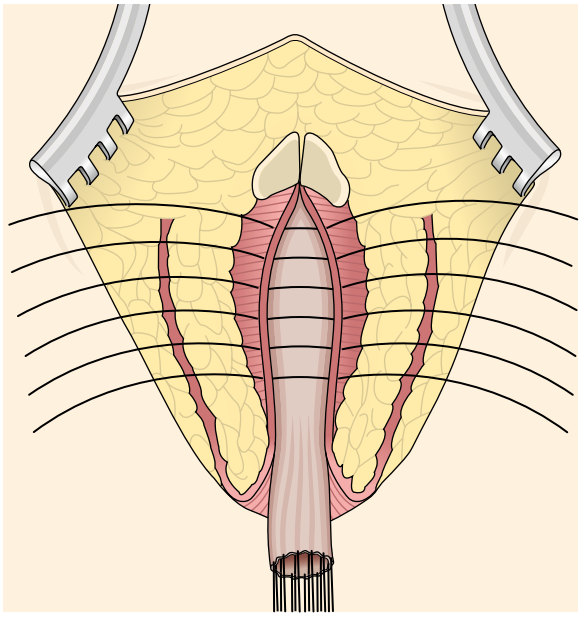

Fig. 43.28 PSARP in a boy with an anorectal malformation with a rectourethral fistula. Reconstruction of the levator ani

half of the patient is prepared to allow the surgeon to work simultaneously from the abdomen and from the perineum. Once the rectum has been prepared and the fistula has been closed, the rectum is fixed to the rubber tube and the patient is again turned to a prone position. Once enough length of rectum has been gained to allow the PT, reconstruction of the perineal body is first performed with reconstruction of the vulva in girls with a rectovestibular fistula. Sutures are placed from the depth to the anterior edge of the muscle complex, which is thus progressively closed (Fig. 43.27). In case of a very dilated rectum, tapering is sometimes needed on its posterior wall. If the levator muscle had to be divided, it is sutured first (Fig. 43.28), followed by the posterior edge of the muscle complex. The dorsal wall of the rectum is fixed with each suture to prevent a prolapse. The next step is the localisation of the anal margins, which are represented by the crossing of the parasagittal fibres with the muscle complex. Both layers of the parasagittal fibres are approximated. Subcutaneous tissue and skin are then closed. All sutures are made with 5.0 or 6.0 absorbable sutures. The anoplasty is then performed. After dividing the rectum into two lateral halves, each one is shortened and fixed under traction to the skin with circumferential 5.0 and 6.0 absorbable sutures.

43.3.3.3 Reconstruction of Cloacal Anomalies

Because of their diversity and the frequently associated malformations of the internal genitalia and the urinary tract, reconstruction of cloacal anomalies are challenging, even for a skilled paediatric surgeon. We shall thus describe only the basic principles of their repair. A thorough anatomical evaluation should be made before starting surgery. In cloacal anomalies, the urethra, the vagina and the rectum end together in a common channel that can be short (less than 3 cm) or long (more than 3 cm) in low and high types of defect, respectively.

Although the technique described herein for the most frequent anorectal anomalies can be used for the repair of cloacal malformations, peculiarities linked to this particular type of defect have to be considered during the surgery. The vagina is often wrapped around the urethra and their separation is therefore difficult. The urethra is reconstructed out of the common channel and this often produces a long gap between the vagina and the vulva. If the vagina cannot be sufficiently mobilised to reach the perineum, other procedures have to be used. The vagina is usually sufficiently broad to allow its anterior aspect to be partly separated in a racket form, while conserving a good blood supply, and tubularised to reach the vulva. In the case of a double vagina, a resection of the hemiuterus can be performed, while preserving the ovary and conserving only one hemiuterus on the other side. The hemivagina is then switched down to the perineum. The rectal fistula can reach the common channel but can also end on the posterior vaginal wall, or sometimes at the level of the vaginal septum in case of a double vagina. The mobilisation of the rectum is made according to the technique described earlier. As the vulva is often hypotrophic or absent in the cloacal anomaly, the reconstruction of the three channels to the perineum is made possible by forming a vulva out of the dorsal part of the vagina.

Peña described another approach for the correction of cloacal anomalies with the aim of avoiding the tedious dissection needed for cloacal repair: total urogenital mobilisation. The results seem to be satisfactory, although long-term follow-up in respect to urinary tract continence has not yet been published [20, 21].

43.3.3.4 Post-operative Anal Dilatations

All patients with an ARM should undergo a programme of anal dilatations that is started 2 weeks after the reconstructive surgery. This point is very important to prevent a stenosis of the anal and the sphincter regions. Dilatations are made with progressively increasing Hegar dilators until the size of dilator corresponds to the age of the patient (Table 43.4).

Until the optimal size is reached, the dilatations are made twice daily, then the frequency is decreased progressively every month. Such dilatations are usually continued for 4–6 months, the colostomy being closed about 3 months after the PT procedure.

Table 43.4 Post-operative dilatations: dilator size

Patient's age	Hegar dilator size to be reached
1–4 months	12
4–8 months	13
8–12 months	14
1–3 years	15
3–12 years	16
> 12 years	17

43.3.4 Complications

All of the known complications that occur after surgery of the bowel, the urinary tract and the internal genitalia can be encountered after ARM repair. Wound dehiscence and infections are rare if care is taken to perform a colostomy, as described earlier. Anal stenosis can be prevented with the aid of a standard programme of dilatations. Rectourethral fistula is encountered when fistula closure is performed under tension on the urethra. Rectovaginal fistulae are seen when both the vagina and the rectum are damaged during dissection. Rotating the rectum after repairing the vagina and the rectum wall can prevent this fistula.

43.3.5 Results

The results after the reconstruction of ARMs depend on two main factors: the type of defect and associated anomalies of the sacrum. The higher the defect, the poorer the sphincter complex will be. Patients with a high type of defect often have a "flat bottom", which represents a poor prognosis for post-operative continence. Sacral agenesis often results in a deficit of both the anal and bladder innervation. Post-operative problems are soiling due to sphincter insufficiency, and constipation. The analysis of post-operative results lacks consensual agreement and multiple classifications have been proposed. The latest classification [22] is simpler and should lead to a better comparison of the results between the different forms of ARM (Table 43.5). Basically, patients who have good sphincter muscles will suffer more from constipation than those with poor sphincter muscles who complain of soiling. Patients with a low type of defect should have a good continence rate of 80–100% after the reconstruction. Patients with a high type of defect have a continence rate ranging from 60 to 30%, with an overall continence rate of 40%, but long-term follow-up based on patient perspective and quality of life is disappointing [22–26].

Table 43.5 Assessment of post-operative continence: the Krickenbeck classification

1	Voluntary bowel movements	
2	Soiling	
	Grade 1	Occasionally (once or twice per week)
	Grade 2	Every day, no social problem
	Grade 3	Constant, social problem
3	Constipation	
	Grade 1	Manageable by changes in diet
	Grade 2	Requires laxatives
	Grade 3	Resistant to diet and laxatives

43.4 HD and Related Innervation Disorders

HD is characterised by the absence of ganglion cells in the distal bowel extending from the internal anal sphincter on a variable distance proximally. In 68–75% of patients the aganglionic zone is restricted to the rectum and the rectosigmoid; this zone extends to the splenic flexure or the transverse colon in about 17%, and o the whole colon, and in some instances to the terminal ileum in the remaining 8%. Other types of dysganglionosis have been described. Hypoganglionosis is found proximal to the aganglionic zone or as an isolated disorder [27, 28], and hyperganglionosis, or intestinal neuronal dysplasia, has been described in 30% of patients with HD proximal to the aganglionosis or as an isolated disorder [29]. Descriptions of these dysganglionoses are still a matter of debate [30].

43.4.1 Origin of the Enteric Nervous System: Neural Crest Cell Migration

Enteric ganglion cells derive primarily from the vagal neural crest cells (NCCs) [31]. These cells migrate in the human foetus in a craniocaudal direction from the 4th to the 12th weeks of gestation. After forming the myenteric plexus, the cells migrate inside the bowel wall to form the submucous plexus. The absence of ganglion cells is attributed to the failure of migration, differentiation and survival of the NCCs [32].

43.4.2 Aetiology

Different factors are thought to cause the arrest of NCC migration. The extracellular matrix is an important factor of the neuronal pathway and its alteration may cause the arrest of NCC migration or abnormal development of the enteric ganglia. Fibronectin and hyaluronic acid provide a migration pathway for NCCs, and laminin and collagen type IV promote outgrowth and maturation of neurites [32]. Neurotrophic factors like nerve growth factor and neurotrophic factor 3 play an essential role in the development and survival of neurons [32]. A lack of expression of neural cell adhesion molecules has been demonstrated in the muscle of patients with HD [32].

Table 43.6 Gene mutations found in Hirschsprung's disease (HD) [34]. *GDNF* Glial cell-line-derived neurotrophic factor, *HMB* high mobility group

Gene	Abbreviation	Localisation	Frequency
Rearranged during transfection	*RET*	10q11.2	17–38% in short HD 70–80% in long HD 50% in familial HD 15–35% in sporadic forms of HD
Endothelin receptor B	*EDRNB*	13q22	3–7%
Endothelin 3	*EDN3*	20q13.2–13.3	5%
Endothelin converting enzyme	*ECE-1*	1p36.1	<1%
SRY-like HMG box gene	*SOX10*	22q13.1	<1%
GDNF	*GNDF*	5p12–13.1	<1%
Neurturin	*NTN*	19p13.3	<1%
GDNF receptor a-1	*GNDF a1*	10q26	<1%
Homeotic box gene	*HOX11L1*	2p12-p13	In some cases of intestinal neuronal dysplasia

43.4.3 Genetics

It has long been known that HD can affect more than one member of a family. Lyonnet et al. were the first to describe a deletion on chromosome 10 associated with HD [33]. Since then, numerous anomalies and syndromic HD cases have been described (TAB genetics) [33]. Different types of gene mutation have been found in patients with HD (Table 43.6) [34].

43.4.4 Pathophysiology

Cholinergic nerve hyperplasia is thought to be responsible for the spasticity of the aganglionic bowel segment. Disorders in the distribution of other non-adrenergic non-cholinergic neurotransmitters are also found in the aganglionic bowel. Numbers of vasoactive intestinal peptide, substance P, metenkephalin and gastrin-releasing peptide nerve fibres are decreased, and numbers of neuropeptide-Y cells and fibres are increased in these regions. Interstitial cells of Cajal, the pacemaker cells of the intestine, have been found to be either decreased or normal in the aganglionic bowel [35, 36]; their ultrastructure might be abnormal [35].

43.4.5 Pathology

The gross pathological features of HD are dilatation of the colon proximal to the aganglionic zone, a gradual narrowing of the bowel lumen in the transitional zone and a narrow, spastic aganglionic zone. Histologically, HD is characterised by the absence of ganglion cells and the presence of hypertrophied preganglionic cholinergic nerve fibres. The transitional zone shows a variable degree of hypoganglionosis (Fig. 43.29).

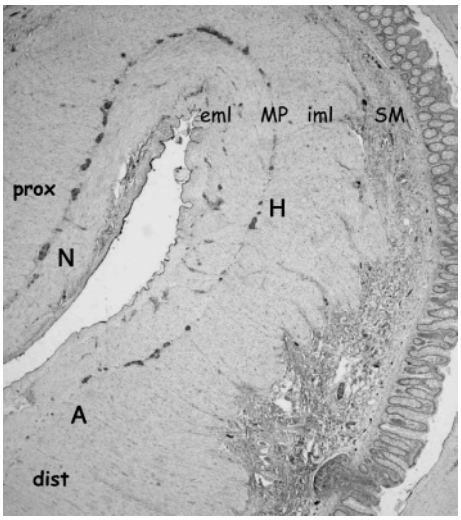

Fig. 43.29 Photomicrograph of a resected colon in Hirschsprung's disease. *Prox* Proximal colon, *N* normal colon, dist distal colon, *A* aganglionic colon, *H* hypoganglionosis, *eml* external muscle layer, iml internal muscle layer, *MP* myenteric plexus, *SM* submucosa

43.4.6 Clinical Presentation

About 80–90% of patients have symptoms in the neonatal period. Delayed passage of meconium in the first 24 h of life is the major symptom in affected neonates, most of who present with abdominal distension, constipation and vomiting. Enterocolitis may be the first symptom with diarrhoea, bile-stained vomiting, abdominal distension, fever and signs of dehydration. It is a life-threatening condition that requires immediate adequate therapy with rectal irrigation and intravenous antibiotics.

43.4.7 Diagnosis

The diagnosis is based on clinical history, radiological studies, anorectal manometry and rectal biopsies.

43.4.7.1 Radiology

Plain abdominal radiography shows dilated loops of small bowel, and in patients with enterocolitis, a thickening of the bowel wall with a dilated colon loop; 3% of patients have a spontaneous perforation of the bowel. Barium enema should be performed before rectal irrigation or digital examination because these may interfere with the visualisation of the transitional zone and give a false-negative diagnosis. The enema should be done without a balloon catheter due to the risk of perforation and the possibility of distorting a transitional zone by distension. It is sometimes useful to confirm the diagnosis with a delayed film 24 h after the enema. In typical cases of HD, the enema shows a spastic aganglionic zone followed proximally by a progressive funnel-like augmentation of the bowel diameter and a more proximal dilated bowel (Fig. 43.30) [37].

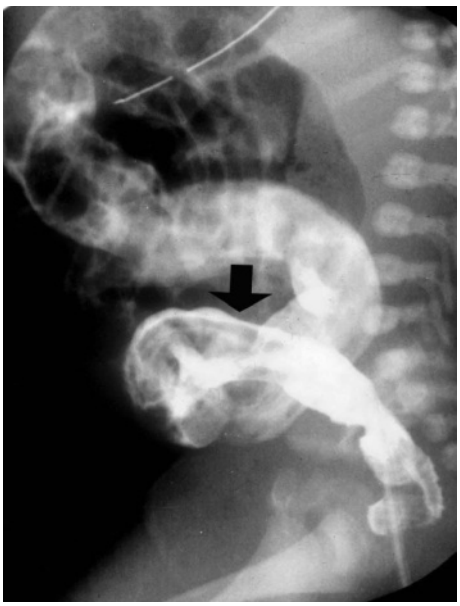

Fig. 43.30 Enema in Hirschsprung's disease. *Arrow* – transitional zone

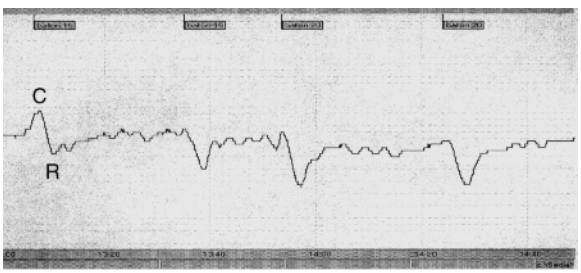

Fig. 43.31 Normal inhibitory rectoanal reflex. The stimulation of the rectum (balloon) is immediately followed by a contraction of the striated muscle (*C*) then by a relaxation of the smooth muscle (*R*)

43.4.7.2 Anorectal Manometry

In the normal bowel, distension of the rectum results in a decrease of the internal anal sphincter pressure, also called the rectoanal inhibitory reflex (RAIR). The duration of this reflex is about 15 s, following a rectal distension of 3 s (Fig. 43.31). The RAIR is absent in patients with HD (Fig. 43.32), and as a predictor it has a sensitivity of 75% and a specificity of 95% [38]. Although the pathways of the RAIR are not known, investigators have shown that interstitial cells of Cajal are involved in the afferent limb, and that nitric oxide is a mediator [39].

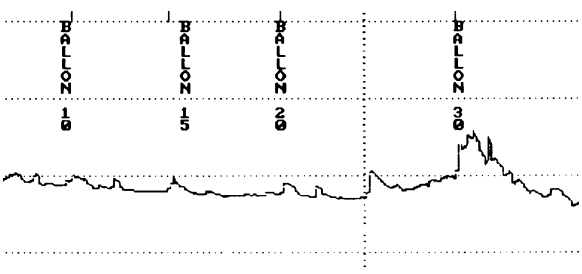

Fig. 43.32 Absence of an inhibitory rectoanal reflex in a patient with Hirschsprung's disease

43.4.7.3 Rectal Biopsies

Since Noblett described her tool for rectal suction biopsies in 1969 [40, 41], it has remained the gold standard for the diagnosis of HD. Many different devices are now used and are of equal value as long as harvested specimens are of sufficient depth and size, contain mucosa and submucosa, and are stained with conventional haematoxylin and eosin or with acetylcholine esterase (AChE) histochemistry [42–44]. Normal biopsy specimens stained with AChE histochemistry show ganglion cells in both the myenteric and the submucosal plexuses, with nerve fibres being barely visible. In HD patients, the diagnosis is based on the absence of ganglion cells and the presence of nerve hypertrophy and a marked increase of AChE activity in the lamina propria and the muscularis mucosae.

43.4.8 Management

After confirmation of the diagnosis, we start with rectal saline washouts that can be continued until the surgical procedure is planned; the patient can feed normally until then. A colostomy is generally not needed unless washouts are inefficient because of a long-segment aganglionosis or in the case of bowel perforation. When it is the case, a double-loop colostomy is then placed above the transitional zone after confirmation via intraoperative biopsy of a normal innervation.

43.4.8.1 PT Procedures

Although several PT techniques have been described, the most commonly used are the rectosigmoidectomy after Swenson, the retrorectal transanal PT after Duhamel and the endorectal PT according to Soave. Each one has been modified by different authors and they all give similar satisfactory results. More recently, De la Torre has described a new approach for the endorectal PT that seems to offer equally good results in comparison with the other techniques. We favour this approach, which can be used in the rectosigmoid classical HD as well as in longer forms of aganglionosis.

Swenson's Procedure

This technique was first described in 1948 [45] and is still used widely with only slight modifications. It was the first successful method of treatment of children with HD. The preparation and the resection of the aganglionic bowel are made intraperitoneally. The redundant aganglionic rectum is excised and sutured. The peritoneal reflection over the distal part of the rectum is incised. It should be stressed that the rectum must be dissected caudally inside its wall in order to avoid damage to the genitourinary innervation. Traction on the rectum facilitates the dissection (Fig. 43.33). The dissection should reach the anal verge posteriorly but should not be carried out as far anteriorly so as to avoid autonomic nerve injury. After localisation of the normal bowel with frozen sections, the proximal colon is prepared for the PT. The perineal part of the operation is started at this point. The rectum is everted through the anus and cut obliquely, leaving no more than 1 cm posteriorly and 2 cm anteriorly (Fig. 43.34). The ganglionic bowel is pulled through and the anastomosis is performed. The bowel is then pulled upwards into the abdominal cavity (Fig. 43.35).

Duhamel's Procedure

In 1960 Duhamel devised a technique that preserves a part of the aganglionic rectum, thus avoiding the tedious dissection of the rectum described by Swenson [46]. This technique has been modified by Martin et al. [47, 48] so as to avoid leaving a redundant rectal pouch anteriorly. The patient is placed in a lithotomy position that will allow a combined abdominal–perineal approach. The first part of the procedure is performed intraperitoneally. It comprises resection of the rectum

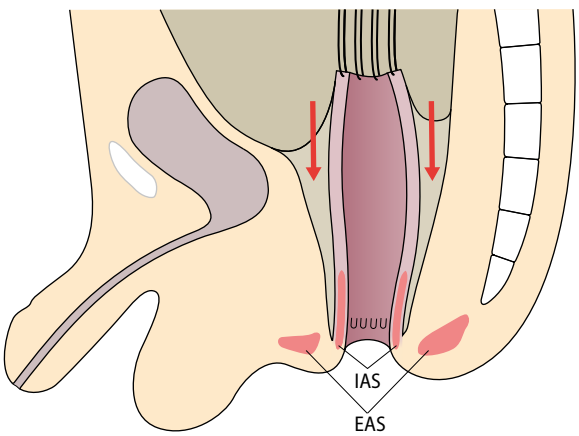

Fig. 43.33 Swenson's procedure. Peritoneal dissection of the rectum (*arrows*). *IAS* internal anal sphincter, *EAS* external anal sphincter

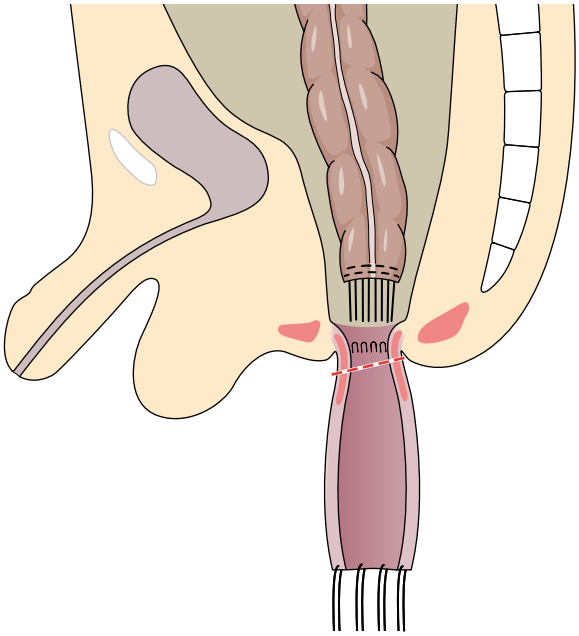

Fig. 43.34 Swenson's procedure. The proximal normal colon is pulled through the everted rectum. *Dotted line*: section of the rectum

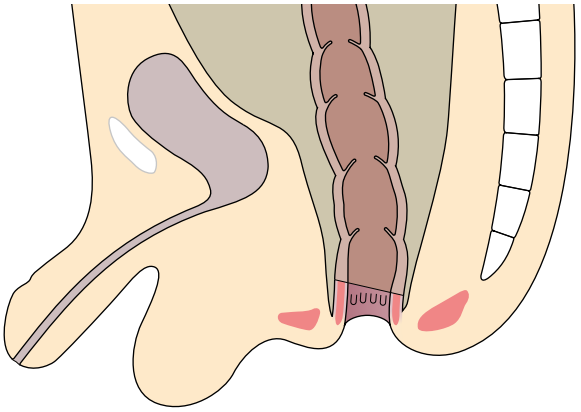

Fig. 43.35 Swenson's procedure. The colon has been sutured to the rectum and inverted back to the peritoneal cavity

down to the peritoneal reflection, preparation of the ganglionic bowel for the PT and creation of a retrorectal space for the pulled-through ganglionic colon. After incision of the peritoneal reflection, the retrorectal dissection should be made strictly in the midline, close to the rectal wall, in order to avoid injury to the pelvic nerves and to the striated sphincters. The ureters should be visualised to avoid injury. The perineal part is then started. A clamp is inserted into this retrorectal space by an assistant and should be felt by finger palpation 1.5 cm above the anal margin (Fig. 43.36). Using cautery, a semicircular incision is made 1 cm above the dentate line on the posterior rectal wall and the ganglionic colon is then pulled through this incision (Fig. 43.37). The anterior aspect of the pulled-through colon is opened and sutured to the superior aspect of the rectal incision (Fig. 43.38). The remaining posterior half of the pulled-through colon is excised and the posterior wall of the colon is sutured to the inferior aspect of the rectal incision. An incision is made intraperitoneally on the anterior aspect of the pulled-through colon at the level of the proximal rectal excision, and the posterior rectal wall is sutured with interrupted sutures to the inferior aspect of the incision made on the colon. A long stapling device is introduced into the anus, with one arm in the rectum and the other one

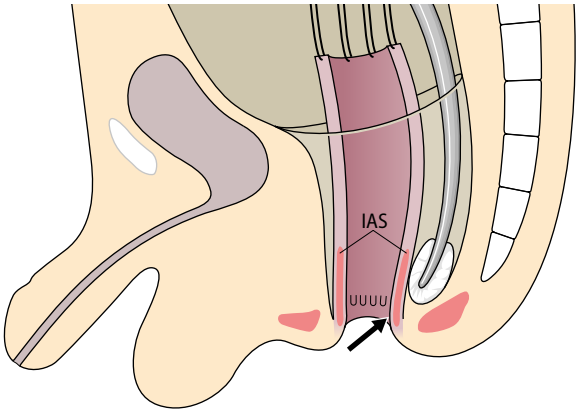

Fig. 43.36 Duhamel's procedure. Creation of a retrorectal space and localisation of the posterior semicircular incision (*arrow*)

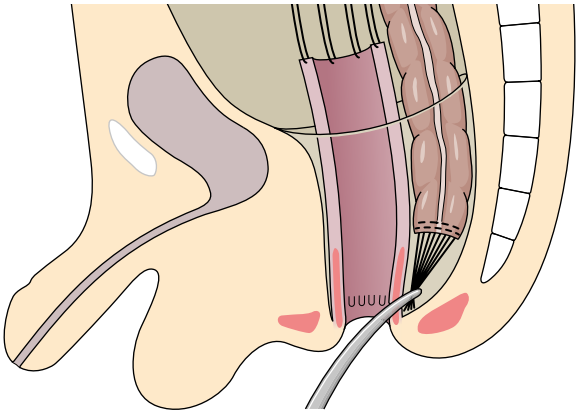

Fig. 43.37 Duhamel's procedure. Retrorectal pull-through: the normal ganglionic colon is pulled through the posterior incision of the rectum

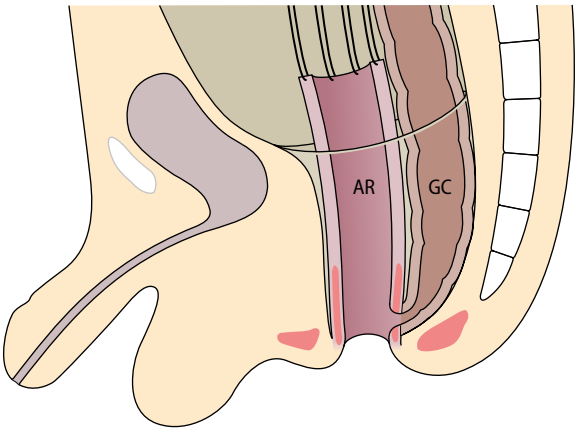

Fig. 43.38 Duhamel's procedure. The semicircular distal suture between the aganglionic rectum (*AR*) and the ganglionic pulled-through colon (*GC*) has been performed

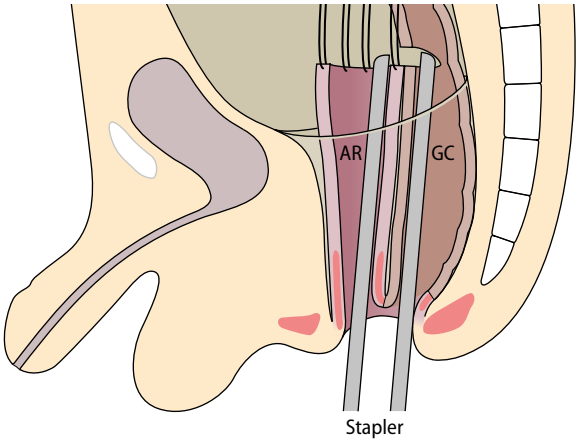

Fig. 43.39 Duhamel's procedure. Shaping of a distal cavity with a stapler device

in the pulled-through colon in order to shape a single distal cavity made out of aganglionic rectum anteriorly and ganglionic bowel posteriorly (Fig. 43.39). The position of the stapler can be checked through the colon incision. Suture lines are checked and the anterior aspect of the rectal wall is sutured to the superior aspect of the colon incision.

Soave's Procedure

Initially described by Soave as a two-step procedure in 1964 [49], this technique has been modified by Boley [50]. The child is placed in a lithotomy position, which allows a combined abdominal perineal approach. The level of aganglionosis is established with frozen sections and the proximal colon is mobilised proximally for the PT. The distal colon is resected at the peritoneal reflection. The endorectal mucosectomy is initiated and carried down to approximately 1 cm above the dentate line (Fig. 43.40). The mucosal tube is everted outside the anus and resected 1 cm above the dentate line (Fig. 43.41). The ganglionic bowel is pulled through the smooth muscle cuff, anastomosed to the distal rectal mucosa, and pulled back into the peritoneal cavity (Fig. 43.42). The muscle should be split intraperitoneally in order to avoid stenosis, and attached proximally to the pulled-through bowel to prevent the colon from prolapsing [51–53].

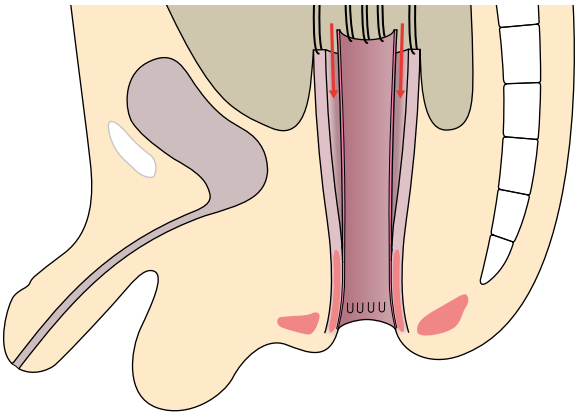

Fig. 43.40 Soave's procedure. Mucosectomy (*arrows*)

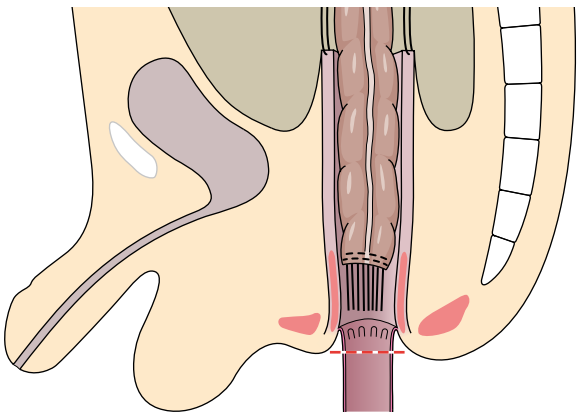

Fig. 43.41 Soave's procedure. The colon is pulled through the everted rectal mucosa inside the rectal smooth muscle cuff. *Dotted line*: section of the rectal mucosa

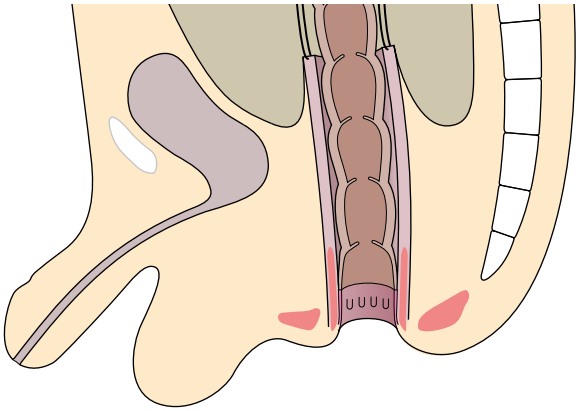

Fig. 43.42 Soave's procedure. After completion of the colorectal circular suture, the colon is pulled back into the abdominal cavity inside the smooth muscle cuff

Transanal Endorectal PT

In order to avoid a laparotomy, De la Torre described a perineal approach to the endorectal PT in 1998 [54, 55]. The principle of this procedure is similar to the technique described by Soave for submucosal dissection of the rectum, resection of the aganglionic colon, PT, and anal anastomosis of the ganglionic colon, but using an exclusively transanal approach. The procedure is made easier if a previous localisation of the transitional zone has been done with a barium enema.

The patient is placed in a supine lithotomy position. We prepare the whole lower body in case we need to perform a laparoscopy or a laparotomy to help with the mobilisation of the colon for the PT. A bladder catheter is placed to monitor renal excretion during the surgery. Two rubber bands are stuck longitudinally on the buttocks in order to fix traction sutures. Traction sutures are placed circumferentially on the anal margin in order to exteriorise the anal canal and the dentate line, and fixed onto the rubber bands. A diluted adrenaline solution is infiltrated into the submucosa to help in its dissection. A circumferential incision is made approximately 1 cm above the dentate line (Fig. 43.43). Traction sutures are placed on the mucosa to help the mucosectomy. The mucosectomy has to be performed strictly in the submucosal layer in order to free the mucosa without damaging the smooth muscle cuff, which can result in ischaemia and stenosis. This dissection is easy in the newborn patient and can be done bluntly with sterile cotton swabs and coagulation of small submucosal blood vessels (Fig. 43.44). The mucosectomy should extend proximally to reach the peritoneal reflection, which in our experience represents approximately 8–10 cm in newborn patients and toddlers. The muscle cuff is then incised circumferentially starting from its anterior aspect so as to reach into the perito-

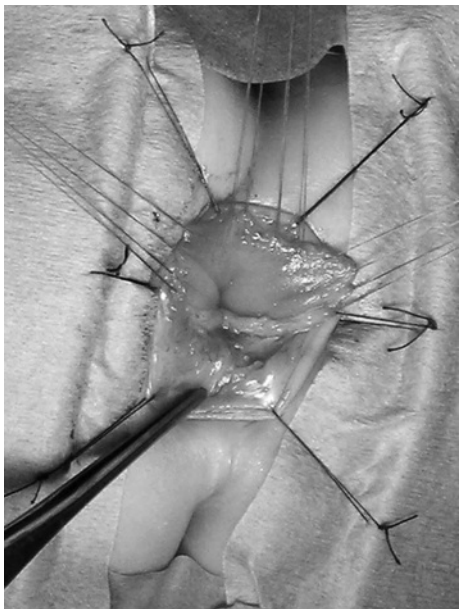

Fig. 43.43 De la Torre's procedure. Mucosal incision. Multiple traction sutures are placed on the edge of the mucosa

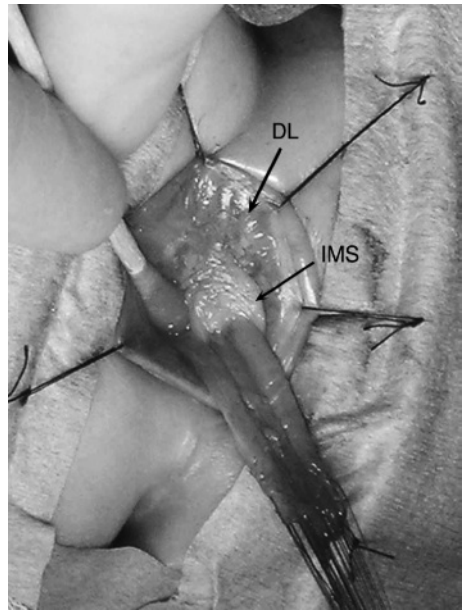

Fig. 43.44 De la Torre's procedure. Mucosectomy. The mucosa is gently separated from the smooth muscle. *DL* dentate line, *IMS* internal muscle sleeve

neal cavity. Traction sutures are placed on the proximal edge of the muscle cuff. These sutures will allow splitting of the muscle cuff posteriorly. We begin the split proximally and leave about 1 cm of the muscle intact distally. These traction sutures also allow the muscle cuff to be placed back into its original position once the colon has been pulled through. Once the peritoneal cavity has been reached, the rectum and the sigmoid colon can be mobilised and the mesenteric vessels are divided under direct vision using cautery or ligatures (Fig. 43.45). After confirmation of the presence of ganglion cells with the aid of frozen sections, the colon is divided above the normal biopsy site and a coloanal anastomosis is performed (Fig. 43.46). This approach can be used in patients with a rectosigmoid aganglionosis. When there is doubt about the localisation of the transitional zone with the barium enema or when the extent of the aganglionosis reaches the descending colon, the procedure can be assisted laparoscopically to take seromuscular biopsy samples or to mobilise of the colon. In some instances, a laparotomy is needed. It is important to stress that post-operative anal dilatations are mandatory in this type of PT. We use the same programme as that described earlier for after surgery for ARM.

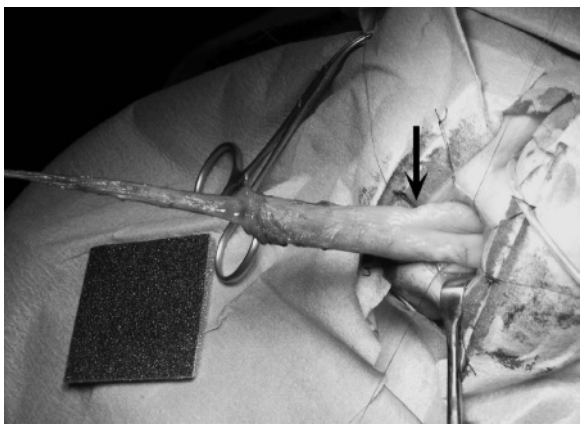

Fig. 43.45 De la Torre's procedure. The rectum and the sigmoid colon have been mobilised through the anus. *Arrow*: transitional zone

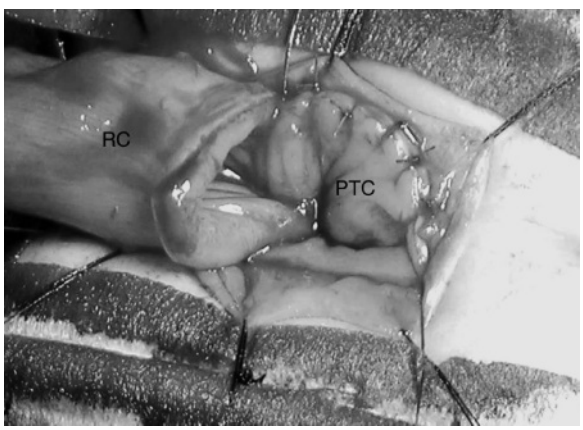

Fig. 43.46 De la Torre's procedure. The ganglionic pulled-through colon (*PTC*) has been partially resected (*RC*) and the coloanal circular suture is completed

43.4.9 Complications and Results

Enterocolitis represents the most important, and sometimes life-threatening, complication after all types of PT and is encountered in 15–30% of patients post-operatively [56]. It seems to occur more frequently after endorectal PT, and seems to be associated more frequently with the Duhamel procedure than with the other procedures, with leakage of intra-abdominal sutures and perineal abscesses. Stenosis due to the dissection of the muscle sleeve in endorectal PT procedures, such as Soave's or de la Torre's procedures, occurs in about 15% of patients. Long-term results are satisfactory in about 70% of patients, constipation remaining the main problem after PT for HD. The various procedures described offer approximately the same results [57–60].

43.5 Other Anorectal Disorders

43.5.1 Rectal Prolapse

Rectal prolapse is common in childhood [61]. Mucosal prolapse is generally a self-limited problem encountered in children aged 1–3 years and does not usually require surgical treatment. It often corresponds to the age of toilet training and is often preceded by episodes of constipation and pain during defaecation. Mucosal prolapse is limited to a less than 3-cm rosette-like swollen mucosa with radial folds at the anal junction. It is frequently associated with slight bleeding of the mucosa. Full-thickness prolapse is less common and can reach several centimetres. Mucosal folds are then circular. Patients are usually older and often complain of stool incontinence or staining. Most prolapses are idiopathic, but they are more common in children with neuromuscular problems such as myelomeningocele, and in patients with parasites, polyps and inflammatory diseases. The first step in the treatment should aim to cure the underlying cause. Mucosal prolapse does

not generally require surgical treatment. Rarely, injection of sclerosing agents is needed in case of recurrent prolapse; we use a solution of 50% glucose injected into four quadrants. Surgical treatment is needed in the case of recurrent full-thickness prolapse after failure of conservative treatment. A rectopexy can be performed laparoscopically or via a Pfannenstiel's incision. After division of the peritoneal folds, the posterior aspect of the rectum is mobilised and fixed with three to four non-absorbable sutures to the facia over the sacral promontory. Results are satisfactory [62].

43.5.2 Haemorrhoids

Haemorrhoids are uncommon in children. A mucosal prolapse with congestive rectal veins or a rectal polyp are often mistaken for haemorrhoids. A description of the lesion by the parents usually leads to the diagnosis: the rectal mucosa is usually pink, a polyp resembles a small raspberry (Fig. 43.2), and haemorrhoids are purple (Fig. 43.47). As haemorrhoids are more frequent with portal hypertension, a Doppler abdominal ultrasound should be performed to rule out this cause [63]. Haemorrhoids are usually encountered in children with constipation [64] and the first treatment aims to obtain a soft stool. Some patients with a persistent problem in spite of medical treatment require surgery. We prefer a simple cauterisation of the veins, which prevents sphincter lesion. As haemorrhoids are sometimes only visible when the child strains, unmasking them can be made by inserting a 20-F Foley catheter and by gently pulling it outside the anal verge, mimicking the passage of stool [65].

43.5.3 Perianal Abscess and Fistula-in-Ano

Perianal abscesses are common in infants. They present as indurated or fluctuant masses near the anal orifice. They often arise from crypt infections and might lead to fistulae-in-ano [66]. If they present in older children or if they have an uncommon, deep localisation [67], an inflammatory condition, such as a Crohn's disease, should be considered. When abscesses are superficial, a simple incision may suffice to treat them. Nevertheless, a fistulous tract should always be meticulously investigated and, if found, laid open at the first procedure (Fig. 43.48) [64].

43.5.4 Condylomata Acuminata

Human papilloma virus is the causative agent in paediatric condylomata. In children older than 1 year, sexual abuse should always be investigated [68]. In younger infants, a vertical transmission from the mother is most often the aetiology. Treatment with topical agents such as diluted podophyllin is usually effective, but the recurrence rate is high. If condylomata are numerous, they can be fulgurated or excised by laser.

43.6 Conclusion

Paediatric surgeons have to treat most of the pathologies they meet while bearing in mind the fact that they are dealing with growing patients. This means that they have to be as conservative as possible in terms of the organ function of their patient. In the future, the ever-

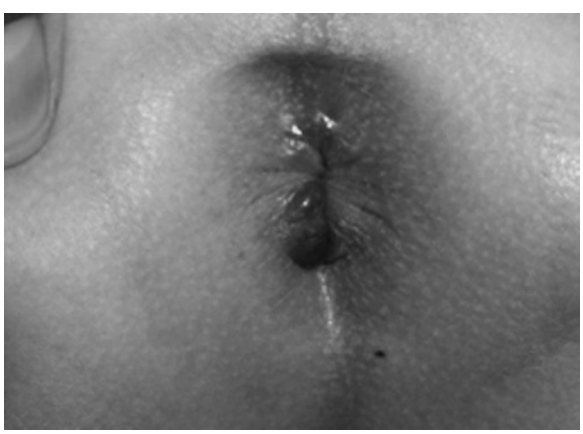

Fig. 43.47 Haemorrhoids. Compare with Fig. 43.2

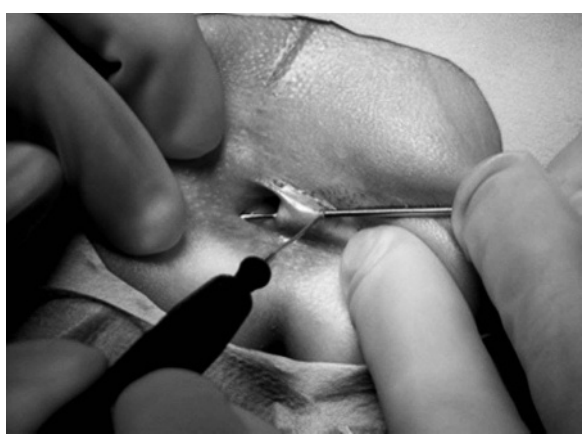

Fig. 43.48 Perianal abscess. The fistulous tract is laid open with the help of a lachrymal probe

developing minimally invasive surgery will certainly replace some of the more invasive techniques used today.

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Self-Assessment Quiz

Question 1

A patient presents with a prolapsing polyp through the anus. Which management would you propose?

a. Excision of the polyp
b. Excision of the polyp and air-contrast barium enema
c. Excision of the polyp and control of haemoglobin for signs of bleeding
d. Wait for spontaneous involution of the polyp
e. Excision of the polyp and colonoscopy

Question 2

A 5-years-old child with positive familial history for colon cancer is found to have numerous adenomatous polyps in the transverse colon. Which management would you propose?

a. Endoscopic excision of the polyps and chemotherapy.
b. At this age, due to the low risk of malignancy, excision of the transverse colon is sufficient.
c. At this age, excision of the colon with preservation of the rectum and a colorectal anastomosis will help maintain water and electrolyte absorption.
d. At this age, if there is no sign of malignancy, repeated biopsies every year are the best management.
e. Total colectomy.

Question 3

A 12-year-old boy has five hamartomatous polyps in the colon, each less than 1 cm in size, and melanotic spots on the lips. There is no familial history of a bowel disease. What would you propose?

a. At that age and with no familial history, a simple endoscopic excision is sufficient.
b. An air-contrast barium enema, then resection of the colon presenting with the polyps. At that age and with no familial history, no further surveillance is requested.
c. Yearly evaluation of symptoms related to polyps, and a clinical evaluation to rule out extraperitoneal tumours.
d. Annual colonoscopy and the removal of all polyps larger than 0.5 cm.
e. Nothing. At that age and with no familial history, the polyps will disappear spontaneously.

Question 4

A girl born without an anus has only one orifice at the perineum. A colostomy has been placed rapidly after birth. At day 5, she presents with an abdominal mass. What is the most probable diagnosis and what therapy would you propose?

a. The mass is probably a hydrocolpos. A cystoscopy should be performed in order to place a catheter into the bladder.
b. The patient probably has pseudohermaphrodism and an associated tumour. Magnetic resonance imaging is the best way to rule out this condition.
c. The distal loop of the colon has filled with meconium. Saline water washouts will help relieve this problem.
d. The patient probably has an intestinal duplication. A colostography will allow confirmation of this diagnosis.
e. The association with renal malformations is frequent. This mass is probably due to hydronephrosis in an ectopic kidney.

Question 5

What is the best method to rule out a Hirschsprung's disease in a 2-year-old child?

a. At this age, a digital examination will allow assessment of the spasticity of the anal canal found in Hirschsprung's disease.
b. A barium enema, as it will show the transitional zone at this age.
c. At any age, only serial colonic biopsies will show the aganglionosis; these can be performed laparoscopically.
d. Rectal suction biopsies.
e. Manometry and a study of the rectoanal reflex. This method is safe and not aggressive. It has a specificity and a sensitivity of nearly 98%.

1. Answer: e
   Comments: A colonoscopy is mandatory to rule out a juvenile polyposis syndrome.
2. Answer: e
   Comments: There is a 100% risk of malignancy whatever the age of presentation. A total colectomy is thus mandatory. As the risk of rectal malignancy is high, the resection should also extend to the rectum.
3. Answer: c
   Comments: This patient probably has Peutz-Jeghers syndrome. Annual surveillance is mandatory. It should include not only a search for signs of polyps, but also for extraperitoneal tumours, for instance in the testicles, or intraperitoneal tumours like pancreas tumours. One should also bear in mind that Peutz-Jeghers polyps are found throughout the entire intestinal tract and not only in the colon.
4. Answer: a
   Comments: A girl born without an anus has an anorectal malformation. If she has only one orifice, this malformation is a persistent cloaca. In high forms of cloaca (i. e. with a long common channel) the sphincters are situated below the confluence of the urethra with the vagina. The urine will then progressively induce a hydrocolpos that, in turn, will cause anuria. The immediate therapy should be the placement of a bladder catheter with the help of a cystoscopy, as the catheter will invariably enter the vagina if placed "blindly". The other procedure could be a vaginostomy. Placing a vesicostomy can be difficult due to the sometimes grotesque size of the vagina.
5. Answer: d
   Comments: Due to the craniocaudal migration of neural crest cells, aganglionosis is always found in the rectum but can extend proximally to any length. Serial colon biopsies can thus be helpful to assess the extent of the aganglionosis, but are useless in the diagnosis of the disease. Rectal biopsies are the only method to rule out Hirschsprung's disease, whatever the age of the patient. The spasticity of the anal canal is very difficult to assess with a digital examination. Barium enema produces many false negative results and is not reliable. The anorectal reflex is sometimes difficult to obtain and is not sufficiently reliable.

44 Pregnancy- and Delivery-Associated Colorectal and Proctological Disorders

Sylvain Meyer and Chahin Achtari

CONTENTS

44.1 Introduction

Normal colorectal physiological function changes during pregnancy. These modifications are generally minor, not serious, and well tolerated by pregnant women. Constipation is the most common problem experienced by pregnant women. Whilst constipation rarely disturbs the course of pregnancy, serious acute colorectal emergencies can sometimes be encountered and should be quickly diagnosed by the colorectal surgeon. Appendicitis is the most common "colorectal" complication seen during pregnancy: to make the diagnosis, it is important to have a high index of suspicion. Specific colorectal inflammatory diseases are generally thought to remain stable during pregnancy, but some larger studies are less optimistic.

Distal venous hypertension in the anorectal venous system due to the enlarged uterus is seen frequently and may magnify local "complications." Hemorrhoids, for example may present with acute thrombotic complications or an anal fissure.

The most important changes to the colorectal system occur during vaginal delivery, especially during forceps-assisted deliveries. Trauma to the anal sphincter neuromuscular structures is unavoidable even during the less "easy" delivery. The "birth trauma" of these structures may be responsible for some degree of fecal incontinence, a serious and humiliating consequence seen in 3–5% of these young women after a delivery that was considered "normal."

44.2 The Colorectal System During Pregnancy: Physiological Modifications

Whether or not physiological and pathological changes in hormone levels are an important cause of constipation during pregnancy remains controversial. In adults aged 15–50 years, constipation is much more common among women. In addition, women often report changes in bowel function during different stages of their menstrual cycle. However, when the whole gut transit rate during the follicular and luteal phases of the menstrual cycle was measured in 18 healthy women in whom ovulation was confirmed biochemically, the mean transit time of 45 h in the follicular phase was

not significantly different from that of 51 h in the luteal phase [1]. Stool weight was also not significantly different between the two phases of the menstrual cycle (132 vs 123 g/day). Some women report that they experience more frequent and weaker bowel contractions on the 1st day of menstruation; this is thought to be due to the action of prostaglandins secreted locally during the 1st day of menstruation, and not to hormones. The rise in serum progesterone is substantially higher during pregnancy than during the luteal phase. The orocecal transit time measured in 15 women during the third trimester of their pregnancies and at 4–6 weeks after delivery was significantly longer during pregnancy than in the postpartum period. Thus, while sex hormones do not appear to have a major effect on bowel function under normal physiological conditions, they may contribute to altered gut function, and thereby to gut symptoms, during pregnancy.

The hormonal modifications during pregnancy are accompanied by a dramatic increase in levels of estrogen and progesterone receptors at different parts of the body. At the colorectal level, the increase in progesterone receptor activity is responsible for physiological slowing of the normal nonpregnant transit.

Recently, dissociated colonic circular muscle cells from women with chronic constipation and nonconstipated women were compared [2]. The cells from patients with chronic constipation showed impaired contraction in response to G-protein-dependent receptor agonists (cholecystokinin and acetylcholine) and to a direct G-protein activator (guanosine 5'-O-3-thiophosphate). Normal contraction was seen in response to G-protein-independent receptor agonists (diacylglycerol and potassium chloride). Western blots showed downregulation of G(alpha)q/11 and upregulation of G(alpha)s in patients with chronic constipation. G(alpha)q mRNA levels were lower and progesterone receptors overexpressed in patients with chronic constipation compared with controls. The authors concluded that slow-transit chronic constipation in women may be caused by downregulation of contractile G proteins and upregulation of inhibitory G proteins, probably as a result of overexpression of progesterone receptors.

44.3 Colorectal Diseases During Pregnancy

44.3.1 Constipation

Bowel modifications have been documented in some clinical studies, and a literature review [3] gave the reported prevalence of constipation during pregnancy as 11–38%. In another study [4], the prevalence of constipation was lower, being 8.9% at 12 weeks gestation and decreasing to 4.2% at 1 year after childbirth. These differences can be explained by the definition of constipation used in the two studies, that in the latter study being more restrictive, as the women were considered to be constipated if they had fewer than three bowel movements a week combined with straining for more than 25% of the time required for a bowel movement. At 12 weeks, constipation was associated with symptoms of painful defecation in 29% of women, a sensation of anal blockage in 42%, and a feeling of incomplete evacuation in 11%, whereas at 36 weeks, all symptoms had slightly decreased (constipation 4.5%, painful defecation 25%, sensation of anal blockage 35%, feeling of incomplete evacuation 9.5%).

Dietary factors may play a role by preventing or alleviating bowel-habit perturbations throughout pregnancy. In a recent study using a prospective 4- to 7-day weighed food diary, an International Physical Activity Questionnaire, and a 7-day bowel-habit diary, dietary factors, physical activity levels, and bowel-habit parameters were assessed and examined concurrently at weeks 13, 25, and 35 of pregnancy [5]. Key dietary factors and physical activity levels were compared between the constipated and nonconstipated groups at each of the three trimesters. Compared with nonconstipated mothers-to-be, constipated participants drank significantly less water during the first trimester ($P = 0.04$), ate more food during the second trimester ($P = 0.04$), and took in less iron ($P = 0.02$) and ate less food ($P = 0.04$) during the third trimester. No significant differences in light, moderate, and vigorous physical activity levels were found between the two groups.

One of the commonly held beliefs about pregnancy is that iron compounds have unpleasant gastrointestinal side effects. To assess the gastrointestinal side effects of iron prophylaxis in pregnancy, a randomized, double-blind study was recently performed on 404 healthy pregnant women allocated to four groups taking a ferrous iron supplement (as fumarate) at daily doses of 20 ($n = 99$), 40 ($n = 100$), 60 ($n = 102$), or 80 mg ($n = 103$) from 18 weeks of gestation to delivery [6]. The iron supplement was predominantly taken at bedtime. Gastrointestinal symptoms (nausea, vomiting, epigastric pain, eructation, pyrosis, meteorism, borborygmi, colic pain, flatulence, constipation, thin feces, and diarrhea), black feces, and laxative use were recorded by interview at 18, 32, and 39 weeks of gestation. The frequencies of gastrointestinal symptoms were not significantly different in the four groups either at inclusion or at 32 and

39 weeks of gestation and thus were not related to the iron dose. This study showed that a supplement of 20–80 mg ferrous iron (as fumarate), taken between meals, had no clinically significant gastrointestinal side effects. The implementation of iron prophylaxis for pregnant women should therefore not be compromised by undue concern about nonexistent side effects.

Constipation complications are rare during pregnancy, but sigmoid volvulus, the third most common cause of colonic obstruction in the United States after cancer and diverticulitis, can be encountered during pregnancy and poses a significant risk to both mother and fetus, requiring a management strategy that varies with each trimester [7]. In the last trimester, this condition can be an indication for cesarean section to make room in the abdomen for surgical treatment of the volvulus.

Volvulus of the cecum can also be observed during pregnancy. We had to perform an emergency cesarean section at 36 weeks to allow our surgeons to perform a right hemicolectomy for a twisted "low-lying" necrotizing cecum in a severely constipated woman confined to bed rest 6 weeks previously because of the high risk of premature delivery (personal observation).

44.3.1.1 Treatment of Severe Constipation During Pregnancy

Most patients respond to dietary measures or simple laxatives.

Dietary Measures

Among dietary measures, evidence supports treatment with fiber supplements with an increase in fluid intake. When fluid intake in healthy volunteers was varied between more than 2,500 ml daily for 1 week and less than 500 ml daily for 1 week in a random order, there was a decrease in stool frequency from 6.9 ± 0.9 to 4.9 ± 0.3 defecations per week ($P = 0.041$) and in stool weight from 1.29 ± 0.20 to 0.94 ± 0.17 kg per week ($P = 0.048$) during fluid restriction [1]. Mean oroanal transit times were similar in the 2 weeks of the study. However, the same authors found a lack of effect on stool weight in a similar experiment in which the change in fluid intake was less (1 or 2 l daily intake for 1 week each in a random order). Irrespective of whether pure water or an isotonic solution was given, there were no differences in bowel habits. Fruit, fresh vegetables, and wholemeal bread with bran are recommended once a day.

Laxatives

The use of a pharmacologic agent for treatment of constipation during pregnancy must be weighed against possible adverse effects. Although most laxatives carry a pregnancy category B or C classification, osmotic laxatives may be beneficial for some patients.

If laxatives must be used, osmotic laxatives should be chosen as first-line treatment: they have a "sponge-like" effect that is responsible for water retention in the fecal bulk, which is thus softened and increased in volume.

Stimulant laxatives (plant extracts, such as bourdaine, and glycerin suppositories) have an irritant effect on the colorectal mucosa, and thus stimulate intestine motility. Abuse of such laxatives can cause proctocolitis, which can be serious.

Short-term use of osmotic or stimulant laxatives is generally reserved for patients who fail to respond to dietary changes or bulking agents [8].

44.3.2 Hemorrhoids

Pregnancy causes a marked increase in pressure in the venous system of the whole pelvic floor. This increases with the duration of the pregnancy, being greatest in the third trimester. At this period, the weight of the mass is greatly increased, reaching about 5–6 kg at pregnancy term. The venous system of the anorectal region is affected by this pressure increase, which prevents venous flow return and can lead to varicose veins in the anal region.

There is no need to treat asymptomatic hemorrhoids during pregnancy unless they become thrombosed. Thrombosed external hemorrhoids (TEH) and anal fissures are two frequent sources of anal pain during childbirth.

44.3.2.1 Thrombosed External Hemorrhoids

In a study in which a proctological assessment was carried out on 165 pregnant women during the last trimester of pregnancy and within the 2 months following delivery, the authors found the prevalence of TEH to be 7.9% in the third trimester and 20% in the postpartum period [9]. In other studies, the prevalence of TEH varied from 24 to 34% in the third trimester and from 5 to 34% in the postpartum period [10].

Meta-analysis using a random-effects model showed that if hemorrhoids become symptomatic with pain,

bleeding, or itching, or become prolapsed, laxatives in the form of fiber have a beneficial effect [9]. The risk of not improving hemorrhoid symptoms and having persisting symptoms was decreased by 53% in the fiber group (risk reduction, RR, 0.47). A significant difference in bleeding in favor of the fiber group was also seen (RR 0.50). Persistent acute thrombosis of a hemorrhoid (a very rare situation) is an indication for surgical incision under epidural or spinal anesthesia.

44.3.2.2 Anal Fissure

Few studies have been published about this pathologic condition. In the relatively small population of pregnant women studied, the prevalence is between 1.2 and 20% in the third trimester of pregnancy and 9–15% in the postpartum period [10]. However, it must be mentioned that the values of 20% during pregnancy and 15% during the postpartum period were obtained in a population of pregnant women attending a specially arranged consultation because of complaints of anorectal disorders, while the other two values were obtained in a population of pregnant women attending a normal pregnancy consultation who mentioned that they had such disorders. The normal conservative treatments are the same as in the nonpregnant state.

44.3.3 Appendicitis

The acute appendicitis incidence among pregnant women is the same as for nonpregnant women (1/1,000). However, the diagnosis is often much less clear during pregnancy, as the appendix is displaced to a higher point by the increased uterine volume, and thus the pain is felt in the upper right abdomen. Apart from the clinical examination, ultrasound imaging can be of some help, but is frequently inconclusive. In this situation, magnetic resonance imaging (MRI) can be performed: the appendix is considered normal if its diameter is less than or equal to 6 mm or if it is filled with air and/or oral contrast material, while an enlarged, fluid-filled appendix (>7 mm in diameter) is considered abnormal [11].

Appendix perforations are 1.5–3.5 times more frequent during pregnancy, increasing the risk of fetal distress or even fetal death. A case of postpartum necrotizing fasciitis necessitating disarticulation of the hip has been described in a 33-year-old woman who was delivered at 35 weeks of gestation, in which the source was a perforated appendix [12].

Treatment for appendicitis is essentially surgical, requiring a higher and perhaps more extensive incision than the habitual McBurney incision. Many surgeons offer laparoscopic appendectomy (LA) as an alternative to open appendectomy (OA). Few studies during early pregnancy have compared the effects of LA versus OA on the fetus and the outcome of the pregnancy: one study demonstrates that the OA approach may be preferred over appendectomy in pregnant patients during the first two trimesters of pregnancy because of unexplained fetal losses in the LA group compared to the OA group [13].

In very rare cases with women near term, a cesarean section to make room for surgery can be discussed.

44.3.4 Perforated Meckel's diverticulum

Perforated Meckel's diverticulum is a rare complication of pregnancy. However, it must be considered in all cases of intra-abdominal disease, as its presentation is similar to that of appendicitis. Prompt diagnosis and appropriate treatment are imperative in these cases due to the high rate of perforation leading to fetal and maternal morbidity and mortality [14].

44.3.5 Inflammatory Bowel Diseases (Crohn's Disease and Ulcerative Colitis)

There are few interactions between these specific inflammatory bowel diseases (IBDs) and pregnancy. In a recent study [15], the authors found that pregnancy did not modify the evolution of IBD. No deleterious effects on IBD were seen during pregnancy, delivery, or the postpartum period. Control of IBD was the main obstetric factor for prognosis. Pregnancy can be advised if the disease is quiescent, with rapid and efficient management of possible flare-ups. The delivery route must be determined on a case-by-case basis, considering pregestational anal continence and the clinical presentation of the perineum. The same results were obtained in another study [16]. Pregnancy did not influence disease phenotype or surgery rates, but was associated with a reduced number of flares in subsequent years.

Another study [17] gave less optimistic results, demonstrating a higher incidence of adverse pregnancy outcomes in IBD patients. A Medline literature search was performed to identify studies reporting outcomes of pregnancy in IBD patients and a random-effect meta-

analysis used to compare outcomes between women with IBD and normal control patients. A total of 3,907 IBD patients (1,952 – 63 – with Crohn's disease and 1,113 – 36% – with ulcerative colitis) and 320,531 controls were reported in 12 studies; women with IBD had a 1.87-fold increased incidence of premature deliveries (<37 weeks gestation), a greater than 2-fold incidence of low birth weight (<2500 g), a 1.5-fold higher incidence of cesarean section, and a 2.37-fold increase in congenital abnormalities.

One study has assessed the risk of the fetus developing IBD [18]. Maternal smoking during early pregnancy reduces the risk of the child being hospitalized with a diagnosis of IBD, whereas severe neonatal infections may increase the risk. Thus, exposure to certain agents during the fetal and neonatal periods seem to affect the risk of IBD later in life.

There is no reason why women suffering from such pathologic states should not become pregnant. However, if they experience an acute reactivation of inflammation of the bowel during pregnancy, they should be treated vigorously and without delay to avoid an increased risk of spontaneous abortion, impaired growth problems, and fetal death.

Current treatment should be continued, including corticoids, sulfasalazine, and the new salicylate derivatives (mesalazine and olsalazine). Immunosuppressive treatment should be stopped if possible, although azathioprine appears to be safe during pregnancy.

These women can be delivered vaginally unless they have anorectal fistulas or abscesses, in which case a cesarean section should be performed.

44.3.6 Pseudomembranous Enterocolitis

This can be present from 4 days after the start, and up to 5 weeks after the end of antibiotic treatment. Onset is acute, with fever, diarrhea, and abdominal cramps. Stool cultures show the presence of *Clostridium difficile* and its toxins. Treatment comprises rehydration, bedrest in an isolated room, and the suspension of antibiotic treatment. Vancomycin (no intestinal absorption) or metronidazole can be prescribed if necessary.

44.3.7 Ogilvie Syndrome

Ogilvie syndrome is also named acute colonic pseudoobstruction. This is a complication that occurs in hospitalized patients with serious underlying medical or surgical conditions and is characterized by acute colonic dilatation in the absence of mechanical obstruction. The pathogenesis is incompletely elucidated, but changes in autonomic nervous system function are likely to play a role, as are metabolic and pharmacologic factors. Early diagnosis and appropriate intervention are critical in this disorder, which is responsible for considerable morbidity and mortality. Ogilvie syndrome involves the whole colonic segment and is generally seen after cesarean section or even normal delivery. The symptoms begin a couple of days after delivery with painful constipation or diarrhea, the patient being in otherwise good health. The abdominal computed tomography scan shows cecal and ascending colonic segment distension, which should be monitored daily to avoid cecal perforation (there is a very high risk of perforation with a colon diameter of 9–12 cm).

Treatment should be conservative (hydration, nasogastric aspiration, and parasympathomimetic drugs to increase the peristalsis). In cases in which there is a high risk of cecal perforation, a decompression procedure (i.e., beginning with colonoscopy, then, in the event of failure, surgical cecostomy or even a right hemicolectomy) should be continued [19].

44.4 Colorectal and Proctological Diseases During and After Delivery. Effect of the "Birth Trauma" on the Anorectal Structures

The neuromuscular structures of the posterior pelvic floor and especially the anal sphincter complex are highly biomechanically stretched during the expulsive phase of labor by the descent of the baby's head and by the delivery of the head and shoulders. Posterior pelvic floor trauma has two physiopathological mechanisms: stretch injury of the pudendal nerves and direct trauma to the muscles and nerves.

44.4.1 Stretch Injury of the Pudendal Nerves

The posterior branch of the pudendal nerve emerges from the Alcock canal and innervates the neuromuscular structures of the anal sphincter complex. The nerve is stretched during the descent of the head and its distal motor latency is increased from 1.8 ms (normal value) to 2.4 ms (pathological value) when measured at 4–6 weeks after delivery. This parameter recovers to normal values in 90% of patients by 3 months after delivery and remains at 2.4 ms in the other 10% [20]. However, pudendal nerve motor terminal la-

tencies (PNMTL) measure the velocities of the most rapid fibers (which are also the largest) and not those of the smallest ones (i.e., the C and a-delta unmyelinated fibers), which can also be injured. In a similar study, measurement of PNMTL and intra-anal squeeze pressures demonstrated that PNMTL returned to predelivery levels at 2 months after delivery, whereas the intra-anal squeeze pressure was still low at 6 months after delivery, and this effect was probably permanent [21]. The pudendal stretch injury effect is complex and can present as a demyelinating lesion and/or an axonal lesion when assessed by quantitative electromyogram (EMG) of the anal sphincter. An abnormal EMG picture was found in 38% of postdelivery women investigated for fecal incontinence [22]. It can be concluded that quantitative EMG abnormal patterns can be seen after any "normal" delivery, even in the absence of abnormal PNMTL, anal sphincter ultrasonographic abnormalities, or fecal incontinence symptoms [23].

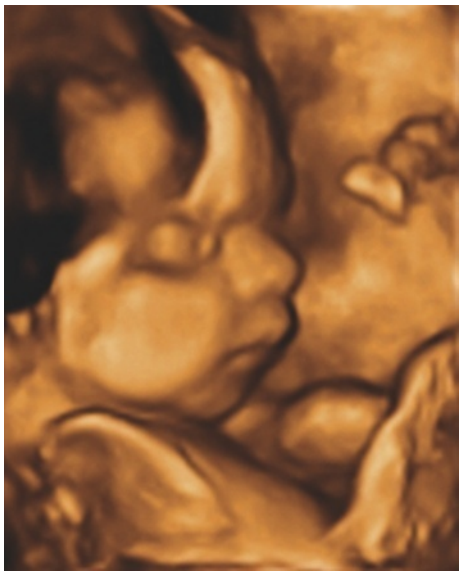

Fig. 44.1 The "pelvic floor terrorist"

44.4.2 Direct Trauma to the Muscles and Nerves

This involves the neuromuscular structures of the lower part of the levator ani (pubococcygeus and puborectal part) and the external-internal anal sphincter complex. The descent of the "pelvic floor terrorist" (i.e., the baby's head; Fig. 44.1) is responsible for a stretch effect on the different neuromuscular units of the pelvic floor. In an MRI modeling study of the female pelvis, this stretching effect on bearing down was found to increase the length of the levator ani muscular bundle to three times that seen normally at rest [24]. This stretch effect was greatest in the muscle bundles of the puborectal muscle and was correlated with the diameter of the baby's head.

When these levator ani muscle defects were assessed by MRI in a population of 160 primiparous women after vaginal delivery, 32 women (20%) had such defects, and in 29 they were located in the lower portion of the levator ani, sometimes bilaterally [25]. These muscle defects can be clinically assessed by introducing a finger into the vagina during pelvic floor squeezing, a gap being felt in the muscle mass. These muscle defects are now beginning to be assessed by 3D-4D evaluation of the pelvic floor (Fig. 44.2).

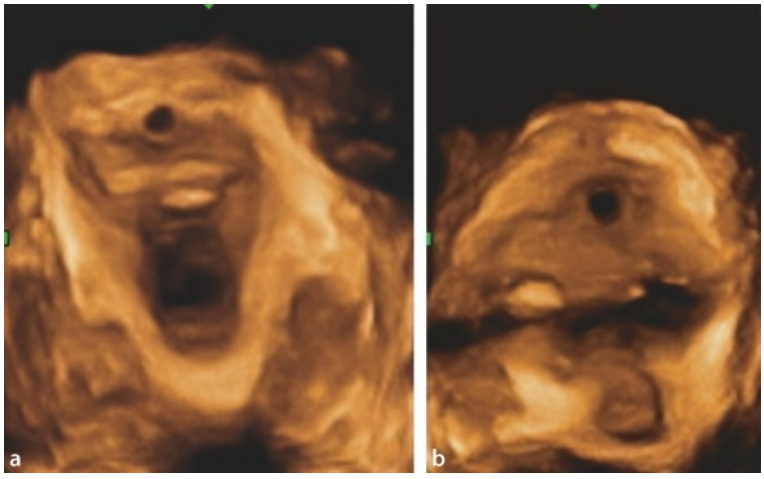

Fig. 44.2 **a** Intact pelvic floor musculature seen with ultrasound 3D reconstruction. **b** Pelvic floor musculature with right and left tears

Partial laceration of the levator ani can affect anorectal continence and should also be assessed during evaluation of postpartum fecal incontinence and the anal sphincter complex. The best solution is to recognize them during delivery and suture them at this time.

The anal sphincter complex is the anatomic region of the perineum most highly stretched during a vaginal delivery, both spontaneous or forceps/vacuum assisted, as the "bearing down" vector of the forceps is directed at this region.

Although fecal incontinence is present in 3–5% of women after their first delivery, the incidence of an "occult" lesion of the anal sphincter is much higher: 35% of 202 primiparae had ultrasonographic defects of the anal sphincter 6 weeks after delivery, and 79% of these had the defect at 6 months after delivery [26]. Two other studies found an occult anal sphincter lesion in 26% of 118 or 28% of 150 primiparous women [27, 28]. No women had occult defects after cesarean section.

Sphincterometric measurements of the anal sphincter complex before and after delivery have been published: a decrease of 8 cmH_2O in anal pressure at rest was found in primiparae with or without fecal incontinence, whereas the decrease in anal pressure during pelvic floor contraction was significantly greater in women with fecal incontinence (20 cmH_2O compared to 8 cmH_2O in women without fecal incontinence) [29]. The authors conclude that each delivery has some deleterious effect on anal sphincter function, even in women without fecal incontinence.

Correlating anal sphincterometry and occult anal defects seen on sonography, a study showed that the intra-anal pressure during pelvic floor contraction decreased from 96 cmH_2O (predelivery level) to 48 cmH_2O in women with ultrasonographic occult anal defects, whereas it decreased from 96 cmH_2O (predelivery level) to only 88 cmH_2O in women without any echographic defects [30].

44.5 What are the Obstetric Risk Factors for Anal Sphincter Trauma?

"Early bearing down" compared to "late bearing down" has no significant effect on postdelivery fecal incontinence (26% vs 38%) [31]. The duration of the second phase of labor was found to have no deleterious effects on fecal continence in one study [32], whereas other studies found that a prolonged second phase has deleterious effects, with a higher prevalence of grade III and IV tears [33, 34].

The delivery of the head in a posterior position, which occurs in 3–4% of all vertex deliveries, results in a sevenfold higher risk of anal sphincter lesion than delivery with the head in the normal anterior position [35]. The same is true for the application of manual pressure to the fundus of the uterus during delivery (Kristeller maneuver), which increases the risk of anal sphincter damage by four- to fivefold [36].

The routine use of episiotomy has now been abandoned and is now only performed when essential. Comparing routine episiotomy and episiotomy on demand, a meta-analysis of the Cochrane database found a lower incidence of posterior trauma in the second group [37]. Analysis of another database also found no advantage of routine episiotomy in the prevention of fecal incontinence [38].

Comparing mediolateral and median episiotomy, the risk of fecal incontinence due to grade III and IV anal sphincter lesions was significantly increased with median episiotomy [39, 40].

If necessary, vacuum extraction should be preferred to forceps extraction where possible. Compared to a noninstrumental delivery, the risk of postdelivery fecal incontinence is increased 7 times by vacuum extraction and 12 times by the use of forceps [41]. Other studies also found a higher risk of postdelivery fecal incontinence using forceps, but the effect was less marked, being 5 times higher when used in combination with mediolateral episiotomy in one study [34] and 3.3 times higher in another [42].

The birth weight of the baby seems to play a weak, but significant, role in the postdelivery appearance of fecal incontinence, the RR being between 1.7 [25] and 2.2 [43].

44.6 What is the Correlation Between Occult Echographic Anal Defects and the Presence of Fecal Incontinence?

Different studies have produced conflicting results. In three studies, of the 31% of primiparae women with occult anal sphincter defects, only 14% had fecal incontinence; the same percentage was found in multiparae [26, 27, 44]. Another study was less optimistic, the probability of fecal incontinence being as high as 77–82% in women with an occult ultrasound-diagnosed anal defect [45].

The correlation between anal sphincterometric measurements and fecal incontinence is more pronounced, with a greater sphincter tear resulting in a lower anal sphincterometry value [46].

Anal sphincter rupture should be evaluated at the moment of delivery. The latest classification according to the International Continence Society recommendations of 2004 [47] is:

1. Grade I: tear of the vaginal mucosa or the skin of the perineum
2. Grade II: tear of the perineal musculature not involving the anal sphincter
3. Grade III: tear of the anal sphincter:
   a. Grade IIIa: <50% of the external sphincter width
   b. Grade IIIb: >50% of the external sphincter width
   c. Grade IIIc: tear of the internal sphincter
4. Grade IV: tear of the anal mucosa (Fig. 44.2)

We believe that it is of utmost importance to carefully inspect the anal region after delivery and, in dubious cases, explore and repair the posterior perineal trauma with the woman well-anesthetized and using the better light available in the operating room (Fig. 44.3). Using these recommendations, an audit of third-degree perineal tears was performed in 1997 and a reaudit in 1998 and 1999 [48]. Following the introduction of these recommendations, there was a significant increase in the number of repairs performed in theater using Prolene and adequate anesthesia. At follow-up, there was a transient improvement in defecatory symptoms in the 1st year of the protocol only (45% in 1997, 32% in 1998, and 50% in 1999, $P < 0.01$). There were more cases of Prolene suture migration. The authors concluded that the introduction of these recommendations was followed by improved performance of appro-

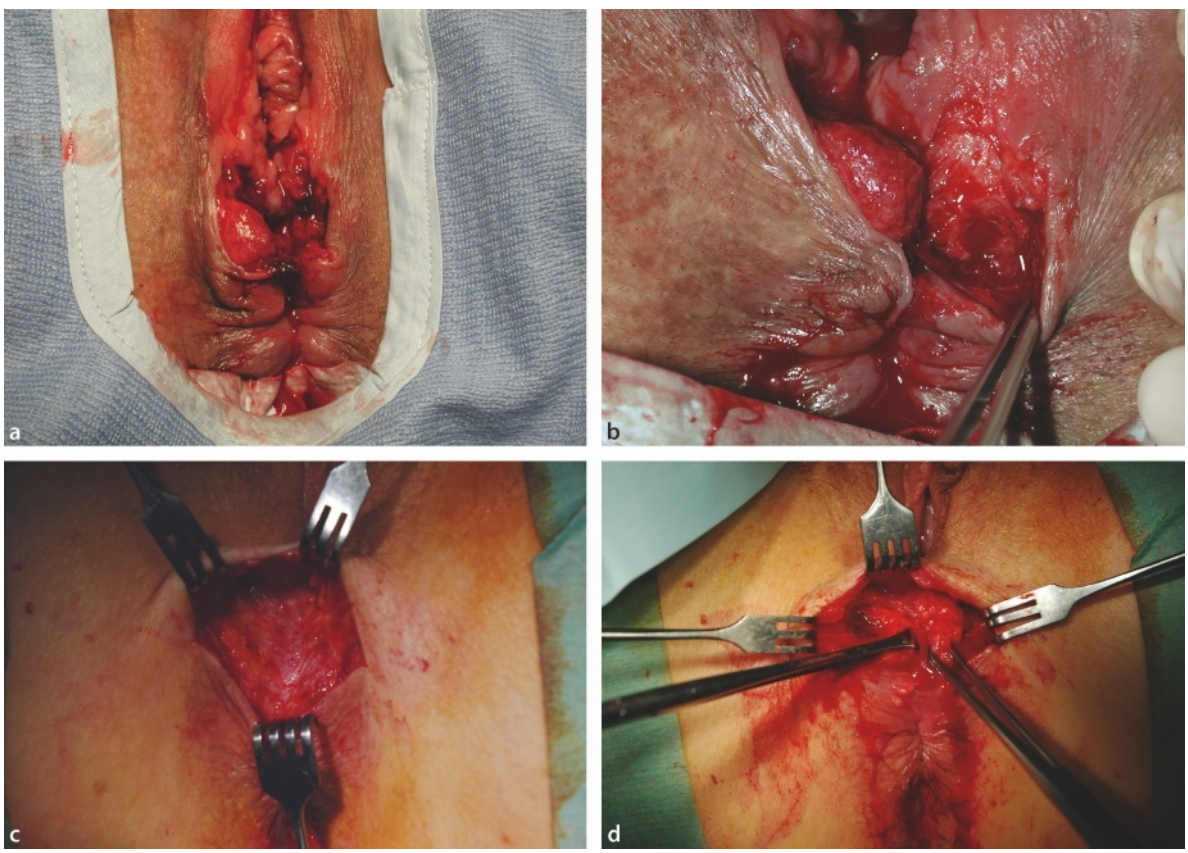

Fig. 44.3 **a** "Fresh" stage IV anal rupture immediately after baby's delivery. **b** "Fresh" stage IV anal sphincter rupture in the operating room: the two extremities of the anal sphincter are easy to distinguish before suturing. **c** Stage IIIc anal sphincter rupture 6 months after delivery: the two extremities of the anal sphincter are less distinct. **d** Stage IIIc anal sphincter rupture 6 months after delivery: the two extremities of the anal sphincter after dissection and refreshing their extremities

priate repair, but without a sustained improvement in fecal symptoms at follow-up.

44.6.1 Suturing of the Anal Sphincter

This suture is generally done with separate polyglycolic long-term resorbable sutures after identification of the two extremities of the external anal sphincter. The internal anal sphincter should also be sutured when possible (sometimes the edema is so extensive that this anatomical structure is difficult to see).

The two recognized methods for the repair of a damaged external anal sphincter are end-to-end (approximation) repair and overlap repair; the latter is generally chosen. Meta-analysis [49] showed that there was no significant difference in perineal pain, flatus incontinence, and fecal incontinence between the two repair techniques at 12 months, but there was a significantly lower incidence of fecal urgency and lower anal incontinence score in the overlap group. The overlap technique was also associated with a statistically significant lower risk of deterioration of anal incontinence symptoms over 12 months. There was no significant difference in quality of life between these two techniques. The conclusions of this Cochrane Database evaluation are that since the experience of the surgeon was not addressed in the studies reviewed, it would be inappropriate to recommend one type of repair over the other.

44.7 What is the Prevalence of Persistent or De Novo Fecal Incontinence in Women with a Sutured Anal Sphincter Tear?

Even when the repaired sphincter appears intact, symptoms of anorectal dysfunction can be present and the long-term success of subsequent anal sphincteroplasty for the treatment of fecal incontinence is discouraging, with fecal continence rates of less than 20% after 5 or more years [50].

A review of 20 studies [51] found that 37% of women with a sutured anal sphincter have symptoms of fecal incontinence after delivery, but there was great variation in the duration of the follow-up period (1 month to 13 years) and in the number of women included (15–177).

Another study compared controls with women with sustained third- or fourth-degree lacerations during childbirth [52]. The women in the sphincter laceration group were more likely (23.0%) to have bowel incontinence than those in the control group (13.4%; $P < 0.05$). The incidence of poor bowel control was nearly tenfold higher in women with fourth-degree lacerations (30.8%) than in those with third-degree lacerations (3.6%; $P < 0.001$). Macrosomia (odds ratio, OR, 2.19), forceps-assisted delivery (OR 4.75), and vacuum-assisted delivery (OR 3.51) were associated with a higher risk of third- and fourth-degree lacerations in women with midline episiotomy (OR 2.24), but not mediolateral episiotomy (OR 0.66). More than half of the women had new onset of urinary incontinence after delivery and reported several lifestyle modifications to prevent leakage. The authors concluded that women with third- and fourth-degree lacerations are more likely to have bowel incontinence than women without anal sphincter lacerations, and that fourth-degree lacerations appear to affect anal continence more than third-degree lacerations.

A longer follow-up of such women was used in a study using questionnaires sent to women 18 years after delivery [53]. This study gave more optimistic results: severe fecal incontinence was reported by 13% of 259 women after a sphincter tear and by 7.8% of 281 controls (RR 1.7). Only 6.4% of the reports of fecal incontinence were attributable to a sphincter tear. The authors conclude that fecal incontinence is frequently reported, even by women who have not sustained an anal sphincter tear, and that only a small fraction of cases of fecal incontinence can be attributed to sphincter tears.

It appears that anal sphincter function is never entirely restored by primary repair of anal sphincter tears at delivery, highlighting the importance of preventing the injury.

Static problems of the pelvic floor are frequently seen after delivery, with a 3% incidence of grade 3 and 4 prolapses. The problems of rectoceles, cystoceles, and uterine prolapse will be discussed in Chap. 45.

Concluding this chapter, it is worth mentioning the information provided to women consulting a French language Internet site: "The frequency of fecal incontinence after first delivery is 13% with, in most cases, gas incontinence, even if 1–2% of the primiparae have not the predelivery ability of her liquid stool continence. This latter percentage may seem low, but, as there are 700,000 deliveries a year in France, it represents between 7,000 and 14,000 young women suffering from fecal incontinence to liquid stools."

44.8 Conclusion

Colorectal problems are diseases that form a common area of interest for gastroenterologists, colorectal surgeons, and gynecologists-obstetricians. Each practitioner of these specialties should be aware of the distinctive features of these illnesses and be able to establish an interdisciplinary collaboration for the optimal treatment of women suffering from one of these disabling and humiliating problems.

Colorectal-specific pregnancy-induced diseases are frequent, but their impact on the quality of the daily life of the future mother is generally low. The incidence of acute colorectal illness is also not frequently seen during pregnancy, but their missed diagnosis, especially for appendicitis, could seriously compromise the health of the young mother and consequently the life of her living child. Such acute situations can lead to obstetric emergencies, themselves leading to specific obstetric decisions.

The trauma to the neuromuscular structures of the posterior pelvic floor, and in particular the anal sphincter complex, during spontaneous and especially forceps-assisted deliveries is perhaps the most important serious colorectal complication. Occurring in young women after what is often described as the "defining moment of her life" and considered as the most magical and important, fecal incontinence is a "daily-life trouble" complication, an "unspeakable" woman's problem that is frequently hidden and that should be taken seriously, investigated, and treated. Reeducation, pelvic floor exercises, biofeedback techniques, surgical repair, and when all else has failed, sacral nerve modulation, are available. Alleviating rather than curing the symptoms of this humiliating condition is usually the rule.

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Self-Assessment Quiz

Question 1

Constipation during pregnancy has a prevalence of:

a. 5–10%
b. 11–40%
c. 40–70%
d. >70%
e. <5%

Question 2

Constipation during pregnancy is more frequently seen:

a. In the first trimester of pregnancy
b. In the second trimester of pregnancy
c. In the third trimester of pregnancy
d. After childbirth
e. Among young pregnant girls

Question 3

Which assertion is true for appendicitis during pregnancy?

a. The incidence for acute appendicitis is higher during pregnancy.
b. The diagnosis of acute appendicitis is to make in the pregnant state compared to the nonpregnant state.
c. Appendix perforation occurs 1.5–3.5 times more frequently during pregnancy, increasing the risk for fetal distress.
d. Treatment for acute appendicitis during pregnancy is essentially conservative with antibiotics.
e. Appendicitis resolves spontaneously during pregnancy.

Question 4

Which physiopathological mechanisms is responsible for anal sphincter trauma?

a. The increased volume of the uterus
b. The pressure against the pubic symphysis during the descent of the head of the baby
c. The bearing efforts during the dilatation phase
d. The stretch injury of the pudendal nerves and the direct trauma to the muscles and nerves of the posterior compartment
e. The increased pressure in the venous system of the anorectal region

Question 5

What is the prevalence of fecal incontinence among women having delivered one or more children?

a. 3–5%
b. 10–15%
c. 15–20%
d. >20%
e. <3%

1. Answer: b
2. Answer: a
3. Answer: c
4. Answer: d
5. Answer: a

45 Gynecological Problems Relevant to Coloproctology

Chahin Achtari and Sylvain Meyer

CONTENTS

45.1 Introduction

During the embryonic period the urorectal septum divides the cloaca into an anterior urogenital sinus, which will eventually become the bladder and urethra, and a posterior anorectum. Pelvic organs therefore share a common origin and assume a similar role: as a reservoir allowing storage and the timely evacuation of urine or feces, thus maintaining continence. Pelvic organs also have a common support complex, the pelvic floor, which is made of muscles and fasciae. The pelvic organ physiology and nerve supply are also very similar. In women, the middle compartment is occupied by the vagina and uterus, the former contributing to pelvic organ support through its close connections to the pelvic sidewalls. Not surprisingly, functional and anatomical dysfunction of the different pelvic compartments frequently coexist. Urinary incontinence (UI) is present in 10–40% of patients consulting for fecal incontinence [14], and symptoms of anorectal incontinence are present in one-third of women consulting for UI. Pelvic organ prolapse also interferes with function by impairing either evacuation or continence. It is therefore of paramount importance for all specialists dealing with pelvic floor dysfunction to be aware of coexisting troubles in other pelvic compartments.

45.2 Pelvic Organ Prolapse

Pelvic organ prolapse is prevalent among women, with about 10% of the female population requiring surgical correction for this condition [18]. In a questionnaire survey in the general population of women between the ages of 40 and 60 years, 15% reported pelvic heaviness, 4% genital bulge, and 12% use of fingers in the vagina or perineum to aid defecation [9]. Swift [22] demonstrated in a population of routine gynecologic consultation that about half of parous women presented some degree of vaginal relaxation. The symptoms of pelvic organ prolapse include dragging pain and vaginal bulging or exteriorization, and may be associated with UI.

The vagina and uterine cervix are supported by the endopelvic fascia (EPF), a layer of dense connective tissue covering the levator ani muscle. The anterior vaginal wall is in close contact with the bladder and urethra; as such, an anterior vaginal prolapse is also called a cystocele or a urethrocele, depending on the location of the prolapse. Anterior vaginal prolapse is the preferred terminology, as physical examination cannot distinguish which organ is actually protruding behind the vaginal wall. After hysterectomy, the vaginal vault is associated with the peritoneum of the pouch of Douglas, so that vault prolapse can be difficult to differentiate from an enterocele. The posterior vaginal wall is in contact with the rectum and the anal canal.

Each compartment and each level of the vagina have a specific support [4], allowing the pelvic organs to remain in their anatomic position. The levator ani muscle complex represents the main support for pelvic organs. It is divided in different parts, the anterior (puborectal muscle) acting as a sling, pulling the pelvic organs forward, and the posterior part (pubococcygeal and iliococcygeal muscles) forming a plate on which the pelvic organs can rest. These muscle have a constant basal (tonic) contraction for support and can be contracted voluntarily (phasic activity), contributing to urinary and anorectal continence. The levator muscles are innervated directly on their inner surface by the anterior branches of S3–S5 sacral nerve roots [3].

The EPF is a layer of dense connective tissue containing blood vessels and nerve fibers, which contributes to pelvic organ support by "stabilizing" or anchoring the pelvic organs to the pelvic sidewalls. Apical support of the vagina and cervix is represented by the parametrium, a ligamentous complex including the uterosacral and cardinal ligaments, which suspend the upper third of vagina and cervix to the pelvic side and back wall. The middle third of the vagina is stretched horizontally and attached to the lateral pelvic wall by short connective tissue fibers (paracolpium) to the arcus tendineus fascia pelvis, a thickened band of EPF extending from the back of the pubic bone to the ischial spine. The distal third of the vagina is strongly and directly fused to the surrounding organs and tissue including the urethra, the pubovisceral part of the levator ani muscle and the perineal body.

The urethrovesical junction needs to be maintained in a high retropubic position to be able to resist sudden increases in abdominal pressure and maintain urinary continence [6]. The urethra is attached distally to the perineal membrane, and to the posterior aspect of the pubic bone in its middle portion (by the pubourethral ligaments). Muscular attachments to the levator ani muscle contribute to the stability of the urethra by contracting and providing posterior support during the Valsalva maneuver.

Anterior-compartment support is traditionally represented by the pubocervical or Halban's fascia, which was initially described as a discrete sheet of EPF separating the anterior vaginal wall from the bladder. More recent studies have shown that the anterior vaginal wall and the EPF form a single layer that is referred to as the viscerofascial layer. Posteriorly, support is provided by the rectovaginal (Denonvilliers') fascia or septum. Recent anatomic dissections have shown the existence of a posterior tendinous arch anchoring and stabilizing the middle posterior vaginal wall [13].

Anterior vaginal prolapse (Fig. 45.1) can be caused an avulsion of the lateral support (paravaginal defect) or to a tear in the pubocervical fascia (central defect) [20]. Tears can happen at the apical insertion of the EPF on the cervix or can be a longitudinal midline or lateral tear. Tears in the pubocervical fascia are usually treated vaginally by a midline plication of the fascia. Paravaginal defects are treated either abdominally (or laparoscopically) or through a vaginal approach. The paravaginal space is developed along the pelvic sidewall to demonstrate the arcus tendineus fascia pelvis. The lateral aspects of the vagina are then sutured to the pelvic sidewall. Unfortunately the recurrence rate is around 15% with either technique. New techniques involving the insertion of a synthetic mesh or xenografts have been developed to decrease the recurrence rate. Complications linked to the synthetic meshes include infection, erosion and dyspareunia [2].

Anterior vaginal wall prolapse is often associated with posterior or vault prolapse, as the risk factors are similar. Abdominal or laparoscopic sacrocolpopexy is one of the most efficient procedures for treating apical prolapse (Fig. 45.2). It can be performed through an abdominal or laparoscopic route [11]. It involves placement of a synthetic mesh between the vaginal apical walls and the sacral promontory. Complications include erosion of the adjacent organs such as the rectum or ureter. Other procedures have been described through the vaginal route, which involve a suture between the vaginal wall and the sacrospinous ligament [19], the prespinous fascia [15], or the uterosacral ligaments [21]. The vaginal route is preferred when correction of other compartments is required.

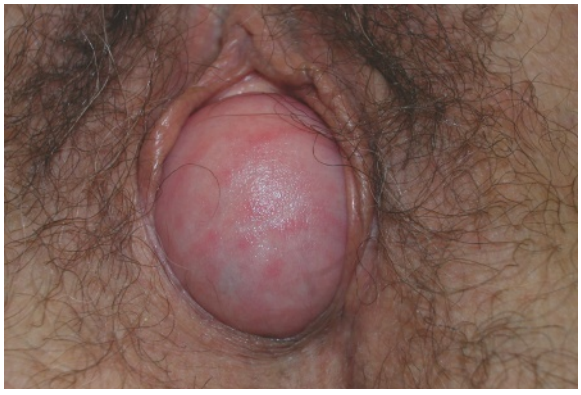

Fig. 45.1 Grade 3 cystocele

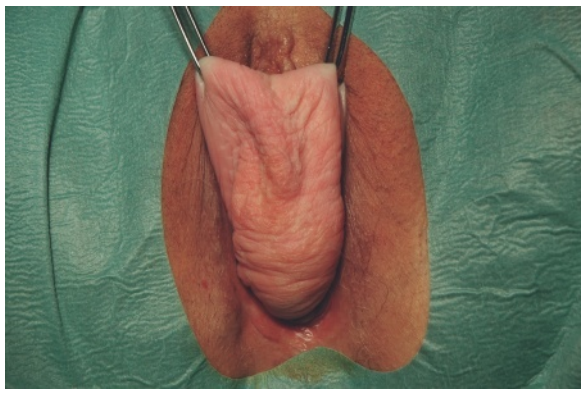

Fig. 45.2 Vaginal vault prolapse

Rectocele is considered to be caused by a defect in the rectovaginal septum (Denonvilliers' fascia) and/or a tear in the perineal body [5]. The consequences of a tear of the rectovaginal fascia and perineal body are different, the former leading to a mid-vaginal rectocele and the latter to a protrusion of the distal third of the vagina. Correction of the posterior compartment is usually performed through a vaginal approach by either suturing the tears in the endopelvic fascia or through a midline fascial plication. The perineum is repaired by suturing the perineal membrane (perineorraphy) or by levator ani muscle plication. The latter gives excellent anatomic results at the expense of a high rate of dyspareunia [1]. Use of mesh in the posterior compartment is controversial given the excellent results (85–90%) of traditional repairs. A randomized trial by Milani et al. [16] comparing the traditional levator plication with and without mesh reinforcement concluded that dyspareunia was significantly more frequent after mesh usage, although other authors found the reverse in nonrandomized trials [8]. One randomized study compared transanal and transvaginal approaches for rectocele repair. Patients' symptoms were significantly alleviated by both operative techniques. The transanal technique was associated with more clinically diagnosed recurrences of rectocele and/or enterocele [17].

45.3 Urinary Incontinence

UI is a frequent symptom, with up to 25% of the female population complaining of urine leakage at some stage of their life [10]. Severe incontinence is present in about 10% of women between the ages of 50 and 59 years. The prevalence reaches a first peak around the age of 50 years and then drops during the seventh decade, increasing again significantly from the age of 70 years.

UI is defined as the involuntary loss of urine that is a social or hygienic problem and should be objectively demonstrable. UI may happen with an increase in intra-abdominal pressure such as that caused by physical exercise, coughing, or sneezing (called stress incontinence), or following a strong, sudden desire to void (urgency; called urgency incontinence). Mixed UI is a condition where both symptoms coexist. UI is rarely reported voluntarily by patients and should be part of the history-taking of all patients presenting with pelvic floor dysfunction. Careful gynecological examination should be performed to evaluate the potential association with pelvic organ prolapse and to objectively demonstrate loss of urine.

A simple way of evaluating the symptoms and severity of urinary symptoms is to ask patients to fill a voiding diary over a period of 1–3 days. Liquid intake, frequency of voiding and urinary leakage are reported on a chart. The voiding diary gives a lot of useful information about voiding habits and allows objective follow-up during and after treatment. The severity of symptoms may also be evaluated through disease-specific questionnaires.

First-line treatment for UI includes pelvic floor muscle training and bladder training, as well as a change in lifestyle – such as weight loss, stopping smoking, and reducing caffeine and tea intake. In the case of a poor response to this initial management, a complete urodynamic test (including uroflowmetry, cystometry, and sphincterometry) is necessary to confirm the diagnosis and orientate the therapeutic approach. Uroflowmetry measures the urinary flow rate and postvoid residual. Filling cystometry provides information about bladder stability, filling sensation, capacity, and compliance. The occurrence of bladder contractions during filling cystometry is called detrusor instability and is associated with urgency incontinence and symptoms of bladder overactivity. Treatment of this condition includes anticholinergic medication, with recent development of specific M3 receptor antagonists. Other treatment options such as intradetrusor botulinum toxin injections or sacral nerve stimulation are available for intractable detrusor instability.

Urodynamic stress incontinence is diagnosed when urine leakage is observed during the Valsalva maneuver or coughing with a full bladder in the absence of bladder contraction. Stress incontinence is caused by anatomic and/or functional impairment of the urethra. The capacity of the urethra to maintain a closure pressure higher than intravesical pressure is dependent upon its muscular layer integrity (measured by sphincterometry) and its fascial attachment, which maintain the urethra in a high retropubic position. The pelvic floor muscles contribute to urethral support, which is the rationale for pelvic floor muscle training in the initial management of stress incontinence. Surgical treatment aims at restoring urethral support. Suspension of the vaginal wall to the iliopectineal ligament (Burch colposuspension) through an abdominal or laparoscopic approach has been the most popular and efficient operation for treating stress incontinence. Recently, a randomized controlled study has demonstrated that the tension-free vaginal tape (TVT) procedure (a minimally invasive procedure with insertion of a synthetic sling under the midurethra) was as efficient as Burch coloposuspension in treating stress inconti-

nence and that it has fewer postoperative complications and is associated with a shorter hospital stay and quicker return to normal activity [23]. Therefore TVT, and more recently, the transobturator tape procedure have progressively become the preferred procedures, with a success rate of 85–90% [12].

45.4 Gynecologic Cancer

A variety of other conditions may be of interest for coloproctologists, especially gynecologic cancer. Most of the gynecologic cancers may invade the surrounding pelvic organs.

45.4.1 Cervical Cancer

Uterine cervical cancer has fortunately become a rare entity in developed countries. However, it remains the most frequent gynecologic cancer in the developing countries, affecting mainly middle-aged women. It is now recognized that cervical cancer, like anal canal cancer, is linked to local infection by the human papillomavirus (HPV). Local progression is slow and may occur in any direction, laterally into the parametrium, cranially into the uterus, caudally into the vagina, anteriorly into the bladder, and posteriorly into the rectum. Dissemination occurs via lymphatic spread to the pelvic and para-aortic lymph nodes. In the absence of lymphatic spread, surgical treatment is warranted and involves radical hysterectomy combined with pelvic lymphadenectomy. Centropelvic recurrence without lymphatic spread requires pelvic exenteration. Lymph node invasion implies adjuvant pelvic radiotherapy that may be extended to the para-aortic lymph nodes, thus involving radiation of the small bowel with the risk of developing immediate and long-term side effects if the delivered dose is higher than 30 Gy.

45.4.2 Ovarian Cancer

The cornerstone of the surgical treatment for ovarian cancer is cytoreduction. Every effort should be made to excise the primary cancer and all visible metastases, leaving as small an amount of cancer as possible within the peritoneal cavity. Survival after adjuvant chemotherapy has been demonstrated to be significantly longer when metastases left in the peritoneal cavity were ≤1.5 cm in size, and even better if ≤5 mm. Hysterectomy and bilateral salpingo-oophorectomy associated with omentectomy, peritoneal biopsies, and appendectomy is the gold standard. When the disease involves focal areas of small or large intestine, resection should be performed if this allows removal of all abdominal metastases.

45.5 Endometriosis

Endometriosis is a prevalent condition among women of childbearing age. Endometrial cells and glands gain access to the peritoneal cavity through retrograde menstruation and implant on the peritoneal surface. Endometriosis may involve any peritoneal surface, but is more frequently described on dependent locations such as the pouch of Douglas, usually involving the uterosacral ligaments or prevesical space. Lesions are recognizable at different stages, from the red inflamed area at the beginning of the process, to the blueish firm area in the center of a retraction process due to fibrosis. Strong local inflammatory reactions promote adhesion formation, which can result in a frozen pelvis. Endometriosis may also involve the ovaries, forming cysts, which are easily recognizable because of their chocolate-colored content. Symptoms include infertility and pelvic pain, usually culminating in the premenstrual period.

Deep endometriosis is a particular form of the disease that involves invasion of the rectovaginal septum [7]. Symptoms include severe dyspareunia, dyschezia, and sometimes rectorrhagia. Vaginal examination may reveal foci of specific blue, indurate, and painful lesions sometimes also involving the uterosacral ligaments. Magnetic resonance imaging is the best imaging test for deep endometriosis, showing the extent and invasion of the surrounding organs by the disease. Treatment is surgical and involves complete excision of the lesion, which sometimes requires rectal resection. Gonadotropin-releasing hormone agonists can be used in the preoperative period to reduce symptoms. It also reduces the inflammatory process and the size of the lesion, but is insufficient as a treatment, as recurrence always happen at the end of the medical treatment.

45.6 Conclusion

Colorectal surgeons dealing with pelvic floor dysfunction should be aware of commonly associated gynecologic pathologies such as UI and pelvic organ prolapse.

Collaboration between colorectal surgeons and gynecologists in specialized pelvic floor clinics should be encouraged to share their experience and improve the management of perineal pathologies.

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Self-Assessment Quiz

Question 1

Urinary stress incontinence is:

a. Due to detrusor instability
b. Always associated with pelvic organ prolapse
c. Caused by bladder neck hypermobility
d. Best treated with anticholinergic medication
e. Less frequent than urgency incontinence

Question 2

Vaginal vault prolapse:

a. Is always associated with urinary incontinence
b. Is caused by loss of support by uterosacral ligaments
c. Is caused by a defect in the Denonvilliers' fascia
d. Always causes sexual dysfunction
e. Should not be treated with synthetic mesh

Question 3

Deep endometriosis:

a. Is always associated with intraperitoneal endometriosis
b. Is best diagnosed by ultrasound imaging
c. Can cause rectal bleeding
d. Should be treated with gonadotropin-releasing hormone agonists
e. Is frequently asymptomatic

Question 4

Cervical cancer:

a. Is caused by infection by human papilloma virus (HPV)
b. Is best treated by chemotherapy
c. Spreads mainly through the hematogenous route
d. Should be treated surgically when the parametrium is invaded
e. Lymph node status is part of the initial staging

Question 5

Ovarian cancer:

a. Can be screened by annual ultrasound
b. Is usually discovered at early stage
c. Is the most frequent genital cancer
d. Is usually associated with pain and vaginal bleeding
e. Can be associated with breast cancer

1. Answer: c
   Comments: Urinary stress incontinence is caused by a combination of urethral hypermobility and intrinsic urethral sphincter deficiency.
2. Answer: b
   Comments: Vaginal vault prolapse is caused by loss of support by the uterosacrocardinal ligaments complex. Treatment includes suspension to the sacrospinous or to the uterosacral ligaments and abdominal or laparoscopic sacrocolpopexy with mesh. Synthetic or biologic meshes can also be used vaginally.
3. Answer: c
   Comments: deep endometriosis is located in the rectovaginal septum and may infiltrate the rectal wall. The best treatment is surgical excision.
4. Answer: a
   Comments: A prophylactic vaccine against high-risk HPV has been developed and offers protection against cervical cancer in young women. The most important prognostic factor in cervical cancer is lymph node status, but this is not part of the clinical International Federation of Gynecology and Obstetrics staging. It can be assessed by pelvic lymph node dissection or imaging (magnetic resonance imaging, positron emission tomography-computed tomography).
5. Answer: e
   Comments: Ovarian cancer is linked to genetic factors such as *BRCA* in 5–10% of cases, and is associated with breast cancer.

46 Urologic Conditions in Coloproctology

Dirk Westermann and Urs E. Studer

CONTENTS

46.1 Introduction

The anatomical proximity of the rectum and genitourinary organs lends itself to overlapping disease manifestations, and this should be considered by the respective specialties. There exists the unavoidable tendency to make a differential diagnosis based on one's own specialty, but this has the unfortunate potential of resulting in the mismanagement of a patient. In this chapter we discuss the urologic presentations of rectal disease as well as the rectal presentations of urologic disease.

46.2 Prostatitis

46.2.1 Epidemiology/Classification

The wide scope of recommended treatments for prostatitis indicates how little is known about what causes the condition and how to diagnose and treat it. Yet prostatitis remains the most common reason for outpatient urologic visits in men under the age of 50 years. Epidemiologic studies report that 11–16% of men have either a current diagnosis or a history of prostatitis [2, 27, 35] and that by the age of 85 years, the accumulative probability of being diagnosed with either acute or chronic prostatitis is 26% [36]. In fact, data from the National Center for Health Statistics show that visits for prostatitis occur more frequently than for either prostatic hyperplasia or prostate cancer [35]. Prostatitis is classified into four categories, as demonstrated in Table 46.1. Although type I prostatitis (acute bacterial prostatitis) is relatively straightforward to diagnose with recurrent cystitis and positive cultures of expressed prostatic secretions for uropathogens in between cystitis episodes,

Table 46.1 National Institutes of Health (NIH) prostatitis classification system

Category	Type
I	Acute bacterial prostatitis
II	Chronic bacterial prostatitis
III	Chronic prostatitis/chronic pelvic pain syndrome
IIIA	Inflammatory
IIIB	Noninflammatory
IV	Asymptomatic inflammatory prostatitis

it accounts for only approximately 5% of patients with prostatitis (National Institutes of Health classification, category II). Chronic prostatitis is much more common and is more difficult to diagnose and treat. Of the types of chronic prostatitis, chronic bacterial prostatitis is rare, accounting for only 5% of prostatitis patients. More than 90% of cases of prostatitis are chronic abacterial prostatitis.

46.2.2 Causative Agents of Bacterial Prostatitis: Categories I and II

Acute prostatitis is an infection of the prostatic gland resulting in lower urinary tract infections (UTIs) or sepsis, while chronic bacterial prostatitis is associated with recurrent lower UTIs and results from bacteria residing within the gland. The most frequent organism identified in acute prostatitis is *Escherichia coli* (65–80%), while *Pseudomonas aeruginosa*, *Serratia* species, *Klebsiella* species, and *Enterobacter aerogenes* are responsible for the remaining 20–35%. Common organisms responsible for chronic bacterial prostatitis, as suggested by the literature, are listed in Table 46.2. Other potentially important organisms include: (1) *Neisseria gonorrhea*, which was a common cause of prostatitis in the pre-antibiotic era; (2) genital viruses, particularly herpes simplex type 1, herpes simplex type 2, and cytomegalovirus; (3) fungi [19, 30, 31].

46.2.3 Clinical Presentations of Bacterial Prostatitis: Categories I and II

Acute bacterial prostatitis often presents with acute onset of fever, chills, perineal pain, and general malaise. Obstructive and irritative voiding symptoms – typically urinary frequency, urgency, and dysuria – may occur secondary to infravesical obstruction (benign prostate enlargement, prostate cancer, bladder-neck sclerosis, urethral strictures), neurogenic bladder outlet obstruction (herniated vertebral discs, spinal cord injury, neurologic diseases), or foreign bodies such as Foley catheters. Digital rectal examination (DRE) reveals a boggy prostate that is extremely tender to palpation. Prostatic massage and transurethral manipulations should be avoided to avert urosepsis or septicemia.

Chronic bacterial prostatitis is suggested by a history of documented recurrent UTIs. Between episodes, patients may either be completely asymptomatic or experience pelvic pain. On DRE, the prostate may be normal or indolent, but may also be enlarged and softer than normal.

46.2.4 Introduction and Clinical Presentation: Categories III and IV

Chronic pelvic pain syndrome (CPPS), which can be either inflammatory and noninflammatory, is the most common type of chronic prostatitis, yet it is the least understood and the most problematic to treat. The challenge arises as a result of inconclusive published clinical trials as well as the unclear nature of the disorder itself. Further more, the symptoms are generalized and nonspecific, predominantly pain localized to the perineum, penis, suprapubic area, or even diffusely through the pelvis. Pain occurring during or after ejaculation is another common complaint. Voiding symptoms include urgency, frequency, hesitancy, and weak and interrupted flow. The quality of life of these patients is often poor, and their associated symptoms can be assessed by the Chronic Prostatitis Symptom Index questionnaire. A tender and painful prostate, with pain often radiating into the tip of the penis or the testicles is elicited on physical examination.

Table 46.2 Organisms responsible for chronic bacterial prostatitis

Traditional and accepted agents	Potential agents
Escherichia coli	*Staphylococcus saprophyticus*
Klebsiella pneumoniae	*Staphylococcus aureus*
Proteus mirabilis	*Staphylococcus epidermidis*
Pseudomonas aeruginosa	*Mycoplasma genitalium*
Enterococcus faecalis	*Ureaplasma urealyticum* *Chlamydia trachomatis*

The etiology of CPPS is complex and multifactorial; likely culprits include infection, inflammation, autoimmunity, and neuromuscular spasms. In additions, many patients with identical presenting symptoms may improve with different therapies targeting the aforementioned causes. With regard to infections, *Chlamydia trachomatis* is potentially responsible for chronic nonbacterial prostatitis, with antibodies being found in up to 30% of cases [24]; *C. trachomatis* was also identified in paraffin-embedded secretions in 31% of men with histologic evidence of prostatitis, compared with none in patients with benign prostatic hyperplasia without inflammation [43]. However, since the detection of *Chlamydia* is challenging, its causative role has not fully been established. Other important factors include functional obstruction, such as bladder-outlet dysfunction or spasm of the pelvic floor muscles (pseudodyssynergia), which can result in prostatic duct reflux of urine and subsequent irritation, inflammation, and pain.

Inflammatory prostatitis (category IV) is an asymptomatic disease that is diagnosed by histologic examination of benign prostatic hyperplasia resection and prostate cancer specimen, or prostate biopsies. Patients are devoid of symptoms, and once the diagnosis has been made there is no need to treat the disease.

46.2.5 Diagnosis of Prostatitis

Acute bacterial prostatitis, although associated with a tender and often diagnostic DRE, requires a midstream urine culture to complete the diagnosis. Since midstream urine cultures are often inconclusive for chronic prostatitis, further detailed examination is required. The three-glass urine collection test will determine whether the source of infection is urethral, bladder, or prostatic (Fig. 46.1). The initial 10 ml of voided urine (VB1) represents the urethral specimen. Midstream urine is evaluated from the VB2 collection and represents bladder urine. The VB3 specimen is the first 10 ml of urine voided after prostatic massage, and correlates with expressed prostatic secretions. Chronic bacterial prostatitis is defined as a tenfold increase in bacteria in VB3 when compared with VB1 and VB2. Diagnosis of category IIIA CPPS requires excessive leukocytosis in VB3 without evidence of uropathogenic bacteria. In category IIIB CPPS, neither bacteria are cultured nor is

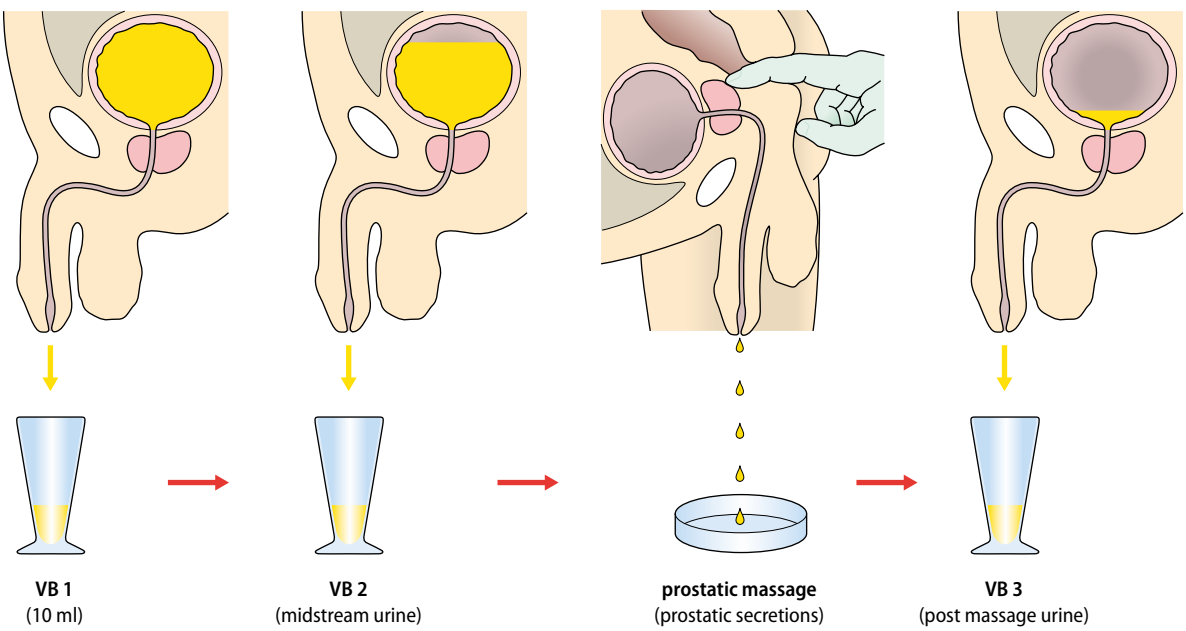


Fig. 46.1 Three-glass urine collection. The initial 10 ml of voided urine (*VB1*) represents the urethral specimen. Midstream urine is evaluated using the *VB2* collection and represents bladder urine. The *VB3* specimen is the first 10 ml of urine voided after prostatic massage and correlates with expressed prostatic secretions

there significant leukocytosis on microscopic examination of VB3.

46.2.6 Treatment

When the etiology of prostatitis is bacterial, antimicrobial therapy is successful in eradicating the bacteria within the prostate and in relieving symptoms. Initial therapy consists of a combination of broad-spectrum penicillins (i.e., ampicillin) and aminoglycosides (i.e., gentamicin), second- or third-generation cephalosporines, or fluoroquinolones (i.e., ciprofloxacin), depending on the severity of the illness. Once the acute infection has been alleviated, an oral fluoroquinolone should be continued for 2–4 weeks. In severe cases, a suprapubic cystostomy to divert urine is advisable.

Chronic prostatitis caused by *E. coli* and other Gram-negative organisms also requires 4 weeks of fluoroquinolone treatment. Ciprofloxacin has demonstrated a 70% efficacy in eradicating Gram-negative bacteria. Penicillin derivates and nitrofurantoin have poor prostatic penetration, and so their use is not advocated unless as a prophylactic agent. Cotrimoxazol and doxycycline are considered to be second-line agents (Table 46.3).

Of interest, antimicrobial treatment appears to provide symptomatic relief in patients with nonbacterial prostatitis (category IIIA). Patients with CPPS also benefit from alpha-blockers, which are further mainstays in the treatment of prostatitis. The bladder neck and prostate are rich in alpha-receptors, which when blocked results in reduced outflow obstruction with subsequent improvements in urinary flow and diminished intraprostatic ductal reflux. Combination therapies such as antimicrobials and alpha-blockers exist; nonsteroidal anti-inflammatory drugs and antidepressants can also be beneficial. Nonpharmaceutical options include biofeedback, electrostimulation of the pelvis, transurethral hyperthermia, and electromagnetic therapy, but these alternatives lack controlled studies, defined entry criteria, and quantified measurements of patient responses. To this day, there are no standardized recommendations for the treatment of asymptomatic prostatitis (category IV).

Table 46.3 Treatment of chronic bacterial prostatitis

Therapy for chronic bacterial prostatitis (NIH II)
First choice:
Fluoroquinolone (4 weeks)
Second choice:
Trimethoprim
Cotrimoxazol, doxycycline (3 months)
Additional alpha-blocker (6 months)

46.3 Enterovesical Fistula

A fistula is an epithelialized tract between two hollow organs or a hollow organ and the body surface. Fistulas exist when proliferative processes, trauma, or inflammation ignore organ boundaries. Genitourinary fistulas are diverse in clinical presentation, etiology, and morbidity, and may involve the gastrointestinal tract, vascular system, lymphatic system, and skin.

Urinary calculi, iatrogenic trauma, diverticulitis, radiation therapy, transitional cell carcinoma, and tuberculosis are among the causes of ureterocolic fistulas [32, 33]. Patients with ureteroalimentary fistulas may present with a myriad of complaints including flank pain, hematuria, recurrent UTIs, pneumaturia, fecaluria, and diarrhea. Imaging studies such as intravenous urography, retrograde pyelography, and delayed contrast-enhanced computed tomography (CT) help make the diagnosis.

Bladder fistulas occur most often in the setting of diverticulitis, gastrointestinal or genitourinary neoplasms, inflammatory bowel disease, and bladder carcinoma [25]. Radiation therapy, pelvic surgery, and foreign bodies have also been implicated. The site of bowel involvement is predictive of the etiology. Colovesical fistulas most often arise from diverticular disease and represent 65% of all diverticular fistulas [47]. Colon adenocarcinoma may also be responsible. Rectovesical fistulas are almost always due to neoplasm or trauma [28]. The clinical presentation of colo- or rectovesical fistulas includes recurrent cystitis, pneumaturia, fecaluria, fever, and abdominal pain. CT is the primary noninvasive imaging modality for suspected disease: typical suggestive findings are intravesical air and focal bladder-wall thickening; nevertheless, it is often unable to demonstrate the fistulous tract itself (Fig. 46.2a). Barium enema studies detect 35% of all fistulas, and the voiding cystogram may show the fistulous tract in only about 10–40% (Fig. 46.2b) [29, 39]. Cystoscopy may reveal a fistulous opening or an area of inflammation (Fig. 46.2c). However, if orally administered, charcoal is utilized then cystoscopy becomes more valuable be-

cause charcoal debris can be seen entering the bladder through the fistula tract in about 50–85% of cases. Colonoscopy can also be used and will reveal the fistulous opening in 0–55% of cases [3, 17]. Another historically interesting but simple diagnostic test is the oral intake of poppy seeds, which when detected in urine, confirms an enterovesical fistula [46].

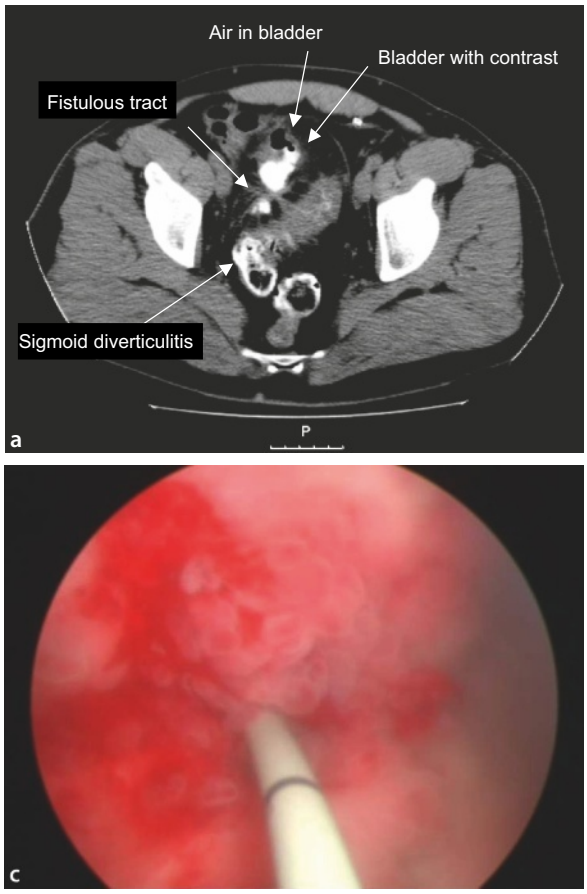
While conservative treatment options do exist, the majority of patients require open surgical intervention. Resection of the diseased colonic segment is often necessary with either a subsequent primary anastomosis or Hartmann's procedure. The bladder defect is managed by en-bloc excision of the fistula with a cuff of bladder.

46.4 Ureteric Injury During Colorectal Surgery

46.4.1 Introduction

All disciplines of pelvic surgery (e.g., vascular, gynecological, visceral) involved in ureteral injury require surgeons to operate in the pelvis and retroperitoneum. Gynecological procedures are at relatively high risk for urological complications followed by interventions in the field of visceral surgery. The incidence of iatrogenic ureteric injuries varies, but rates between 1% and 10% are reported. If unrecognized, ureteric trauma may lead to loss of the affected kidney or even threaten the patient's life.

Due to the close proximity of the ureter and the colon and rectum, ureteric injury is a potential complication in colorectal surgery, especially in the face of advanced carcinoma or inflammatory masses that may infiltrate or displace the ureter, making its identification difficult. Most injuries follow low anterior rectosigmoid and abdominoperineal resection, where the ureter is at particular risk for being injured during mobilization of the sigmoid, ligature of the inferior mesenteric artery, and take-down of the lateral rectal ligaments.



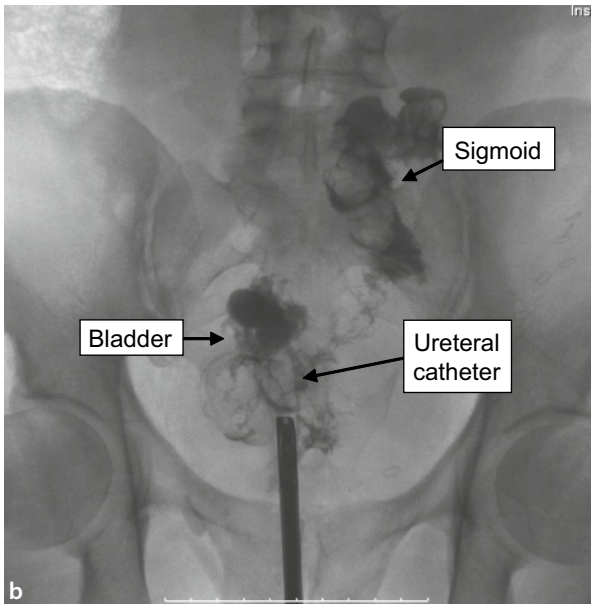


Fig. 46.2 **a** Computed tomography shows air in the bladder and contrast in both the bladder and sigmoid in a patient with colovesical fistula due to sigmoid diverticulitis. **b** Cystogram on the same patient, demonstrating the fistula with contrast injected into the bladder fistula site via an open-ended ureteral catheter, and then transversing into the sigmoid. **c** Cystoscopic view of the fistula, with a ureteral catheter placed in the fistulous tract

46.4.2 Clinical Presentation and Diagnosis

Different forms of ureteral injury can occur. Typical lesions are complete or partial suture ligation, complete or partial crush by clamps, partial incision of the ureter, complete transection, devascularization from skeletonization, and segmental resection because of involvement of the ureter in the tumor.

Identification of ureteral trauma during surgery is of utmost importance. Only 20–30% of ureteral injuries are recognized at the time of surgery. Patients require about 1.8 procedures to restore ureteral continuity when a lesion is detected postoperatively, compared to 1.2 procedures for injuries detected at operation. In addition, prompt recognition or ureteral injuries with immediate repair results in fewer complications or loss of renal function [13].

If the ureteric lesion is not recognized during surgery, anuria, flank pain, gross hematuria, hydronephrosis with or without fever, and urine extravasation through the wound drains may indicate ureteral injury in the early postoperative period. Abdominal CT will show urine extravasation to the retroperitoneum or abdominal cavity. Intravenous pyelogram and retrograde pyelogram document the extent of stricture and distance between the injury and the bladder. In combination with a cystogram, they also rule out ureteral or vesical fistula.

46.4.3 Therapy

If ureteral injury is suspected during surgery, 5 ml of indigo carmine with an intravenous fluid bolus will help identify the ureteral defect. The optimal treatment of ureteric injuries is immediate repair, if feasible. The principles of management of ureteral injury include ureteral mobilization with preservation of the vascularization, debridement of devitalized ureteral tissue, and a spatulated tension-free anastomosis.

A ureteral incision or tear is managed by approximation of the ureteral edges with interrupted sutures, provided the tissue is viable. Mobilization of both ureteral ends is necessary to allow tension-free anastomosis of the ureteroureterostomy. In the case of longer incisions, it is preferable to place an intraluminal stent to assure proper drainage. If the ureteric tissue around the tear/incision is mechanically damaged or poorly vascularized, then a segmental resection with a spatulated end-to-end anastomosis is preferable (Fig. 46.3).

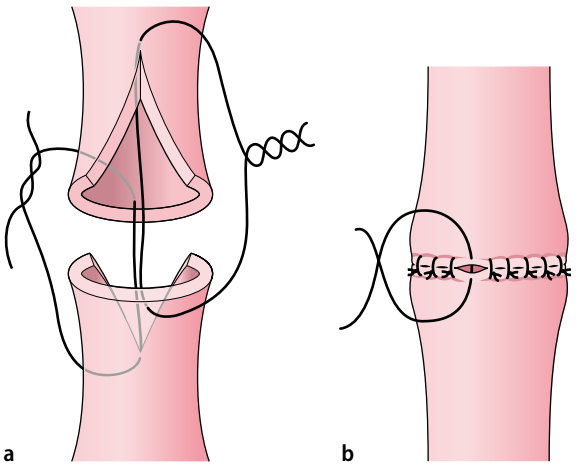


Fig. 46.3a,b End-to-end ureteroureterostomy. **a** The ureters are spatulated for an oblique anastomosis. **b** Approximation of the edges with interrupted sutures

Defects of up to 5 cm can be managed by this technique.

The management of transected or resected ureters depends on the site of injury.

46.4.3.1 Lower Ureteral Injuries

Injuries to the lower third of the ureter, particularly if the defect is long, are best treated by ureteroneocystostomy, as the blood supply of the distal ureter might be compromised after injury or transection. To avoid tension, the psoas hitch technique, in which the fixation of the mobilized anterolateral bladder wall to the psoas muscle is combined with a nonrefluxing submucosal implantation, may be necessary.

46.4.3.2 Midureteral Injuries

If the defect is < 5 cm, then the proximal and distal remnants of the ureter must be mobilized for a tension-free end-to-end anastomosis as described above. When necessary, the kidney may be mobilized downward to give additional length to the proximal ureteral end. If the defect is longer or approximation of the two ends is not feasible without tension, then the Boari flap plastic (a tunneled strip of the anterior bladder wall) can bridge defects up to the lower pole of the kidney. Preconditions are good bladder capacity, normal com-

pliance of the bladder wall, and no history of previous radiation therapy to the bladder.

46.4.3.3 Upper Ureteral Injuries

An end-to-end anastomosis is usually possible after mobilization of the kidney and the distal ureter. If the defect is longer than 5 cm, then replacement of the injured ureter by an ileal segment interposed between the renal pelvis and the bladder should be used. In general, however, major reconstructive surgery should not be combined with major exenterative surgery, which itself lasts several hours. Compromised wound healing, dehiscence of the anastomosis, and urinary fistulas, for example, may be the consequence, namely in patients who have had previous radiation therapy. In such cases, definitive treatment should be deferred until the patient is stable enough to undergo a long-lasting repair. Therefore, if the ureter cannot be easily reanastomosed or reimplanted into the bladder at the time of the ureteral injury, then the urine of the respective kidney should simply be diverted. Urine diversion is realized by insertion of a stent into the proximal injured ureter, which is then brought out through the skin (so-called ureterostomia in situ). As an alternative, the distal end of the proximal ureteral stump is closed watertight intraoperatively with a titanium clip. A percutaneous nephrostomy is placed immediately after surgery. Definitive ureteric reconstruction can then be attempted in a second stage, but usually not before 3 months.

46.5 Rectourethral Fistula

Adverse effects and injuries to the rectum can occur as a complication of open retropubic, perineal, or laparoscopic radical prostatectomy. Changes in stool regularity and fecal incontinence are reported in perineal prostatectomy due to the anatomic proximity to the anal sphincter in 2.7–7% of cases [14].

The majority of rectal injuries are discovered and repaired intraoperatively. In certain cases, a temporary diverting colostomy may be necessary. Factors predisposing to intraoperative rectal injury include a history of pelvic radiation therapy, previous rectal surgery, and transurethral resection of the prostate [26].

Although considered rare (1–2%), a devastating complication is a rectourethral fistula, which can occur after pelvic radiotherapy, surgery for prostate cancer or colorectal cancer, cryotherapy, high-intensity focused ultrasound treatment, and in locally advanced malignant prostatic or rectal disease. Patients present with anorectal pain, fecaluria, mucus discharge, diarrhea, rectal ulceration, or bleeding [41]. Time from radiation to fistula is a median of 25 months [20, 41], but patients must be followed continuously because late developments of fistulas do occur. In the setting of radical prostatectomy, most fistulas arise from unrecognized rectal injury and become manifest after removal of the transurethral catheter.

For precise diagnosis, a CT of the pelvis, cystoscopy, proctoscopy, retrograde urethrogram, and cystogram are required. Patients initially require a bowel diversion (colostomy or ileostomy) to decrease the possibility of sepsis and reduce inflammatory changes of the fistula and the surrounding tissues. Urinary diversion is optimally achieved with a suprapubic catheter. In some cases rectourethral fistulas close in this manner without further surgery of the urinary tract.

The surgical approach consists of resection of the fistula through a perineal approach. Excision of the surrounding scar tissue is necessary until normal tissue is reached. The rectal defect is closed by one layer of mucosa and submucosa and a second layer of muscularis at right angles. In a second step, the urethra is closed with a third layer of 4-0 synthetic absorbable suture. Healthy tissue such as fat, peritoneum, omentum, or gracilis muscle is placed in between. Another method is the use of buccal mucosa graft interposition to close the prostatic urethral defect. In all cases adequate mobilization of both the rectum and urethra, and tension-free suture lines are of utmost importance. Since the external urethral sphincter may be injured during the initial or reparative surgery, patients must be informed that future transurethral resection of the prostate or bladder-neck incision is contraindicated and will cause urinary incontinence.

An alternative method of repair is the transrectal transsphincteric procedure (York-Mason procedure). The patient is placed in a prone position and an incision is made from the tip of the coccyx through the rectal wall and anal sphincters. The fistula is visualized and excised as described above. Finally, the posterior wall is closed with special attention to accurate approximation of the sphincters.

Only in rare cases do the patient's comorbidities rather than the extent of surgical or radiation injury determine whether an abdominoperineal rectum resection is required.

46.6 Rectal Complications Associated with Prostate Cancer

46.6.1 Introduction

Prostate cancer is the most common non-skin cancer among men in the western hemisphere and it is the second leading cause of cancer death among men in the USA. With the advent of prostate-specific antigen (PSA) screening, several men with prostate cancer may not have clinically significant disease and so their diagnosis may neither improve their lifespan nor their quality of life. However, the extent to which overdiagnosis represents a true problem relates to the consistency with which this diagnosis results in treatment. With stage migration, men are diagnosed at earlier stages and with lower-risk features, yet they are less likely now than a decade ago to undergo watchful waiting.

DRE and serum PSA are the most useful tools for evaluating patients for prostate cancer. PSA should be measured in any man older than 50 years of age with a life expectancy greater than 10–15 years. When cancer is suspected, prostate biopsy is recommended regardless of the PSA level, because 25% of men diagnosed with prostate cancer have PSA levels less than 4.0 ng/ml.

Therapeutic options for clinically localized prostate cancer include watchful-waiting protocols, radiation therapy, and radical prostatectomy. Radiation therapy consists of either external-beam radiation therapy (EBRT) or brachytherapy (BT) and is a treatment option for patients with localized prostate cancer devoid of adverse features. BT is performed using either low-dose-rate BT, which involves the permanent implantation of multiple radioactive seeds into the prostate (Fig. 46.4), or high-dose-rate BT, which uses a single high-intensity radioactive source stored in a computer-controlled machine called a remote afterloader. The afterloader sends and retracts this single source sequentially into each implanted needle, delivering the radiation in a short time. For EBRT, treatment is delivered in daily dose fractions of 2 Gy, given five sessions per week with a four-field approach and rotation technique in which parts of the bladder and rectum also receive high doses. Dose escalation with simultaneous reduction of the rectal dose has been made possible by intensity-modulated radiation therapy (IMRT). With this procedure, dose calculation is achieved by computerized treatment-planning algorithms based on acquisition of data derived from CT images. Nevertheless, biochemical and tumor-specific outcome is dose-dependent, but dose escalation from 60 to 84 Gy also causes both an increase in the number and severity of side effects.

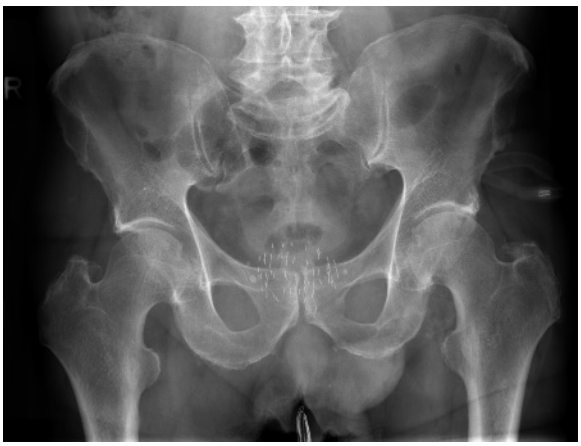


Fig. 46.4 Radioactive seeds implanted into the prostate to treat prostate cancer

46.6.2 Rectal Toxicity-Related Lesions

BT- or EBRT-induced acute rectal toxicity is defined as radiation-induced injury of the rectum during or within 3 months of radiotherapy. Chronic radiation proctitis can either be prolongation of the acute phase or a de novo episode after a latent period of at least 90 days [7]. Radiation-induced acute proctitis is associated with edema and fibrosis of arterioles in the luminal crypts of the colonic mucosa [6, 38]. With increased fibrosis, the mucosa becomes more friable and likely to bleed. An increased risk for developing radiation-induced proctitis is related to patients with underlying vascular disorders such as diabetes, hypertension, peripheral vascular disease, and chronic inflammatory bowel disease. With these conditions there is also an increased risk for fistula formation. Rectal adverse effects are more common during the first 6 weeks, but long-term complications are of a more serious nature. In BT, proctitis is one of the most common side effects, with an incidence of 2–72% [12, 44]. Although it is normally mild and self-limiting, symptoms can persist in up to 14% of cases in the 3rd year [44], with a peak incidence of grade 1 and 2 toxicity reported at 8 months after radiation. Interestingly, the addition of EBRT to BT does not impact the incidence of rectal morbidity

Table 46.4 Acute gastrointestinal (GI) complications according to the Radiation Therapy Oncology Group morbidity grading system

Grade 1	GI increased frequency or change in quality of bowel habits not requiring medication/rectal discomfort not requiring analgesics
Grade 2	Diarrhea requiring parasympatholytic drugs/mucous discharge not necessitating sanitary pads/rectal or abdominal pain requiring analgesics
Grade 3	Diarrhea requiring parenteral support/severe mucous or blood discharge necessitating sanitary pads/abdominal distension (flat-plate radiograph demonstrates distended bowel loops)
Grade 4	Obstruction, fistula, or perforation; GI bleeding requiring transfusion; abdominal pain or tenesmus requiring tube decompression or bowel diversion

[12]. Rectal morbidity presenting as diarrhea, urgency, fecal incontinence and tenesmus can also significantly impair quality of life (Table 46.4) [18, 40].

The prevalence of late and severe toxicities such as fistulas, stricture formation of the rectum, or secondary cancers after pelvic radiotherapy has been estimated to be 5% at 10 years [5]. Older series concerning three-dimensional conformal EBRT report increased rates of rectal bleeding and discomfort [40, 42, 48], with the cumulative incidence of grades 2 and 3 toxicity at 12 months being approximately 40% and 25%, respectively [45]. More recent studies report a decrease in late rectal toxicity (LRT) that is attributed to modern radiation techniques: with IMRT grade I, LRT can be reduced to 12.6%, while grade II–III toxicity is reduced to about 2.2% [21], and with high-dose BT, grade I LRT rates are 5–8%, with no reported grade II toxicities [15].

46.6.3 Management

There is currently no standard protocol for managing these patients. First-line therapy includes anti-inflammatory agents such as rectal prednisolone, rectal sulfate suspension, betamethasone enema, and oral medications such as metronidazole, mesalazine, and sulfasalazine. Alternatives are short-chain fatty acids (SCFAs), of which butyric acid is the most important. SCFAs exert a trophic effect on the colonic mucosa and have a dilational effect on the arteriolar walls; they are administered in the form of an enema.

Sucralfate is given rectally; it stimulates epithelial healing and forms a protective barrier. Formalin may sclerose and seal fragile neovascularized telangiectasias in radiation-damaged tissue, preventing further bleeding.

A review of the literature reveals that sucralfate may be a better option than anti-inflammatory agents, which in turn may have greater effect if used with metronidazole. In addition, rectal hydrocortisone may be better than betamethasone [5]. Endoscopic thermal coagulation therapy is reserved for focal bleeders rather than diffusely friable mucosa.

46.6.4 Locally Advanced Prostate or Bladder Cancer and Rectal Obstruction

Several reports have described rectal obstruction from adenocarcinoma of the prostate or transitional cell bladder cancer that clinically resembles intrinsic colorectal carcinoma. Obstructive symptoms, which may include rectal bleeding, are similar to those of primary colorectal neoplasm. Obstruction may occur by direct local extension of the enlarged prostate into the rectal lumen, or can be secondary to invasion of the rectum resulting in an annular lesion. Mucosal integrity is suggestive of an extrinsic process such as prostate or bladder cancer [10]. Transrectal or transvesical biopsies confirm the diagnosis and determine the therapeutic measures: in prostate cancer, treatment is androgen deprivation, resulting in shrinkage of the prostate, while in bladder cancer neoadjuvant or palliative chemotherapy is the appropriate choice, followed possibly by pelvic exenteration.

On the other hand, local recurrent or bulky primary tumors of the rectum may infiltrate adjacent structures such as the prostate, bladder, or ureter in 5–12% of cases [1, 4, 8, 34]. If the resection margins are clean, invasion of the abdominal wall or urinary bladder by colorectal carcinoma does not affect the prognosis [9]. The surgical approach to these advanced tumors often encompasses the urinary tract, and the most important aim is a complete resection with no tumor left behind.

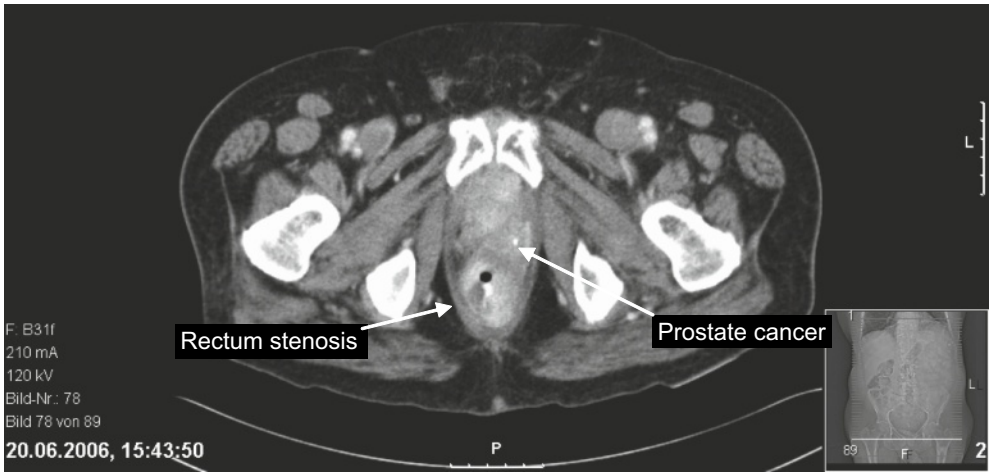


Fig. 46.5 A diverting colostomy is required because of rectal infiltration and compression by locally advanced prostate cancer

Depending on tumor infiltration, concomitant partial cystectomy, prostatectomy, or pelvic exenteration may be necessary. Surgeons should never hesitate to resect urogenital tract structures if extended surgery would result in complete tumor resection and an improved prognosis. There will always be a way to repair the defects. If a urinary diversion is required options include the ileal orthotopic bladder substitute, ileum conduit, and as a last resort a ureterocutaneostomy. A bladder-sparing approach is preferred because it is associated with a lower rate of surgical complications and improved quality of life [11]. In most cases adequate primary or secondary urinary tract reconstruction is possible by an experienced urologist, but requires a careful preoperative work up and collaboration between the urologist and the colorectal surgeon (Fig. 46.5).

46.7 Disturbance to the Bladder and Sexual Function in Pelvic and Rectal Surgery

Damage to the sacral parasympathetic hypogastric nerves and the pelvic autonomic nerve plexus is a complication of rectal surgery that can impair bladder and sexual function. Sacral parasympathetic fibers from S2 to S4 are responsible for penile erection, vaginal lubrication, and contractility of the detrusor muscle. Therefore, parasympathetic nerve damage may not only result in erectile dysfunction, vaginal dryness, and dyspareunia, but also in peripheral, partial or complete bladder denervation, hypo- or acontractility of the detrusor muscle, and consequent incomplete voiding or urinary retention in 9–40% of cases [16].

The sympathetic nerve fibers originate from spinal cord segments T10–L2, then form the sympathetic trunk, and proceed to the superior and then the inferior hypogastric plexus anterolaterally to the sigmoidorectal junction. Sympathetic stimulation results in bladder-neck closure, preventing retrograde ejaculation and contributing to urinary continence. Furthermore, it is responsible for semen emission from the seminal vesicles into the urethra. Iatrogenic damage to the sympathetic pathways during radical rectal surgery may result in ejaculatory disorders.

Adequate treatment consists of early suprapubic cystostomy and later voiding attempts. Bladder function often recovers after 2–3 months and voiding to completion is achieved. If after 3 months residual urine does not decrease, then a detailed urodynamic study evaluating detrusor acontractility or bladder outlet obstruction (e.g., benign prostate enlargement) should be performed. In cases of acontractility, a clean intermittent self-catheterization program needs to be instituted.

Sexual problems resulting from peripheral denervation include erectile dysfunction (25%) and anejaculation or retrograde ejaculation (16%). Increased rates of sexual dysfunction are reported more frequently after abdominoperineal resections than with low anterior resections [16]. The initial recommendation for the treatment of postsurgery erectile dysfunction is a 5-phosphodiesterase inhibitor (sildenafil, tadalafil, vardenafil), which treats this condition successfully in up to 80% of cases [22]. In refractory cases, intracav-

ernous injection therapy with prostaglandins may be necessary.

Intraoperative preservation of the pelvic autonomic nerves prevents neurogenic bladder and maintains sexual function. In the hands of experienced surgeons, nerve preservation is improved without compromising local control and survival [23].

46.8 Conclusion

Although urologic and rectal disorders are managed by separate specialties, there exists enough disease overlap to warrant each specialist being cognizant of the others' differential diagnoses, diagnostic tools, and treatment options. Patients are managed optimally by close interdisciplinary collaboration, which allows the team to systematically evaluate all the possible differential diagnoses.

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Self-Assessment Quiz

Question 1

Which of the following statements concerning prostatitis is wrong?

a. Outpatient clinic attendance is more frequent for prostatitis than for prostatic hyperplasia or prostate cancer.
b. The cumulative lifetime probability for being diagnosed with prostatitis is about 25%.
c. Acute prostatitis is more common than chronic prostatitis.
d. The most frequent organism identified in acute prostatitis is *Escherichia coli*.
e. Digital rectal examination reveals a boggy prostate that is very tender to palpation.

Question 2

Which of the following statements concerning prostatitis is wrong?

a. Prostate massage is contraindicated in acute prostatitis because of the possibility of septicemia or urosepsis.
b. Diagnosis of prostatitis is made by the three-glass urine collection test.
c. *Chlamydia trachomatis* is believed to be potentially responsible for chronic pelvic pain syndrome.
d. Category III prostatitis is treated with a 2-week course of antibiotics
e. Alpha-blockers are beneficial in the treatment of prostatitis, as they result in reduced subvesical outflow obstruction and diminished prostatic influx.

Question 3

Which of the following statements is wrong concerning enterovesical fistula?

a. Colovesical fistulas arise most often from diverticular disease and represent 65% of all diverticular fistulas.
b. Gastrointestinal or genitourinary neoplasms, radiation therapy, and inflammatory bowel disease are predisposing factors.
c. The clinical presentation includes recurrent cystitis, pneumaturia, fecaluria, and abdominal pain.
d. Computed tomography often detects the fistulous tract itself.
e. Resection of the diseased colonic segment and en-bloc excision of the fistula with a cuff of bladder is the most common treatment.

Question 4

Which of the following statements concerning pelvic radiation is wrong?

a. In modern radiation therapy of prostate cancer, dose escalation from 60 to 84 Gy results in better tumor-specific outcome, but also causes an increase in the number and severity of side effects.
b. Proctitis is the most common adverse rectal side effects, with an incidence up to 72%.
c. In the treatment of radiation proctitis, sucralfate may be a better option than anti-inflammatory agents such as rectal prednisolone.
d. Rectourethral fistulas develop quite often after radiation therapy of the prostate, usually within the 1st year after brachytherapy.
e. Advanced rectal tumors encompassing the urinary tract should be resected, as with clean resection margins the prognosis is not negatively affected.

Question 5

Which of the following statements is wrong concerning pelvic innervation?

a. Sacral parasympathetic nerve fibers from S2 to S4 are responsible for penile erection, vaginal lubrication, and contractility of the detrusor muscle.
b. Sympathetic nerve fibers form the sympathetic trunk and proceed to the superior and then inferior hypogastric plexus anterolaterally to the sigmoidorectal junction.

c. In the case of intraoperative parasympathetic nerve damage and consequent bladder acontractility, bladder function usually recovers within the first 2–3 months and should be treated with an early suprapubic cystostomy.

d. Erectile dysfunction or retrograde ejaculation resulting from peripheral denervation occurs more frequently after low anterior resections than with abdominoperineal resections.

e. Intraoperative preservation of the pelvic autonomic nerves is possible without compromising local tumor control and survival.

1. Answer: c
2. Answer: d
3. Answer: d
4. Answer: d
5. Answer: d

47 Sexually Transmitted Infections in Coloproctology

Anne Edwards

CONTENTS

47.1 Introduction

"Know syphilis in all its manifestations and relations and all other things clinical will be added unto you." William Osler (1849–1919)

It is strange that almost 100 years since the death of Sir William Osler, syphilis has re-emerged as a major public health problem in the developed world. This is despite the enormous medical advances made over the last 50 years. In addition, the overall public health burden of sexually transmitted infections (STIs) has also, paradoxically, increased over the last 30 years. Most humans are sexually active at some point in their adolescent and adult lives and therefore at risk of acquiring and transmitting an STI. In most branches of medicine, one or more STIs may be part of the differential diagnosis. This chapter will outline the current epidemiological picture, consider sexual behaviours and the assessment of patients at risk of STIs, and review the diagnosis and management of infections that are particularly relevant to the practise of coloproctology.

47.2 Epidemiology

STIs and their associated diseases remain a major cause of morbidity and mortality worldwide. Over the centuries the patterns of STI disease incidence, prevalence and virulence have changed, and especially so over the course of the last century. In the early 20th century, gonorrhoea and syphilis were major causes of perinatal and infant morbidity and mortality in Britain, as well as impacting substantially on the adult population. In the report of the Royal Commission set up in 1913 to look into methods of controlling the spread of venereal disease [1], the authors comment that "Among adults the loss of working power from the earlier effects of the disease is important. The naval statistics for the year 1912 show for an average strength of 119,510 men a total number of 269,210 days lost as a result of venereal diseases; in the army at home during the same year … with a strength of 107,582 men … a loss of 216,445 days … If corresponding figures from the civil population could be obtained they would be found to be extremely large", especially when the deficient provision for treatment is considered. In contrast, infection causes <1% of deaths in the UK today [2].

In the latter part of the 20th century, gonorrhoea rates began to decline globally and *Chlamydia trachomatis* emerged as a major problem in the developed world. The first cases of acquired immune deficiency syndrome (AIDS) were described in the early 1980s,

and clusters of cases of proctitis in gay men caused by lymphogranuloma venereum (LGV), an STI that is usually confined to the tropics, were reported from centres in Europe in the 21st century [3].

The Royal Commission recommended the setting up of a network of so-called "Special Clinics" across Britain [4]. These were open access, confidential and provided free treatment for anyone found to have a venereal disease. The clinics also collected data on the number of cases of the three legally defined venereal diseases: syphilis, gonorrhoea and chancroid. This system of data collection was expanded in 1974 to include other STIs and has been a useful monitoring tool. For example, in Britain there have been three epidemics of syphilis and gonorrhoea over the last century: two heterosexual outbreaks after the first and second World Wars and a third outbreak in the 1960s largely related to infection amongst men who have sex with men (MSM; Fig. 47.1). More recently, these returns have provided evidence of significant increases in cases of early infectious syphilis. The absolute case numbers in individual clinics has been small, but collectively there has been a several-hundred-fold increase across the UK – a trend that has been mirrored in other European countries [5].

Three recently identified infections, *C. trachomatis*, human immunodeficiency virus (HIV) and hepatitis C, have become increasingly significant over the last 30 years.

C. trachomatis was first isolated in 1969, although for many decades before, clinicians had recognised a clinical syndrome that was very similar to gonorrhoea in presentation but where tests for *Neisseria gonorrhoea* were negative. Since then, with the development of nucleic acid amplification tests (NAATs) for detecting chlamydia infection, it has become clear that this pathogen has a high and increasing prevalence, particularly in the developed world [6].

HIV, the causative agent of AIDS, was first identified in the early 1980s and is a truly new sexually transmitted pathogen. Originally thought to be one of the human T-lymphotropic viruses (HTLVs), HIV was initially classified as HTLV III [7]. Subsequent research demonstrated two distinct lymphotropic viruses: HIV 1 and HIV 2 [8], both of which caused a similar spectrum of disease in humans, although HIV 2 tends to be less pathogenic. HIV has spread extensively since it was first identified. In the developed world in the early 1980s, HIV/AIDS mostly affected MSM (so-called pattern 1 countries), whilst in Sub-Saharan Africa it caused an epidemic mostly affecting heterosexuals (pattern 2 countries; Fig. 47.2).

In the latter part of the 1980s, HIV/AIDS emerged in Thailand and the Far East, where it spread through a

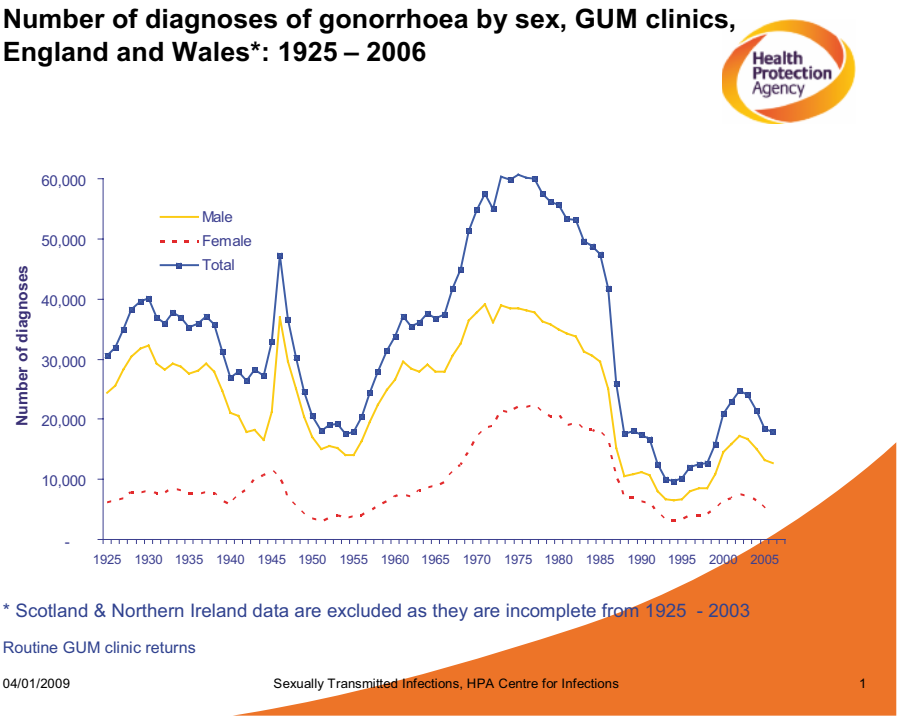

Fig. 47.1 Diagnoses of gonorrhoea England and Wales 1925–2006 [52]

combination of intravenous drug misuse, prostitution and heterosexual transmission [9]. More recently, India has been affected with HIV/AIDS, initially spreading in big cities such as Mumbai and again primarily through prostitution and then largely heterosexually. Throughout the 1990s in India, it became clear that HIV had spread to the general population. Cases of infection were increasingly observed among people who had previously been seen as "low risk", such as housewives and richer members of society [10].

Hepatitis C virus (HCV) infection is the third relatively new sexually transmissible pathogen. So-called non-A non-B hepatitis has been recognised for several decades as a blood-borne viral (BBV) infection associated with chronic liver disease. In 1989 the causative organism was isolated and named Hepatitis C [11].

Whilst most HCV is transmitted through contaminated blood via injecting drug use, blood transfusion and needle-stick injuries, it is now recognised that approximately 5–10% of infections are sexually acquired,

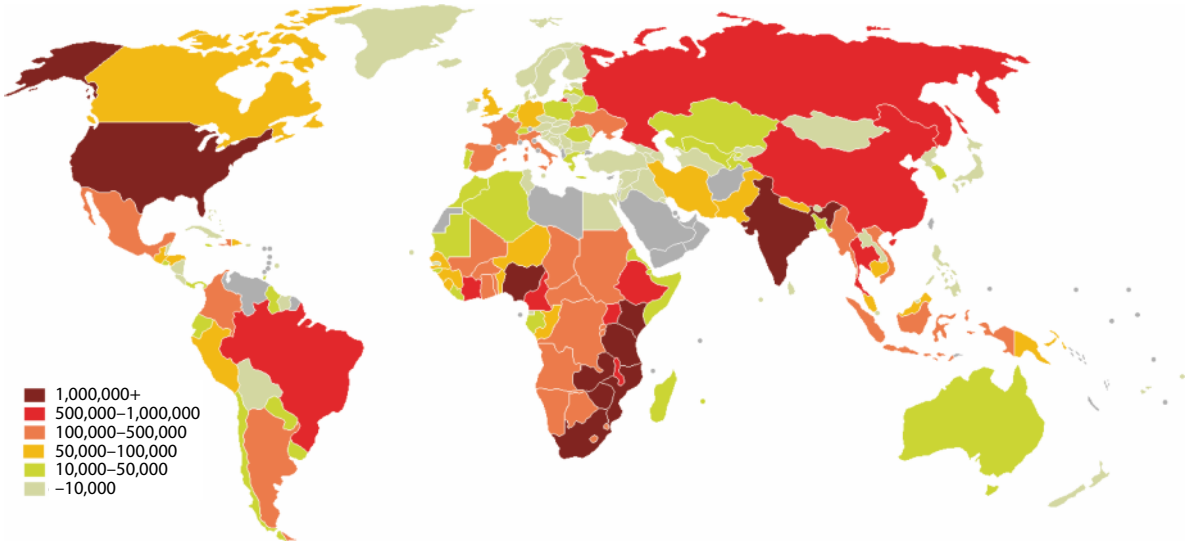

Fig. 47.2 Worldwide HIV infection rates for adults [53]

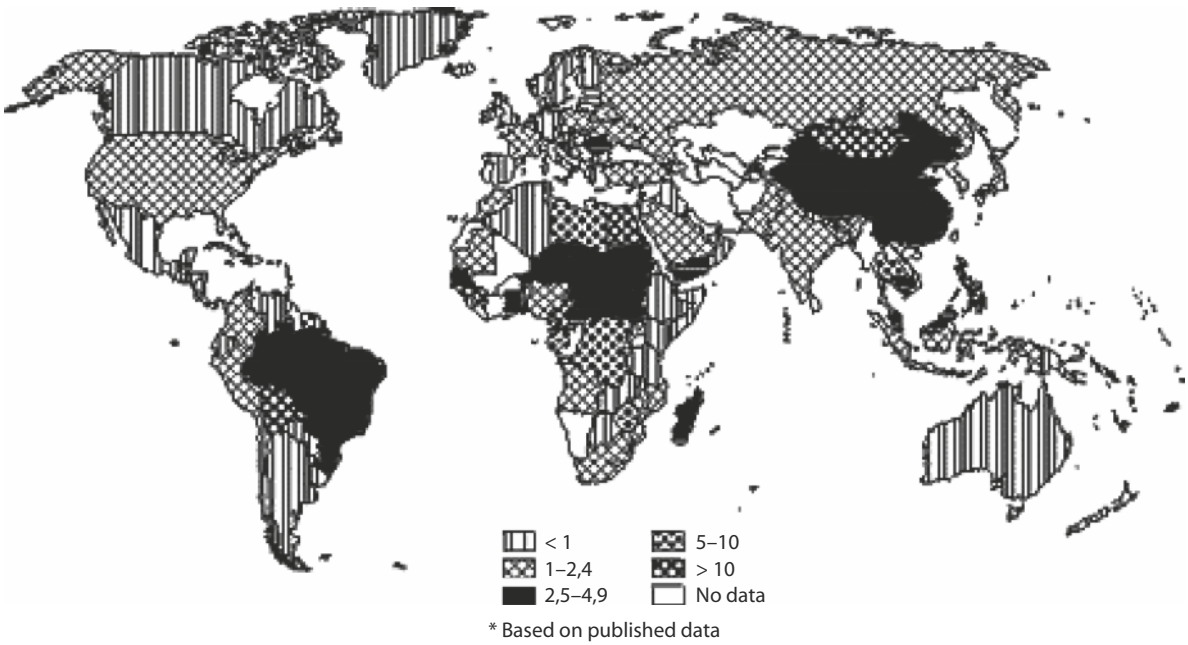

Fig. 47.3 Global prevalence of hepatitis C [54]

and there is recent evidence that amongst MSM, rates of transmission may be higher and strongly associated with concomitant HIV infection (Fig. 47.3) [12].

47.3 STIs and Coloproctology

An understanding of STI epidemiology and pathology is particularly relevant to coloproctology for two reasons. Firstly, the differential diagnosis of some presentations may include an STI and/or secondly, the patient may have an unrecognised underlying infection, such as HIV, which may impact on management.

For the clinician, BBV infections such as hepatitis B virus (HBV), HCV and HIV are a risk to those who carry out invasive procedures, and especially surgery in the pelvis. Studies have demonstrated that in surgical units, BBV infections are often not identified and surgeons may be unaware of the risk [13, 14]. Needle-stick injuries in surgery are common and often not reported [15].

Protection against HBV is achieved though vaccination. Minimising risk from other BBV infections depends on other factors. These include recognising high-risk patients so that additional investigations and possibly treatment can be considered. For example, the risk of acquiring HIV is related to the viral load, and in HIV-positive patients not on treatment and who have a high viral load, the risk to surgeons could be reduced by giving highly active anti-retroviral therapy (HAART) for a few weeks preoperatively. Other suggestions include avoiding scalpels by using other techniques for cutting in such patients. Where risk factors are identified, an HIV pre-test discussion and counselling should be undertaken, with testing where the patient has consented. Rapid tests that can be performed at the bedside are increasingly becoming available and may be appropriate in some settings [16]. It is good practice to apply these principles when testing for other infections such as HBV, HCV and syphilis.

47.4 Sexually Transmitted Infections

47.4.1 General principles

More than 50% of all STIs do not cause symptoms, and the key to making an STI diagnosis is awareness of risk factors together with routine sexual history taking. The risk factors for STIs are listed in Table 47.1. Unlike other infections, STIs are of low infectivity because the pathogens that cause disease are adapted for transmission in specific ways (i.e. during close sexual contact, usually, but not always, requiring penetrative intercourse). Effective management includes contact tracing (at least one other individual will be infected) and partner treatment. The commonest reason for recurrent bacterial STIs remains failure to screen and treat infected sexual partners.

Table 47.1 Risk factors for sexually transmitted infections (STIs). *MSM* Men who have sex with men

- Age (16–25 years)
- Partner change (two or more per annum or recent, <3 months, partner change)
- Multiple sex partners
- MSM
- Low socioeconomic class
- Some ethnic minorities (e.g. patients of African/Afro-Caribbean origin) have higher rates of gonorrhoea
- Failure to use the barrier method of contraception
- Other STI diagnosis
- A sexual contact with an STI diagnosis
- Past history of STIs

47.3.2 Risk Factors for STI

47.3.3 Sexual History

A sexual history should be a routine part of patient assessment. This ensures that the clinician does not make assumptions about individual patients. For example, it is often assumed that:

1. Married patients cannot be at risk of STIs.
2. Married men do not have sex with men.
3. Only men who have sex with men practise anal sex [17].
4. Older patients and those under 16 years are not sexually active.

The UK national sexual behaviour study [18] found that up to 13% of heterosexuals have practised anal intercourse, that ~7% of heterosexual males have had homosexual sex, and that ~19% of males and 7% of females first had intercourse under the age of 16 years. It has also recently become clear that with the increasing rates of divorce and relationship breakdown, STIs are increasing in incidence in patients older than 40 years [19]. Table 47.2 summarises a basic sexual history and Table 47.3 lists the risk factors for HIV.

Table 47.2 Basic sexual history. *HIV* Human immunodeficiency virus

1 Include sexual history as part of routine medical
2 The information needed from a sexual history
   a. Timing of last intercourse: "When was the last time you had sex?"
   b. Who was this with? A regular or casual partner (ask about length of relationship – definitions of regular or casual vary)
   c. Gender and country of origin of sexual contact
   d. Use of barrier method
3 Repeat for the penultimate sexual contact and for all sexual contacts in the last 6 months

HIV risk assessment should be completed; see Table 47.3

Table 47.3 Risk factors for HIV

- MSM
- History of injecting drug use
- Country of origin is a pattern 2 country (heterosexual transmission – see Fig. 47.2)
- Sexual contact with any of the above

47.5 STIs and Colorectal Disease

Most sexually transmitted pathogens can directly cause anorectal infections or associated disease, but some are much more likely to do so than others. Table 47.4 lists those STIs that can be found perianally and/or in the anal canal, or which are risk factors for other anorectal disease.

47.5.1 General Approach

Rectal symptoms/signs that may suggest an STI diagnosis – *these are largely non-specific and rarely pathognomic* (Table 47.5). An STI assessment of the patient with rectal symptoms includes:

1. Full sexual history (see above)
2. Examination including proctoscopy (unless too painful)
3. Rectal swab for Gram-stained slide looking for Gram-negative diplococci and/or inflammatory cells

Table 47.4 STIs with colorectal presentations. *AIN* Anal intraepithelial neoplasia, *AIDS* autoimmune deficiency syndrome, *HPV* human papillomavirus, *HSV* herpes simplex virus

Class	Pathogen	Disease	Presentation (colorectal)
Bacteria	*Neisseria gonorrhoeae*	Rectal gonorrhoea	Usually no symptoms – may have proctitis ± rectal discharge
	Chlamydia trachomatis	Rectal chlamydia	Usually no symptoms – may have proctitis ± rectal discharge
	Chlamydia trachomatis (L1–3)	Lymphogranuloma venereum (S1–3)	Proctitis ± discharge
	Treponema pallidum	Syphilis	Primary chancre – may mimic fistula-in-ano
	Haemophilus ducreyi	Chancroid	Genital ulceration
	Klebsiella granulomatis	Granuloma inguinale	Genital ulceration usually penile/vulval
Viruses	HSV 1 & 2	Rectal herpes	Perianal ulcers – heal fully
	HPV (types 6, 11, 16 and 18 are the most common genital strains)	Anal warts 6/11	Macroscopic, exophytic warts
		AIN if high grade then associated with 16/18	Flat hyperkeratotic plaques
		Squamous cell carcinoma 16/18	Usually ulcerated, may be raised anal margin lesion
	Molluscum contagiosum	Perianal molluscum	Discreet pearly, umbilicated lesions usually not limited to the perianal area
	HIV 1 and 2	AIDS	Kaposi's sarcoma (associated with HIV caused by human herpesvirus 8, perianal herpes)
	Hepatitis B	Acute hepatitis	No colorectal presentation
	Hepatitis C	Acute hepatitis	No colorectal presentation
Yeasts/ Fungi	*Candida albicans*	Perianal candida	Pruritus ani – candida may be implicated, but not always
Protozoa			"Gay bowel syndrome"

4. Specific tests for *N. gonorrhoea* (currently culture is the most reliable) and *C. trachomatis* (polymerase chain reaction – PCR – and if the initial test is positive and the patient is a man who has sex with men, additional tests for LGV should be requested)
5. Other tests depend on findings (e.g. if ulceration is present, swab for *Herpes simplexvirus* – HSV)
6. Blood tests for syphilis
7. Additional blood tests, depending on risk, for HBV, HCV and HIV

Table 47.5 Rectal symptoms/signs that may suggest an STI diagnosis – these are largely non-specific and rarely pathognomonic

- Perianal/rectal soreness/pain ± discharge
- Perianal/rectal ulcers and/or fissures
- "Lumps"
- Itching
- Fistula-in-ano/strictures – late complications in asymptomatic cases where diagnosis is delayed

47.5.2 Bacterial STIs

47.5.2.1 Gonorrhoea: N. gonorrhoea, Gram-Negative Diplococcus

Clinical Presentation

Rectal gonorrhoea is more commonly, but not exclusively, found in MSM practising receptive anal intercourse. In women, rectal cultures may be positive in 25–70% of those with gonorrhoea. Most do not have a history of anal intercourse, and infection is believed to result from contiguous spread. Rectal gonorrhoea is often asymptomatic (>50%) [20, 21]. When present, symptoms are mild and include irritation, anorectal discomfort, constipation and mucopurulent discharge. Complications are rare, but in long-standing, untreated infection they include fistulae, abscesses, strictures, and disseminated infection.

Transmission

Gonorrhoea in adults is transmitted sexually.

Diagnosis

The diagnosis is most commonly made by screening high-risk patients, including those who present as a contact of a confirmed index case. In symptomatic patients, proctoscopy may show evidence of proctitis and discharge.

Investigations

The diagnosis is confirmed by taking a rectal swab for Gram staining and culture. Gram staining may reveal the presence of Gram-negative intracellular diplococci (positive in ~40% of infected patients); culture will be positive in ~80–90% of cases. The sensitivity can be increased by repeating culture tests 24–48 h later if the first set of tests is negative.

Treatment

Worldwide, *N. gonorrhoea* has developed resistance to a wide range of commonly prescribed antibiotics. Most centres have guidelines that recommend antibiotics for use before sensitivities are known. Resistance to penicillin and 4-quinolone is common and these are no longer recommended as first-line treatment. Avoiding intercourse until contact tracing and partner treatment has been completed is key to the successful treatment of gonorrhoea [22, 23].

Some recommended regimens for first-line treatment in uncomplicated infection include:

1. Ceftriaxone: 250 mg intramuscularly as single dose
2. Cefixime: 400 mg orally as single dose
3. Spectinomycin: 2 g intramuscularly as single dose

Most centres give epidemiological treatment for *C. trachomatis* because of the high risk (~30%) of concomitant infection.

Follow-Up

It is routine to review patients at 7–10 days to ensure compliance with treatment, review contact tracing and repeat gonorrhoea culture tests.

47.5.2.2 C. trachomatis and Non-specific Proctitis

Chlamydia (serovars D–K) is a much commoner infection than gonorrhoea, especially in the developed world. The spectrum of presentation is almost identical to that for gonorrhoea and, similarly, most rectal infections are asymptomatic [21]. Rectal infection is commonest in MSM, and testing for rectal chlamydia is now a routine part of screening that population. Although rectal infection is found in 5–20% of women, rectal swabs are not taken routinely but should be considered in women with symptoms suggesting proctitis or those practising anal intercourse.

Diagnosis

Symptoms when present are mild and consist of discharge, mild rectal discomfort and tenesmus. Proctoscopy may be normal or show evidence of a mild proctitis.

Investigations

A Gram-stained rectal swab may show evidence of proctitis with polymorphonuclear leucocytes (PMNL) present (5–10 per high-powered field) but no evidence of Gram-negative intracellular diplococci. An NAAT for chlamydia should be positive. Most centres in the UK would now test chlamydia-positive rectal samples for the LGV serovars (see below).

A diagnosis of non-specific proctitis is made where PMNL are present but tests for gonorrhoea and chlamydia are negative [24]. Non-specific proctitis is thought to be chlamydial in most cases. The term non-specific proctitis is still in use and reflects the fact that specific tests for chlamydia were not routinely available and inflammatory cells were a surrogate marker for infection. It is likely that with the increasing availability of NAATs that are more sensitive and specific, the diagnosis of non-specific proctitis will rarely be made. The management is the same as for chlamydia-positive cases.

Treatment

C. trachomatis is sensitive to tetracyclines, macrolides/azalides and ofloxacin (of the 4-quinolones) [22]. A not uncommon reason for treatment failure is use of an ineffective antibiotic. Avoidance of intercourse until completion of contact tracing with partner treatment is also essential (as for gonorrhoea – see above).

Recommended regimens for uncomplicated infection include:

1. Doxycycline: 100 ng orally twice daily for 7 days
2. Azithromycin: 1 g orally taken as single dose

Follow-Up

It is routine to review patients at 7–10 days to ensure compliance with treatment and review contact tracing. As a PCR test is used for the diagnosis, specific tests are not repeated at follow-up.

47.5.2.3 Syphilis: Treponema pallidum

Syphilis rates in the developed world declined from the early 1980s until the mid 1990s. The dissolution of the USSR was followed by the re-emergence of syphilis in Russia [25]. This was first noted when cases of early infectious syphilis started appearing in neighbouring Finland, with cases doubling between 1994 and 1995 [26]. Since then, several European countries have reported rising rates of early syphilis, and this trend is continuing. The aetiology is mixed, with both heterosexual and homosexual outbreaks [5].

Diagnosis

Syphilis is most commonly asymptomatic and usually diagnosed as part of routine STI screening [22]. When symptomatic, early infectious syphilis may present with a primary chancre, a painless solitary raised ulcer that develops at the site of inoculation. This appears typically within 10–14 days of exposure. Alternatively, patients may present in the secondary stages with a range of potential symptoms including rash, lymphadenopathy, and mucous patches of the mouth or genital area. In patients practising receptive anal sex, the primary chancre may be missed and/or not recognised if the site is not examined. In addition, it is not unusual for symptomatic primary anorectal syphilis to be misdiagnosed as a fissure, haemorrhoids or a traumatic lesion. Drusin et al. [27], reporting on four cases managed through a surgical unit, commented that "Failure to

make the diagnosis of primary syphilis of the anorectum rests on two factors. First, physicians do not appreciate the varied manifestations of primary syphilis" and "Second, and more important, inadequate diagnosis of primary syphilis of the anorectum is a consequence of failure to maintain a high index of suspicion when dealing with lesions in this area". Their four case reports emphasise the fact that primary chancres are often atypical. For example, three of the four patients complained of pain at the site of the lesion, whereas the classical primary chancre is asymptomatic. This probably reflects secondary infection, and in one of the patients, pain and secondary infection were so severe that he was thought to have had an anorectal abscess. In addition, the authors recommend that any factor that makes the anal lesion atypical for a diagnosis of "haemorrhoids, fissure, fistula or abscess should especially alert the physician to the possibility of co-existing syphilis. For example, an anal fissure that occurs laterally rather than in the anterior or posterior commissures should arouse immediate suspicion". The clue to the diagnosis is the sexual history, careful examination and appropriate blood tests. STI clinics may have facilities for dark-ground microscopy, which may allow an immediate diagnosis.

Case History

A 35-year-old homosexual man presented to an STI clinic with perianal discomfort. He had a longstanding problem with intermittent constipation, for which he used regular laxatives. He had had unprotected receptive anal sex with a casual male contact 14 days earlier. He was seen by a junior doctor and a full genital examination with perianal examination and proctoscopy was normal, apart from the presence of a small, painful perianal fissure. Full STI infection screening tests were undertaken and he was advised to increase the fibre in his diet. Two days later, the patient returned complaining of continuing rectal pain. He was seen by an experienced senior doctor who took samples for dark-ground microscopy. Treponemes were noted and the rapid plasma reagin test showed a titre of 1.64. A diagnosis of primary syphilis was made.

Learning Point

Primary chancres, and especially perianal lesions, are often atypical. A careful sexual history with identification of sexual orientation will heighten awareness of possible risk. As Drusin et al. stated "Surgery has no role in the treatment of primary (infectious) syphilis of the anorectum".

Treatment

Parenteral penicillin remains the mainstay of therapy for patients who are not allergic. The regimens are complicated and patients diagnosed with syphilis should be referred to a specialist service for further management, including contact tracing and partner treatment [22].

Recommended treatment regimens (in HIV-negative patients) for primary/secondary/early infectious syphilis include:

1. Benzathine penicillin: 2.4 MU intramuscularly as a single dose
2. Procaine penicillin G: 0.6 MU intramuscularly daily for 10–14 days
3. In the case of penicillin allergy – doxycycline: 100 mg twice daily or 200 mg once daily, orally for 14 days

Patients who are HIV-positive have a higher risk of relapse and require daily parenteral therapy and careful follow-up.

47.5.2.4 The Tropical Bacterial STIs

There are three tropical bacterial STIs: LGV (caused by *C. trachomatis* serovars 1–3), chancroid (caused by *Haemophilus ducreyi*) and Donovanosis (caused by *Klebsiella granulomatis comb. nov.*, formerly *Calymmatobacterium granulomatis*), all of which can cause genital ulceration and associated lymphadenopathy [28]. LGV is the only one that is likely to present in the developed world as part of the differential diagnosis of infectious proctocolitis. Chancroid and Donovanosis are rare causes of perianal ulceration, especially in the developed world, and are considered only briefly herein.

LGV: *C. trachomatis* serovars L1–3

LGV infection is caused by *C. trachomatis* serovars L1–3. It is more commonly found in tropical and subtropical areas such as Asia, Africa, South America and the Caribbean, but has recently emerged in European countries and the US as a cause of proctitis in MSM

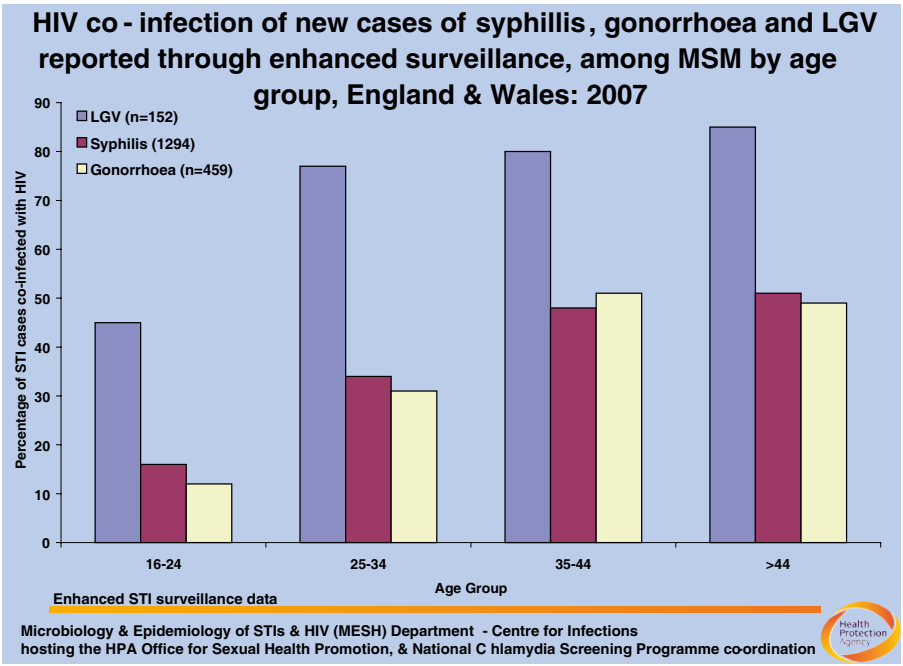

Fig. 47.4 Human immunodeficiency virus (*HIV*) coinfection of new cases of syphilis, gonorrhoea and lymphogranuloma venereum (*LGV*) reported through enhanced surveillance among men who have sex with men (MSM) [55]

[29]. These cases are strongly associated with HIV seropositivity (Fig. 47.4) [30, 31].

Diagnosis

LGV typically presents with an evanescent primary lesion such as a small pustule or ulcer that may not be noticed. Rectal LGV may be asymptomatic but can present initially with anal pruritus and discharge, followed by rectal pain, fever and tenesmus. Proctoscopy in symptomatic patients usually reveals nodular and ulcerated mucosae. The secondary stage, which develops between 10 days and 6 months after initial infection, is characterised by marked inguinal and, less commonly, femoral lymphadenopathy. Patients may also have systemic symptoms with fever and malaise. If unrecognised in the early stages, long-term complications including rectal fistulae and strictures may develop [28].

Investigations

Investigations are as for *C. trachomatis*, as described above. If NAATs are positive, then an LGV-specific DNA test should be requested. In the MSM outbreak there is a strong association with HIV, and all MSM found to have LGV should be offered HIV testing; they should in addition have full STI screening and HCV testing.

Treatment

The recommended treatment regimen for LGV is doxycycline: 100 mg orally twice daily for 3 weeks [28]. Alternatively, erythromycin: 500 mg four times daily for 21 days. Contact tracing and partner treatment are also essential (as above).

Chancroid: *H. ducreyi*, a Gram-Negative Coccobacillus [28]

This is a tropical STI. It is uncommon in Western Europe and is mostly found in Africa, Asia, Latin America, the Caribbean and some parts of the USA. It is associated with low socioeconomic status and poor hygiene. It is rarely responsible for primary anorectal ulceration.

Diagnosis

The patient typically presents with large, multiple, painful genital ulcers. The diagnosis should be suspected in patients with genital ulceration who are either from a country where the infection is endemic or who have had sexual partners from such an area. Transmission is sexual, but autoinoculation of extra-genital sites has been reported. NAATs are used to make the diagnosis.

Treatment

Recommended regimens:
1. Ciprofloxacin: 500 mg orally twice daily for 3 days
2. Erythromycin: 500 mg three times daily for 7 days
3. Azithromycin: 1 g immediately as a single dose
4. Ceftriaxone: 250 mg intramuscularly immediately as a single dose

Granuloma Inguinale (Donovanosis): *K. granulomatis*

This is endemic in India, Papua New Guinea, Brazil and South America, and among the Aborigines of Northern Australia, although a programme targeting this latter group has almost eliminated Donovanosis from Australia. Like chancroid, granuloma inguinale is associated with lower socioeconomic status and poor hygiene, and is rarely reported in the developed world. It is caused by *K. granulomatis*, previously known as *Donovania granulomatis* or *Calymmatobacterium granulomatis*. Donovanosis is a rare cause of primary perianal ulceration, but this may be a late complication of untreated disease [28].

Diagnosis

The genitals are affected in 90% of cases – the penis in males and the labia minora and fourchette in women. Ulceration is preceded by the development of a papule, which occurs 9–90 days after initial infection. Ulcers are usually solitary, but there is often pronounced associated lymphadenopathy, and further ulceration may develop in association with these nodes. About 10% of lesions occur in extra-genital areas. Diagnosis by an experienced clinician has a high positive-predictive value when coupled with the finding of Donovan's bodies on a Giemsa stain.

Treatment

Suggested regimes:
1. Azithromycin: 1 g on day 1 followed by 500 mg daily for 7 days or 1 g weekly for 4 weeks
2. Co-trimoxazole: 960 mg twice daily for 14 days
3. Doxycycline: 100 mg twice daily for 14 days
4. Erythromycin: 500 mg twice daily for 14 days
5. Tetracycline: 500 mg twice daily for 14 days

47.5.3 Viral STIs

47.5.3.1 Genital Herpes – HSV 1 and 2

Genital herpes is highly prevalent worldwide and has become the primary cause of genital ulcer disease (GUD) [32]. There are two strains: HSV 1, which is predominantly associated with cold sores, and HSV 2, which is most commonly associated with GUD. Genital HSV 1 is uncommon in the developing world but it is estimated to cause >30% of all cases of primary herpes in the US; 30% or more of infected individuals are not aware that they are carriers (i. e. infected). Genital herpes is commonly (>50%) transmitted by asymptomatic carriers [33].

Primary/First-Episode Genital Herpes

Of the patients acquiring genital herpes for the first time, probably <25% of patients will present with a primary, symptomatic episode. The remaining ~70–80% will not be symptomatic. They may be identified if a sexual partner presents with symptoms or they may remain unaware that they have genital herpes.

Diagnosis

This is based on a typical history. For primary herpes simplex proctitis a flu-like illness with inguinal lymphadenopathy, severe anorectal pain, tenesmus, constipation and rectal discharge is highly suggestive. This may be preceded by "prodromal" symptoms, where patients experience tingling/neuropathic pain in the distribution of nerves usually arising from the sacral plexus. Symptoms may include difficulty in initiating micturition, posterior thigh pain or paraesthesiae of the buttock or perineal region, and impotence (up to 50% of cases) [34]. Some findings occur significantly more fre-

Table 47.6 Findings that are significantly more frequent in men with HSV proctitis versus other infectious causes of proctitis [33]

Finding	Percentage affected (n=23)
Anorectal pain	100%
Tenesmus	100%
Constipation	78%
Perianal ulceration	70%
Inguinal lymphadenopathy	57%
Fever	48%
Difficulty urinating	48%
Sacral paraesthesiae	26%

quently in men with HSV proctitis versus other infectious causes of proctitis (Table 47.6) [34].

Patients may present at the early stages before localising symptoms develop, commonly leading to misdiagnosis. The incubation period (i.e. time from exposure to development of symptoms) is typically about 14 days, but can be longer. Proctoscopy, which may not be possible because of severe pain, may reveal vesicular lesions and/or ulceration usually no more than 10 cm above the anal verge.

Case History

A 24-year-old woman presented to her primary-care physician with a short history of constipation and anorectal discomfort. She was not examined and mild laxatives were prescribed; 24 h later she was still constipated and had worsening rectal discomfort. She presented to a hospital emergency department and was admitted under the general surgeons, who performed an examination under anaesthesia and anal dilatation. Perianal fissuring/ulceration was noted. She was treated with analgesics and discharged the following day. She developed further rectal and perianal pain and the fissuring worsened. She attended an STI clinic. A sexual history confirmed that she was in a long-term stable relationship with a regular boyfriend. He was asymptomatic and had no history of previous STIs. They occasionally practised anal sex. Examination revealed extensive perianal ulceration. A diagnosis of primary perianal herpes was made. She was started on oral acyclovir and her symptoms resolved over the following 2 weeks.

Learning Points

1. The early symptoms and signs in genital herpes may be misleading.
2. A sexual history is an important part of routine history taking.
3. HSV is a neurotropic virus. Dysuria and urinary retention are well-described complications of primary genital (vulvovaginal) infection in women. Primary perianal herpes may present with rectal pain, constipation, urinary retention and, in men, impotence. This is a much less well-recognised presentation, but should be considered in MSM and those heterosexuals who practise anal sex.

Investigations

Most genital/perianal herpes is diagnosed by the combination of the clinical history assessment during an episode of genital ulceration, when swabs can be taken for either culture or a PCR test. PCR, which is more sensitive, is beginning to replace culture techniques. Serology for HSV 2 antibodies may support a diagnosis of genital herpes. It cannot be used to confirm the diagnosis in asymptomatic patients because it does not identify the site of infection, which may be oral or genital.

Most patients presenting with primary genital herpes will experience at least one symptomatic recurrence in the subsequent year [34]. This risk is increased for patients with HSV 2 infection. For the majority, however, the risk of clinical recurrences declines significantly over the first 2 years following acquisition. In most cases recurrences are mild and can be managed with simple analgesics and reassurance. An option for patients who experience frequent recurrences (see below) is a period of treatment with suppressive therapy.

Recurrent Genital Herpes

Diagnosis

Herpes is the commonest cause of recurrent genital ulceration in the developed world. Patients who present with a history of intermittent itch/soreness/fissuring/ulceration with full resolution and subsequent recurrences (this may range from one to two episodes per annum to several episodes a year) should be exam-

ined when they are symptomatic and swabs for herpes should be taken. For some patients the diagnosis of genital herpes may be delayed because recurrent episodes can be confused with other genital infections. In women, for example, mild vulvovaginal herpes and recurrent candida can be confused, and perianal herpes may occasionally mimic anal fissures, or pruritus ani may be due to recurrent herpes. The clue to herpes as the aetiology is the characteristic self-limiting (usually a few days at most) episodes. Awareness and a high index of suspicion will help in making a correct diagnosis [33].

Management

Primary (first-episode) herpes should be treated as soon as possible with oral antiviral agents [22]. This shortens the length of the episode and reduces the risk of complications such as urinary retention or constipation. However, if the patient presents more than 5 days into an episode and is not developing new lesions, specific therapy will not usually be beneficial.

Recommended regimens:

1. Acyclovir: 200 mg orally, five times daily for 5 days
2. Valacyclovir: 500 mg orally, twice daily for 5 days
3. Famcyclovir: 125 mg orally, twice daily for 5 days

Recurrent herpes does not usually require specific therapy as episodes are usually mild, self-limiting and infrequent. Some patients experience frequent recurrences, defined as six or more episodes per annum, or four episodes that are prolonged (i. e. lasting up to 10 days). This group will benefit from a period of suppression by taking daily antiviral agents for between 3 and 6 months to prevent attacks.

Recommended regimens used for 6–12 months:

1. Acyclovir: 400 mg orally twice daily or 200 mg four times daily
2. Valacyclovir: 500 mg orally once daily
3. Famcyclovir: 250 mg orally once daily

47.5.3.2 Genital Warts – Human Papillomavirus

Human papillomaviruses (HPVs) are the causative agents of warts. Genital wart virus infection is the commonest viral STI reported from STI clinics in the UK, with the highest rates of new cases being found among 20- to 24-year-old men and 16- to 19-year-old women (Fig. 47.5).

There are more than 100 strains of HPV, and approximately 40 of these cause genital infection, including some oncogenic strains associated with genital squamous and glandular premalignant and malignant

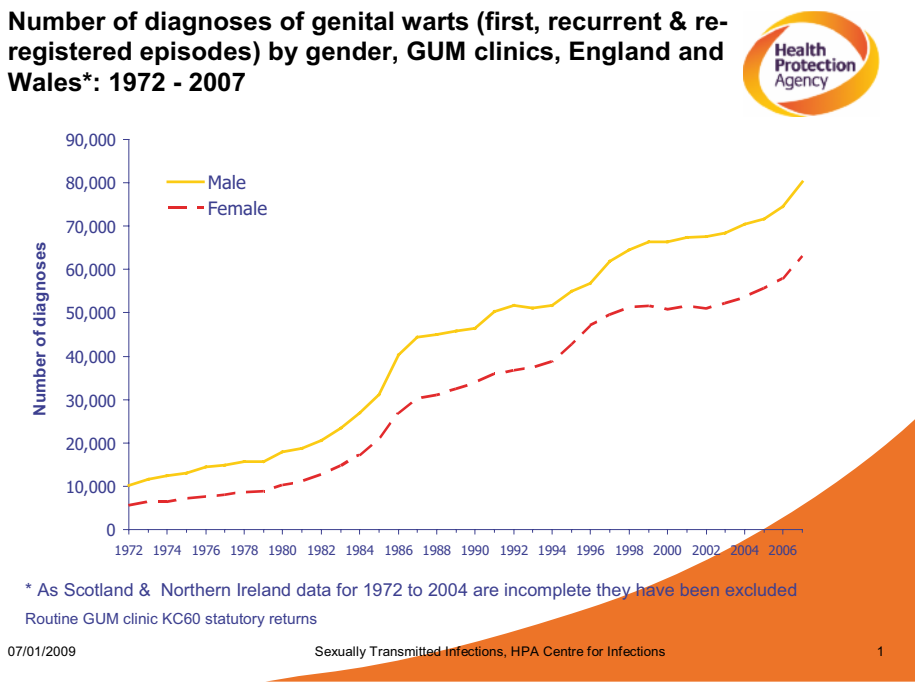

Fig. 47.5 Diagnoses of genital warts in England and Wales 1972–2007. *GUM* Genitourinary medicine [56]

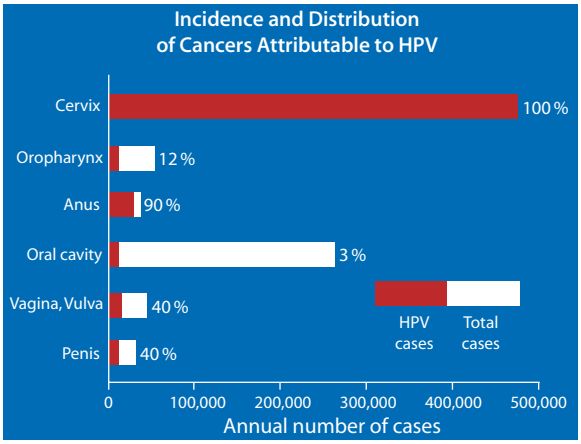

Fig. 47.6 Human papillomavirus (HPV)-related cancers from: "The global health burden of infection-associated cancers in the year 2002" [57]

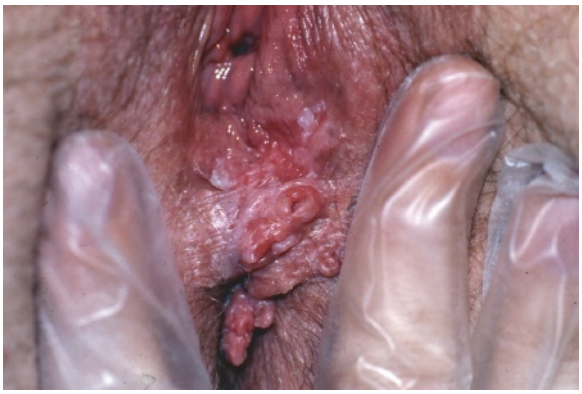

Fig. 47.7 Atypical vulvoperianal warts with vulval–intraepithelial neoplasias and possible invasion on biopsy

disease, genital warts and genital papillomavirus disease [35]. The most prevalent strains in the genital area are HPV types 6, 11, 16 and 18, of which types 16 and 18 are oncogenic. HPV types 6 and 11 are the commonest causes of macroscopic genital warts. HPVs 16 and 18 cause 70% of HPV-associated cancers (Fig. 47.6) [36].

Clinical Presentation

As for other STIs, the majority of individuals who acquire genital HPV do so asymptomatically, and most do not develop macroscopic genital warts [16]. In those who develop genital warts, the diagnosis is usually made because they can either be seen or felt and/or cause itch. Perianal warts may be missed unless the patient is examined for some other reason. Sometimes patients present with perianal itch and in some patients warts are confused with external piles. Less common differentials include condylomata lata, the characteristic lesions of secondary syphilis, malignancy (usually a solitary lesion, whereas warts are commonly multiple), and other skin disease.

Transmission

Genital warts are sexually acquired through either penetrant intercourse or close genital skin-to-skin contact. The HPV types that cause hand and foot warts very rarely cause genital infection, with <2% of non-genital HPV types being found in the genital area. HPV is most commonly transmitted by an asymptomatic carrier who would be unaware that they have HPV infection. A proportion of the contacts of patients with newly diagnosed genital warts will have unrecognised macroscopic warts. It is good practice to recommend an assessment with STI screening for the contacts of such patients (Fig. 47.7).

Diagnosis

In most cases warts are easily identified because of their typical appearance. If there is any doubt then a biopsy should be taken. There is currently no routine method for diagnosing asymptomatic HPV infection.

Treatment

Approximately 80% of patients clear the wart virus within about 12 months of acquisition [37]. Most patients respond to simple outpatient treatment regimens that combine a destructive modality such as cryotherapy, topically applied trichloracetic acid or hyfrecation (with local anaesthetic) with an antimitotic agent such as podophyllotoxin. Approximately 30% of patients who respond to an initial treatment regimen will develop a recurrence, usually within the first 3 months. These patients will often respond to further treatment using the same regimen. A surgical approach may be beneficial for patients with recalcitrant warts or very extensive perianal involvement. As the risk of recur-

rence is high, such patients should be carefully followed up so that any further warts can be treated early before further extensive lesions develop. An alternative second-line option is outpatient, topical immunotherapy using an agent such as imiquimod.

Prevention

Genital HPV infection can now be prevented by the use of a therapeutic vaccine. Two types of vaccine are currently available, one that is effective against HPVs 6, 11, 16 and 18 (Gardasil), and another that will protect against HPVs 16 and 18 (Cervarix). Many countries in the developed world have begun to implement vaccination programmes.

Late Complications

Oncogenic HPV is associated with 90% of anal cancers (see Chap. 22).

Case History

A 45-year-old married man presented to his primary-care physician complaining of perianal itching. He had also noticed perianal "lumps". He had remarried 2 years earlier and his wife had no symptoms. He had not had any other sexual partners in the last 2 years. Examination revealed several small perianal warts. The referral letter stated that the patient had "denied" male sexual contact. He was referred to the local STI clinic for infection screening and treatment. He was screened and started treatment with topical agents. The warts resolved 3 weeks after his initial presentation. His wife was examined and had no evidence of genital warts but gave a history of a mildly abnormal cervical smear (Pap) test 12 months earlier.

Learning Point

Perianal warts are found in both heterosexual and homosexual men. Whilst they are commoner among MSM, it is wrong to assume that all men with perianal warts must have had sex with men.

47.5.3.3 Molluscum Contagiosum

A poxvirus is the causative agent of this benign, self-limiting skin infection. It occurs worldwide but is more prevalent in tropical areas. Infection is most common in children, sexually active adults and persons with impaired cellular immunity, particularly HIV-positive patients. Although *M. contagiosum* is chiefly a disease of children, the incidence in adults is rising, probably reflecting sexual transmission [38].

Clinical Presentation

Sexually active adults typically present complaining of a papular rash in the genital area with small, discreet, pearly lesions with a central indentation. Giant molluscum lesions, which are often atypical in location, for example presenting on the face or neck, may indicate underlying HIV infection. Perianal lesions are uncommon.

Transmission

Sexually active adults may pass the virus through close skin-to-skin contact. Penetrant sexual intercourse is not necessary for transmission.

Diagnosis

This is based on the characteristic appearance. Lesions are sometimes confused with genital warts, but can be easily distinguished with a magnifying glass.

Treatment

Infection is usually self-limiting, but traumatising lesions with a needle with or without the use of phenol will accelerate this natural process.

47.5.3.4 HIV Infection – HIV 1 and 2

This new STI was first identified in the early 1980s when epidemiologists in New York noticed increased reporting of Kaposi's sarcoma (KS) in young Caucasian males. By March 1981 at least eight cases of a more aggressive form of KS had occurred amongst young gay

men in New York [39]. This was highly unusual, as KS was previously a rather indolent disease found in elderly, black, African males. At about the same time there was an increase in the number of cases of the rare lung infection *Pneumocystis carinii* pneumonia in both California and New York [40]. These observations led to the discovery of HIV, the causative agent of AIDS.

Until quite recently an AIDS diagnosis predicted death in less than 5 years. However, since the mid 1990s a range of HAART drugs has been developed. In combinations of at least three taken together, these are highly effective in preventing the development of immunodeficiency and AIDS and in prolonging life. These drugs are also effective in reducing mother-to-child transmission during pregnancy and have reduced the perinatal transmission rate from 25% to <2% [41].

Clinical Presentation

Most patients acquire HIV infection without reporting symptoms, with approximately 30% experiencing an infectious mononucleosis-like illness at the time of HIV seroconversion [42]. The diagnosis is usually dependent on clinician or patient awareness of risk. In the developed world, HIV is found most commonly in MSM, or in heterosexual patients who come from pattern 2 countries, or the sexual partners of high-risk patients. A careful sexual history as part of a routine assessment will identify most at-risk patients.

Some patients are either unaware of the risk or choose not to be tested for HIV. They may present at various stages of immunodeficiency and diagnosis may depend on recognising the later presentations of HIV infection.

Case History

A 40-year-old single man was referred by his primary-care physician for a private consultation with a rectal surgeon. He had a history of several weeks of perianal discomfort and the GP had noted some pigmented lesions around the anus. He underwent sigmoidoscopy and biopsy under a general anaesthetic. The histology showed KS and it was recommended that he should be referred for HIV testing. He was seen by an STI specialist who took a sexual history, which confirmed that he was a gay man in a regular relationship of 6 months duration. He practised both receptive and insertive anal sex usually, but not always, with condoms and lubrication. He had had two other casual contacts in the preceding 6 months. After discussion and counselling he underwent HIV testing. The result was positive and a subsequent blood test showed some evidence of immunodeficiency, suggesting that the infection had been present for some time.

Learning Points

1. A sexual history would have indicated risk of HIV infection and an earlier diagnosis might have been made.
2. KS is now uncommon in the developed world because most patients present relatively early and are given antiretroviral treatment before becoming immunocompromised.
3. KS is an easy diagnosis to miss. Lesions may be present elsewhere on the skin and in the mouth. Examining the rest of the skin is important in assessing patients with perianal skin lesions.

Transmission

HIV is most commonly sexually transmitted (90% of cases worldwide). Other routes of transmission are mother-to-child during pregnancy, perinatally or during breast feeding, intravenous drug misuse, and needle-stick injuries or use of contaminated equipment.

Diagnosis

Almost all patients develop HIV antibodies, which are detectable on blood testing, within 3 months of exposure. Blood tests taken within the so-called window period should be repeated at least 3 months after the risk episode. All patients with an initial positive test should undergo a repeat test to confirm the diagnosis.

Treatment

From the mid 1990s an increasing range of antiretroviral drugs has become available. If taken reliably, and used in combinations of three or more, these have proved highly effective in controlling viral replication and preventing the immune deterioration previously associated with long-term HIV infection. Management

is complex and all HIV-positive patients should be referred to a specialist for long-term care.

47.5.3.5 HBV – Hepadnavirus

HBV primary infection is associated with three possible long-term outcomes. The first is the development of full immunity, and the second two are long-term carrier states (5–10% of patients, but 18–20% of HIV-positive patients) of either low-risk (surface antigen positive) or high-risk ("e" antigen positive) HBV infection [43].

Clinical Presentation

Many primary infections are asymptomatic (60–80%), but some patients develop acute hepatitis with jaundice and deranged liver function. Of those who develop acute hepatitis, most recover spontaneously, but <1% may develop fulminant hepatitis, which has a high mortality rate.

Transmission

Worldwide, HBV infection is most commonly acquired perinatally or during infancy and childhood in areas of high prevalence. However, carriers can transmit infection sexually to uninfected, non-immune sexual partners. The most at-risk groups in the developed world are MSM and heterosexuals with high rates of partner change.

Diagnosis

This is usually based on serological tests.

Treatment

This is complex, and patients diagnosed with HBV should be referred for specialist management [44]. There is now an effective vaccine available for the prevention of primary HBV infection. Different countries vary in their approaches to vaccination. Some favour universal immunisation in childhood, whereas others, like the UK, offer immunisation to at-risk groups, which include MSM and injecting drug users. Patients who are low-risk carriers (surface antigen positive and "e" antigen negative) can be monitored with annual liver function tests and referred if these become abnormal. Those who are high risk (e-antigen carriers), where there is a risk of cirrhosis and liver cancer, should be referred for treatment.

47.5.3.6 Hepatitis C

Clinical Presentation

HCV is most commonly acquired asymptomatically, with 5–10% of patients presenting with jaundice and mild hepatitis.

Transmission

HCV is most commonly acquired parenterally. Up to 50% of current or former intravenous drug users have evidence of infection with HCV. Probably less than 10% of cases of HCV are related to sexual exposure. The risk of transmission is greater in long-term (i. e. >12 months) relationships. There have been some reported clusters of HCV infection among MSM, where the risk of sexual transmission may be higher than previously recognised. This appears to relate to sexual practices such as "fisting" (insertion of the fist into the rectum), which increase the risk of transmission [45]. There is also a strong association with HIV seropositivity [46].

Diagnosis

As most cases are acquired asymptomatically, diagnosis is dependent on the recognition of risk. MSM, and especially those who are HIV positive, current or former intravenous drug users and patients from countries with high reported rates of HCV infection should be offered HCV testing (see Fig. 47.3). The initial screening test is an antibody test. All antibody-positive samples are then re-tested using a PCR test. If positive, this latter test indicates active infection. HCV antibody patients who are PCR negative are thought to be immune.

Treatment

Until quite recently, HCV infection was not treatable and up to 50% of patients with active infection had a risk of developing cirrhosis. A range of treatments is now available for HCV carriers and all should be re-

ferred to specialist liver units for further investigation and treatment.

47.5.4 Other STIs

Other pathogens such as certain parasites and some viruses, notably cytomegalovirus and hepatitis A, can be sexually transmitted but are not generally listed as STIs (Table 47.7) [47]. The risk for sexual transmission is almost always sex between men, both anilingus and penetrative anal sex [48]. In most cases patients do not have symptoms. Previously, such infections have been more significant in patients with HIV disease, but in the developed world HAART has significantly reduced the number of patients presenting with bowel disease. Evidence that suggests possible sexual transmission includes a higher prevalence in MSM populations and infection in the absence of travel.

47.5.5 Related Problems

Male sexual trauma, voluntary or involuntary, including male rape and child abuse, is under-reported and may not be recognised unless the clinician is aware [49]. Trauma also increases the risk of acquiring an STI [50, 51]. In 2005–2006, 1,118 cases of male rape were reported to the police in the UK (Home Office Statistics: verbal communication Philip Rumney, Law School, Sheffield-Hallam University). This is a reporting rate of 15–25%, indicating the extent to which male rape is believed to be under-reported. Such cases may present with evidence of rectal trauma through emergency departments or in other settings. In addition, some voluntary sexual practices such as fisting, use of dildos and other practices may produce trauma and/or infection. Whilst these are more common among MSM, some heterosexuals also report such practices.

47.6 Conclusion

STIs and their associated complications remain an important and often neglected area of medicine. The epidemiological data and events over the last 30 years provide good evidence that despite substantial medical advances we are not yet close to either controlling or eradicating these infections. The development of HPV vaccines represents a significant step forward, but vaccines against other STIs are disappointingly elusive. The development of new antibiotics is closely followed by the development of antibiotic resistance.

Sexual history taking is more likely to be an auto-

Table 47.7 Sexually transmissible infections (not necessarily HIV-associated): presentation, diagnosis and treatment. *CMV Cytomegalovirus*, *HAART* highly active antiretroviral therapy

Pathogen	Presentation	Investigations	Treatment
Shigella	Abrupt-onset diarrhoea (usually watery – may contain mucus/blood), fever, nausea and cramps	Culture	Supportive – avoid antibiotics if possible
Campylobacter species (not *C. jejuni*) rare – atypical – mode of transmission not clear, but increased carriage in MSM	Chronic diarrhoea and mild proctitis	Culture	Not always necessary, if very symptomatic then can treat
Giardia lamblia	Diarrhoea, abdominal cramps, bloating and nausea	Multiple stool examinations, or jejunal sampling/biopsy	Treatment recommended
Entamoeba histolytica	No symptoms in 50%, range of mild diarrhoea to fulminant bloody dysentery, proctocolitis	Wet mount of swab, or biopsy	Treatment recommended of all including asymptomatic cases
CMV	Often asymptomatic, but may cause colitis in late HIV disease as a result of reactivation of latent CMV infection	Biopsy and serum CMV antibodies. HIV antibody test if status not known	In acute colitis antivirals are used and, if there is untreated underlying HIV disease, HAART will be instituted
Hepatitis A	Often asymptomatic or acute self-limiting hepatitis	Serum antibodies	Treatment is supportive

matic part of the routine assessment of the patient. Despite this, the possibility of an STI as part of the differential diagnosis or a complicating factor is too often not considered. Many patients with HIV infection remain undiagnosed and patients with other STI diagnoses will occasionally undergo unnecessary investigations and/or surgery when a short course of antibiotics would have cured the problem.

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Self-Assessment Quiz

Question 1

1. A surgeon is generally not at risk of contracting which of the following blood-borne infections from a patient at operation?

a. Hepatitis B
b. Hepatitis C
c. Human immunodeficiency virus (HIV)
d. Syphilis
e. Gonorrhoea

Question 2

2. Bacterial sexually transmitted infections (STIs):

a. Usually have symptoms
b. Are only transmitted through penetrative sex
c. Can recur if the partner(s) are not treated
d. Are cured by most antibiotics
e. Only occur in individuals with multiple sex partners

Question 3

3. Perianal herpes

a. Is found only in men who have sex with men
b. Is commonly symptomatic
c. Can be prevented by vaccination
d. Can be treated with antiviral agents
e. Is associated with rectal carcinoma

Question 4

4. Which of the following statements regarding rectal STIs is true?

a. Rectal gonorrhoea requires anal sex.
b. Rectal STIs are not found in exclusively heterosexual men.
c. Co-infection with more than one infection is common.
d. Patients over the age of 40 years are unlikely to have an STI.
e. HPVs 6 and 11 are associated with anal carcinoma.

Question 5

5. A perianal ulcer is not generally associated with:

a. Cancer
b. Syphilis
c. Lymphogranuloma venereum
d. Human papillomavirus (HPV)
e. Chancroid

1. Answer: e
   Comment: Infections a–d are all systemic and can be transmitted via contaminated blood.
2. Answer: c
   Comments: The commonest cause for recurrent bacterial STIs is reinfection by an untreated partner. Contact tracing and partner treatment are an essential part of managing bacterial STIs.
3. Answer: d
   Comments: Heterosexuals may also practise anal intercourse; most STIs are commonly asymptomatic and herpes is more commonly passed on by someone who does not know they have infection. There are no vaccines for herpes, and wart virus not herpes virus is associated with rectal carcinoma.
4. Answer: c
   Comment: Once an STI is diagnosed it is common practise to test for others for this reason.
5. Answer: d
   Comments: HPV causes exophytic cauliflower-like lesions. The possibility of a malignancy is raised if ulceration is present in association with HPV, and a biopsy sample should be taken.

48 Radiation Injury

Henri A. Vuilleumier and Abderrahim Zouhair

CONTENTS

48.1 Introduction

The deleterious effects of radiation on normal tissues were recognized soon after Roentgen's original publication on "A new kind of ray" in 1885 [66]. Rowland reported a case of actinic dermatitis in 1896 [67] and Walsh reported on gastrointestinal toxicity in 1887 [78]. Since then, radiation-related damage to all organs has been described and studied extensively. Despite the evolution of radiotherapy into a more powerful, accurate, and safer tool for tumor control, radiation injury remains its most important limiting factor. In fact, as this modality has gained broader applications, a parallel increase in the number of patients with radiation-induced complications has been seen [1, 51].

The manifestations of radiation injury range from mild to disabling or life-threatening and can present during the course of radiation or any time later. The patients affected are often debilitated physically and psychologically. As a consequence, multifaceted problems may arise that require the involvement of several specialists. In this context, an early and precise diagnosis, coupled with appropriate treatment, cannot be overemphasized.

Radiation delivered to a malignancy located in the prostate, bladder, cervix, uterus, ovaries, anus, and rectum frequently causes injury to normal portions of the colon and rectum. Such susceptibility is due to the proximity to irradiated tumors, the mucosal sensitivity to radiation, and the fixed position of segments that can not be mobilized away from radiation portals. In addition, pre- or postoperative irradiation for rectal tumors may increase the risk of anastomotic dehiscence and poor wound healing.

This chapter provides a background on radiobiology and physics, and then reviews the clinical features and treatment of radiation-induced disorders of the colon, rectum, and anus. Management issues are emphasized, taking into consideration both medical and surgical options. The aim is to provide useful information for colorectal surgeons and other specialists likely to encounter these problems in their practice.

48.2 Definitions

Forms of radiation in clinical use include X-rays, gamma (γ)-rays, beta (ß)-rays, and electrons. X-rays and γ-rays are types of electromagnetic radiation and have similar properties. ß-rays and electrons are examples of particulate radiation. All of these variants produce ionizing radiation, which is energy that generates ion radicals upon interaction with tissues. These radicals are responsible for damage to DNA and cell membranes, with their biological consequences.

The unit of radiation dose is the Gray (Gy), which is defined as the absorbed dose of energy per kilogram of soft tissue; 1 Gy is equal to 1 J/kg. The unit previously used was the rad, which corresponds to 1 centigray (cGy; 100 rad = 1 Gy). Energy lost during passage

through tissues is called linear energy transfer (LET), and each type of radiation has its own particular LET. Therefore, equal doses of different forms of radiation may produce variable biological effects [16]. Radiation damage correlates linearly with the total dose delivered, and the toxicity for each tissue has been divided into a minimal tolerance dose (TD 5/5) and maximal dose (TD 50/5). TD 5/5 is the dose leading to complications in 5% of patients within 5 years, and TD 50/5 is the dose leading to complications in 50% of patients within 5 years. The volume of tissue irradiated is also a critical factor influencing the development of radiation sequelae. In contrast to chemotherapy, few prospective dose-escalation studies have been conducted to determine the maximum tolerated dose of radiation at any given site. The radiation tolerance of most organs is not precisely known.

Radiation can be delivered by beam sources, brachytherapy, or radionuclides. For external-beam radiotherapy (EBRT), megavoltage photon irradiation can be delivered by cobalt-60 sources (γ-rays) or high-energy linear accelerators (X-rays). The latter are preferred for abdominopelvic malignancies because of potent effects in deep tissues with minimal skin toxicity. Brachytherapy or curietherapy uses radioactive sources adjacent to (cavitary) or within (interstitial) tumors. With this technique, a high dose can be delivered to the area adjacent to the source. For instance, doses of up to 200 Gy may be given in endocavitary uterine brachytherapy, which may lead to severe damage to the surrounding normal tissues. The isotopes commonly used in brachytherapy are cesium-137, iridium-192, iodine-125, and gold-198. Remote afterloading systems have been engineered to permit the loading of radiation sources without exposing staff to ionizing radiation [54]. The introduction of second-generation remote afterloading systems, and changes in EBRT methods, have been associated with an increased risk of radiation-induced bowel disease [2].

Radiotherapy is often prescribed in courses, which are combinations of dosage, timing, and physical factors established empirically. Standard fractionation of doses, immobilization devices, and limited-field (target volume more defined) irradiation are techniques used to minimize the risk of injury to normal tissues while maintaining a high likelihood of tumor control. With the same goal, conformal techniques employ immobilization by cast, precise definition of tumor volume in 3D, and individually shaped radiation portals. Conformal 3D EBRT, and the more recent intensity-modulated radiotherapy, are excellent techniques for delivering a sufficiently high dose to the tumor while limiting the risk of toxicity to the surrounding organs.

Chemical and physical factors may alter the cellular response to radiation. Doxorubicin, 5-fluorouracil (5-FU), and oxygenation are examples of radiosensitizers [71], and agents such as amifostine (Ethyol) appear to have radioprotectant properties [53]. Potential intestinal radioprotection has been demonstrated for vitamin E [22], glutamine [10, 47], and hyperbaric oxygen [21] in some animal studies.

The term "radiation injury" refers to several morphological and functional changes that occur in noncancerous tissues as a result of ionizing radiation. Clinically, early and late forms of injury are recognized. Terms such as radiation proctitis, enteropathy and the like, can be more elucidating when their acute or chronic nature is specified.

48.3 Pathophysiology and Pathology

The initial step of radiation injury occurs at the molecular level and involves damage to DNA. Subsequent alterations that develop at the level of cells, tissues, and organs depend on the extent of such damage and on the ability of the cell to repair the DNA molecule. Severe DNA damage results in the immediate arrest of cell division and in cell death. In this case, normal tissue injury results from depletion of a population of cells. Moderate DNA damage may allow cells to proliferate, but mutations transmitted to the progeny eventually culminate in cellular death. This mechanism is implicated in the delayed clinical response of tumors to radiation; cell death occurring only after several cycles of division. Mild DNA damage may be readily repaired by cellular mechanisms that allow the cell to maintain its original capacity for division and function. This is one of the reasons for using fractionation. Because normal cells usually have greater capacity to repair DNA than cancer cells, spacing the dose of radiation may permit recovery of normal tissues but not tumor, thus increasing the therapeutic dose–effect ratio. Sublethal damage to portions of DNA also explains long-term mutagenesis leading to malignant transformation, a well-known effect of radiation.

In general, the more differentiated the cell, the more resistant it is to radiation. Cells in the active mitotic phase are more likely to die, and damage occurs more rapidly in cells with short mitotic cycles. A high prolif-

erative rate is characteristic of "acute reactants" such as gut mucosal cells, which are involved in acute, transient radiation toxicity. Endothelial and smooth muscle cells are slowly dividing or "late reactants." Their injury is associated with chronic radiation-induced alterations. An important factor governing a cell's response to irradiation is its position in the cell cycle. However, any cell, at any time of its cycle, is susceptible to damage if it receives enough dosage of radiation. Also, each cell type, tumor or tissue, shows different sensitivity to both the degree and time of radiation damage. For example, the rectum is considered more tolerant than the colon and small bowel, with a TD 5/5 of 55 Gy and a TD 50/5 of 80 Gy. The colon, as well as the small intestine, has a TD 5/5 of 45 Gy and a TD 50/5 of 65 Gy. Individual variability has been noted among patients, especially regarding chronic radiation-induced changes, and recent research has focused on the role of fibroblasts in these reactions [65].

Treatment factors that influence the development of injury include total radiation dose, fractionation schedule, volume of irradiated tissue, and source positioning [32]. For instance, studies assessing intestinal mucosal regeneration and repair following fractionated radiation have confirmed the importance of a rest period between radiation doses to permit regrowth of normal epithelium from stem cells [81]. The combination of cytotoxic drugs or radiosensitizers with radiation increases cytotoxicity, as has been demonstrated in vitro and in vivo with 5-FU [3, 77]. 5-FU interferes with rejoining of radiation-induced damage to double-strand breaks or with recovery from potentially lethal damage [36]. Adriamycin, methotrexate, and actinomycin may have similar effects [62, 72]. Oxygenation has also been implicated in the sensitization of cells to radiation [34].

Microscopic examination of the irradiated bowel reveals a great variety of pathological changes. Such effects may be seen in acute radiation injury hours or days after irradiation, or in chronic radiation injury after months or years. In acute injury, the changes are predominantly in the mucosa. Due to damage to progenitor cells, the epithelium is not adequately replaced and the mucosa becomes denuded within a few days. Findings include nuclear atypia and depletion of epithelial cells, bacterial invasion of the mucosa, vascular congestion, edema, and hemorrhage. Depletion of lymphoid cells and lymphangiectasia are found, especially in the small bowel [7]. Fibroblasts in the lamina propria are reduced. Bizarre cellular changes may be seen in the crypts of the colon and rectum, including abnormal mitotic figures and nuclear fragments within epithelial cells. Inflammation and crypt abscess formation also occur. There are infiltrates of neutrophils, mucosal congestion, and atrophy of villi. Electron microscopy of epithelial cells shows a reduction in the number of microvilli, disrupted tight junctions, dilatation of the endoplasmic reticulum, basement membrane thickening, damaged mitochondria, and irregular, enlarged nuclei with prominent nucleoli. These acute changes may result in diarrhea, malabsorption of nutrients, dehydration, electrolyte loss, and bacterial translocation, and tend to disappear within 1–2 months, but in severe radiation damage, ulceration, necrosis, and hemorrhage may ensue.

The late effects of radiation develop months or years after treatment and are predominantly the result of progressive obliterative endarteritis leading to ischemia and fibrosis. Age, arteriosclerosis, hypertension, and diabetes may therefore increase the risk of manifestations, as may trauma or surgery at an irradiated site. Morphologically, there is subintimal thickening or fibrosis and hyalinization of the entire wall of arteries of all sizes. Foam cell deposits beneath the intima may produce significant narrowing in small vessels. "Skip areas" of relatively normal vessels may be observed. Involved bowel usually displays areas of ischemic necrosis or ulceration due to occlusive changes of small mural vessels. This can cause gastrointestinal symptoms that begin a few months after radiotherapy [9]. Ulceration and surface erosion are common. The columnar epithelium is attenuated near the ulcer and the crater characteristically contains neutrophils, lymphocytes, plasma cells, histiocytes, and eosinophils within granulation tissue. Eroded vessels may result in gastrointestinal bleeding and eventual anemia. Deep fissures and ulcers may lead to perforation, fistulization, abscess or peritonitis. Fistulas may be covered by either epithelium or inflamed connective tissue. A nonhealing rectal ulcer is usually associated with severe fibrosis. Anal sphincter biopsy samples in patients with anorectal dysfunction after radiotherapy demonstrate damage to the myoenteric plexus and smooth muscle hypertrophy [75]. Irradiated bowel fibrosis may involve the submucosa, causing a great variation of its thickness, the muscular layers, and the serosa. Fibrotic reaction of connective tissues surrounding the bowel may lead to formation of adhesions and ultimately intestinal obstruction. Ischemic strictures may produce obstructive symptoms and, especially in the ileum, may lead to malabsorption [19].

"Radiation fibroblasts" may be present in the irradiated bowel, as well as in a variety of other irradiated tissues. These bizarre cells are enlarged, pleomorphic, basophilic, and spindle-shaped, and may be confused with malignant cells. Adipose cells may be also seen within fibrous tissues. "Colitis cystica profunda" is the presence of cysts lined by colonic epithelium in the submucosa or muscular layers. This may be the result of entrapment of epithelium that migrated into ulcerations or fissures that later healed. Such glandular structures within the bowel wall may pose diagnostic problems because of confusion with cancer.

The presence of the tumor itself may predispose the surrounding normal tissue to injury. The tumor destroys normal tissue and produces proteolytic enzymes, which cause fibrosis.

48.4 Classification

Acute, subacute, and chronic radiation injury have been arbitrarily defined as occurring within 1 month, between 1 and 3 months, and more than 3 months after radiotherapy, respectively [12]. The severity of damage has been further classified into grades of toxicity. For acute morbidity, the World Health Organization Handbook for Reporting Results of Cancer Treatment [79] has been widely used, but a more recent scoring system developed by the Radiation Therapy Oncology Group (RTOG) is preferred [15]. For chronic morbidity, the most commonly accepted classification is that of the European Organization for Research and Treatment of Cancer (EORTC)/RTOG [20], based on the Common Toxicity Criteria, with a new version published recently [8]. These scoring systems aim to provide a means by which to compare results from different studies. Toxicity criteria for combined-modality treatment strategies have not yet been fully devised [69].

48.5 Epidemiology

More than half of all cancer patients receive some form of radiotherapy [39]. In the treatment of abdominopelvic malignancy, the rectum, colon, and small intestine are frequently involved in the radiation field [44]. The likelihood of injury to normal tissues depends on the radiation technique, the dose, the volume of irradiated tissue, and patient factors [17]. For example, EBRT combined with intracavitary sources results in a higher risk compared with either technique alone. Furthermore, adhesions from previous surgery or pelvic inflammatory disease predispose to radiation damage to the intestine during abdominopelvic irradiation [45, 24], and vascular changes from diabetes or arteriosclerosis may accelerate the onset of chronic manifestations [17].

Acute toxicity is usually self-limited and reversible, whereas late effects are progressive and irreversible. However, acute toxicity does not predict the incidence or severity of late reactions. About 5% of patients develop late manifestations, with an average onset 2 years after radiotherapy, but occurring sometimes as early as 1 month or as late as 20 years [38]. The incidence of serious complications appears to have increased following the introduction of protocols that combine various therapeutic modalities [1, 68], but there is a wide variation in estimates of radiation-related toxicity, particularly for long-term complications [18]. Thus, the literature should be interpreted with caution. Factors that make such data difficult to report and to analyze include the following:

1. Common terminology is not employed. For example, identical findings may be defined as "complication," "reaction," or "side-effect."
2. There is a weak correlation between pathological and clinical features.
3. Severity scales for symptoms and clinicopathologic findings are not uniformly used.
4. The variable latency of late reactions demands frequent surveillance and long periods of follow-up.

Therefore, results from different series can rarely be compared, and much of our knowledge depends upon anecdotal experience. Unfortunately, doses of radiation that are curative for cancer also place patients at significant risk of developing complications. If radiation is given in sufficient amounts, some degree of injury to normal tissues will occur. The clinical significance of such damage depends on the many factors discussed previously. The most frequent complications that the coloproctologist will encounter are skin and wound problems, radiation enteritis, coloproctitis, fistulization, and stenosis. Epidemiological data may aid decision-making and informing patients about the risks of radiotherapy. In this section, epidemiological data is presented according to irradiated tumor sites.

48.5.1 Uterine Carcinoma

Uterine carcinoma is frequently treated with radiation, and for advanced carcinoma of the cervix exter-

nal-beam and intracavitary sources are customarily combined. Enteritis and rectovaginal fistula are common complications [38]. An analysis of 1,801 cases treated between 1962 and 1982 revealed a progressive rise in radiation-induced bowel disorders, including rectovaginal fistula. Late complications necessitating surgical consultation occurred in 4.3% of patients [1]. In another report, preoperative radiotherapy for endometrial adenocarcinoma using brachytherapy in combination with EBRT resulted in moderate or severe complications affecting 17% of patients. The sigmoid colon was most frequently involved, followed by the rectum and genitourinary organs [46]. In a study of 831 patients with cancer of the cervix, Strockbine et al. [73] found a linear correlation between the incidence of small-bowel complications and the radiation dose delivered. Similar observations have been made for colonic injuries [30].

48.5.2 Carcinoma of the Vagina

Radiation is a major treatment modality in most patients with carcinoma of the vagina [61]. In a report of 165 cases receiving total doses of 80–120 Gy, rectovaginal or rectovesical fistulas developed in 4% of patients [60]. The accepted TD 5/5 for ulceration of the vagina is around 90 Gy and for fistula formation it is greater than 100 Gy [70]. However, a threshold dose of only 80 Gy has been reported for the development of a rectovaginal fistula [35]. Tumor stage and location in the vagina are factors influencing these variations.

48.5.3 Prostate Cancer

More than 30% of prostate cancers are treated with radiotherapy [49]. The risk of rectal injury is great when high doses are delivered by intraprostatic implants in addition to EBRT. For instance, radioactive gold seeds placed in the prostate deliver doses exceeding 70 Gy to portions of the rectum [71]. For EBRT alone, acute gastrointestinal effects occur in 30–40% of patients and usually develop within 4 weeks of therapy. Diarrhea, rectal discomfort, and tenesmus may lead to interruption of therapy in 5% of cases. Chronic complications affect about 12% of patients and consist of diarrhea, rectal ulcers, strictures, and fistulas that may require surgical intervention in 1% of cases [11]. Grade 3 and 4 late complications were found in 3.3% of patients studied by the RTOG [41].

48.5.4 Urinary Bladder Tumors

In the treatment of urinary bladder tumors, radiation doses exceeding 65 Gy may be delivered to the pelvis using EBRT. Brachytherapy is used mainly for small tumors because large tumors require multiple implants and a higher total dose, leading to severe complications [23]. An RTOG study reported that 10% of patients treated with 60–70 Gy developed grade 3 or 4 toxicities at 18–24 months after treatment [14].

48.5.5 Cancer of the Anal Canal

Radiotherapy is the treatment of choice for carcinomas of the anal margin and anal canal. Nevertheless, it results in radionecrosis requiring colostomy in 5% and anal incontinence in 5–25% of patients [58, 74, 75]. The addition of pelvic surgery, brachytherapy, or chemotherapy has been reported to significantly increase posttreatment complications [13]. Today, a substantial proportion of cases of squamous cell carcinoma of the anus is associated with acquired immune deficiency syndrome. In these patients, delayed healing and increased normal tissue damage have been consistent findings after radiotherapy [33].

48.5.6 Rectal Cancer

The rectum may be the target for radiation in the treatment of rectal cancer. When radiation is given prior to proctectomy, there is concern regarding the healing of abdominal or perineal wounds and dehiscence of colorectal anastomoses. Since most series include patients who have undergone abdominoperineal excision of the rectum, it is difficult to know the true incidence of radiation-related complications. Various studies report problems in 5–15% of cases [80]. The EORTC reported a mean delay of perineal wound healing of 60 days when abdominoperineal excision was performed within 2 weeks following irradiation [28]. Other groups using a 4-week or longer delay between irradiation and surgery did not observe any difficulty in wound healing [40]. A substantial number of patients who underwent sphincter-saving resection were included in the Medical Research Council trial [52]. In the group that had surgery alone, 30% developed an anastomotic leak, compared with 8% in the group receiving 5 Gy and 16% in the group receiving 20 Gy. This paradox is perhaps due to special care taken with the anastomo-

ses performed after irradiation. In a study in which the control group received sham irradiation, no difference in complication rate was seen between the two groups [63]. In another study the combination of intraoperative 10–20 Gy with EBRT of 45–55 Gy resulted in acceptable local control but high toxicity [31].

Pelvic irradiation with doses of 45–50 Gy over 5 weeks is associated with small-bowel obstruction requiring surgery in 5% of cases [25, 42]. With doses above 50 Gy, this complication rate rises to 25–50% [43]. In a study of 11 patients receiving pelvic irradiation, all developed mucosal abnormalities on rectal biopsy that resolved 1 month after cessation of X-ray exposure [27].

48.6 Prevention

Despite multiple experimental attempts, there is currently no drug therapy that is clinically useful for protecting normal tissues against radiation-induced damage [53]. Therefore, prevention depends on the manipulation of radiation techniques and the mobilization of normal tissues away from radiation fields. Conformal 3D radiotherapy, with or without intensity-modulated radiotherapy techniques, is associated with reduced acute toxicity [32] and is also likely to decrease late toxicity.

Fractionation is also useful to improve the dose–response of tumors by minimizing toxicity, although there is little consensus regarding the best schemes [56]. Several surgical procedures have been designed to exclude the small bowel from the pelvis and avoid radiation enteritis. These include the use of omental and synthetic slings [57], and redundant sigmoid colon. Also, anterior parietal peritoneal flaps can be sewn to the posterior parietal peritoneum to function as bowel slings [76]. Most of these procedures have been incompletely effective and some are associated with significant complications. Another technique aimed at preventing postoperative radiation morbidity is the staging of cervical cancer via a retroperitoneal approach [24]. Furthermore, for stapled anastomoses, a maximum anvil size must be used in order to minimize the risk of anastomotic strictures that are prone to occur when pre- or postoperative radiotherapy is given.

48.7 Clinical Features and Diagnosis

Acute and chronic radiation disorders differ in the way that they present and in their evolution. Symptoms of acute toxicity tend to occur a few days after radiation and subside within 1 month. In chronic radiation damage, the latent period between radiotherapy and the development of symptoms varies widely, usually appearing in 2–6 years, but sometimes as soon as 1 month or as long as 20–40 years after irradiation [17, 38]. Besides the confounding issues of comorbidities that aggravate the effect of radiation, it has long been recognized that there is significant variability among patients regarding their reaction to similar radiotherapy protocols.

Acute dermatitis involving the perianal area, buttocks, vulva, and perineum may be asymptomatic or cause pruritus, burning sensation, and pain. Examination reveals erythema, maculopapular changes, vesicles, or ulcerations. Following irradiation, mild erythema usually appears in the 2nd week and becomes more accentuated and painful around the 3rd week. Associated edema and moist desquamation reach a peak at 4 weeks. Severe reactions are rare and are characterized by ulceration, hemorrhage, and necrosis. After healing occurs, the new skin is usually erythematous for several weeks, followed by hyperpigmentation that fades over a period of months. A special problem that may be encountered is wound dehiscence after abdominoperineal amputation, a cloaca being the most dramatic presentation. This has been described even with the use of a pediculated graft of omentum to fill the perineal cavity.

Radionecrosis involving the anodermis or the entire anal canal is a serious complication. It usually presents within the first 2 weeks following irradiation for anorectal or, more rarely, gynecologic malignancy. Patients may complain of pain, constipation, and rectal bleeding. They may develop fever and occasionally a necrotizing infection of the perianal area and perineum. Examination under anesthesia is recommended to evaluate the full extent of the lesions. Edema, spasm of the anal sphincter, and necrosis are common findings.

The most frequent symptoms of acute proctitis are urgent calls, tenesmus, blood, and mucus discharge. Proctosigmoidoscopy will show an edematous, inflammatory, and friable mucosa. This symptomatology usually resolves after a few weeks. One must remember that an associated colitis or enteritis may cause similar complaints. Also, if irradiation caused significant proctitis, other sites of injury in the vagina, ureter, and bladder should be searched for.

Acute radiation colitis usually manifests as diarrhea and rectal bleeding, but only a small percentage of patients experiences symptoms despite documented radiation damage. Obstruction, perforation, and peritonitis

rarely occur and usually involve colonic segments that are fixed anatomically or secondary to adhesions.

Acute enteropathy is characterized by mucosal edema, hyperemia, and ulcerations. In studies using 30 Gy or more, the most common symptoms were diarrhea, nausea, vomiting, and abdominal pain. Examination may reveal abdominal distension, increased bowel sounds, and occult or gross blood in the stool. This acute injury syndrome is generally self-limiting and resolves after a few weeks.

Chronic radiodermatitis frequently causes a sensation of dryness, but hyperesthesia and significant pain may also occur. Findings include hyperpigmentation or depigmentation, hyperkeratosis, epilation, atrophy, fibrosis, telangiectasia, edema, ulceration, and necrosis. Squamous cell cancers may ultimately appear years later.

Sphincter dysfunction is usually found in the setting of chronic proctitis with reduced rectal compliance and volume. Anal manometry may show a reduced maximum resting pressure, an abnormal rectoanal reflex, and a decrease in the functional sphincter length. However, in some studies, no significant anal manometry changes could be identified in patients receiving 45 Gy to the anus and rectum.

Chronic proctitis is frequently a progressive disorder with features ranging from mild to disabling forms. Problems include hemorrhage, ulceration, perforation, fistulization, and stenosis. The median onset of symptoms is about 10 months. Proctosigmoidoscopy reveals a pale, telangiectatic, and friable mucosa. The presence of ulceration on the anterior rectal wall may be difficult to distinguish from recurrent tumor, either from previous rectal cancer after low anterior resection, or after treatment of prostate cancer. The first concern in the management of rectal or anastomotic stricture is to rule out tumor recurrence. Biopsies and imaging studies are usually necessary. Barium enema is helpful to determine the severity, height, and topography of the area of stenosis, and a computed tomography scan may identify extrinsic masses and metastatic disease. Most recurrences occur within 2 years following operation. Rectal strictures are encountered especially after radiotherapy for cervical cancer with doses exceeding 60 Gy. Rectovaginal fistula formation is preceded by a painful anterior rectal wall ulceration developing at the level of the cervix. Induration of the rectovaginal septum deserves careful surveillance, and again tumor recurrence should be suspected, particularly if the patient develops increasing pain in this area.

Late injury to the large or small intestine most frequently causes obstructive symptoms with colicky abdominal pain, diarrhea, nausea, and vomiting. Clinically, it is difficult to determine whether diarrhea is due to small-bowel injury or impaired rectal function. Contrast studies may demonstrate nonspecific mucosal changes, with areas of thickening and stenosis, reduced peristaltic activity, and diminution of caliber as a consequence of chronic ischemia, especially on the colon. Endoscopy findings include a pale and telangiectatic mucosa.

In the differential diagnosis of radiation-related lesions it is most important to rule out tumor recurrence or de novo neoplasia that may be induced by radiation. In addition, cytomegalovirus-induced coloproctitis, perianal herpetic eruptions, and bacterial infections resulting from immunosuppression induced by cancer or chemotherapy may occur in irradiated areas. It is essential to determine the role of these infections in the cause of symptoms because they usually respond to specific therapies. Other important conditions that may be confused with radiation-induced injury are Crohn's disease, arteriosclerotic ischemic colitis, intestinal tuberculosis, and lymphoma.

The disparity between acute and chronic effects and the inability to predict the eventual manifestations of late injury indicate the importance of careful patient follow-up. Surveillance at regular intervals searching for radiation-related complications as well as for tumor recurrence is recommended for all patients receiving radiation to the pelvis. Evaluation should include a thorough history, routine physical examination, gynecologic and proctologic exam, and rectosigmoidoscopy. Colonoscopy, imaging, biopsies, and microbiology are employed selectively. In view of the risk of iatrogenic perforation, endoscopy and barium enema should be performed, and with special caution when radiation damage is suspected. Despite all modern diagnostic tools, histological examination may be the only way to establish the diagnosis with certainty.

48.8 Conservative Treatment

In the management of radiation-related injury, it should be emphasized that conservative measures are always considered first. Most acute radiation effects are reversible and require only supportive and symptomatic care. Also, less severe forms of chronic injury can be effectively controlled by medical intervention.

Grade 1 and 2 skin lesions, including erythema and dry desquamation, are best treated by application of sulfadiazine ointments. Grade 3 lesions should be kept dry with eosin solution.

Acute proctitis can be treated symptomatically with sitz baths, antidiarrheal drugs and steroid retention enemas. Mild chronic proctitis can be managed by low-residue diets, stool softeners, 5-aminosalicylic acid or by sucralfate enemas. When there is rectal bleeding, phototherapy of telangiectasia or petechiae can be considered and anemia should be treated early. Laser therapy is effective [55], but it is expensive and can lead to rectal perforation. Local application of 4% formaldehyde is simple, can be performed on an outpatient basis, and may be the treatment of choice for hemorrhagic radiation proctitis [64].

Chronic enteritis, depending upon the symptoms, should be treated symptomatically. Patients usually respond to conservative treatment comprising low-residue, low-fat, and sometimes lactose-free diets, and antidiarrheal and antispasmodic drugs. Furthermore, cholestyramine may be used to manage bile-salt diarrhea and, less frequently, corticosteroids – sometimes in association with sulfalazine for malabsorption. Enteral or parenteral nutrition formulas may be needed in the more severe cases.

Because of their ischemic component, the behavior of actinic ulcerations resembles that of arterial ulcers. Therefore, similar precautions may be considered when dealing with these lesions. Ulcerated areas should be protected from additional injury. Correction of low-flow states such as heart failure or dehydration may increase tissue oxygenation and thus accelerate the healing process. Wounds should be clean and free of secondary infection. Intraluminal ulceration, and likewise fistulas, may require diversion to allow healing.

Many patients receiving radiotherapy are at an advanced age, have diseases other than cancer, are malnourished, have organ dysfunction, and have had surgery or chemotherapy. Thus, drugs should be used with caution and treatment should be individualized. Before prescribing several narcotic, analgesic and anti-inflammatory agents, it is advisable to determine kidney and liver function because these organs are often affected by the tumor or the side effects of treatment. The gastrointestinal toxicity of nonsteroidal anti-inflammatory drugs [50, 61] may be exacerbated after chemotherapy due to mucosal fragility, and bleeding can be a serious complication in this setting. Patients with dementia, depression, or who are treated with high doses of narcotics may present poor compliance to therapy. They may benefit from simplified regimens and the aid of paramedical caregivers. Special care is recommended during application of enemas since radiation may predispose the patient to rectal perforation. Overall, most patients can have satisfactory control of their symptoms with medical treatment and reassurance. Surgery is reserved for cases not responding to optimal medical therapy and for disabling or life-threatening complications.

48.9 Surgical Therapy

Surgery is reserved for the most severe and symptomatic cases of radiation injury. The usual indications are grade 4 complications of the Late Effects of Normal Tissues classification. Before any intervention, a careful assessment of the extent of radiation damage and exclusion of cancer recurrence are mandatory. In choosing an operation, life expectancy, quality of life, and the patient's general condition should be taken into account. Reconstruction attempts are all based on the use of nonirradiated and well-vascularized tissue. For instance, when constructing anastomoses, at least one limb of nonirradiated bowel must be used. Operations that may be useful in the management of radiation injury are discussed below according to anatomical involvement and clinical syndromes.

Large perineal defects after abdominoperineal resection are best managed with a myocutaneous flap using the gracilis muscle in order to bring in well-vascularized tissue. A gracilis myocutaneous flap is raised with division of the distal tendon and mobilized to the perineum to cover the defect. The neuromuscular bundle must be preserved. This technique was popularized by Ingelman-Sundberg [37]. In our experience, wound healing has usually been observed within 3 weeks.

Radionecrosis of the anal canal is treated with diverting colostomy. If healing occurs, anal stricture usually ensues, but surgical treatment is rarely advisable since most flap-advancement techniques are not suitable for irradiated tissues. The best option is to leave the stoma permanently because there is no safe surgical option for restoring anal function when the sphincter has been damaged by radiation.

For proctitis, diverting colostomy is disappointing since it does not prevent the progression of radiation damage in the defunctionalized segment. Proctectomy is rarely indicated except in conditions with severe tenesmus and blood loss refractory to conservative treatment, perforation, stenosis, or fistula. Younger patients may benefit from a coloanal anastomosis provided that the anal sphincter function is preserved. A Hartmann's procedure is suitable in the elderly, and should be preferred to abdminoperineal amputation since it avoids perineal wound healing problems.

Techniques available for rectal stenosis include diverting stoma, Hartmann's procedure, abdominoperineal resection, low anterior resection, coloanal anastomosis, and Bricker's repair. These should be individually tailored. One should remember that the first step in the management of rectal or anastomotic strictures is to rule out any recurrent tumor by biopsy and imaging studies. Dilatation can be performed manually if it is within finger reach. For higher stenoses, a Hegar's dilator, Savary bougies, or endoscopic balloon dilatation may be useful. However, these methods are associated with high rates of restenosis requiring further dilatations at 3- to 4-month intervals, and perforation is a major complication. Other methods include transanal lysis with electrocautery, transanal proctoplasty, and the endorectal use of a linear stapler for strictures due to anastomosis performed laterotерminally. Diverting stomas may be required for acute obstruction or in debilitated patients. When resection is needed, sphincter-saving procedures are associated with poor results. The distal rectal stump may be poorly vascularized after radiotherapy and an associated high leakage rate is expected with either stapled or hand-sewn anastomoses. A coloanal sleeve anastomosis, as described by Parks et al. [59], can be employed in selected cases, but patients with anal sphincter impairment are unlikely to benefit. The technique is based on resection of the strictured area, mucosectomy of the anal canal, and use of proximal healthy colon anastomosed at the level of, or just above, the dentate line for better functional outcome. A protective temporary diverting colostomy is mandatory. Bricker's repair [4] has been performed only rarely. It involves a patch graft of proximal colon with an antimesenteric split that is folded over to correct a linear stricture. Other than the authors' series of 26 patients, there is scarcely any experience with this complicated technique, which seems to be associated with high morbidity. In elderly or debilitated patients who need resection, a permanent colostomy is safer than restoring the continuity of the bowel by any of these methods.

In the absence of local tumor recurrence, fistulas that are proven to be radiation-related usually require operative management. Since direct suture is not recommended, more sophisticated surgical techniques are necessary. In high, small, colovaginal, or rectovaginal fistulas, a pediculated graft of the greater omentum may be used. The fistulous tract is excised and the edges of the bowel and vagina are trimmed. The omentum is then mobilized on a pedicle based on the right or left gastroepiploic artery, to be brought in between the rectal wall and the vagina [29]. The Martius technique [48] uses a bulbocavernous flap or labial fat pad to cover a rectovaginal fistula. The fistula margins are completely excised, followed by wide separation of the rectal and vaginal walls. The rectal defect is then closed transversely and the fat and fibromuscular content of the labium is mobilized to the fistula site through a subcutaneous tunnel. The vascular supply can be based on either the internal or the external pudendal arteries. Success with this method was reported in 80% of cases [6]. Bricker's operation is suitable for a large fistula alone or in association with a rectal stricture. Three types of patch using proximal healthy colon have been described.

1. Type I: a loop of colon is fashioned after proximal transection and brought over the fistula site as a terminolateral anastomosis. A colocolonic anastomosis is made on the loop to reconstitute the transit.
2. Type II: the antimesenteric border of the colon is split to provide length to cover a long strictured area with or without fistula.
3. Type III: the proximal colon is used to construct a wide colorectal anastomosis after excision of a stricture or fistula site.

A temporary diverting stoma is required in all cases. Bricker reported a 50% morbidity rate and satisfactory results in terms of continence in 73% of cases [5].

The operation of choice for large defects is a coloanal anastomosis, as described by Parks et al. [59]. There is probably more experience with this procedure than with any other. The splenic flexure is mobilized to bring the nonirradiated left colon down to the pelvis. In the case of a very low stricture, the rectum must be resected; otherwise, the rectum is left in place and no attempt is made to free it from the vagina. The mucosa is excised and the colon threaded through the rectal wall, with an anastomosis performed at the level of the dentate line. However, functional results in terms of continence may be better when anastomosis is performed 2 cm higher. The anastomosis is protected by a temporary diverting stoma, which is closed 3 months later. Full continence is achieved in 75% of patients after 1 year. Preoperative assessment of anal sphincter function is essential when considering this type of reconstruction [59].

Colovesical fistulas are rare and all of the procedures described above may be used in their management. Although they usually require surgical treatment, there is no need for an urgent operation. Patients may recover well from drainage of a paracolic abscess through a fistula into the bladder, and surgery can be delayed

until conditions are more favorable. Inability to rule out cancer indicates the need for earlier intervention.

Small-bowel fistulas, with the ileum most frequently involved, are often associated with radiation damage to the colon and rectum. Areas of radiation injury found in the small bowel during laparotomy for other reasons should be managed with caution. Extensive adhesiolysis is best avoided since the thickened intestine is poorly vascularized and prone to fistulization if any lesion occurs. Malabsorption secondary to radiation damage may be worsened after intestinal resection; therefore, only resections that are strictly necessary should be performed, and at times an intestinal bypass is preferred.

In general, anastomotic leaks in the irradiated pelvis with signs of sepsis or abscess formation require abdominal drainage and proximal diversion. If the patient is eligible for future reestablishment of the continuity, a right transversostomy is preferable because it preserves the integrity of the left colon and will serve as a protective stoma after reconstruction. In cases of complete disruption of the anastomosis, a Hartmann's procedure may be necessary.

When rectal cancer is treated with preoperative irradiation, a covering stoma is recommended for patients undergoing sphincter-saving resection after receiving 45 Gy or more over a 4- to 5-week period [80]. Similarly, after irradiation and abdominoperineal excision within a short interval, it has been recommended that the perineum should not be closed primarily [26].

48.10 Management Pitfalls

There is a lack of well-established guidelines for the management of radiation injury. Expertise in this complex area is difficult to achieve because only a small number of cases is seen by any single physician. Therefore, substantial caution should be exercised and several pitfalls should be kept in mind. The investigation of each case should not be limited to the presenting symptoms or obvious lesions. It is important to recognize that symptoms may be due to primary disease, an associated condition, the radiation itself, or to a combination of these factors. Even problems in organs distant to the radiation site may be implicated in the cause of symptoms.

Lesions found to be secondary to radiation should not be underestimated. Mild alterations may be the tip of an iceberg representing changes in deeper structures, especially the microvasculature. Knowledge of the doses, sources, and techniques used to deliver treatment may help in estimating the extent of damage. In addition, healing of a radiation-induced lesion does not necessarily mean that the problem is resolved. Recurrent lesions may manifest in even more severe forms. These may be attributable to the progression of radiation endarteritis or to the development of associated conditions, such as congestive heart failure or diabetes, which may precipitate symptoms in a previously stable area of injury. Patients with pain or who are noncooperative with examination for other reasons should be examined under anesthesia for an adequate estimation of local findings. When imaging studies are needed, the differentiation between changes due to radiation, surgery, or tumor may be difficult or impossible. One must realize that the use of invasive tests is associated with higher complication rates.

From the operative point of view, the cornerstone of therapy is the use of healthy tissue for reconstruction. In anastomoses, at least one end should be well-vascularized, and frozen-section histology should be used if any doubt exists. Preoperative radiation for rectal cancer followed by colorectal or coloanal anastomosis is an indication for more careful follow-up, even in the presence of a protective stoma.

General practitioners, general surgeons, and proctologists must be familiar with radiation-related problems. Nevertheless, early referral or opinion from other specialists may help to prevent serious consequences.

48.11 Conclusion

The aim of radiotherapy is to deliver irradiation to a precisely localized tumor volume with minimal effects on the surrounding normal tissues. Recent improvements in imaging and the widespread use of 3D conformal radiotherapy, with or without intensity-modulated radiotherapy, have contributed to more adequate dose delivery to the target volume while sparing the normal surrounding organs. To date, sparing of normal organs is achieved only to a limited extent, and for the near future radiation injury will remain a problem encountered by those involved in the care of cancer patients.

Colorectal and adjacent structures are at great risk of injury secondary to radiotherapy for abdominopelvic malignancy. Surveillance, early and precise diagnosis, and appropriate therapy are important principles in the management of these complications. In view of the combined effects of cancer, chemotherapy, radio-

therapy, and underlying diseases, a multidisciplinary approach is often required.

Treatment should be as conservative as possible because of the increased risk of intraoperative and postoperative complications. Drug therapy may need frequent adjustments depending on liver and renal function as well as the patient's general condition. Psychosocial aspects must be carefully taken into account.

Surgical interventions are reserved for specific indications and for the most severe forms of injury when the patient's condition permits. A thorough preoperative evaluation must be done and procedures should be performed by surgeons experienced in coloproctology and acquainted with the problems of radiation injury. Operative approaches may be demanding and complication rates are usually high. Each operation must be individually tailored according to anatomical involvement by radiation damage as well as the patient's general condition. A major concern in reconstructions is to use sufficiently vascularized tissues. This may require flaps, grafts, and the aid of specialists in reconstructive surgery.

Attempts to estimate the full extent of radiation injury should be made when following patients after abdominal and pelvic radiotherapy, and several pitfalls must be kept in mind for the management of these problems.

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Self-Assessment Quiz

Question 1

The biological effects of ionizing radiation result principally from damage to the:

a. Cell membrane
b. DNA
c. Mitochondria
d. Lysosomes
e. Golgi apparatus

Question 2

The standard dose of fractionation in radiation treatment is:

a. 3 Gy per fraction, three times per week
b. 2 Gy per fraction, five times per week
c. 5 Gy per fraction, three times per week
d. 6 Gy per fraction, two times per week
e. 1 Gy per fraction, five times per week

Question 3

Radiation late side effects are considered essentially secondary to:

a. Nerve damage
b. Vascular damage
c. Mucosal changes
d. Hemorrhagia
e. Infection

Question 4

With which of the following conditions are patients least likely to develop the long-term complications of radiation?

a. Hypertension
b. Diabetes mellitus
c. Surgery
d. Vascular disease
e. Normal hemoglobin

Question 5

The treatment of late radiation injury is:

a. Surgery alone
b. Brachytherapy
c. External radiotherapy
d. Conservative management first and surgery if needed
e. Psychological treatment

1. Answer: b
   Comments: The principal effect of ionizing radiation is DNA damage. This biologic effect results in mitotic cell death.
2. Answer: b
   Comments: The standard dose of fractionation in radiation treatment is 1.8–2 Gy per fraction, five times per week delivered on five consecutive weeks with curative intent. Hypofractionated treatment means that the daily dose fraction is higher than 2 Gy, and hyperfractionated in less than 1.8 Gy/day.
3. Answer: b
   Comments: Radiation late side effects are considered essentially secondary to vascular damage. Radiation fibrosis and vascular obstruction result in hypoxic areas, and therefore complications. Nerve damage is sometimes encountered if higher radiation doses are administered.
4. Answer: e
   Comments: Late complications are reported more frequently in patients with vascular comorbidity or previous surgery, for example. Patients with normal hemoglobin are at lower risk of developing late radiation effects.
5. Answer: d
   Comments: There is no standard treatment in the case of late radiation injury. Conservative management is considered first and surgery added if needed.

49 The Role of Plastic Surgery in the Management of Perineal Wounds

Jian Farhadi and David A. Ross

CONTENTS

49.1 Introduction

Patients undergoing colorectal and perineal surgery are often faced with resections that can be functionally debilitating and slow to heal. Prior surgery, infection and neoadjuvant chemo-/radiotherapy all contribute to a delayed or non-healing wound. This can prove of great cost to both the patients and the health system looking after them; in one series, 26% of patients remained unhealed at 1 year after abdominoperineal excision (APE) [1].

Over the last 8 years we have been increasingly asked to contribute to the management of defects at primary surgery, or to delayed wound healing following surgery. This chapter will review this experience and reflect on the important contribution that plastic surgery can make to improve the outcome of these often complex procedures.

Plastic surgery aims to restore form and function. Reconstructive principles can be applied to manage perineal wounds as for other parts of the body, and can be applied following surgery for colorectal, gynaecological and urological diseases. Plastic surgery has an essential role to play in the management of primary colorectal disease, surgical complications and complex wounds.

49.2 The Surgical Challenge

Defects of the perineal surface (vulva, scrotum, penis) usually follow excision of squamous cell cancers, trauma or due to infectious processes (i. e. Fournier's gangrene). Extensive defects of the perineum with loss of pelvic support follow treatment of recurrent or locally advanced anorectal, prostate, vulval and cervical carcinomas. These wounds may be further complicated by radiotherapy and repeated surgical procedures.

Increasingly, patients are undergoing neoadjuvant chemo-/radiotherapy combined with wide perineal excision, as for example in the treatment of low rectal carcinoma. This combination is associated with a high risk of wound breakdown and delayed healing. Postoperative wound complications with significant morbidity have been reported in up to 44% of patients after APE [2] and in over 50% after pelvic exenteration [3]. Poor tissue vascularity, dead space and loss of pelvic support are the main causes of such problems. Intestinal adhesions, fistulae and pelvic herniation are additional problems [4] that lead to extensive and debilitating chronic wounds.

Plastic surgery can contribute to the management of these patients and their wounds by utilising techniques to provide skin cover using other well-vascularised donor tissues, often with local or regional flaps.

Reconstructive surgery for the perineal region achieves several goals: tension-free closure of skin defects, lower seal of the peritoneal cavity and supply of vascularised tissue to control irradiated dead space. However, of equal importance to the patient, reconstruction will help maintain body image and, where possible, sexual function.

49.3 Principles of Perineal Reconstruction

Ideally, patients should be managed by a multidisciplinary team that includes a plastic surgeon. Careful planning of any procedure will help to minimise wound complication, facilitate healing and aid restoration of function.

49.3.1 The Patient

Patients presenting with perineal cancer are usually over 60 years of age and may have other intercurrent illness, including malnutrition, cardiorespiratory disease or diabetes. Furthermore, patients may undergo surgery following chemotherapy and radiotherapy, which may limit the use of local tissues as potential flaps. Chronic inflammatory disease can lead to malnutrition, which maybe exacerbated by fistula. Wound healing is directly correlated to the nutritional status of the patient, and therefore particular attention should be directed to optimising the patient's general condition prior to surgery. Percutaneous gastrostomy or nasogastric feeding should be considered if nutritional status is poor.

An essential part of the patient's assessment must include a thorough understanding of their concerns and expectations of surgery. It is important to provide the patient with a comprehensive discussion of options, their potential limitations and complications (including donor-site morbidity), and any associated scarring or pain.

49.3.2 The Defect

Assessment of the defect includes consideration of the location and size of the resection. As elsewhere, when considering reconstruction of complex three-dimensional structures, they need to be analysed in terms of cover, support and lining. Cover is the main issue in surface defects of the vulva and perineum. In vaginal reconstruction, the lining needs to be considered. Support is necessary after pelvic exenteration due to an open lower-peritoneal seal.

49.3.3 Function

The main function of reconstructive surgery in the perineal region is to help provide rapid and safe closure of defects and to reduce acute and long-term complications, such as intestinal prolapse or fistula. Functional vaginal reconstruction should always be considered [5].

49.4 Reconstructive Options in the Perineal Region

As noted earlier, once the resection is complete, attention focuses on analysis of the component parts of the defect. Reconstruction of each component requires careful consideration in order to select the appropriate tissue replacement. In this way, the optimal result can be achieved with the least expense in terms of patient and donor-site morbidity. In addition, thought should be given to a "back-up" method in the event of failure. Selection of the method of closure in perineal reconstruction abides by the same principles as elsewhere; the initial and most important objective is to achieve uncomplicated primary wound healing, especially in previously irradiated areas. This is essential to prevent fistulae and sinus formation, and to minimise morbidity.

The complexity of reconstructive methods follows a "reconstructive ladder", beginning with simple split-thickness skin grafts (SSGs) at one end, proceeding to free-tissue transfer at the other end (Fig. 49.1). Ascent of this ladder does not always imply a superior result, as outcome depends on the appropriate selection of the right technique for the wound or defect.

49.4.1 Skin Grafts

SSGs and full-thickness skin grafts (FSGs) can be used to provide lining and cover at several sites in the perineal region (Fig. 49.2) [6]. SSG donor sites are plentiful, simple and safe to harvest. SSGs are prone to contraction, and in some cases hypertrophic scar-

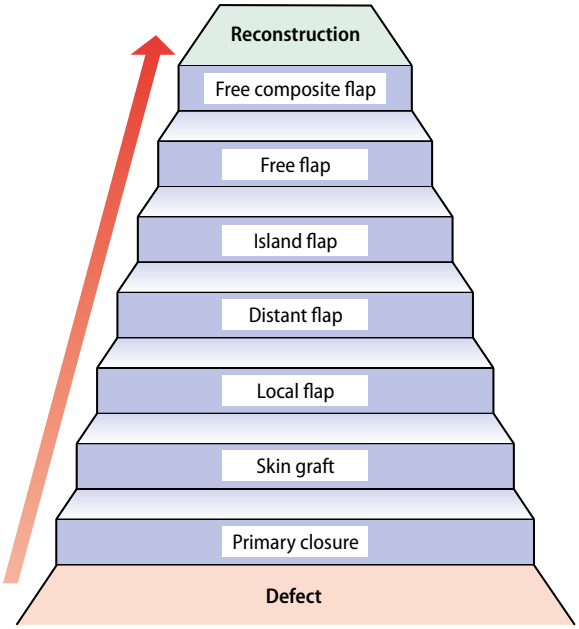

Fig. 49.1 Complex perineal wounds often demand techniques that commence at higher levels of the ladder (i. e. starting with flaps)

ring at their margins. FSGs are only available in limited quantities and are usually harvested from the groin or abdominal area. Compared to SSGs, they provide a better texture match and are less susceptible to contraction. Skin grafts are dependent on the vascularity of the wound bed; they are therefore unlikely to take on a previously irradiated area and will not survive on bare bone or a sloughy, infected wound.

49.4.2 Flaps and Reconstructive Surgery

Flaps traditionally comprise an area of skin and subcutaneous tissue that is moved to the defect from a donor site while surviving on its own blood supply. In fact, flaps may comprise any tissue or combination of tissues, including skin, fat, muscle, fascia, bone and tendon. These are to be distinguished from grafts that are detached from their blood supply and rely on a recipient source and neovascularisation for survival. Flaps can be classified by their route and type of vascularity [7], the method of transfer and the tissues composing the flap.

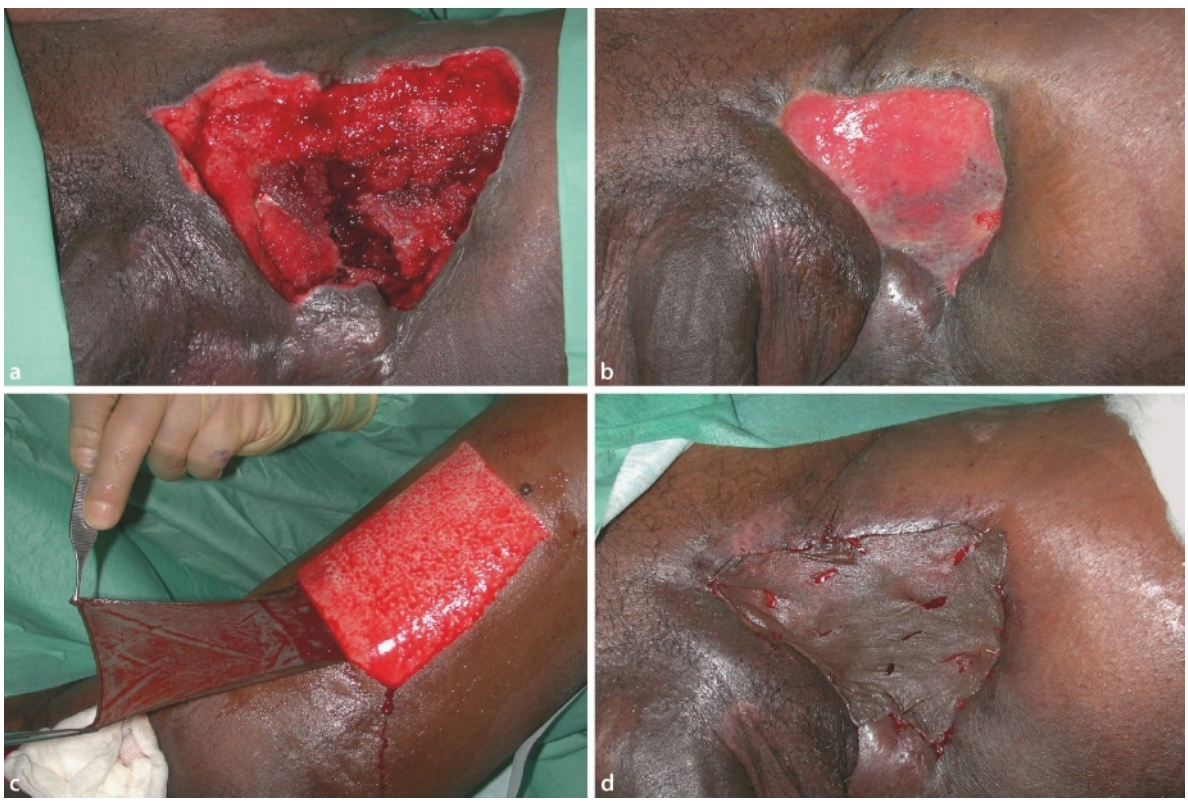

Fig. 49.2a–d Application of a split-skin graft to a groin defect following treatment of a contaminated wound, with debridement and the aid of a vacuum-assisted closure device

Skin flaps are perfused by either a random or axial vascular pattern. Random-pattern flaps have no discernible dominant blood supply and are usually fed by a dermal–subdermal plexus supplied by direct cutaneous, musculocutaneous or fasciocutaneous vessels. The relevance of this distribution is that the length of random-pattern flaps is usually limited to the width of the flap base. Axial-pattern flaps are perfused by an identifiable, single arteriovenous system that proceeds along the longitudinal axis of the flap. Skin flaps may further be defined by their method of transfer and the distance between the donor and recipient sites, and can be divided into local, regional and distant. The aim of reconstruction is to match reconstructed tissues to the original resection tissue as closely as is possible in terms of thickness, texture, colour and function. Local flaps utilise tissues adjacent to the defect that may be advanced along the axis of the flap (i. e. V–Y). Alternatively, they may be rotated, transposed or interpolated (i. e. passed over or under an intervening tissue bridge to reach the defect).

The blood supply of skin and muscle has now been described in detail, particularly following Taylor's concepts of angiosomes [8]. Large cutaneous flaps may be perfused by several routes, although the most common involve perforators arising from the fascia or underlying muscle. Distant flaps, as their name implies, are raised from sites away from the resection and may be transferred either with the aid of a pedicle (i. e. the rectus abdominis flap) or by disconnection and revascularisation using microsurgical techniques.

49.4.3 Routine Flaps for Perineal Reconstruction

Flaps usually provide the best method of reconstructing perineal defects, as they are composed of robust, well-vascularised tissues. Having examined the patient and their defect, it is beneficial to consider reconstructive options at different levels of the reconstructive ladder. The flaps listed below represent a partial, though not exhaustive list of those that should be considered preoperatively.

49.4.4 Local Flaps

49.4.4.1 Random-Pattern Flap

The V–Y amplified sliding flap from the pubis is indicated in symmetric and anteriorly located defects, which include the anterior commissure and the labia majora and minora [9]. This flap is harvested from the pubis and is vascularised by the deep arterial network of the pubis. Sensory innervation is provided by branches of the ileoinguinal nerve.

49.4.4.2 Internal Pudendal Flap

Fasciocutaneous flaps based on the terminal branches of the superficial perineal artery [10] remain one of the "workhorse" flaps in genitoperineal reconstruction. Multiple perineal flaps have been described [11–14], all basically having the same source of blood supply, but with different anatomic supports. The "lotus petal" flap (Fig. 49.3) is a fasciocutaneous flap that can be harvested from the gluteal fold. These flaps are sited over a dense area of perforators with a rich anastomotic network. This network exists just lateral to the midline between the vagina and the anus. Once elevated, the flap can be rotated around an arc similar to the leaves of the lotus flap, hence its title [11].

The neurovascular pudendal thigh flap for vaginal reconstruction (Fig. 49.4) was described by Wee and Joseph [13] from Singapore in 1989 and modified by Woods et al. [12] in 1991 (Fig. 49.5). It is a fasciocutaneous flap based on the posterior labial vascular bundle and innervated by the posterior labial branch of the pudendal nerve. It provides large amounts of well-vascularised tissue that is thin, pliable and can be inserted easily into the rectovaginal space.

49.4.5 Distant Pedicle Flaps

49.4.5.1 Rectus Abdominis Myocutaneous Flap

Myocutaneous flaps from the abdomen are the most common source of tissue used to reconstruct significant defects of the vagina and perineum and to fill dead space [15–21]. The rectus abdominis myocutaneous flap described by Taylor et al. [22] consists of a large skin paddle, the underlying rectus abdominis muscle being vascularised by the deep inferior epigastric ves-

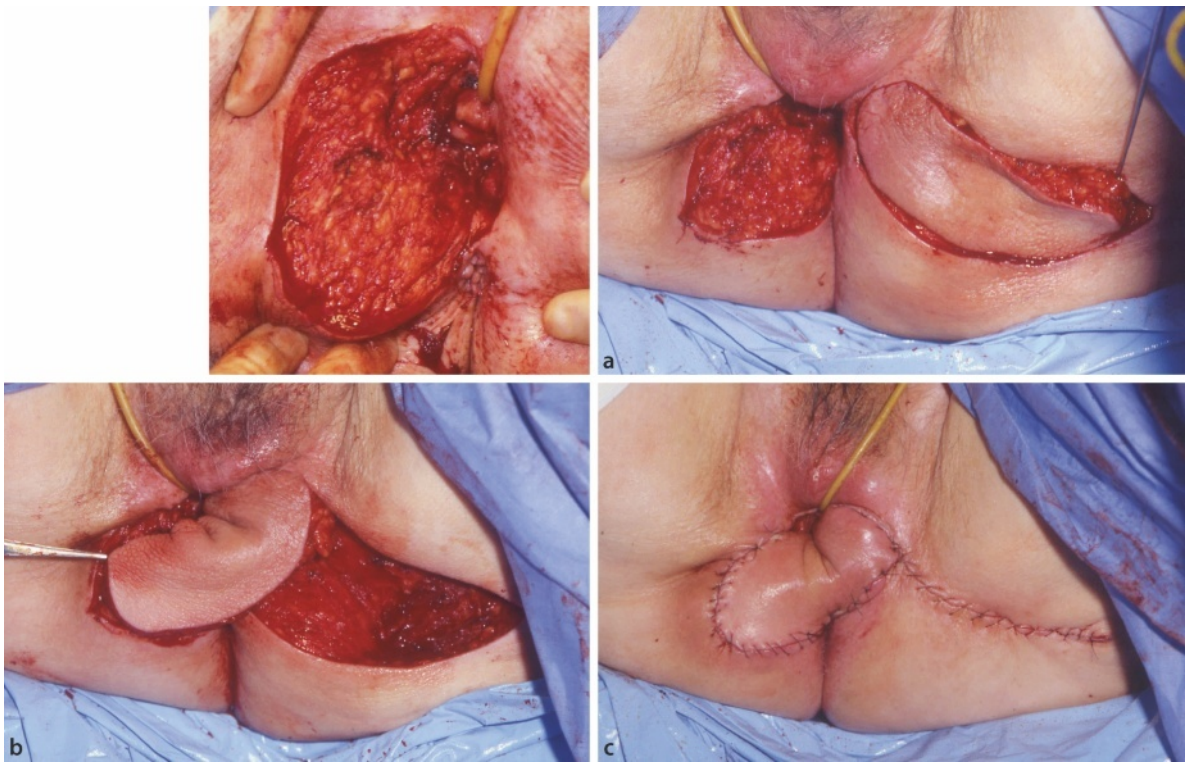

Fig. 49.3a–c Repair of a large vulval defect within an area that had been treated with radiotherapy. **a** A "lotus-petal" flap was raised on the contralateral side. This is rotated (**b**) to allow insetting of the flap into the defect (**c**)

sels that can be passed retropelvically to the perineum (Fig. 49.6). This flap has several advantages:

1. It may be moved around a wide arc of rotation based on the consistent inferior epigastric artery pedicle
2. It provides large tissue bulk
3. It is robust
4. It can be raised relatively easily and quickly
5. It is associated with minimal donor-site morbidity

The rectus abdominis flap can be modified in a variety of ways depending on the extent of the defect. In most cases it is raised as a vertical rectus abdominis (VRAM) flap. By modifying the skin island to an oblique paddle, a larger area of skin can be harvested in order to reconstruct larger perineal and vaginal defects (the extended deep inferior artery flap; Fig. 49.7) [23].

49.4.5.2 Gracilis Flap

The use of the gracilis flap (Fig. 49.8) for reconstruction in the perineal region was first reported by McCraw et al. [24]. The use of the gracilis-muscle-only flap for anal sphincter reconstruction was described much earlier [25]. The gracilis muscle originates from the pubis symphysis and inserts on the medial tibial condyle. Its blood supply is from the medial circumflex branch of the profunda femoris vessel and can be found 8–10 cm from its origin. The location of the pedicle can limit the rotation of the flap, and thus limit the depth of the reconstructed vault.

49.4.5.3 Posterior Thigh Fasciocutaneous Flap

The posterior thigh fasciocutaneous flap is an extremely reliable flap for providing closure of the perineal region. It represents a significant alternative to muscle-based flaps, as minimal functional deficit will result.

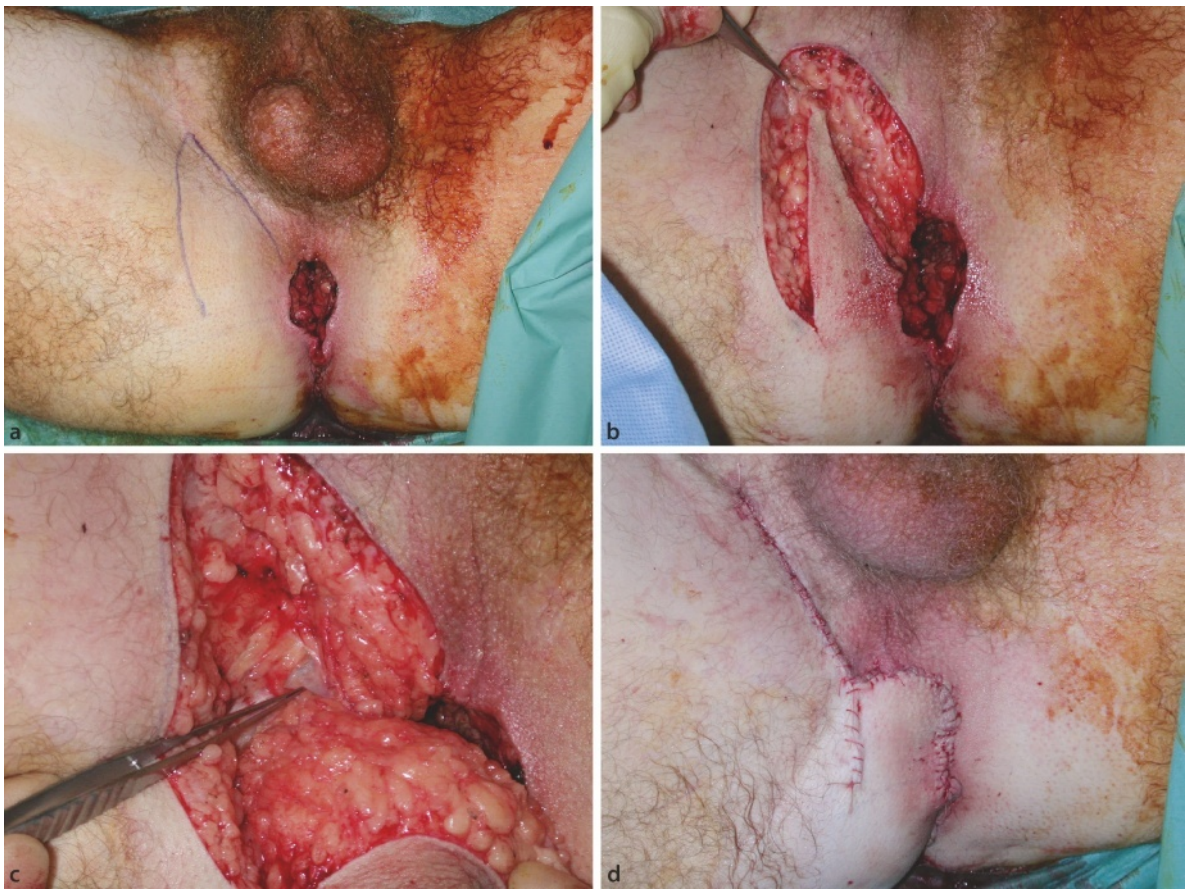

Fig. 49.4a–d Closure of a persistent sinus following successful surgery for Crohn's disease. **a** The perineal sinus has been widely excised. **b** An axial pattern flap, based on perforators from the internal pudendal vessels, is raised (pedicle shown in **c**). **d** The distal half of the flap has been de-epithelialised and inset into the defect, introducing healthy, well-vascularised tissue, which led to uncomplicated healing of the wound

The flap is based on the descending branch of the inferior gluteal artery, which provides an excellent source of sensate coverage [26].

49.4.5.4 Anterolateral Thigh Flap

Wang et al. [27] described the use of the anterolateral thigh flap for perineal reconstructions. This flap was first reported by Song et al. in 1984 [28]. It has subsequently been used widely to reconstruct defects both as a free and as a pedicled flap. The anterolateral thigh flap is highly versatile, and is a large skin flap based on a single suitable fasciocutaneous or musculocutaneous perforator. The major clinical application for this flap is in head and neck reconstruction, but it is gaining popularity in vulvar reconstruction.

49.4.5.5 Inferior Gluteal Artery Perforator Flap

Holm has advocated use of bilateral gluteal musculocutaneous flaps to aid primary closure following APE [29]. However, this involves significant muscle injury with its attendant problems of pain and delayed mobility. The inferior gluteal artery perforator flap is a perforator flap that utilises the same skin and subcutaneous tissue, but avoids the need to use or injure any underlying muscle. It is described as a pedicled flap for coverage in ischial and sacral pressure sores [30]. We have

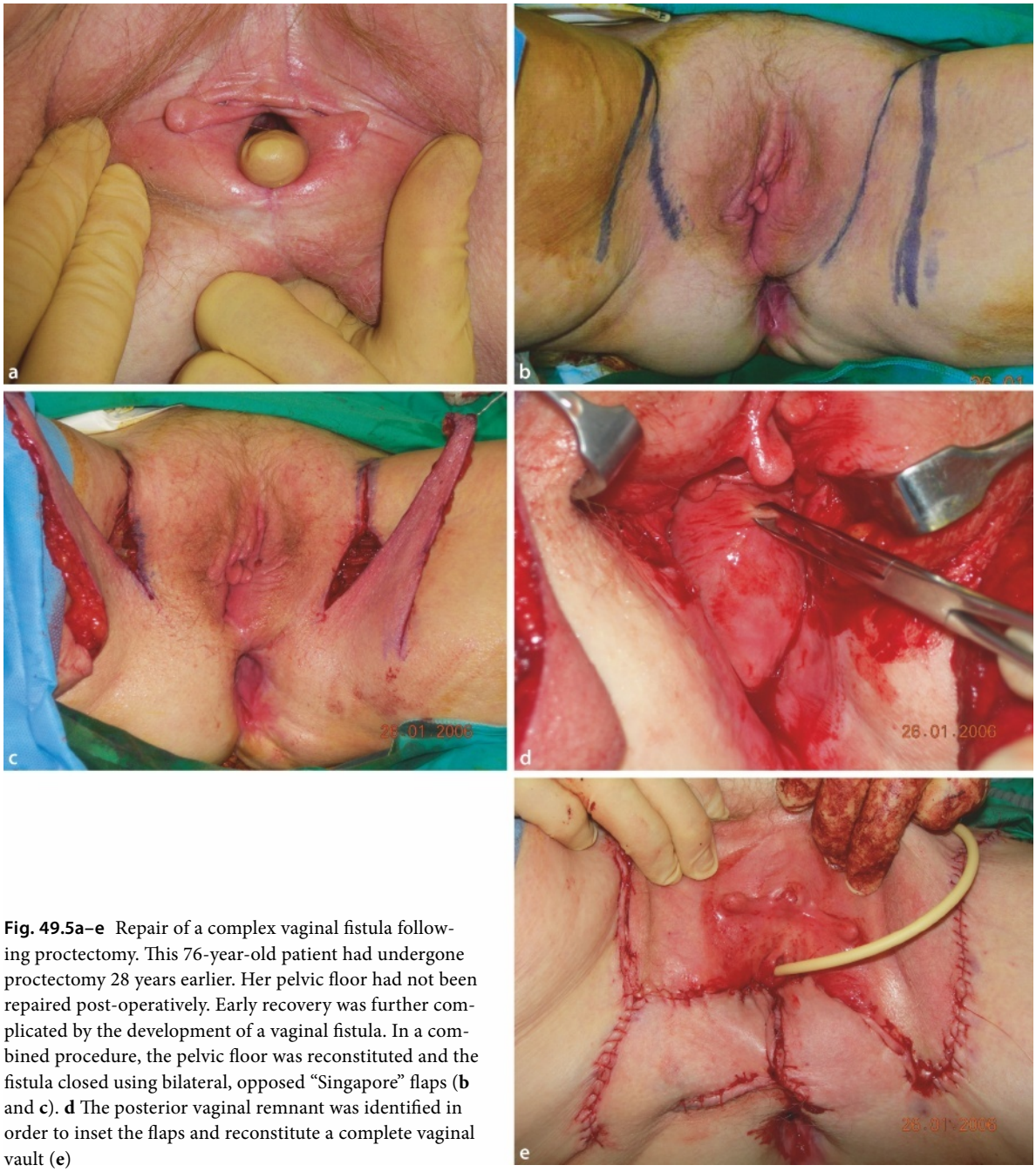

Fig. 49.5a–e Repair of a complex vaginal fistula following proctectomy. This 76-year-old patient had undergone proctectomy 28 years earlier. Her pelvic floor had not been repaired post-operatively. Early recovery was further complicated by the development of a vaginal fistula. In a combined procedure, the pelvic floor was reconstituted and the fistula closed using bilateral, opposed "Singapore" flaps (**b** and **c**). **d** The posterior vaginal remnant was identified in order to inset the flaps and reconstitute a complete vaginal vault (**e**)

recently used this flap to reconstruct perineal defects with encouraging success (Fig. 49.9). This flap has low donor-site morbidity in comparison to its alternatives, allows early mobilisation and can be shaped to provide vaginal reconstruction where necessary.

49.4.6 Microvascular Flaps

Microsurgery has increased the repertoire of flaps available for reconstruction. As the number of options in locoregional and pedicled flaps in perineal recon-

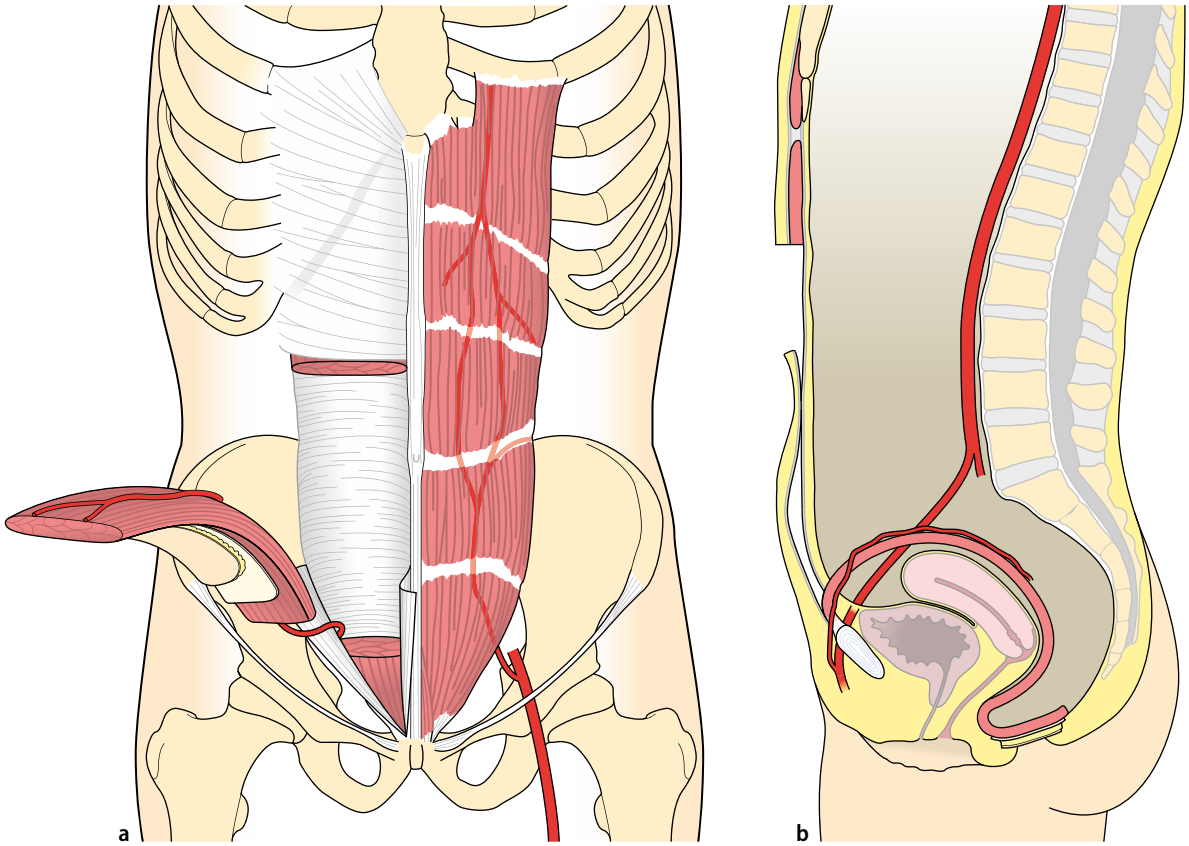

Fig. 49.6a–d The inferior pedicled vertical rectus myocutaneous flap. This is regarded as one of the main "workhorse" flaps for the closure of large perineal defects. The main blood supply originates from the deep inferior epigastric artery, allowing the flap to be moved in a wide arc of rotation (**a** and **b**).

struction is large, the indications for microsurgical reconstructions are limited to the repair of very large defects.

49.4.6.1 Radial Forearm Flap

The radial forearm flap is a fasciocutaneous flap that is supplied by the radial artery, with perforators travelling vertically upwards in the intermuscular septum, and others descending to the underlying radius. It supplies a thin, pliable skin paddle that is suitable for vaginal lining [31] or creation of a neopenis [32].

49.4.6.2 Latissimus Dorsi Muscle Flap

The latissimus dorsi flap is a musculocutaneous flap that is supplied by the thoracodorsal artery. It is the largest muscle in our body. It's use in perineal reconstruction has been described in case reports [33, 34].

49.5 Perineal Reconstruction: Clinical Challenges and Problems

49.5.1 Defects Due to Infection

Necrotising fasciitis of the genital and perineal region, also known as Fournier's gangrene, is a rare but life-threatening disease. Treatment includes wide excision of devitalised tissue followed by several debridements and broad-spectrum antibiotics. This leads to an exten-

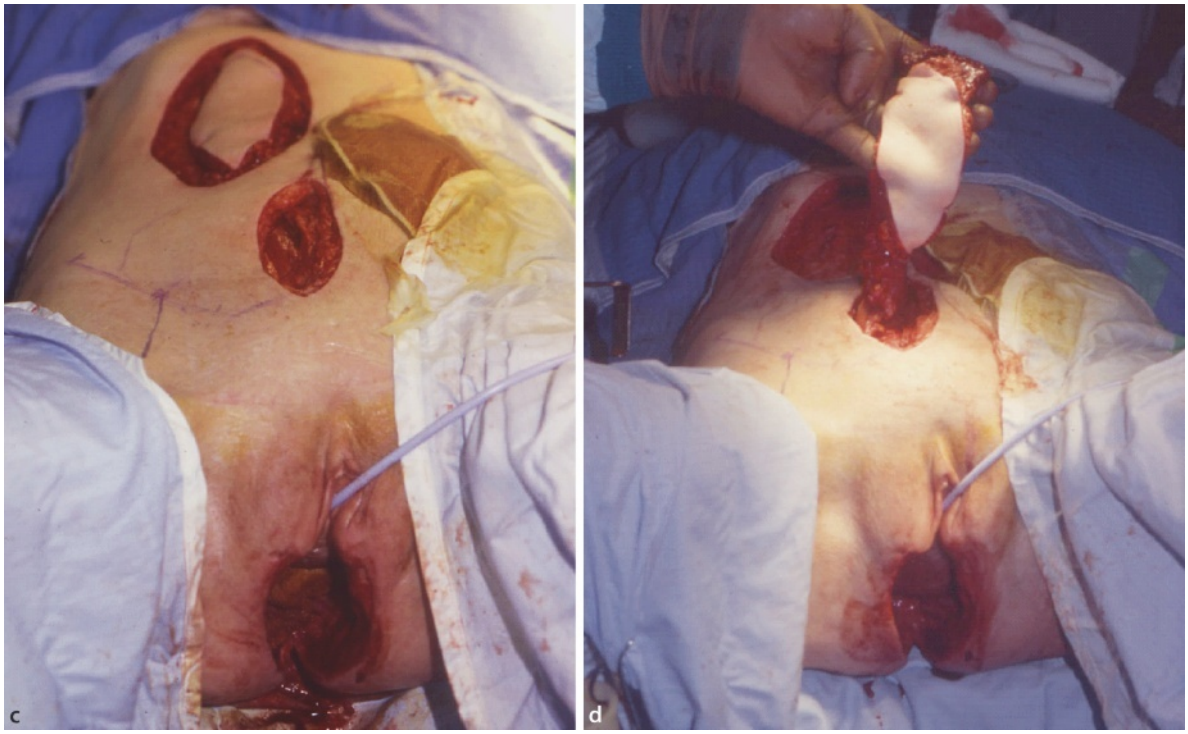

Fig. 49.6a–d *(continued)* The intraoperative views show elevation of a vertical rectus abdominis (VRAM) flap (**c** and **d**) in a patient with a dehisced abdominoperineal excision (APE) wound at 9 weeks post-surgery. The patient had undergone prior chemoirradiation (see Fig. 49.8)

sive soft-tissue defect that can involve the penis, scrotum and anus. In most instances these defects can be closed with the aid of SSGs.

49.5.2 Acquired Perineal Fistula

Patients with acquired fistulae in this region can present a considerable challenge. Fistulae occur as a result of either inflammatory bowel disease or previous surgery. The effects of radiation therapy to the surrounding soft tissue may further complicate these wounds. This is particularly true in the treatment of acquired fistulae that occur following brachytherapy for prostate cancer. In these circumstances a fistula may develop between the rectum and bladder, or as a communication between the prostatic urethra and the rectum. Patients typically complain of pneumaturia or of urine leakage from the rectum. To effectively treat these fistulae, several conditions must be met. First, the fistula tract must be completely excised and the involved structures (rectum, bladder, urethra) repaired without tension. Well-vascularised, soft-tissue flaps are interposed to separate the individual repairs from each other. This provides greater local blood supply to the area while preventing the surgical repairs from abutting against one another. Options here include local flaps that may be partially de-epithelialised in order to both fill the dead space and further restore vascularity to the wound.

In larger defects, the gracilis muscle flap works very well. This is due to ease of transfer of this flap to the lower pelvis and reliability of the muscle, as the medial femoral circumflex vessels are generally outside the local field of radiation.

49.5.3 Reconstructive Surgery Following APE

Perineal resection remains an essential aspect of surgery for low rectal and anal tumours. In order to achieve greater local control, patients are undergoing wide resections, often following neoadjuvant chemo-/radiotherapy. As a consequence, patients are at high risk for wound complication, including wound breakdown and delayed or non-healing. A review of practise within our own unit has shown the benefit of simultaneous intro-

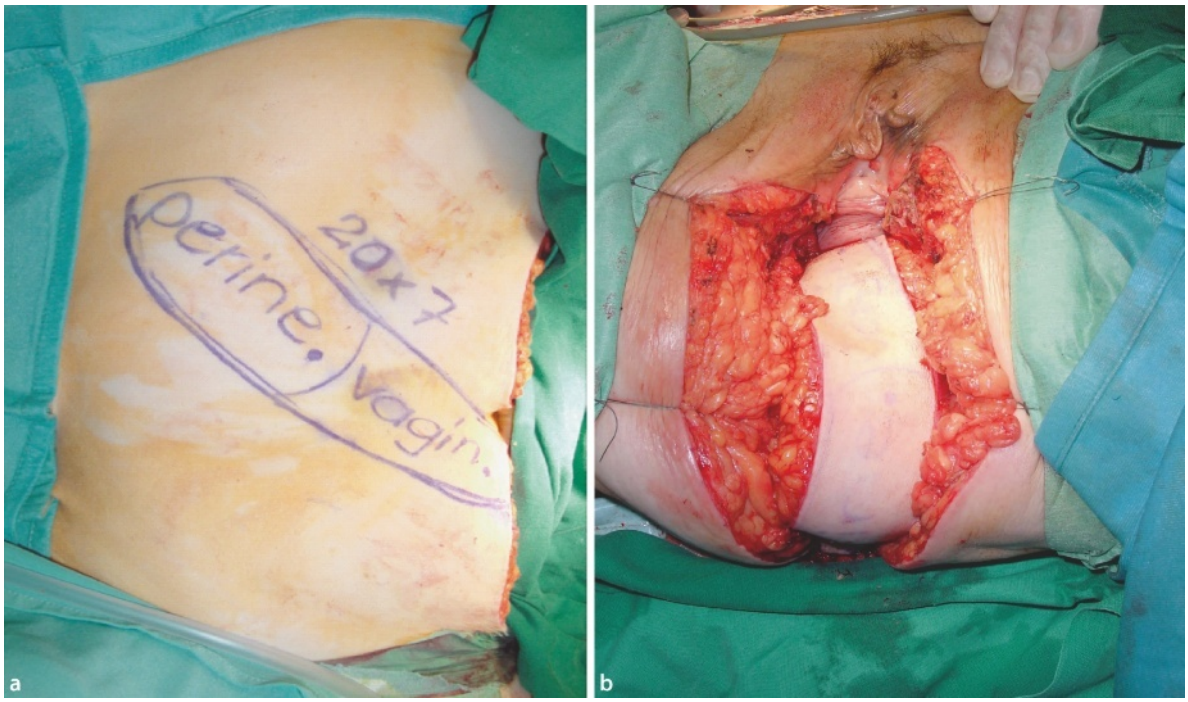

Fig. 49.7 The extended oblique deep inferior epigastric artery flap allows elevation of a large skin paddle (**a**) to close large perineal defects (**b**)

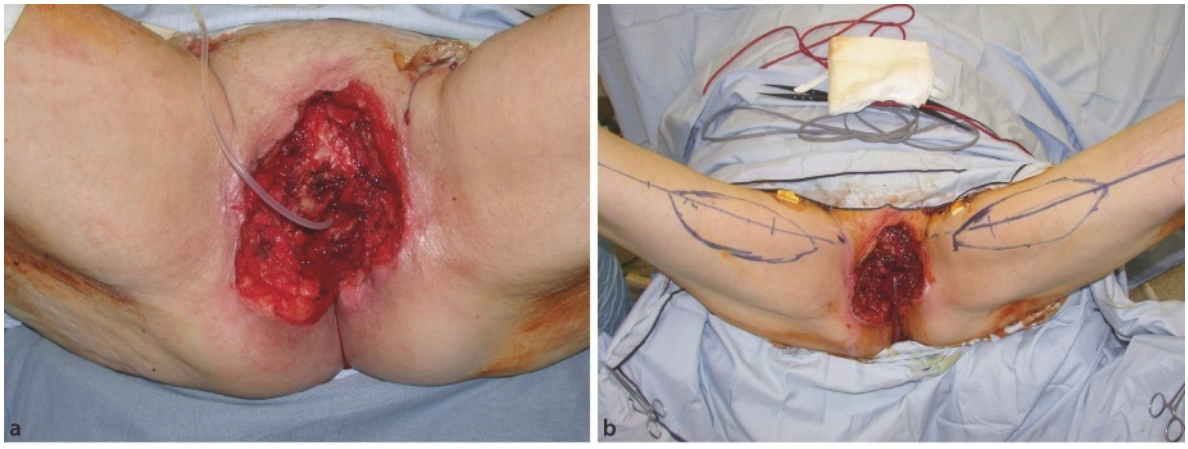

Fig. 49.8a–d Vulvovaginal reconstruction using bilateral gracilis myocutaneous flaps. The defect (**a**) is shown with the skin flaps marked out over the middle third of the muscle (**b**).

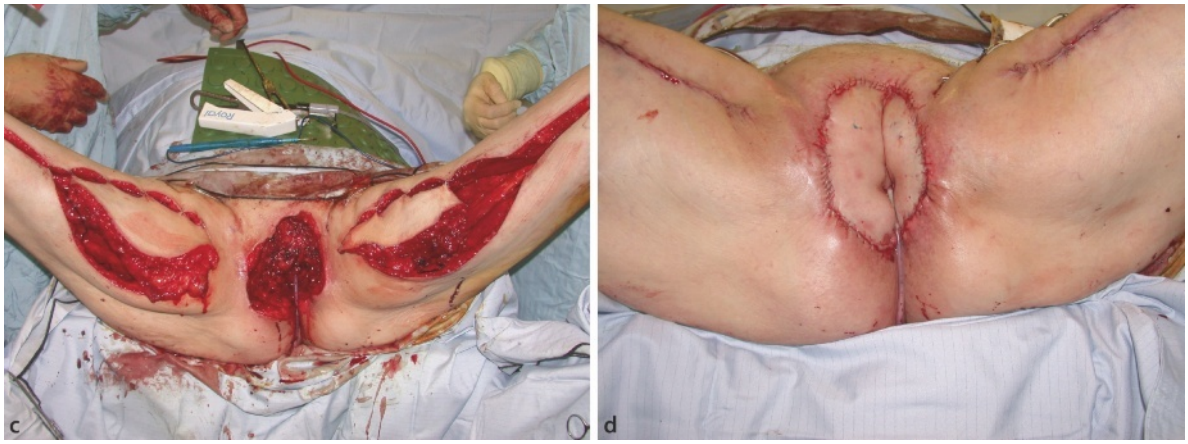

Fig. 49.8a–d (*continued*) The flaps are raised (**c**) and inset to provide both lining and cover (**d**)

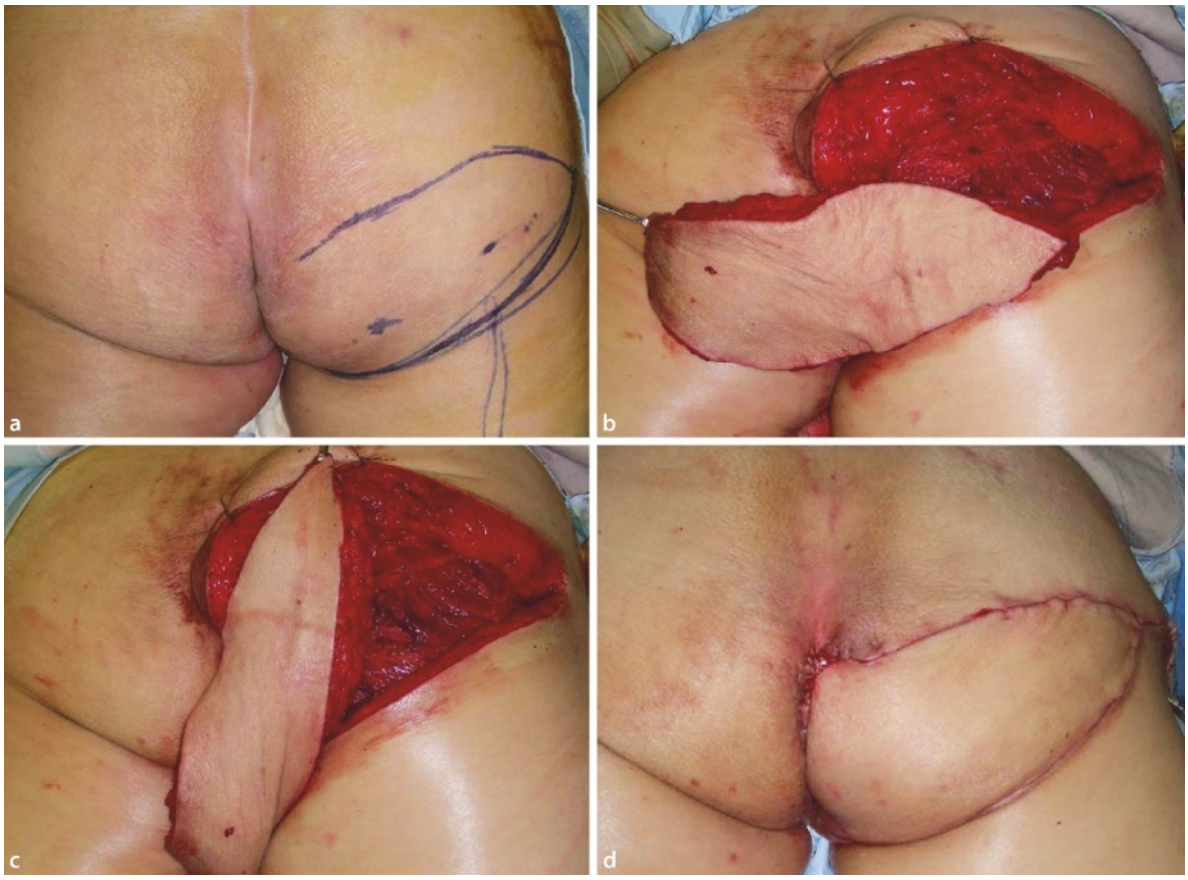

Fig. 49.9a–d The inferior gluteal artery perforator flap is a promising source of tissue for the closure of primary and dehisced APE defects. **a** The skin markings of a unilateral flap. The *blue pen dots* indicate the position of the perforators identified using a simple hand-held Doppler scanner. Once islanded (**b**), the flap can be advanced and rotated (**c**) to close defects, leaving a well-concealed incision (**d**)

duction of myocutaneous flaps at the time of cancer resection. Specifically, we have shown a reduced wound complication rate and length of in-patient stay [35].

Reliable tissue transfers for these defects include the VRAM (Fig. 49.10), gracilis muscle and posterior thigh flaps. As noted earlier, free-tissue transfers are rarely needed. Flap selection is based on:

1. The amount of tissue needed
2. The adequacy of the local blood supply
3. The presence of surgical scars in the donor region
4. The positioning of the patient during surgery
5. The operative approach used (i. e. laparotomy or perineal approach)
6. The need to construct a neovagina

The rectus abdominis myocutaneous flap presently remains the first choice for partial or total vaginal reconstruction because of the volume of the flap and the generous skin paddle that can be harvested. The skin paddle can be oriented vertically, as in the VRAM flap, obliquely, as in an extended deep inferior epigastric flap, or transversely over the lower abdomen [18]. Defects of the anterior or posterior vagina can be closed by insetting the flap along the margins of the wound or, in cases of total vaginal reconstruction, a VRAM flap can be folded longitudinally and sutured to itself to form an epithelialised tube that can be used to create a total neovagina (Fig. 49.11).

Caution should be used when a patient requires both faecal and urinary diversion, as the anterior abdomen becomes an unsuitable donor area. Our early experience with the inferior gluteal artery perforator flap indicates that it shows considerable promise as an alternative to the VRAM flap. In many cases, unilateral

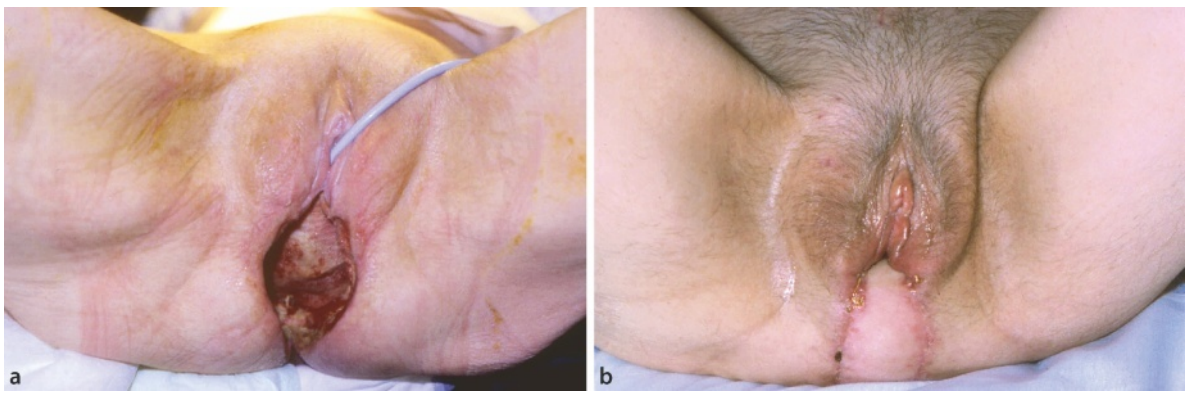

Fig. 49.10a,b Repair of a dehisced APE wound following neoadjuvant chemoradiation (see Fig. 49.6). **a** The defect following wound breakdown. Note the lack of granulation at the wound edge even though this photograph was taken at over 2 months post-dehiscence. **b** The VRAM flap inset, providing control of dead-space and stable closure

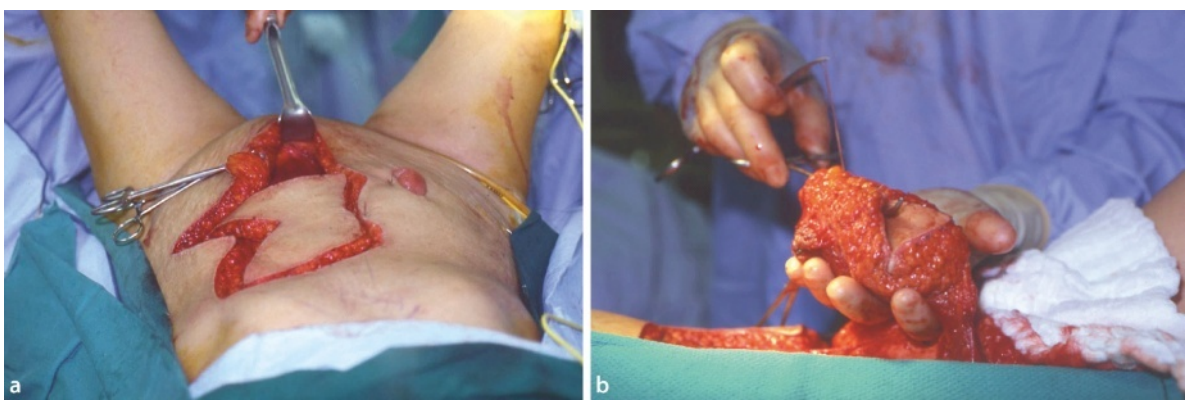

Fig. 49.11a,b Total vaginal reconstruction using a VRAM flap. **a** The transverse orientation of the skin paddle is shown. **b** The skin paddle is then tubed to create the neovagina

flaps can provide enough soft tissue if the skin paddle is of sufficient volume. Bilateral flaps will allow the fashioning of a neovagina.

Posterior thigh flaps generally lack the volume necessary to fill large pelvic defects. Bilateral flaps are usually needed in cases where the posterior thigh flap is used. In such cases, a perineal approach can be performed, thus avoiding the need for laparotomy to gain access to the pelvic wounds. Recovery is rapid and the donor-site scars are quite acceptable.

49.6 Conclusion

Reconstruction of perineal wounds optimally requires advance planning and cooperation between oncologic and reconstructive surgeons. The reconstructive goals in these procedures are to achieve a closed wound that is functional and to provide well-vascularised tissue to aid healing and prevent further complications. Careful selection of appropriate procedures frequently results in successful one-stage reconstruction at the same time as the extirpative surgery.

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Self-Assessment Quiz

Question 1

1. What is the purpose of the reconstructive ladder?

a. To choose the simplest solution for each defect
b. To choose the best option for a the specific situation regardless of the complexity
c. To use a flap according to the surgeon's level of experience
d. As a reminder for all possible reconstruction options
e. To start with the bottom option first, and if it fails, to progress to the next

Question 2

2. When should a plastic surgeon be involved in a perineal wound?

a. At every planned abdominoperineal excision (APE)
b. In all APEs following radiotherapy
c. Only in females when vaginal reconstruction is needed
d. In a multidisciplinary setting
e. When primary closure has failed

Question 3

3. What is the most important advantage of a flap in comparison to a primary closure in an APE?

a. Better aesthetic result
b. Vaginal reconstruction
c. Better vascularised skin flaps for closure
d. Closure of dead space
e. Reduced infection risk

Question 4

4. The vertical rectus flap:

a. Is supplied by the superficial inferior epigastric artery flap
b. Is the only method available to recreate a vagina
c. Comprises only skin and fat
d. Allows reliable reconstruction of posterior vaginal wall defects
e. Is only indicated following wound breakdown

Question 5

5. Wound complications following APE:

a. Are common and increased following chemoradiotherapy
b. Are decreased by radiotherapy
c. Should be managed with dressings alone
d. Are due to poor tissue handling
e. Regranulate rapidly

1. Answer: b
   Comments: By choosing the best option, one will minimise the possibility of failure.
2. Answer: b
   Comments: Acute or chronic wound problems are likely to occur following APE with previous radiotherapy. A vascularised flap will reduce wound problems significantly in such a setting.
3. Answer: c
   Comments: Primary flap closure significantly aids wound healing, particularly following chemoradiation.
4. Answer: d
   Comments: This flap allows the control of dead space as well as reconstruction of skin and vaginal defects.
5. Answer: a
   Comments: Neoadjuvant chemoradiotherapy significantly increases the risk of wound breakdown following APE and primary closure.

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