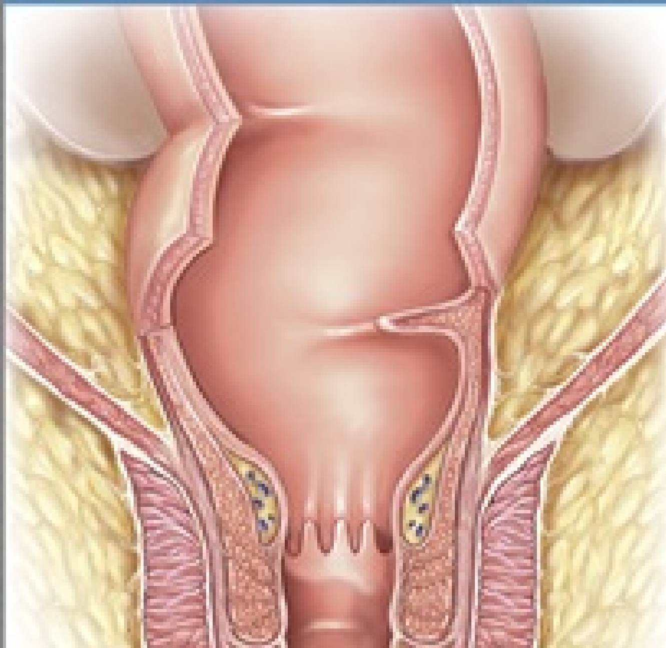
STEVEN D. WEXNER
JAMES W. FLESHMAN

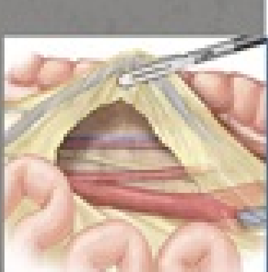
MASTER TECHNIQUES IN SURGERY

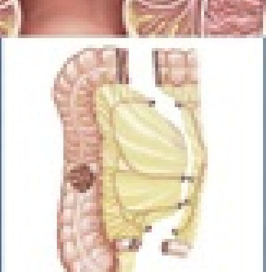
Colon and Rectal Surgery

Abdominal Operations

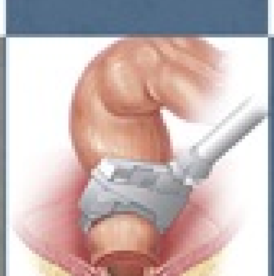
Series Editor
JOSEF E. FISCHER







SECOND EDITION



Wolters Kluwer

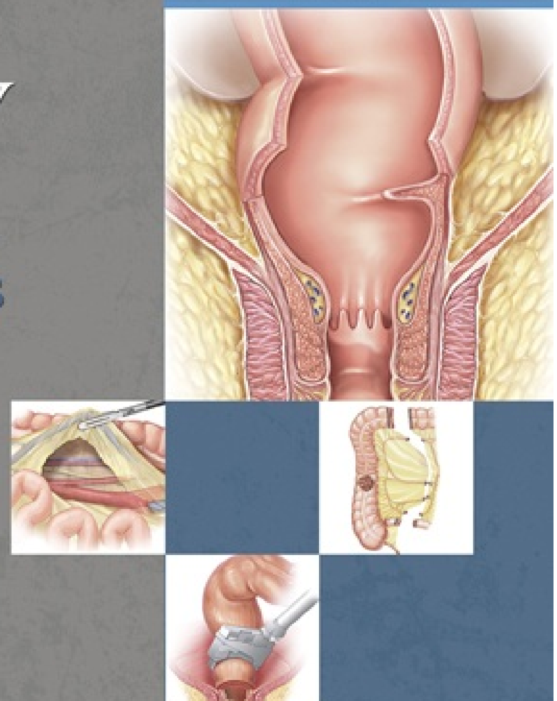
STEVEN D. WEXNER
JAMES W. FLESHMAN

MASTER TECHNIQUES IN SURGERY

Colon and Rectal Surgery

Abdominal Operations

Series Editor
JOSEF E. FISCHER



SECOND EDITION

Wolters Kluwer

MASTER TECHNIQUES IN GENERAL SURGERY

Colon and Rectal Surgery

Abdominal Operations

Colon and Rectal Surgery

Abdominal Operations

SECOND EDITION

Wolters Kluwer

Philadelphia • Baltimore • New York • London
Buenos Aires • Hong Kong • Sydney • Tokyo

MASTER TECHNIQUES IN GENERAL SURGERY

EDITED BY

Steven D. Wexner, MD, PhD (Hon), FACS, FRCS, FRCS (Ed), FRCSI (Hon), FASCRS, FACG

Director, Digestive Disease Center Chair, Department of Colorectal Surgery Cleveland Clinic Florida Weston, Florida

Affiliate Professor

Florida Atlantic University College of Medicine Boca Raton, Florida

Clinical Professor

Florida International University College of Medicine Miami, Florida

Affiliate Professor

University of South Florida College of Medicine Tampa, Florida

Professor of Surgery

Ohio State University

Columbus, Ohio

James W. Fleshman, MD, FACS, FASCRS

Helen Buchanan and Stanley Joseph Seeger Professor and Chairman Department of Surgery

Baylor University Medical Center Professor of Surgery

Texas A&M Health Sciences Dallas, Texas

SERIES EDITOR

Josef E. Fischer, MD, FACS, DM(Hon) Lund, FRCS(E)(Hon)

William V. McDermott Distinguished Professor of Surgery Harvard Medical School

Christian R. Holmes Professor of Surgery and Chair Department of Surgery

University of Cincinnati College of Medicine, Emeritus Chair, Department of Surgery Beth Israel Deaconess Medical Center, Emeritus Boston, Massachusetts

Acquisitions Editor: Keith Donnellan *Editorial Coordinator:* Tim Rinehart
Editorial Assistant: Levi Bentley
Marketing Manager: Dan Dressler
Senior Production Project Manager: Alicia Jackson *Design Coordinator:* Holly McLaughlin *Artist/Illustrator:* Body Scientific International, LLC
Manufacturing Coordinator: Beth Welsh *Prepress Vendor:* S4Carlisle Publishing Services Second Edition

9 8 7 6 5 4 3 2 1

Printed in China
Library of Congress Cataloging-in-Publication Data
Names: Wexner, Steven D., editor. | Fleshman, James W., editor.
Title: Colon and rectal surgery. Abdominal operations / edited by Steven D. Wexner, James W. Fleshman.
Other titles: Abdominal operations | Master techniques in surgery.
Description: Second edition. | Philadelphia, PA : Wolters Kluwer, [2019] | Series: Master techniques in surgery | Includes bibliographical references and index.
Identifiers: LCCN 2017043474 | ISBN 9781496347237 | eISBN: 9781496349002
Subjects: | MESH: Colon—surgery | Rectum—surgery | Abdomen—surgery | Digestive System Surgical Procedures—methods Classification: LCC RD544 | NLM WI 650 | DDC 617.5/547—dc23
LC record available at https://lccn.loc.gov/2017043474

LWW.com

Dedication

This book is dedicated to my family: to my late father Ira and my mother Arlene, for all of the guidance that they have given me throughout my life. In addition to my sons Wesley and Trevor for although I have hopefully imparted knowledge to them, I have also acquired an inordinate amount of insight from them. Furthermore to my life-partner Dr. Mariana Berho, for her wisdom, counsel, and especially love. This dedication would be incomplete without thanking people besides my family. Thank you, Jim Fleshman, for decades of friendship during which we have collaborated on many endeavors including this book. Thanks to the hundreds of alumni who have allowed me to try to help them help their patients. I hope that this book furthers your education and reminds you of your time at Cleveland Clinic Florida. Thank-you to my executive assistant, Debbie Holton, and my publications assistant, Elektra McDermott, for your patience, indulgence, assistance, and perseverance in this project and in many others before it.

Steven D. Wexner

One can never repay completely the incredible gift that my friends, colleagues, and acquaintances have contributed to this set of books. As time goes on, I would like to think that they will all look back with pride to see that is indeed a great contribution to the training and practice of colorectal surgery. Thank-you is not enough but is sincerely given to each one of you. Thanks to Steve Wexner for including me in this effort and to Dr. Josef Fischer for his trust. I would like to dedicate this book to my wife Linda, who has tolerated my mental absences throughout many of the last year’s weekends and evenings to edit these chapters. While I am sure she will never read these books, she has contributed support and tolerance. Jennifer Hernandez, in our department at Baylor University Medical Center, deserves special mention for her ability and patience to read my edits on each manuscript and for keeping track of the whole process. Thanks to you.

James W. Fleshman

Contributors

Piyush Aggarwal, MD
Fellow
Advanced Colorectal Oncology
Department of Surgery
Memorial Sloan Kettering Cancer Center New York, New York

Azah A. Althumairi, MD
Professor
Department of Surgery and Urology Executive Vice Chair
Chief Division of Colorectal Surgery Department of Surgery
Johns Hopkins University
Baltimore, Maryland

Donato F. Altomare, MD
Associate Professor of Surgery Department of Emergency and Organ Transplantation University Aldo Moro of Bari
Associate Professor of Surgery Department of Emergency and Organ Transplantation Azienda Ospedaliero Universitaria Policlinico Bari Bari, Italy

Vikram Attaluri, MD, FACS, FASCRS
Partner, SCPMG
Southern California Permanente Medical GroupKaiser Permanente Los Angeles Medical Center Los Angeles, California

Se-Jin Baek, MD, PhD
Clinical Assistant Professor
Division of Colorectal Surgery, Department of Surgery Korea University College of Medicine Clinical Assistant Professor
Division of Colorectal Surgery, Department of Surgery Korea University Anam Hospital Seoul, Korea

Debbie Bakes, MD
Clinical Fellow
Department of Colon and Rectal Surgery University of Miami—Miller School of Medicine Miami, Florida

David E. Beck, MD, FACS, FASCRS
Professor and Chairman Emeritus Department of Colon and Rectal Surgery Ochsner Clinic
The University of Queensland School of Medicine Ochsner Clinical School
New Orleans, Louisiana

Cigdem Benlice, MD
Department of General Surgery Cleveland Clinic Foundation
Cleveland, Ohio

Robert D. Bennett, MD
Fellow, Colon and Rectal Surgery Department of Colon and Rectal Surgery University of Louisville School of Medicine Fellow, Colon and Rectal Surgery Department of Colon and Rectal Surgery University of Louisville Hospital Louisville, Kentucky

Greta V. Bernier, MD
Assistant Professor
Department of Surgery
University of Washington
Seattle, Washington

Mitchell Bernstein, MD, FACS, FASCRS
Associate Professor
Department of Surgery
NYU Langone School of Medicine Chief
Division of Colon and Rectal Surgery NYU Langone Medical Center
New York, New York

Edward Borrazzo, MD, FACS
Associate Professor of Surgery Department of Surgery
Larner College of Medicine, University of Vermont Chief, Division of General and Gastrointestinal Surgery Department of Surgery
University of Vermont Medical Center Burlington, Vermont

Charles E. Butler, MD, FACS
Professor and Chairman
Department of Plastic Surgery University of Texas MD Anderson Cancer Center Houston, Texas

Winston M. T. Chan, MD

Fellow in Colorectal Surgery
Baylor University Medical Center Dallas, Texas

Manish Chand, MBBS, BSc, MBA, FRCS, PhD
Associate Professor
Division of Surgery and Interventional Sciences University College London
Consultant
GI Services
University College London Hospital London, United Kingdom

William C. Chapman Jr., MD
Research Fellow
Department of Surgery
Washington University School of Medicine St. Louis, Missouri

Mark W. Clemens, MD, FACS
Associate Professor
Department of Plastic Surgery The University of Texas MD Anderson Cancer Center Houston, Texas

Kyle G. Cologne, MD, FACS, FASCRS
Assistant Professor of Surgery Division of Colorectal Surgery Keck School of Medicine of the University of Southern California Los Angeles, California

Molly M. Ford, MD, FACS, FASCRS
Assistant Professor
Department of General Surgery, Colon and Rectal Surgery Vanderbilt University Medical Center Nashville, Tennessee

Meagan M. Costedio, MD, FACS, FASCRS
Associate Professor
Department of Surgery
Case Western Reserve University Cleveland, Ohio
Staff Surgeon
Colorectal Surgery
University Hospitals Ahuja Medical Center Beachwood, Ohio

Andre J. L. D’Hoore, MD, PhD, FASCRS (Hon)
Professor of Surgery
Department of Oncology
Catholic University of Leuven—Faculty of Medicine Head of the Department

Department of Abdominal Surgery University Hospitals Leuven
Leuven, Belgium

David W. Dietz, MD, FACS, FASCRS
Associate Professor
Department of Surgery
Case Western Reserve University School of Medicine Cleveland, Ohio
Chief, Division of Colorectal Surgery Elizabeth King Family Chair
Vice President, System Surgery Quality and Experience University Hospitals
Cleveland, Ohio

Colleen Donahue, MD
Associate Professor
Department of General Surgery Tufts University School of Medicine Boston, Massachusetts
Resident
Department of General Surgery Lahey Hospital and Medical Center Burlington, Massachusetts

Eric J. Dozois, MD, FACS, FASCRS
Professor of Surgery
Department of Surgery, Division of Colon and Rectal Surgery Mayo Clinic College of Medicine and Science Rochester, Minnesota

S. Alexander Earle, MD, FACS
CEO
Pure Plastic Surgery, LLC
Miami, Florida

Jonathan E. Efron, MD, FACS, FASCRS
Professor
Department of Surgery and Urology Executive Vice Chair
Chief Division of Colorectal Surgery Department of Surgery
Johns Hopkins University
Baltimore, Maryland

Valerie S. Emuakhagbon, MD
Assistant Professor
Department of Surgery
University of Texas Southwestern Medical School Staff Surgeon
Department of Surgery

Department of Surgery
VA North Texas Medical Center Dallas, Texas

Seth I. Felder, MD
Colorectal Surgical Oncologist Department of Gastrointestinal Oncology Moffitt Cancer Center
Tampa, Florida

Linda Ferrari, MD
Research Fellow
Department of Gastrointestinal Surgery University of Washington Medical Center Seattle, Washington

Alessandro Fichera, MD, FACS, FASCRS
Professor
Department of Surgery
University of Washington School of Medicine Section Chief Gastrointestinal Surgery Department of Surgery
University of Washington Medical Center Seattle, Washington

Josef E. Fischer, MD, FACS, DM(Hon) Lund, FRCS(E)(Hon)
William V. McDermott Distinguished Professor of Surgery Harvard Medical School
Christian R. Holmes Professor of Surgery and Chair Department of Surgery University of Cincinnati College of Medicine, Emeritus Chair, Department of Surgery
Beth Israel Deaconess Medical Center, Emeritus Boston, Massachusetts

James W. Fleshman, MD, FACS, FASCRS
Helen Buchanan and Stanley Joseph Seeger Professor and Chairman Department of Surgery
Baylor University Medical Center Professor of Surgery
Texas A&M Health Sciences Dallas, Texas

Todd D. Francone, MD, MPH, FACS, FASCRS
Assistant Professor
Department of Surgery
Tufts Medical School
Director, Section of Colon and Rectal Surgery Division of Colon and Rectal Surgery Newton-Wellesley Hospital
Massachusetts General Hospital/Newton-Wellesley Hospital Boston,

Massachusetts

Joseph L. Frenkel, MD, FACS, FASCRS
Division of Colorectal Surgery Lankenau Medical Center
Wynnewood, Pennsylvania

Garrett G. Friedman, MD
Clinical Assistant Professor
Department of Surgery
University of Nevada
Mike O'Callaghan Federal Medical Center Las Vegas, Nevada

Charles M. Friel, MD, FACS, FASCRS
Associate Professor of Surgery Department of Surgery
University of Virginia
Charlottesville, Virginia

Wolfgang B. Gaertner, MD, MSc, FACS, FASCRS
Assistant Professor
Department of Surgery
University of Minnesota
Minneapolis, Minnesota

Norbert Garcia-Henriquez, MD
Colon/Rectal Surgery Fellow
Department of Surgery
Brown University Warren Alpert School of Medicine Fellow, Division of Colon and Rectal Surgery Department of Surgery
Rhode Island Hospital/Brown University Warren Alpert School of Medicine Providence, Rhode Island

Mahmoud Abu-Gazala, MD
Lecturer in General Surgery
General Surgery Department
Hadassah Hebrew University School of Medicine Senior Surgeon
General Surgery Department
Hadassah Ein Kerem Medical Center Jerusalem, Israel

Bruce D. George, MS, FRCS
Honorary Senior Lecturer
University of Oxford

Consultant Colorectal Surgeon Department of Surgery
Oxford University Hospitals NHS Trust Oxford, United Kingdom

Emre Gorgun, MD, FACS, FASCRS
Krause-Lieberman Chair in Laparoscopic Colorectal Surgery Department of Colorectal Surgery Cleveland Clinic Lerner School of Medicine Staff Surgeon
Department of Colorectal Surgery Cleveland Clinic Foundation
Cleveland, Ohio

Michael J. Grieco, MD
Assistant Professor
Department of Surgery
New York University
New York, New York
Colon and Rectal Surgeon
Department of Surgery
Bellevue Hospital Center
New York, New York

Alexis Grucela, MD, FACS, FASCRS
Assistant Professor of Surgery Division of Colon and Rectal Surgery Department of Surgery
NYU Langone School of Medicine New York, New York

Jose G. Guillem, MD, MPH, FACS, FASCRS
Professor
Department of Surgery
Cornell Medical College
New York, New York
Attending Surgeon
Department of Surgery
Memorial Sloan Kettering Cancer Center, Room SR201C
New York, New York

Torbjörn Holm, MD, PhD, FASCRS (Hon)
Professor
Department of Molecular Medicine and Surgery Karolinska Institutet
Senior Consultant Surgeon
Department of Colorectal Surgery Karolinska University Hospital Solna, Sweden

Farah A. Husain, MD, FACS, FASMBS
Assistant Professor, Division Chief, Division of Bariatric Surgery Department of Surgery
Oregon Health & Science University Portland, Oregon

Neil H. Hyman, MD, FACS, FASCRS
Professor
Department of Surgery
Position-Chief, Section of Colon and Rectal Surgery Codirector, Center for Digestive Disease University of Chicago Medicine Department of Surgery
University of Chicago College of Medicine Chicago, Illinois

Colette Inaba, MD
Research Fellow
Department of Surgery
University of California, Irvine Orange, California

W. Forrest Johnston, MD
Staff Surgeon
Department of Colon and Rectal Surgery Ochnser Clinic
New Orleans, Louisiana

Seon-Hahn Kim, MD, FACS, PhD
Professor
Division of Colorectal Surgery, Department of Surgery Korea University College of Medicine Seoul, Korea
Professor
Division of Colorectal Surgery, Department of Surgery Korea University Anam Hospital Seoul, Korea

Jean A. Knapps, MD
Clinical Fellow
Division of Colon and Rectal Surgery University of Miami Miller School of Medicine Miami, Florida

Antonio M. Lacy, MD, PhD, FASCRS (Hon)
Professor of Surgery
Department of Surgery
School of Medicine
University of Barcelona

Chief
Department of Gastrointestinal Surgery Institute of Digestive and Metabolic Diseases Hospital Clínic of Barcelona
Barcelona, Spain

Jorge A. Lagares-Garcia, MD, FACS, FASCRS
Chief Division Colorectal Surgery Roper St Francis Healthcare
Roper St Francis Physicians Partners Roper Hospital
Charleston, South Carolina

Ron G. Landmann, MD, FACS, FASCRS
Assistant Professor, Surgery
Mayo Clinic College of Medicine Consultant, Colon and Rectal Surgery Mayo Clinic
Jacksonville, Florida

Aaron Lee, MD
Clinical Assistant Professor of Surgery Department of Surgery
Western University of Health Sciences Pomona, California
Staff
Department of Surgery
Riverside Community Hospital
Riverside, California

Sang W. Lee, MD, FACS, FASCRS
Charles W. and Carolyn Costello Chair in Colorectal Diseases Professor and Chief of Colon and Rectal Surgery Department of Surgery
University of Southern California Keck School of Medicine
Los Angeles, California

Amy L. Lightner, MD
Assistant Professor of Surgery, College of Medicine Department of Surgery
Senior Associate Consultant
Department of Surgery, Division of Colon and Rectal Surgery Mayo Clinic
Rochester, Minnesota

Edward Lin, DO, MBA, FACS
Chief, Gastrointestinal and General Surgery Professor of Surgery
Department of Surgery
Emory University School of Medicine Atlanta, Georgia

Martin A. Luchtefeld, MD, FACS, FASCRS
Clinical Assistant Professor
Department of Surgery
Michigan State University
Staff Surgeon and Section Chief of Digestive Diseases Division of Colon and Rectal Surgery Spectrum Health/Ferguson Clinic Grand Rapids, Michigan

Peter W. Marcello, MD, FACS, FASCRS
Chairman
Division of Colon & Rectal Surgery Lahey Hospital and Medical Center Burlington, Massachusetts

Jorge E. Marcet, MD, FACS, FASCRS
Professor
Department of Surgery
University of South Florida
Director
Department of Colon and Rectal Surgery Tampa General Hospital
Tampa, Florida

Floriano Marchetti, MD
Associate Professor of Surgery Department of Colon and Rectal Surgery University of Miami—Miller School of Medicine Miami, Florida

David A. Margolin, MD, FACS, FASCRS
Professor
Department of Surgery
Ochsner Clinical School
University of Queensland
Director Colorectal Research
Department of Colon and Rectal Surgery The Ochsner Clinic Foundation New Orleans, Louisiana

John H. Marks, MD, FACS, FASCRS
Professor
Lankenau Institute of Medical Research Chief
Division of Colon and Rectal Surgery Lankenau Medical Center
Main Line Healthcare
Wynnewood, Pennsylvania

Benjamin M. Martin, MD
Assistant Professor of Surgery Division of Surgical Oncology—Colon and Rectal Surgery Department of Surgery
University of Kansas Medical Center Kansas City, Kansas

Beatriz Martín-Pérez, MD
Gastrointestinal Surgery Specialist Gastrointestinal Surgery Department Hospital Clínic
Barcelona, Spain

Elizabeth C. McLemore, MD, FACS, FASCRS
Chief
Colorectal Surgery LAMC
Southern California Permanente Medical Group Kaiser Permanente Los Angeles Medical Center Los Angeles, California

Anders Mellgren, MD, PhD, FACS, FASCRS
Turi Josefsen Chair in Surgery Professor and Chief
Division of Colon and Rectal Surgery University of Illinois at Chicago Chicago, Illinois

Genevieve B. Melton-Meaux, MD, PhD, FACS, FASCRS
Professor
Department of Surgery
University of Minnesota
Chief Data and Health Informatics Officer Fairview Health Services
Minneapolis, Minnesota

Emanuele Lo Menzo, MD, PhD, FACS, FASMBS
Clinical Associate Professor
Department of Surgery
Charles E. Schmidt College of Medicine Florida Atlantic University Boca Raton, Florida
Director Research Department, Staff Surgeon The Bariatric and Metabolic Institute Cleveland Clinic Florida
Weston, Florida

Fabrizio Michelassi, MD, FACS
Lewis Atterbury Stimson Professor and Chair Department of Surgery
Weill Cornell Medicine
Surgeon-in-Chief

Surgeon-in-Chief
Department of Surgery
New York Presbyterian-Weill Cornell Medical Center New York, New York

John Migaly, MD, FACS, FASCRS
Associate Professor
Program Director General Surgery Residency Department of Surgery
Duke University School of Medicine Associate Professor, Program Director General Surgery Residency Department of Surgery
Duke University Medical Center Durham, North Carolina

Ido Mizrahi, MD
Assistant Professor
Department of General Surgery Hadassah Hebrew University
Colorectal Surgeon
Department of General Surgery Hadassah Medical Center
Jerusalem, Israel

Harvey G. Moore, MD, FACS, FASCRS
Assistant Professor
Department of Surgery
Duke University School of Medicine Attending Surgeon
Department of Surgery
Duke University Medical Center Durham, North Carolina

Roberta L. Muldoon, MD, FACS
Assistant Professor of Surgery Department of Surgery
Vanderbilt University
Nashville, Tennessee

Venkatesh Munikrishanan, MRCS, FRCS
Consultant Colorectal Surgeon Institute of Colorectal Surgery Apollo Hospitals
Chennai, Tamil Nadu, India

W. Conan Mustain, MD, FACS
Assistant Professor
Department of Surgery
University of Arkansas for Medical Sciences Little Rock, Arkansas

Matthew G. Mutch, MD, FACS, FASCRS
Solan and Bettie Gershman Professor of Colon and Rectal Surgery Chief Section of Colon and Rectal Surgery Department of Surgery

of Colon and Rectal Surgery Department of Surgery
Washington University of School St. Louis, Missouri

Juan J. Nogueras, MD, MBA, FACS, FASCRS
Clinical Professor of Surgery Department of Surgery
Florida Atlantic University
Boca Raton, Florida
Staff Surgeon
Department of Colorectal Surgery Cleveland Clinic Florida
Weston, Florida

James W. Ogilvie Jr, MD, MS, FACS, FASCRS
Clinical Assistant Professor
Department of Surgery
Michigan State University
Staff Surgeon
Division of Colon and Rectal Surgery Spectrum Health/Ferguson Clinic Grand Rapids, Michigan

Daniel J. Park, MD
Department of Plastic Surgery Cleveland Clinic Florida
Weston, Florida

William J. Peche Jr, MD, FACS, FASCRS
Assistant Professor
Department of Surgery
University of Utah School of Medicine Salt Lake City, Utah

Walter J. Peters Jr, MD, MBA, FACS, FASCRS
Clinical Associate Professor
Department of Surgery
Texas A&M Health Science Center Chief
Division of Colon and Rectal Surgery Baylor University Medical Center Dallas, Texas

Alessio M. Pigazzi, MD, PhD, FACS, FASCRS
Vice Chair of Clinical Operations Clinical Professor of Surgery Department of Colon and Rectal Surgery University of California, Irvine Orange, California

Alon J. Pikarsky, MD
Associate Professor
Department of Surgery

Department of Surgery
Hebrew University
Chairman
Department of Surgery
Hadassah University Hospital
Jerusalem, Israel

Aaron J. Quyn, MB, ChB, FRCS, PhD
Associate Clinical Professor
Leeds Institute of Biomedical and Clinical Sciences University of Leeds
Honorary Consultant Surgeon
John Goligher Colorectal Department St James's Hospital
Leeds, United Kingdom

Sowsan H. Rasheid, MD, FACS
Associate Professor
Department of Surgery
University of South Florida
Surgeon
Department of Surgery
Tampa General Hospital
Tampa, Florida

John P. Ricci, MD, FACS
Assistant Professor
Department of Surgery
Donald and Barbara Zucker School of Medicine at Hofstra/Northwell
Hempstead, New York
Chief Colon and Rectal Surgery Department of Surgery
Long Island Jewish Medical Center Queens, New York

Rocco Ricciardi, MD, FACS, FASCRS
Department of Surgery
Harvard Medical School
Chief, Section of Colon and Rectal Surgery Department of Surgery
Massachusetts General Hospital Boston, Massachusetts

David E. Rivadeneira, MD, MBA, FACS, FASCRS
Professor
Department of Surgery
Hofstra Northwell University School of Medicine Hempstead, New York

Hofstra-Northwell University School of Medicine Hempstead, New York
Director of Surgical Services and Colorectal Surgery Huntington Hospital/Northwell Health Huntington, New York

Raul Rosenthal, MD, FACS, FASMBS
Professor
Department of Surgery
Charles E. Schmidt College of Medicine Florida Atlantic University Boca Raton, Florida
Chairman
Department of General Surgery Cleveland Clinic Florida
Weston, Florida

Howard M. Ross, MD, FACS, FASCRS
Professor and Chief
Department of Colon and Rectal Surgery Temple University
Vice Chair, Clinical Affairs
Department of Surgery
Temple University Hospital
Philadelphia, Pennsylvania

Bashar Safar, MBBS, MRCS, FACS, FASCRS
Assistant Professor
Department of Surgery
Johns Hopkins University
Baltimore, Maryland
Chief of Ravitch Division of Colorectal Surgery Department of Surgery
Johns Hopkins University
Baltimore, Maryland

Peter M. Sagar, MD, FASCRS
Consultant Surgeon
The John Goligher Department of Colon & Rectal Surgery St James's University Hospital Leeds, United Kingdom

Jaime E. Sanchez, MD, MSPH, FACS
Assistant Professor
Division of Colon and Rectal Surgery University of South Florida Morsani College of Medicine Vice Chief of General Surgery Department of Surgery
Tampa General Hospital
Tampa, Florida

Tampa, Florida

Laurence R. Sands, MD, MBA, FACS, FASCRS
Professor of Clinical Surgery Department of Surgery
University of Miami Miller School of Medicine Chief, Division of Colon and Rectal Surgery Daughtry Family Department of Surgery University of Miami Hospital
Jackson Memorial Hospital
Miami, Florida

Cesar Santiago, MD, FACS, FASCRS
Colorectal Surgeon
Department of Surgery
St. Joseph's Hospital
Chief, Colon and Rectal Division Director Center for Advanced Robotic Surgery Department of Surgery
BayCare Health System
Tampa, Florida

David M. Schwartzberg, MD
Department of Surgery, Division of Colorectal NYU School of Medicine
Chief Resident
Department of Surgery, Division of Colorectal Tisch Hospital
New York University Medical Center New York, New York

Joongho Shin, MD
Assistant Professor of Clinical surgery Department of Surgery
Keck School of Medicine
Attending surgeon
Department of Surgery
Keck Medical Center of USC
Los Angeles, California

Chaya Shwaartz, MD
Staff Surgeon
Department of Surgery and Transplantation Sheba Medical Center
Tel Hashomer, Israel
Sakler School of Medicine
Tel Aviv University
Tel Aviv, Israel

Pierpaolo Sileri, MD, PhD, MS, FACS, FASCRS
Assistant Professor of Surgery Director Laparoscopic Colorectal Surgery Master Program
Department of Surgery
University of Rome Tor Vergata Consultant Surgeon
Department of Surgery
Policlinico Tor Vergata
Rome, Italy

Constantinos Simillis, BSc(Hons), MBBS, AICSM, PGCert, MRCS, MA, MD, FRCS, CCT
Department of Colorectal Surgery Department of Radiology
Royal Marsden Hospital, Chelsea & Westminster Hospital, London, UK

Pamela C. Sivathondan, MD, MA, BM, BCh
Specialist Registrar
Department of Surgery
Oxford University Hospitals NHS Trust Oxford, United Kingdom

Bradford Sklow, MD, FACS, FASCRS
Clinical Associate Professor
Division of Colon and Rectal Surgery University of Minnesota
Abbott Northwestern Hospital
Minneapolis, Minnesota

Radhika K. Smith, MD
Assistant Professor
Department of Colon and Rectal Surgery Washington University in St. Louis St. Louis, Missouri

Toyooki Sonoda, MD, FACS, FASCRS
Associate Professor of Clinical Surgery Section of Colon and Rectal Surgery Weill Medical College of Cornell University New York, New York

Scott R. Steele, MD, FACS, FASCRS
Professor of Surgery
Case Western Reserve University School of Medicine
Chairman
Department of Colorectal Surgery Cleveland Clinic
Cleveland, Ohio

Sharon L. Stein, MD, FACS, FASCRS
Associate Professor
Department of Surgery
Case Medical Center
Program Director
Department of Colon and Rectal Surgery University Hospitals Cleveland Medical Center Cleveland, Ohio

David B. Stewart Sr, MD, FACS, FASCRS
Associate Professor of Surgery Department of Surgery
Penn State Hershey Medical Center Hershey, Pennsylvania

Patricia Sylla, MD, FACS, FASCRS
Associate Professor
Department of Surgery, Division of Colon and Rectal Surgery Icahn School of Medicine at Mount Sinai New York, New York

Samuel Szomstein, MD, FACS
Clinical Associate Professor
Department of Surgery
Florida International University Miami, Florida
Associate Director
Bariatric and Metabolic Institute and Division of MIS
Cleveland Clinic Florida
Weston, Florida

Paris P. Tekkis, BM, BS, BMedSci, MD, HonD, FRCS
Professor of Colorectal Surgery and Consultant Colorectal Surgeon The Royal Marsden Hospital
Honorary Consultant Colorectal Surgeon St Mark’s Hospital
London, United Kingdom
Adjunct Staff
The Cleveland Clinic Foundation Cleveland, Ohio
Professor of Colorectal Surgery Imperial College London
London, United Kingdom

Petr V. Tsarkov, MD, PhD, FASCRS (Hon)
Chief
Academic Department of Surgery, Faculty of Prophylactic Medicine Director
Clinic of Colorectal and Minimally Invasive Surgery I.M. Sechenov First

Moscow State Medical University Moscow, Russia

Inna Tulina, MD
Associate Professor
Department of Surgery
Faculty of Prophylactic Medicine Chief
Department of Oncologic Colorectal Surgery I.M. Sechenov First Moscow State Medical University Moscow, Russia

Michael A. Valente, DO, FACS, FASCRS
Assistant Professor of Surgery Program Director, Colorectal Surgery Residency Department of Colorectal Surgery Cleveland Clinic
Cleveland, Ohio

Brian T. Valerian, MD, FACS, FASCRS
Associate Professor of Surgery Department of Surgery
Section of Colon and Rectal Surgery Albany Medical College
Albany, New York

H. David Vargas, MD, FASCRS
Staff Surgeon and Colon Rectal Surgery Fellowship Program Director Department of Colon and Rectal Surgery Ochsner Clinic Foundation
Staff Surgeon and Medical Director Endoscopy Services Department of Colon and Rectal Surgery Ochsner Medical Center
New Orleans, Louisiana

Christina V. Warner, MD
Research Fellow
Division of Colon and Rectal Surgery Surgical Resident
Department of Surgery
University of Illinois at Chicago Chicago, Illinois

Martin R. Weiser, MD, FACS, FASCRS
Professor of Surgery
Department of Surgery
Weill Cornell Medical School
Attending Surgeon
Department of Surgery
Memorial Sloan Kettering Cancer Center New York, New York

Eric G. Weiss, MD, FACS, FASCRS, FACG

Affiliate Professor and Affiliate Dean Florida Atlantic University College of Medicine Clinical Professor and Affiliate Dean Florida International University College of Medicine Clinical Professor
Department of Surgery
Nova Southeastern University's College of Allopathic Medicine Clinical Assistant Professor of Surgery Cleveland Clinic Lerner College of Medicine of Case Western Reserve University
Chief Academic Officer
Education Center Director
DIO and Chairman of Graduate Medical Education Associate Residency Program Director, Colorectal Residency Department of Colorectal Surgery Cleveland Clinic Florida
Weston, Florida

Yuxiang Wen, MD
Department of Surgery
University of Mississippi Medical Center Jackson, Mississippi

Steven D. Wexner, MD, PhD (Hon), FACS, FRCS, FRCS (Ed), FRCSI (Hon), FASCRS, FACG
Director, Digestive Disease Center Chair, Department of Colorectal Surgery Cleveland Clinic Florida
Weston, Florida
Affiliate Professor
Florida Atlantic University College of Medicine Boca Raton, Florida
Clinical Professor
Florida International University College of Medicine Miami, Florida
Affiliate Professor
University of South Florida College of Medicine Tampa, Florida
Professor of Surgery
Ohio State University
Columbus, Ohio

Charles B. Whitlow, MD, FACS, FASCRS
Chairman
Department of Colon and Rectal Surgery Ochsner Medical Center
New Orleans, Louisiana

Matthew Z. Wilson, MD, MSc, FACS
Assistant Professor of Surgery Department of Surgery

Assistant Professor of Surgery Department of Surgery
Dartmouth Hitchcock Medical Center Lebanon, New Hampshire

Joshua H. Wolf, MD
Department of Surgery
Sinai Hospital
Baltimore, Maryland

Albert M. Wolthuis, MD, FACS, FASCRS
Assistant Professor
Department of Abdominal Surgical Oncology Catholic University of Leuven—Faculty of Medicine Clinical Head
Department of Abdominal Surgery University Hospitals Leuven
Leuven, Belgium

Cindy Wu, MD
Staff Surgeon
Department of Surgery
WellSpan Health Good Samaritan Hospital Lebanon, Pennsylvania

Heather Yeo, MD, MHS, FACS, FASCRS
Assistant Professor of Surgery Department of Surgery
Weill Cornell Medicine
Attending Surgeon
Department of Surgery
New York Presbyterian-Weill Cornell Medical Center New York, New York

Tonia Young-Fadok, MD, MS, FACS, FASCRS
Professor of Surgery
Division of Colon and Rectal Surgery Mayo Clinic
Phoenix, Arizona

Foreword to the First Edition

We live in a high-technology world where the "miracles" of modern surgery make headline news around the globe. It is no longer surprising to hear of yet another start-up medical technology company that promises a new surgical device that will save countless lives, improve outcomes, and significantly decrease pain and suffering. People find themselves mesmerized by watching "keyhole surgery" broadcast in high definition to their home television and find it surprisingly elegant and bloodless compared with their prior mental picture of surgeons at work. So it is perhaps understandable that many patients today go online to find surgeons and institutions offering the newest approaches and latest technology. It seems as though the modern surgeon armed with high-tech devices and digitalized equipment should be invincible. Indeed, it is easy for surgeons to be inappropriately swept up by the siren song of technical innovation.

In this kind of world, one might question the utility of yet another surgical textbook, especially one devoted to operative technique. Fortunately, editors Steven Wexner and James Fleshman have created a unique publication that is a far cry from the traditional textbook of the past. The list of contributing authors includes seasoned master surgeons schooled in traditional techniques and highly innovative researchers and entrepreneurs who are exploring new frontiers of surgical technology. Over the course of their busy clinical careers, the editors themselves have successfully bridged both perspectives. Their unique experiences are apparent in this new, tightly edited and highly practical textbook that emphasizes tried and true open techniques and new, less invasive techniques.

Drs. Wexner and Fleshman understand that surgical outcomes are dependent on many factors including clinical acumen and mature judgment to guide individualized decision making. But they also know that surgeons must master basic operative skills and develop a full reservoir of different techniques that can be used to fit the demands of the case at hand. As importantly, they know that no matter how revolutionary or exciting, technology has its limits. Innovation is providing new tools, but it is the surgeon's skill in deciding what tools to use and the way in which they are used that determines the surgical outcome. Operative technique remains critical to minimize patient morbidity, cure cancer and other life-threatening conditions, and preserve function and quality of life. All colon and rectal surgeons will find this book to be a valuable adjunct to their practice. The artist's color drawings are superb and anatomically correct. The text is easy to read, very focused, and useful for busy surgeons. I congratulate the editors for bringing this book to us.

David A. Rothenberger, MD
August 1, 2011

August 1, 2011

Foreword

Surgery is both an art and a science, and there is no substitute for acquiring both knowledge and skill to the highest level for the best outcomes for our patients. When we talk about mastering a subject we mean just this. Mastery comes from repeating and refining a procedure until it is as good as we can get it. In this we need the help and guidance of master surgeons, and these excellent two volumes provide just that. In this second edition, the techniques have been brought right up to date with step-by-step descriptions of the essential operations in colorectal surgery by carefully chosen experts in their field. It is lavishly illustrated, and there is access to a companion website with an image bank and videos of the procedures. Steve Wexner and Jim Fleshman have done a great job in revising and renewing this outstanding couple of volumes in the Master Techniques series.

Neil Mortensen
Oxford, United Kingdom August 7, 2017

Preface to the First Edition

The Mastery of Colorectal Surgery textbook is a two-volume compendium that demonstrates virtually all of the currently employed techniques for abdominal and anorectal surgery. All of the chapters have been written by internationally acclaimed experts, each of whom was given literary license to allow the book to be more creative and less rigorously formatted. Although some techniques are self-explanatory and the authors therefore concentrated their verbiage upon results and controversies surrounding a particular technique, other procedures are described in a more algorithmic manner. Specifically, some techniques require a much more heavily weighted description of preoperative and/or postoperative parameters rather than intraoperative variables. The matching of illustrations and videos has also been tailored to suit the needs of each chapter. Because of the quantity of material, the book is divided into two volumes: one that includes the abdominal and the other that includes anorectal procedures. While many textbooks vie for the attention of surgeons in training and surgeons in practice, the Mastery series, edited by Dr. Josef Fischer, has established itself as the resource for expert management of each theme. Therefore, this book was deliberately crafted to augment rather than to replace several other excellent recently published textbooks. It is our hope that these volumes be used in that context, so that the reader can learn the fundamentals and basics using many other excellent source materials and then rely upon the Mastery of Colorectal Surgery books for more clarity in terms of review of very specific procedures. In that same manner, these books perform a ready preoperative resource before embarking upon individual procedures.

We wish to thank Josef Fischer with having entrusted us with this latest of his literary offspring. The project took a considerable amount of time and effort, and we certainly thank him for his patience. In addition, we thank our respective staff in Weston and in Saint Louis, especially Liz Nordike, Heather Dean, Dr. Fabio Potenti, and Debbie Holton for their extensive efforts as well as Nicole Dernoski at Wolters Kluwer. We wish to express our sincerest and deepest gratitude to each and every contributor for their time, attention, expertise, and commitment to the project. Without our individual chapter authors, this work would not exist. We know that each of them has many significant competing obligations for their limited time and thank them for having participated to such an important degree in this project. Last, our appreciation goes to our families for their love and support as it is always time away from them that allows us to produce these types of books. In particular, appreciation goes to Linda Fleshman and to Wesley and Trevor Wexner.

Steven D. Wexner
James Fleshman

Preface

Six years have elapsed since we published the two volumes of *Master Techniques in General Surgery on Colorectal Surgery* including anorectal and abdominal operations. Owing to the overwhelming popularity of that book, we are pleased and proud to offer you this second edition. We are indebted to the authors and coauthors of the 117 chapters in these two volumes. We hope that you will agree with us that these two volumes provide beautifully illustrated, authoritatively written chapters about virtually every currently practiced colorectal surgical technique.

We have endeavored to make each chapter relatively focused rather than broad, and the authors have, as requested, presented clinically relevant material that can be readily digested. We have deliberately avoided publishing a comprehensive compendium about each subject. Thus, many areas are addressed with multiple chapters each of which has its own very specific view and offers clinical guidance on the basis of practical expertise. Although the preferences of the authors vary, many facets within these two volumes are quite consistent including the world-renowned nature of the authors and coauthors, the consistently high quality of the artwork, and the style of the chapters. We hope that readers will again, as was the case with the first edition, find the second edition of these two volumes to be an excellent clinical resource often consulted for both patient management and academic endeavors.

We again thank the authors and coauthors of these 117 chapters for their time, efforts, energy, expertise, and cooperation with the author guidelines, which enabled us to offer you this second edition.

Steven D. Wexner
James Fleshman

Contents

PART I

RIGHT COLON

Chapter 1

Open Medial-to-Lateral Right Colectomy

Valerie S. Emuakhagbon and Jaime E. Sanchez

INDICATIONS/CONTRAINDICATIONS

There are several approaches that can be utilized in performing a right colectomy, either open or laparoscopic, which include medial-to-lateral and lateral-to medial dissections. This chapter focuses on the open medial-to-lateral technique.

Indications for right colectomy include malignancy, inflammatory bowel disease, bleeding, obstruction, and ischemia. Indications specific for performing a medial-to-lateral mobilization include appropriate benign lesions that are unable to be removed endoscopically, as well as locally advanced malignancy with invasion into surrounding structures. The medial-to-lateral approach for a right colectomy has several advantages, including early ligation of the vascular pedicle, which in theory can allow for more aggressive manipulation of the specimen. This method is known as the “no-touch” technique. This concept was introduced in the early 20th century where vigorous manipulation of malignant tumors was found to result in the development of extensive liver metastases in mice models. The technique was then described and further popularized by Turnbull and Barnes wherein early lymphovascular control prior to tumor manipulation showed an improvement of 5-year survival rates when compared with patients undergoing conventional colectomy. By first elevating the mesentery, this dissection also allows the surgeon to better define retroperitoneal structures that may be vital in cases of locally advanced cancer.

PREOPERATIVE PLANNING

As in all cases of colon cancer, patients should undergo a preoperative staging evaluation. This assessment includes a carcinoembryonic antigen level as well as computed tomography scan of the chest, abdomen, and pelvis, which will help determine if there is locally advanced disease, invasion into surrounding structures, or distant metastasis. If needed, a magnetic resonance imaging or magnetic resonance angiogram may be obtained for further evaluation. Also, appropriate medical optimization and cardiopulmonary risk assessment are essential.

At our institution, mechanical bowel preparation is not routinely performed for patients undergoing a right colectomy. This topic remains controversial but has not been shown to definitively change surgical site infection or anastomotic leak rates, based on a Cochrane review by Guenaga et al., in patients undergoing segmental colectomy. However, many surgeons feel that a mechanical bowel preparation, which should include oral antibiotics, will decrease stool burden and postoperative morbidity.

SURGERY

Positioning

The patient should be placed in a supine position on the operating room table. Unlike laparoscopy, the patient's upper extremities may be left out on arm boards instead of being tucked to the sides.

Technique

A bladder catheter should be inserted prior to prepping and draping the patient. A periumbilical midline incision should be made. Upon entrance into the peritoneal cavity, an inspection of all quadrants should be performed and solid organs such as the liver palpated, paying close attention to evidence of metastases. If there are any concerns for metastatic disease, a frozen specimen should be obtained if it will change the indication for operation.

The key maneuver to beginning this operation is obtaining adequate visualization. The small bowel should be retracted to the left side of the abdomen, allowing for clear exposure of the terminal ileum and ascending colon mesentery. As well, the omentum and transverse colon should be retracted cephalad to the upper abdomen in order to provide full, unobstructed visualization.

The medial-to-lateral dissection begins with identification of the ileocolic vascular pedicle. This maneuver can be accomplished with anterior and lateral retraction of the cecum (Fig. 1-1). The ileocolic artery should be clearly identifiable as it tents within the mesentery. A peritoneal opening should be made alongside the vascular pedicle. Lifting the mesentery and pedicle toward the anterior abdominal wall and gently sweeping the retroperitoneum down allows for development of an avascular plane between these two structures. This avascular dissection is continued laterally toward the abdominal wall beneath the colon. Care must be taken during this portion of the dissection, to avoid injury to the duodenum, which should be swept down with the retroperitoneum (Fig. 1-2). After sufficient dissection to the bulb of the duodenum, attention is turned to cephalad dissection toward the hepatic flexure. The dissection continues in the avascular plane, sweeping retroperitoneum down until we are limited in exposure due to our intact vascular pedicle. Once this limit has been reached, the vascular pedicle is skeletonized and ligated. In an effort to perform an appropriate oncologic resection with complete lymphadenectomy in cases of malignancy, a high ligation of the ileocolic artery, between 1 and 2 cm from its origin at the superior mesenteric artery, is performed (Fig. 1-3). At our institution, the vascular pedicle is generally ligated with a bipolar electrosurgical energy device, but others may opt for a clamp and tie technique or use of a vascular stapler.

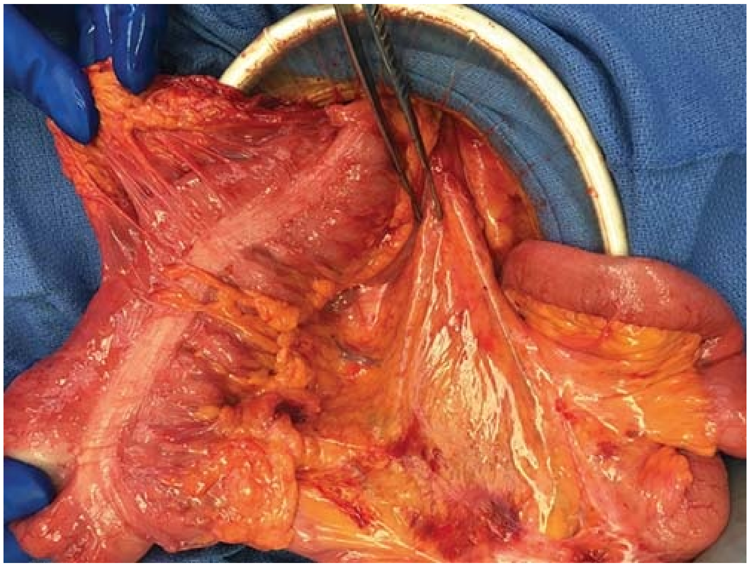


FIGURE 1-1 Retraction of the cecum allows for identification of the ileocolic vascular pedicle within the colonic mesentery (identified by forceps).

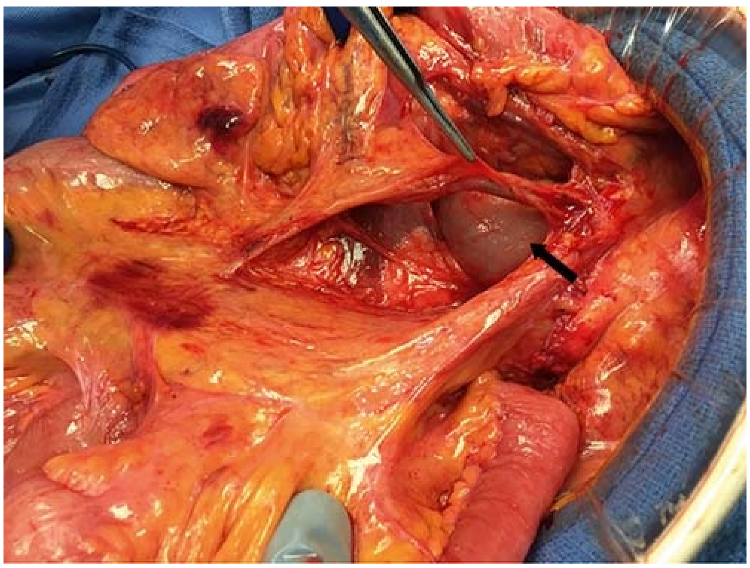


FIGURE 1-2 Dissection within the avascular plane

creates a window between the colonic mesentery (tented at the ileocolic artery by forceps) and the underlying retroperitoneal structures including the duodenum (black arrow).

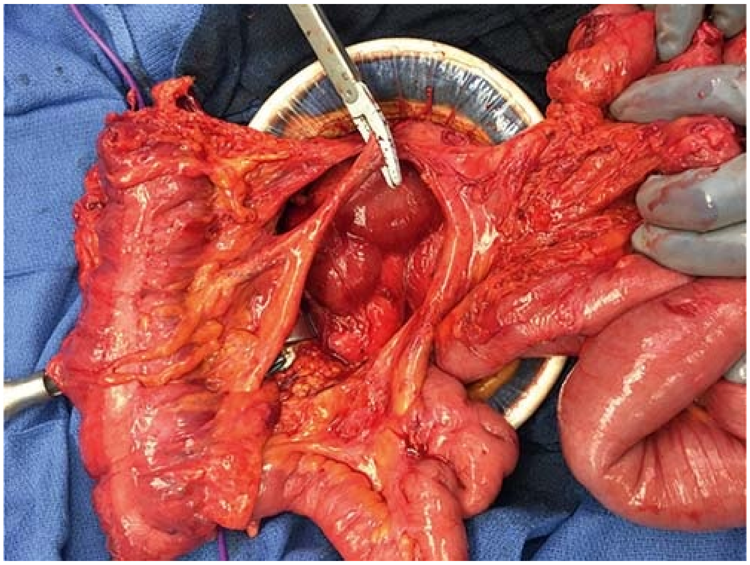


FIGURE 1-3 High ligation of the ileocolic artery 1–2 cm from its origin at the superior mesenteric artery (SMA).

After vascular pedicle ligation, the dissection continues cephalad toward the transverse colon by transecting the transverse mesocolon, including ligation of the right colic artery and right branch of the middle colic artery. At this point, attention is focused on completing the medial dissection, by transecting the mesentery of the terminal ileum to the site where the bowel is to be divided (Fig. 1-4). This step completes the medial dissection.

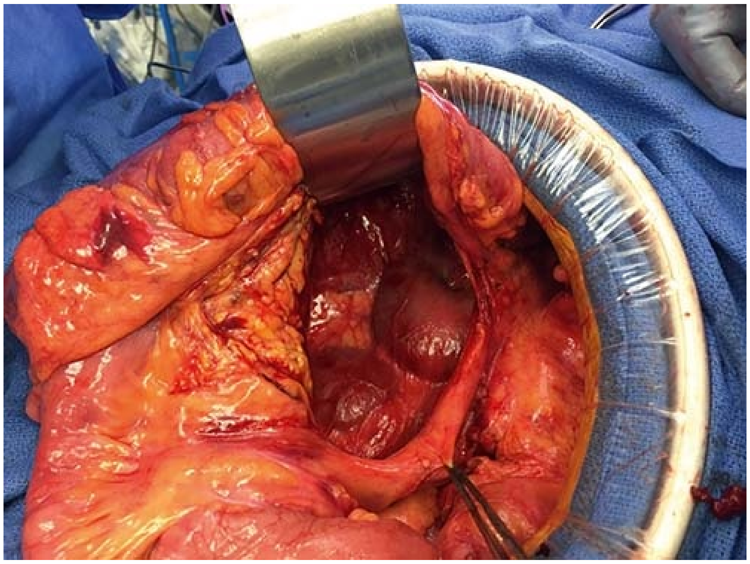


FIGURE 1-4 Completed medial dissection with ligated vascular pedicle and mesentery.

Entrance into the lesser sac begins the lateral dissection. After entrance into the lesser sac and with caudal and medial retraction of the transverse colon, one should be able to easily ligate the gastrocolic and hepatocolic ligaments as the mobilization continues laterally. Ligation of these attachments should allow for complete mobilization of the hepatic flexure (Fig. 1-5). With continued medialization of the hepatic flexure and ascending colon, the white line of Toldt and lateral wall attachments are incised (Fig. 1-6). One must ensure that as the colon is medially retracted and that the kidney and ureter remain down within the retroperitoneum. The ureter is not routinely identified during right colectomy if the dissection proceeds within the avascular plane described earlier.

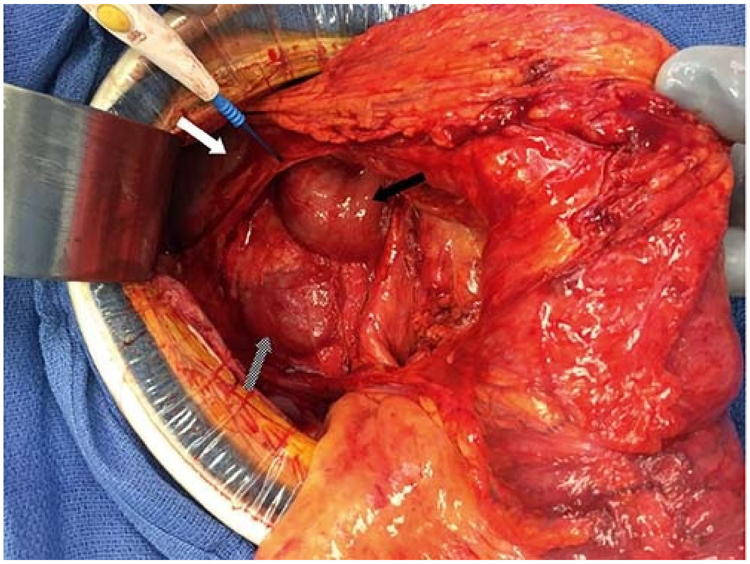


FIGURE 1-5 Mobilization of the hepatic flexure by transection of hepatocolic ligaments (right kidney identified by gray arrow; duodenum identified by black arrow; liver identified by white arrow).

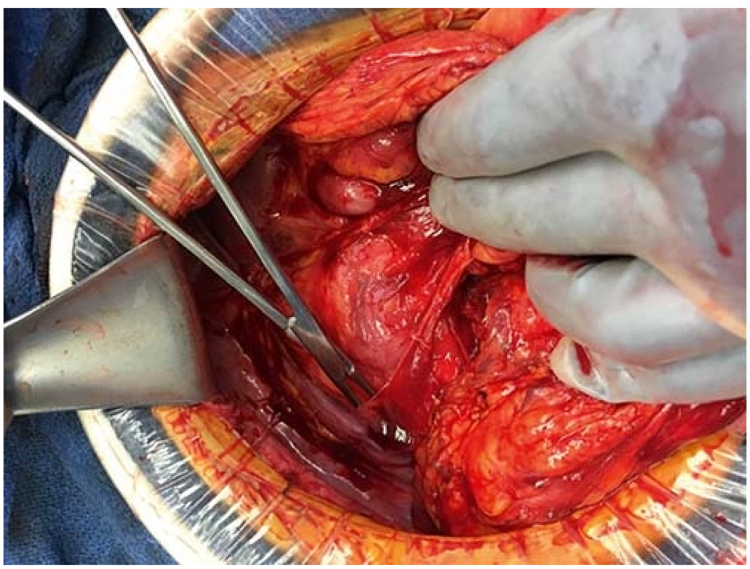


FIGURE 1-6 Transection of remaining lateral peritoneal attachments at the white line of Toldt.

In cases of locally invasive disease, surrounding structures should be resected en bloc with the colon. To the extent possible, one should have this information based on preoperative imaging and discuss with consultants, such as vascular surgery or urology, if necessary.

Once the colon has been fully mobilized, the terminal ileum and transverse colon should be transected using a bowel stapler to avoid contamination of the peritoneal cavity. An ileocolic anastomosis is created based on surgeon preference. Although we prefer a stapled anastomosis, both hand-sewn and stapled techniques provide equivalent patient outcomes.

For a stapled anastomosis, the antimesenteric corners of the stapled lines for both ileum and colon are removed. Each limb of a gastrointestinal stapler is inserted into the lumens and fired to create a side-to-side ileocolic anastomosis. The resulting common enterotomy is then closed with use of another staple load. However, it can also be closed using a hand-sewn technique.

The anastomosis should be inspected for completeness, patency, and hemostasis. Once satisfied, any available omentum may be used to cover the anastomosis and attention should be turned to closure of the peritoneal cavity, based on surgeon preference.

POSTOPERATIVE MANAGEMENT

Postoperatively, patients follow an enhanced gastrointestinal recovery protocol. On the night of surgery, patients are assisted out of bed, allowed a clear liquid diet, and strongly encouraged to ambulate. Nasogastric tubes are not routinely used. The amount of narcotic pain medications is limited in the postoperative period in an effort to decrease postoperative ileus and length of stay. Pain control can be achieved with multiple adjuncts, such as the use of an epidural, long-acting local anesthetics, as well as non-narcotic medications.

Working together with the anesthesia team, we limit pre-and intraoperative fluids by using a goal-directed approach with a target urine output of about 0.3–0.5 ml/kg/hr as a general rule. Postoperative fluid administration is limited throughout the perioperative period. According to Noblett et al., the use of protocol-based intraoperative fluid administration was shown to lead to shorter hospital stays and decreased morbidity in patients undergoing elective colorectal resection.

The bladder catheter is removed on the first postoperative day and prophylactic perioperative antibiotics are discontinued within the first 24 hours after surgery, as per previous surgical care improvement project (SCIP) guidelines. For this reason, we routinely use ertapenem as our antibiotic of choice as it provides 24-hour coverage with a single dose.

Patients are offered a regular diet on the morning after the operation as long as they tolerate without nausea or emesis. Hospital discharge occurs when the patient is tolerating oral diet, pain is adequately controlled, and the patient is ambulating without major difficulty. Discharge is not conditional upon having bowel function if the patient’s postoperative recovery is otherwise satisfactory.

COMPLICATIONS

After an open medial-to-lateral right colectomy, complications can include, but are not limited to, surgical site infection, prolonged ileus, anastomotic leak, and intra-abdominal abscess. The incidence of ileocolic anastomotic leak occurs in less than 2% of patients and that of surgical site infection has been reported to vary but should be less than approximately 10%. The 30-day mortality rate following a right colectomy is rare and if it does occur, it is usually due to cardiovascular or thromboembolic events.

RESULTS

Although past studies have shown a survival advantage when using the “no-touch” technique, these outcomes have not been reproducible in modern studies. In a randomized prospective trial, Wiggers et al. showed there was no difference in morbidity or mortality comparing the “no-touch” technique to conventional resections.

CONCLUSION

Any surgeon performing right colectomies should be familiar with the medial-to-lateral approach. Although no oncologic advantage has been proven as compared to the lateral-to-medial technique, it may offer superior visualization in some situations.

RECOMMENDED REFERENCES AND READINGS

Anwar S, Hughes S, Eadie AJ, Scott NA. Anastomotic technique and survival after right hemicolectomy for colorectal cancer. *Surg J R Coll Surg Edinb Irel* 2004;2:277–80.

Barnes J. Physiologic resection of the right colon. *Surg Gynecol Obstet* 1952;94:722–6.

Guenaga KK, Matos D, Wille-Jorgensen P. Mechanical bowel preparation for elective colorectal surgery. *Cochrane Database Syst Rev* 2009:CD001544.

Konishi T, Watanabe T, Kishimoto J, Nagawa H. Elective colon and rectal surgery differ in risk factors for wound infection. *Ann Surg* 2006;244:758–63.

Moghadamyeghaneh Z, Hanna MH, Carmichael JC, *et al.* Nationwide analysis of outcomes of bowel preparation in colon surgery. *J Am Coll Surg* 2015;220:912–20.

Noblett SE, Snowden CP, Shenton BK, Horgan AF. Randomized clinical trial assessing the effect of Doppler-optimized fluid management on outcome after elective colorectal resection. *Br J Surg* 2006;93:1069–76.

Turnbull RB, Kyle K, Watson FR, Spratt J. Cancer of the colon: the influence of the no-touch isolation technic on survival rates. *Ann Surg* 1967;166:420–5.

Tyzzer EE. Factors in the production and growth of tumor metastases. *J Med Res* 1913;28:309.

Wiggers T, Jeekel J, Arends JW, *et al.* No-touch isolation technique in colon cancer: a controlled prospect trial. *Br J Surg* 1988;45:409–15.

Chapter 2

Open Lateral-to-Medial Colectomy

Benjamin M. Martin, Farah A. Husain, and Edward Lin

INDICATIONS/CONTRAINDICATIONS

Indications

Surgical resection of the right colon may be indicated for malignant, premalignant, and benign etiologies. The location and underlying pathology determine the extent of resection. An extended right hemicolectomy may be needed for lesions spanning the hepatic flexure to mid-transverse colon, multiple adenomas, or synchronous lesions.

- Malignant—colon cancer, appendiceal cancer
- Premalignant—polyps not amenable to endoscopic removal
- Benign—ischemia, inflammatory bowel disease, right-sided diverticulitis, infection, cecal volvulus, bleeding from arteriovenous malformation, trauma

Even in the era of minimally invasive colon resections, 9–21% of laparoscopic colectomies require open conversion because of the patient's inability to tolerate CO_2 insufflation or because of dense intra-abdominal adhesions from previous surgery.

Contraindications

There are no absolute contraindications to an open right colectomy. Difficult circumstances such as a patient with severe cardiopulmonary disease and a large right-sided polyp that is not amenable to endoscopic removal present distinct challenges. Each patient should be reviewed on a case-by-case basis for appropriateness.

PREOPERATIVE PLANNING

Before elective colon resection, medical comorbidities should be identified and optimized. This may include correction of anemia, electrolyte and acid–base disorders, fluid deficits, and malnutrition. Most patients will have undergone a contrast-enhanced computed tomography (CT) scan of the abdomen and pelvis during the diagnostic workup, providing a road map to the mesenteric vasculature. Chest CT is also indicated for those with stage II or greater colon cancer to rule out metastatic disease, as well as a complete colonoscopy to identify potential synchronous lesions. Aside from the cecum and rectum, the accuracy of exact tumor location cannot always be ascertained by colonoscopy. When feasible, endoscopic ink tattooing or clip marking should be performed because intraoperative colonoscopy to localize the tumor is time consuming and may unnecessarily induce bowel distension.

Traditionally, preoperative bowel preparation has been performed before elective colon resection. This point has been debated without clear resolution. If time permits, a mechanical bowel preparation with a polyethylene glycol solution followed by the oral antibiotics neomycin and erythromycin, the eponymous Nichol’s prep, can be used. Otherwise, any oral lavage solution is acceptable. It is important to note that the surgeon is not always afforded the luxury of time in preoperative planning and bowel cleansing. Fortunately, bowel preparation may not be as critical for right colon resections when compared to left colon and rectosigmoid resections.

SURGICAL ANATOMY

Topography

Oncologic colon resection and lymph node harvest are based on the vascular supply of their subsegments. The colon and rectum are derived from the embryologic midgut and hindgut, with the blood supply following the superior mesenteric artery and inferior mesenteric artery, respectively. Derivatives of the midgut include the cecum and the right half to two-thirds of the transverse colon. The derivatives of the hindgut are the left one-third to one-half of the transverse colon, the descending colon, sigmoid colon, rectum, and the superior portion of the anal canal.

Cecum

The cecum is located in the right iliac fossa and is approximately 10 cm long, with the widest transverse diameter of all the colon segments averaging 7.5 cm. It is completely enveloped in visceral peritoneum and is usually mobile. The gonadal vessels and the right ureter typically course posterior to the medial border of the cecum. The terminal ileum empties from a medial-to-lateral direction into the cecum through a thickened invagination called the ileocecal valve. The valve prevents retrograde flow from the colon into the small bowel, but in approximately 25–30% of individuals the ileocecal valve is incompetent. The incompetent valve is most evident during colonoscopy when colonic air readily passes into the small intestine, resulting in marked abdominal distension and patient discomfort. Patients with distal colonic obstruction and a functional ileocecal valve typically have colonic dilatation on radiography that mimics a closed-loop obstruction. Although the cecum is quite distensible, a diameter greater than 12 cm can result in ischemic necrosis and perforation.

Ascending Colon

From the cecum, the ascending colon is the 12–20 cm segment that courses superior toward the liver on the right side. With the exception of its posterior surface, which is fixed to the retroperitoneum, the ascending colon is covered laterally and anteriorly by visceral peritoneum. The psoas muscle, second portion of the duodenum, right ureter, and the inferior pole of the right kidney have important anatomic relationships to the posterior aspect of the ascending colon. Laterally, the ascending colon is attached to the parietal peritoneum via an embryonic fusion plane between the visceral and parietal peritoneum. This subtle anatomic landmark, sometimes called the "white line of Toldt," is relatively avascular and serves as the classic landmark for surgical mobilization of the ascending colon away from its retroperitoneal attachments. The hepatic of the ascending colon away from its retroperitoneal attachments. The hepatic flexure of the ascending colon rests under the right liver and turns medially and anteriorly into the transverse colon. The hepatic flexure can often be identified during colonoscopy by the purplish impression of the liver on the superior aspect of the colon wall when the scope reaches the right side.

Transverse Colon

The transverse colon is suspended between the hepatic flexure and the splenic flexure on its mesentery and spans 40–50 cm, sharing important anatomic relationships with the stomach, tail of the pancreas, spleen, and the left kidney. It is completely invested with peritoneum and has a long mesentery known as the transverse mesocolon, which may be redundant enough to reach into the pelvis. Anatomically, the transverse colon is attached to the greater curvature of the stomach by the gastrocolic ligament or omentum. The greater omentum is attached by a thin, relatively avascular membrane to the antimesenteric surface of the transverse colon. Locally advanced tumors of the transverse colon may involve the stomach, pancreas, and/or duodenum posteriorly, as well as the spleen and omentum.

Blood Supply

Arteries

The right colon and up to two-thirds of the proximal transverse colon are derived from the midgut, a region supplied by the superior mesenteric artery. The distal transverse colon and left colon are derived from the hindgut, supplied by the inferior mesenteric artery (Fig. 2-1). All the terminal vessels that vascularize a limited area of the bowel wall are supplied by these arteries. Collateralization is excellent along marginal arteries at the mesenteric border, serving as an important source of a segment’s blood supply when a major vessel is occluded. The presence of these marginal arteries also allows the sacrifice of major vessels, facilitating the colon’s mobilization for anastomosis. An extreme example of such a mobilization would be a colonic interposition for esophageal replacement. The lymphatics and innervation of the colon follow the vascular supply.

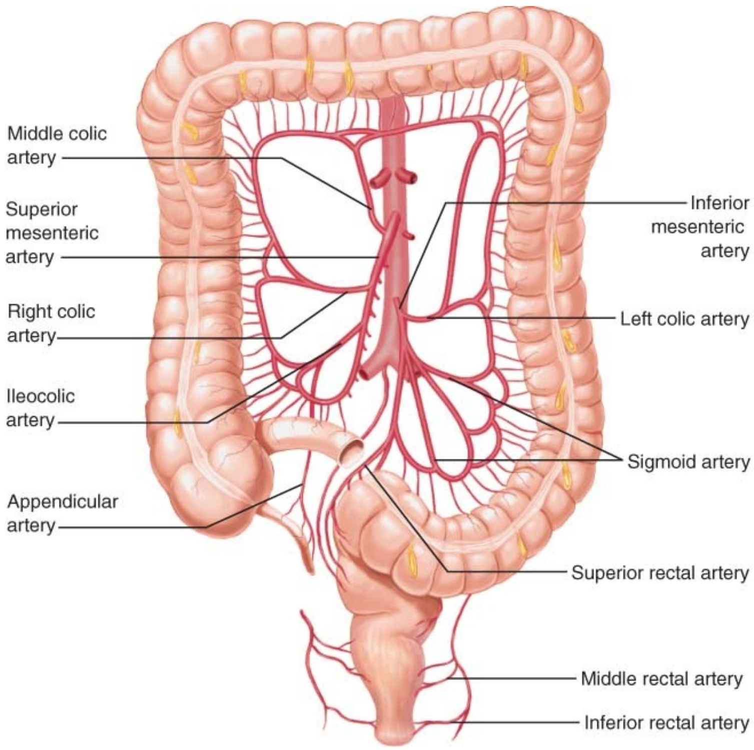


FIGURE 2-1 Arterial supply to the colon and rectum.

p. 6

p. 7

The superior mesenteric artery (SMA) supplies the entire small bowel with 12–18 jejunal and ileal branches to the left and three major colonic branches to the right. The ileocolic vessel is the most constant of these branches and supplies the terminal ileum, appendix, and cecum. The right colic artery is the most variable blood supply of the colon and may be absent in up to 20% of patients. When present, the right colic artery can originate from the SMA as a branch of the ileocolic artery or middle colic artery. The right colic artery communicates with the middle colic artery through the marginal arteries.

The middle colic artery is a major source of blood supply to the colon and is an important surgical landmark when planning a colon resection because it is a demarcation point for the clinical definition of a right or left hemicolectomy. This artery arises proximally as the SMA enters the small bowel mesentery at the inferior border of the pancreas. The middle colic artery then ascends into the transverse mesocolon and classically splits into the right and left colonic blood supply through the marginal arteries. The middle colic artery may be absent in some patients, and the presence of an accessory middle colic artery may be seen in 10% of patients.

Veins

With the exception of the inferior mesenteric vein, the colon's venous anatomy parallels the arterial supply of the corresponding midgut-or hindgut-derived segments. Drainage of the midgut-derived right colon is achieved by the superior mesenteric venous system, which includes the ileocolic, right colic, and middle colic veins. This configuration forms the superior mesenteric vein and joins the splenic vein to empty into the portal venous system as it superiorly progresses.

Lymphatic Drainage

Lymphatic supply parallels the blood supply. Lymphatics originate in the bowel wall as a plexus in the lamina propria and drain into the submucosal lymphatics. The most proximal lymph nodes to the bowel wall are the epicolic nodes, located between the intestinal wall and the arterial arcades. Drainage continues into the paracolic nodes, which mirror the marginal arteries. Together, the epicolic and paracolic lymph nodes make up the majority of colonic lymph nodes and are the most likely sites of regional metastatic disease. Intermediate nodes are found along the main colic vessels, and they drain into the principal nodes located at the origin of the superior and inferior mesenteric arteries.

SURGERY

The major surgical procedures for the right colon include the right hemicolectomy and extended right hemicolectomy (Table 2-1, Fig. 2-2). Tumors located in the appendix, cecum, or ascending colon require a right hemicolectomy, the anatomic boundaries of which span the distal terminal ileum and cecum to the proximal half of the transverse colon. An extended right hemicolectomy lengthens the resection to also include the transverse colon to the splenic flexure, including the left branch of the middle colic artery. The procedure is appropriate for tumors at the hepatic flexure and in the transverse colon. Many surgeons avoid isolated transverse colon resections because a hepatic flexure to splenic flexure anastomosis is a potentially problematic one because of inconsistent blood supply.

TABLE 2-1 Standard Resections for Right-Sided Colon Tumors

Tumor location	Resection
Cecum/appendix	Right hemicolectomy
Ascending colon	Right hemicolectomy
Hepatic flexure	Extended right hemicolectomy
Transverse colon	Extended right hemicolectomy

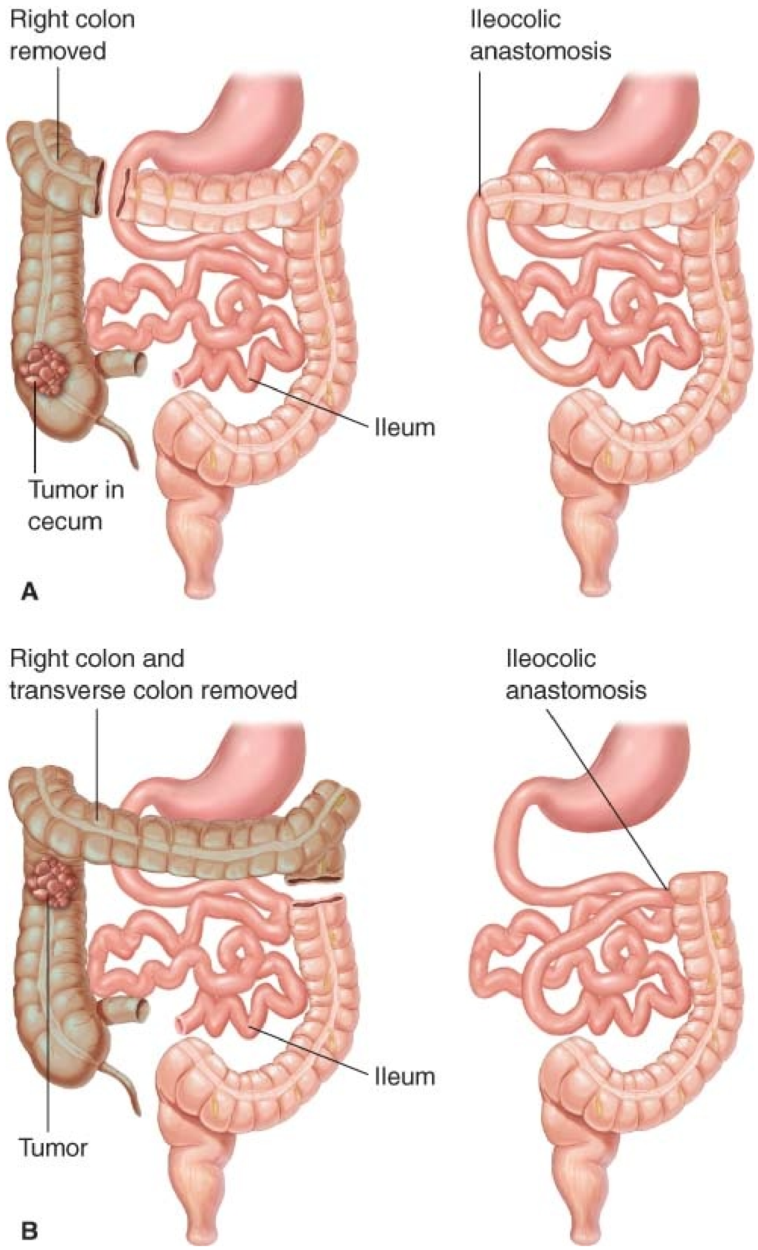


FIGURE 2-2 Standard resections for right-sided colon tumors. A. Right hemicolectomy with ileocolic anastomosis for a tumor in the cecum. B. Extended right hemicolectomy with ileocolic anastomosis for a hepatic flexure mass.

Positioning

The patient is positioned supine with pressure points padded and a safety strap

The patient is positioned supine with pressure points padded and a safety strap across the anterior thighs. Bilateral sequential compression devices should be placed on the lower extremities before induction of general anesthesia. The selective use of ureteral stents may be advisable for patients with bulky tumors, a history of radiation, or reoperative fields. Ureteral stents have not been shown to prevent injuries but aid in their intraoperative identification, enabling immediate repair. In practice, ureteral stents for right colectomy are used less frequently than for left colon resections. The abdomen is then cleared of hair with an electric clipper and prepped with chlorhexidine. Patients should receive a prophylactic dose of antibiotics 30–60 minutes before the incision is made. Choice of antibiotics should be based on the hospital's infection nomogram but, in general, should cover enteric gram-negative bacilli, anaerobes, and enterococci.

Technique

Abdominal incisions used to perform a right hemicolectomy may vary, with choices including a midline, paramedian, transverse supraumbilical, or even a Pfannenstiel incision. We prefer the standard midline, with the surgeon standing to the patient's left. The peritoneal cavity should first be inspected for gross metastases. The small bowel should be evaluated from the ligament of Treitz to the ileocecal valve and the liver closely examined. A solitary hepatic metastasis may be resected at the same time, but with appropriate presurgical evaluation, this occurrence is generally anticipated rather than unexpected. The uterus and ovaries should be identified and examined. The mass should be identified and the surrounding tissue assessed for extension beyond the colon because in most cases, an en bloc resection is planned. If a complete resection is not possible, the primary tumor is often resected to avoid the complications of obstruction and hemorrhage. A self-retaining abdominal retractor is then placed and the bed tilted slightly toward the surgeon, allowing for gravity retraction of the small bowel.

The planned resection for a right hemicolectomy includes the final 6–10 cm of the ileum and the proximal transverse colon. Tumors of the cecum, also including appendiceal masses, should include 10–15 cm of the ileum.

Mobilization of the Colon

Mobilization of the right colon can begin from the cecum toward the hepatic flexure. In this manner, the peritoneal attachments to the cecum are incised with electrocautery. The colon is retracted anteriorly and medially so that electrocautery can be used to further release the lateral peritoneal attachments up the right gutter. This can be accomplished by placing the left index finger behind the peritoneal attachments while using electrocautery above the finger (Fig. 2-3). Blunt dissection with a sponge can be used to divide any remaining thin attachments to the retroperitoneum. This maneuver will aid in ensuring the gonadal vessels, and ureter remains posterior to the specimen. Awareness of the course of the ureter and gonadal vessels is crucial. The right ureter can be visualized as it courses from the posterior aspect of the duodenum toward the bifurcation of the iliac vessels. Mobilization of the right colon is completed when the hepatic flexure is freed superiorly from the liver and posteriorly from the duodenum. The duodenum and head of the pancreas can be visualized when the hepatic flexure dissection is completed. The renocolic ligament that anchors the hepatic flexure may be thick, requiring ligation with suture ties or division with ultrasonic shears or electrothermal bipolar device. Medial mobilization along the transverse colon is then accomplished by division of the gastrocolic ligament just below the gastroepiploic arcade of the stomach using the same energy sources. The omentum attached to the future specimen can also be taken. Three areas require caution during cephalad mobilization of the right colon: (1) excessive mobilization deep to the retroperitoneum and entering Gerota’s fascia, (2) avulsion of a collateral venous branch between the inferior pancreaticoduodenal and middle colic veins, and (3) injury to the second and third portions of the duodenum.

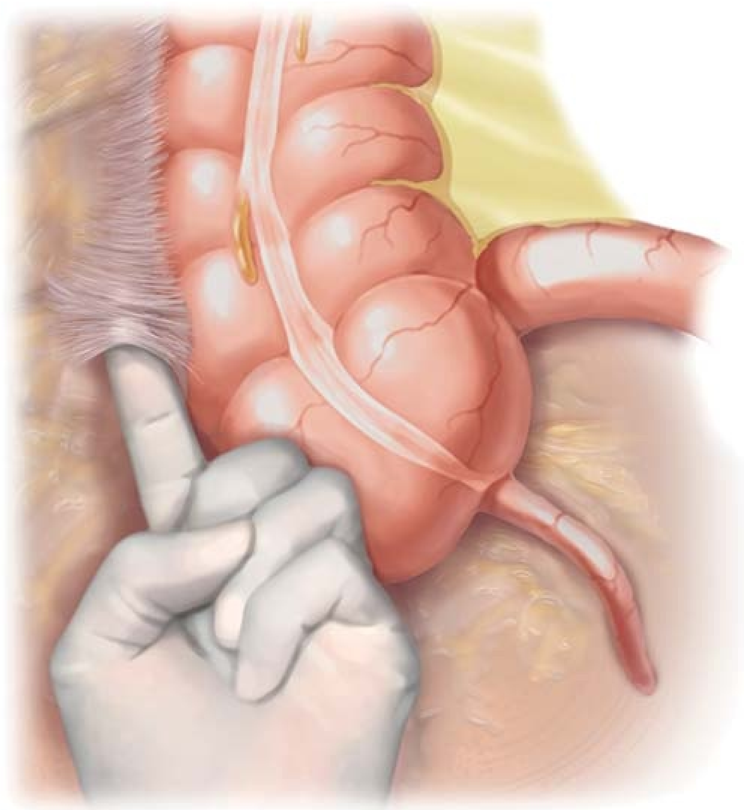


FIGURE 2-3 Release of the lateral peritoneal attachments to the cecum using the left index finger and electrocautery.

Vessel Ligation and Division of the Mesentery

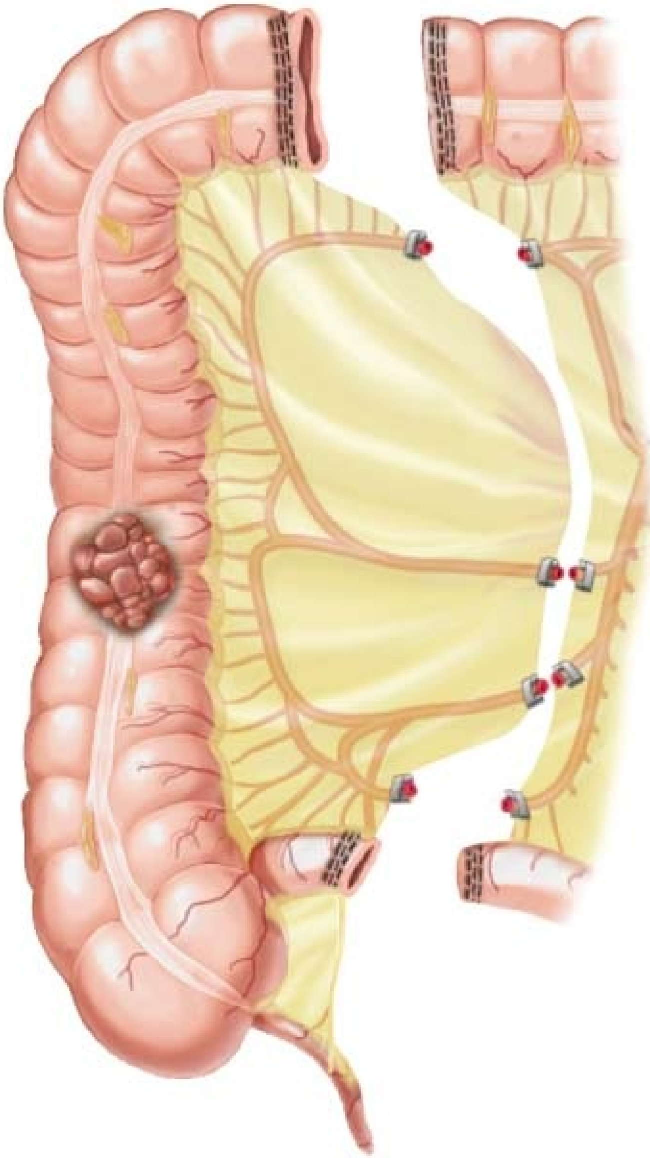
The ileocolic, right colic, and right branch of the middle colic vessels require ligation at their origin from the SMA to perform an adequate oncologic resection. To identify the ileocolic pedicle, the right colon is retracted caudally away from the midline; the ileocolic pedicle becomes visible as a pulsatile ridge. The mesenteric window at the vascular base is opened on either side of the pedicle before dividing the pedicle. Once divided, the ileocolic pedicle is lifted anteriorly like a handle, and blunt dissection along the avascular retroperitoneal plane is achieved by lifting the mesentery and simultaneously sweeping the retroperitoneum posteriorly. The mesentery and cecum should be free from posterior attachments.

The remainder of the mesentery can be divided from the ileocolic pedicle down to the right branch of the middle colic artery. The right colic vessel commonly emanates from the ileocolic artery and, therefore, may not need to be individually ligated. The extent of the mesenteric resection varies depending on the indication for surgery. Oncologic indications warrant ligation of the mesenteric vessels close to their root for optimal lymph node harvest, whereas benign pathology allows for division closer to the mesenteric border of the colon. The ultimate landmark of the cephalad dissection is to identify the duodenum and remain anterior to it. The right branch of the middle colic can be suture ligated at this junction, or a bipolar cutting and sealing device can be used. Care should be taken to preserve the main middle colic artery when performing a right hemicolectomy. For tumors located in the hepatic flexure or transverse colon in which an extended right hemicolectomy is warranted, the middle colic vessel should be ligated before the bifurcation at the inferior border of the pancreas. It is probably best to avoid direct manipulation of the tumor during the dissection, but this technique is more a surgeon preference than supported by data.

Resection and Anastomosis

The transverse colon can be divided with a linear cutting stapler, typically with a blue or white cartridge. Similarly, the appropriate site of the ileum is divided with the same stapler. Resection margins should be greater than 5 cm when performing resection for cancer. Intestinal continuity can be restored by the hand-sewn (one-or two-layer) or stapled technique with equivalent functional results; however, the stapled technique does save some time.

The stapled anastomosis begins by aligning the two ends of the bowel along the end of the antimesenteric borders. The general spillage of bowel content is minimal during this procedure, and it is therefore unnecessary to place bowel clamps proximal and distal to the anastomosis. The antimesenteric corner of the staple line is excised on both ends of the bowel, and the forks of the linear cutting stapler are inserted into the ileum and colon. After firing with a blue cartridge, the internal staple line is checked for bleeding, and the resultant ileocolostomy edges are aligned using Allis clamps or anchored with stay sutures. The opening of the ileocolostomy can be closed with another application of the linear cutting stapler. It is also acceptable to close the common opening using interrupted 3-0 silk sutures or running 3-0 vicryl sutures followed by Lembert sutures. The merits of closing the mesenteric defect are unknown, but a running suture should suffice if closure is desired (Fig. 2-4).



A

B

FIGURE 2-4 A. Vessel ligation, division of the mesentery, and resection of an ascending colon mass. B. Side-to-side functional end-to-end stapled ileocolic anastomosis.

For extended right hemicolectomy, we prefer to bring the ileum directly to the proximal descending colon and not to the splenic flexure to avoid the risk of involving the watershed area.

The fascial incision is closed with heavy absorbable sutures such as a running 1-0 polydioxanone suture.

POSTOPERATIVE MANAGEMENT

Most patients undergoing elective right hemicolectomy will be managed postoperatively on an enhanced recovery protocol. Nasogastric tubes are not used routinely. Patients are started on a clear liquid diet within 24 hours of surgery, during which time they may be given perioperative antibiotic prophylaxis. Urinary catheters are removed as soon as possible—many times in the operating room—to encourage early ambulation, which is a key component in preventing venous thrombosis and postoperative pneumonia. Intravenous fluids should be given sparingly to target a urine output of 0.5–1.0 ml/kg/hr. Multimodal pain management, including transversus abdominis plane, blocks preoperatively, and the early institution of oral analgesics postoperatively, such as nonsteroidal anti-inflammatories, is encouraged. The aim of enhanced recovery pathways is to shorten the interval to resumption of normal activities.

COMPLICATIONS

Potential postoperative complications following open lateral-to-medial right colectomy include bleeding, surgical site infection, anastomotic leak, prolonged ileus, bowel obstruction, venous thrombosis, urinary tract infection, and pneumonia. According to data available from the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP), an average risk patient undergoing a segmental colectomy with primary anastomosis has a 13.2% incidence of surgical site infection (superficial 8.0%, deep 1.4%, organ space 3.8%). A bundled approach to the prevention of surgical site infections containing evidence-based risk mitigation measures may decrease these rates. The incidence of anastomotic leak is approximately 2% and may manifest as a localized intraperitoneal abscess, colocutaneous fistula, or frank peritonitis. Management may require placement of a radiologically guided drain or reoperation. Thirty-day mortality is less than 1%, with emergent operations carrying an increased risk.

RESULTS

The open operative technique is employed in approximately 40–50% of elective colectomies in the United States. This number is undoubtedly higher for emergency operations. In the lateral-to-medial approach, the colon is first mobilized, permitting the accurate identification of critical structures—duodenum, right ureter, root of mesentery—before vessel ligation. The alternative open medial-to-lateral mobilization (“no-touch technique”) has been espoused to have theoretical advantages when resecting colon cancer, but scientific data have not borne this out. Medial-to-lateral mobilization may be advantageous in laparoscopic right colectomy because the lateral colon attachments serve as natural counter traction as the surgeon dissects out the vascular pedicles. Aside from the surgeon’s preference as to the operative approach, when performing right colectomy for an oncologic indication, the lymph node harvest is a key quality benchmark. A minimum of 12 lymph nodes are required for adequate nodal (N) staging. This was established in the Intergroup 0089 trial for adjuvant chemotherapy in stages II and III colon cancer, in which survival increased as more lymph nodes were analyzed while controlling for the number of lymph nodes involved.

CONCLUSIONS

In this chapter, we have outlined the open surgical technique with a lateral-to-medial approach. Location of the pathology is the major determinant of the type and extent of colon resection, influencing the degree of resection based on the arterial, venous, and lymphatic drainage of the affected colon segment. Furthermore, there is increasing reliance, by medical societies and health care payers, on quality indicators such as the adequacy of lymph node resection in resections for malignancy.

RECOMMENDED REFERENCES AND READINGS

Berg DF, Bahadursingh AM, Kaminski DL, Longo WE. Acute surgical emergencies in inflammatory bowel disease. *Am J Surg* 2002;184:45–51.

Garcia-Ruiz A, Milsom JW, Ludwig KA, Marchesa P. Right colonic arterial anatomy. Implications for laparoscopic surgery. *Dis Colon Rectum* 1996;39:906–11.

Goldenberg EA, Khaitan L, Huang IP, Smith CD, Lin E. Surgeon-initiated screening colonoscopy program based on SAGES and ASCRS recommendations in a general surgery practice. *Surg Endosc* 2006;20(6):964–6.

Goldstein NS. Lymph node recoveries from 2427 pT3 colorectal resection specimens spanning 45 years: recommendations for a minimum number of recovered lymph nodes based on predictive probabilities. *Am J Surg Pathol* 2002;26:179–89.

Kahokehr A, Sammour T, Zargar-Shoshtari K, Srinivasa S, Hill AG. Recovery after open and laparoscopic right hemicolectomy: a comparison. *J Surg Res* 2010;162(1):11–6.

Keller DS, Pedraza R, Flores-Gonzalez JR, LeFave JP, Mahmood A, Haas EM. The current status of emergent laparoscopic colectomy: a population-based study of clinical and financial outcomes. *Surg Endosc* 2016;30:3321–26.

Le Voyer TE, Sigurdson ER, Hanlon AL, *et al.* Colon cancer survival is associated with increasing number of lymph nodes analyzed: a secondary survey of intergroup trial INT-0089. *J Clin Oncol* 2003;21:2912–9.

Marcello PW, Roberts PL, Rusin LC, Holubkov R, Schoetz DJ. Vascular pedicle ligation technique during laparoscopic colectomy. A prospective randomized trial. *Surg Endosc* 2006;20:263–9.

Neutzling CB, Lustosa SA, Proenca IM, da Silva EM, Matos D. Stapled versus handsewn methods for colorectal anastomosis surgery. *Cochrane Database Syst Rev* 2012;(2):CD003144.

The Clinical Outcomes of Surgical Therapy Study Group. A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med* 2004;350:2050–9.

Chapter 3

Laparoscopic Medial-to-Lateral Right Colectomy

Toyooki Sonoda

INDICATIONS AND CONTRAINDICATIONS

In general, a laparoscopic dissection of the right colon is more straightforward than that of the transverse colon, left colon, or the rectum. The right colon can be mobilized from the medial, lateral, superior, or inferior aspect, and any competent surgeon must be able to perform the colonic mobilization from all four directions, as dictated by anatomic variations. The main advantages of the *medial-to-lateral* approach to mobilization of the colon include the following:

- Early ligation of the vascular pedicles in cancer may prevent the liberation of tumor cells into the mesenteric circulation during mobilization (the Turnbull no-touch technique).
- Preservation of the lateral colonic ligament until the end of the mobilization keeps the right colon fixed in place and utilizes the lateral ligament as a natural retractor, as opposed to a lateral-to-medial mobilization which then requires one to retract and manipulate a floppy colon.

Indications

The most common indications for a laparoscopic right colectomy include malignant neoplasm, benign polyp not amenable to colonoscopic removal, and Crohn’s disease. Uncommon, yet possible, indications are right-sided diverticulitis, chronic volvulus, hemorrhage, and ischemia.

Contraindications

There are both absolute and relative contraindications to the laparoscopic approach to colectomy. Absolute contraindications include the following:

- Hemodynamic instability
- Known history of hostile adhesions from prior surgery

Relative contraindications to laparoscopy depend on each clinical circumstance, as well as the comfort level of the surgeon. These include the following:

Large tumor size (>8 cm)

Tumor invading other structures

Bowel dilation from obstruction or ileus

Emergency surgery

History of prior surgery

A patient may have had many operations in the past, but the presence of adhesions *may not* preclude a subsequent laparoscopic colectomy. For example, even patients who have undergone one or more open ileocolic resections for Crohn’s disease may still be candidates for laparoscopic ileocolectomy. It is worthwhile planning an initial diagnostic laparoscopy to assess this feasibility. However, when extensive adhesions are present necessitating conversion to open surgery, the decision to convert should be made early in the operation. Extensive omental adhesions to the abdominal wall can be favorable for the laparoscopic approach, whereas significant intraloop bowel adhesions may be more challenging.

PREOPERATIVE PLANNING

The patient should be prepared for surgery, with attention paid to the optimization of preoperative comorbidities. Neoplasms should be evaluated with preoperative computed tomography (CT) scan and colonoscopy, with additional imaging by magnetic resonance imaging or positron emission tomography scan when appropriate. Patients with Crohn's disease should undergo colonoscopy and complete imaging of the small intestine with a magnetic resonance or CT enterography or capsule endoscopy. In ileal Crohn's disease, it is important to examine the images for an ileosigmoid fistula, because this finding may affect the magnitude of the operation or the planning of an incision.

Whenever a neoplastic lesion is present, especially one that may not be visible on the serosal surface, an endoscopic tattoo must be placed using permanent ink. Tattooing allows for laparoscopic identification of the tumor-bearing segment, and eliminates the risk of either removing an incorrect segment of the intestine or resecting a tumor with inadequate lateral margins. The tattoo should be placed in a uniform manner, in 3–4 quadrants to ensure that the tattoo is visible on the serosal surface and not hidden by the mesentery. It is recommended that the tattoo is injected at the distal aspect of a tumor, rather than placing both proximal and distal tattoos. This method limits confusion in case only one tattooed area is visible, and is helpful in planning the distal line of resection.

The use of mechanical bowel preparation before elective colorectal surgery is controversial. Several randomized prospective trials have not demonstrated an advantage to mechanical bowel preparation in reducing rates of anastomotic leak and superficial surgical site infection (SSI) compared with no mechanical preparation. As a result, many surgeons no longer utilize routine mechanical bowel preparation before elective colon resection. However, a recent evaluation of 4,999 patients using the 2012 Colectomy-Targeted American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database revealed that rates of anastomotic leak (2.8% vs. 5.7%, $P = 0.001$), incisional SSI (3.2% vs. 9.0%, $P < 0.001$), and procedure-related hospital readmission (5.5% vs. 8.0%, $P = 0.03$) were lower with the combination of mechanical and oral antibiotic preparation before surgery as compared with no preparation. Patients who received either mechanical or oral antibiotic preparation did not fare better than did patients who did not receive preparation.

Another argument in favor of mechanical bowel preparation is that with the laparoscopic approach, the ability to palpate an intraluminal lesion is limited. If the location of a tumor or polyp cannot be ascertained during laparoscopic surgery, an intraoperative colonoscopy should be performed rather than a blind resection. Colonoscopy can be difficult in the setting of an unprepared colon. Intraoperative colonoscopy should be performed with CO_2 insufflation rather than air whenever possible, because CO_2 insufflation limits bowel distension due to the rapid absorption of intraluminal CO_2 compared with air. With the use of air insufflation, the terminal ileum must be occluded with a laparoscopic bowel grasper to avoid bothersome small bowel distension; with CO_2 insufflation, however, this precaution is not necessary.

In addition, there are elements of enhanced recovery after surgery (ERAS) pathways that apply to preoperative care. ERAS pathways are evidence-based protocols that standardize pre-, intra-, and postoperative care to improve outcomes, enhance recovery, and ultimately decrease health care costs. To prevent preoperative dehydration resulting in hemodynamic instability upon induction of anesthesia and thus requiring an increased volume of intravenous fluids that may then delay recovery after surgery, patients are encouraged to drink clear liquids up to 2 hours of surgery. They are also asked to consume a 12-oz. helping of a carbohydrate-rich drink 2 hours before surgery. Aggressive multimodal narcotic-sparing analgesia starts preoperatively as well. Patients receive a combination of acetaminophen, gabapentin, and a nonsteroidal anti-inflammatory drug (NSAID) such as celecoxib in the preoperative holding area, which will then be postoperatively continued.

SURGERY

Patients undergoing laparoscopic bowel resection should receive appropriate intravenous antibiotics within 1 hour of skin incision. For a lengthy operation, the antibiotics must be intraoperatively redosed on the basis of their pharmacokinetics. Prophylaxis against deep vein thrombosis should be given preoperatively.

Positioning

A gel pad is placed on the operating table to avoid patient slippage during extreme positioning. For most cases, a laparoscopic right colectomy is performed with the patient in the supine position, with both arms tucked at the sides. However, in cases of Crohn's disease, patients are placed in the modified lithotomy position, because standing between the legs facilitates the examination of the proximal small bowel ("running the bowel"). Furthermore, the modified lithotomy position helps when an occult ileosigmoid fistula is found. Other indications of a modified lithotomy position include the following:

In a difficult right colectomy, an additional assistant can stand between the legs and help with retraction and exposure through additional ports.

When a lesion or a tattoo is difficult to identify, an intraoperative colonoscopy can readily be performed.

When a patient is placed in a modified lithotomy position, the degree of hip flexion must be kept to a minimum to prevent the thighs from becoming an impediment as they collide with the handles of the laparoscopic instruments during upper abdominal work.

Technique

Port Placement

The camera port is placed in a periumbilical position. Whether it is placed superior or inferior to the umbilicus is based on the body habitus and location of the umbilicus. The camera port is best placed at the "top of the dome" when the abdomen is insufflated; in most patients, this position will be infraumbilical. However, when the umbilicus is located low in the abdomen (in obesity and in some males), the camera port is best placed in the supraumbilical position. In the majority of cases, this periumbilical port wound is then extended around the umbilicus as a mini-laparotomy for exteriorization of the colon, resection, and anastomosis.

A typical port placement is illustrated in Figure 3-1. We favor the blunt Hasson technique (10 or 12 mm) for the camera port. The surgeon begins the operation from the left side of the patient using the left lower quadrant and suprapubic ports. The assistant stands to the right of the surgeon, holding the camera and using the left upper port. A monitor placed near the right shoulder of the patient is used by both operators. After vascular ligation and medial-to-lateral retromesenteric dissection, the surgeon moves to the right of the assistant, using the two left-sided ports, for hepatic flexure takedown and lateral ligament mobilization. The assistant helps through the suprapubic port.

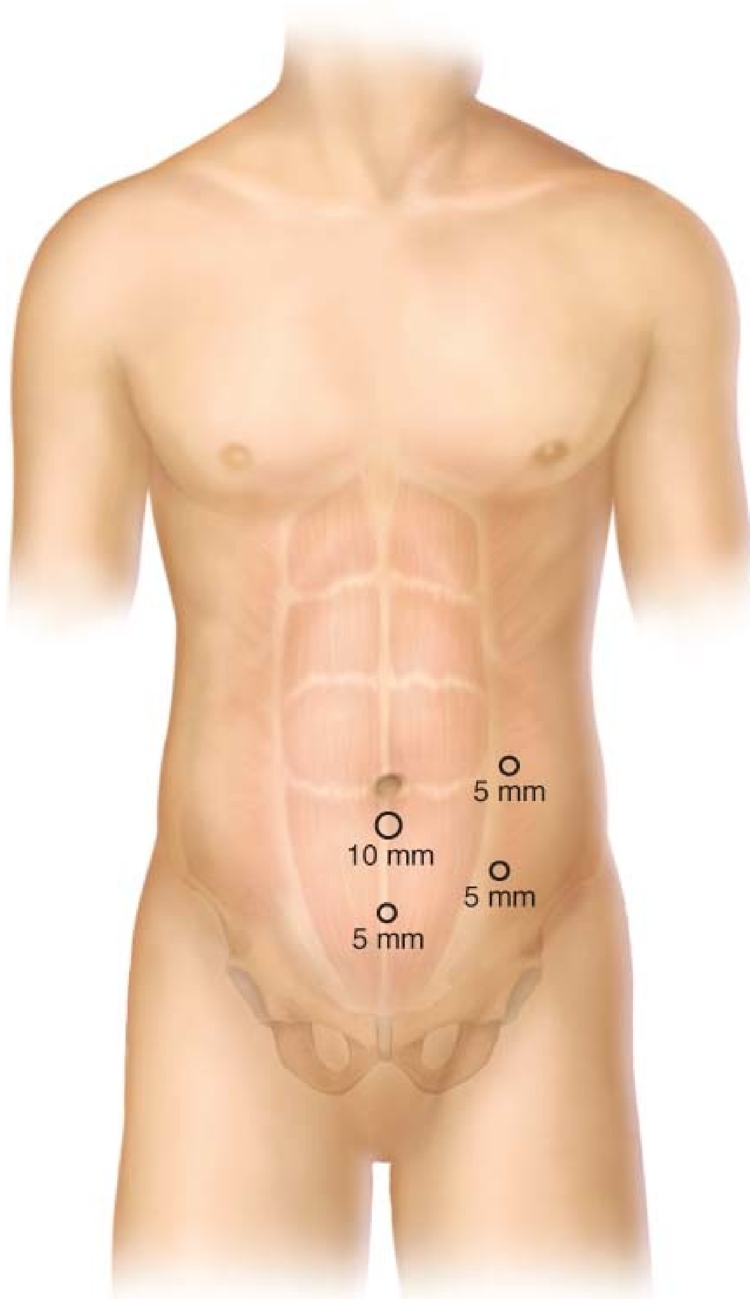


FIGURE 3-1 The port placement for a medial-to-lateral laparoscopic right hemicolectomy.

Operative Steps

The following are the general operative steps in a medial-to-lateral laparoscopic

The following are the general operative steps in a medial-to-lateral laparoscopic right hemicolectomy:

- Isolation and division of the ileocolic pedicle
- Isolation and division of the right branch of the middle colic vessels
- Separation of the right colon and mesentery from the retroperitoneal fascia in a medial-to-lateral direction
- Dissection of the gastrocolic ligament, takedown of the hepatic flexure and lateral ligament
- Mobilization of the ileum and mesentery off of the retroperitoneum
- Division of the bowel proximally and distally

Anastomosis

Ileocolic Pedicle

The patient is placed in a slight Trendelenburg position. The omentum is lifted above the transverse colon, and the distal ileum is moved into the pelvis. The patient is tilted steeply with the right side up, and the more proximal small bowel loops are swept to the left of the midline.

The operation starts with the isolation of the ileocolic pedicle. The ileocolic artery is a proximal branch off of the superior mesenteric artery that courses just inferior to the third portion of the duodenum. Therefore, the identification of the duodenal sweep through the mesentery is an important initial step in identifying the ileocolic pedicle as the transverse colon is retracted in a cephalad direction. Ample tension on this vessel is critical in distinguishing it from the superior mesenteric vessels. With traction on the ileocecal region in an anterolateral direction, the ileocolic artery will be seen “bowstringing” through the mesentery (Fig. 3-2). The right colic artery arises from the ileocolic artery to supply the hepatic flexure in 90% of patients. Since the vascular ligation will be performed proximal to the takeoff of the right colic artery, it does not need to be separately ligated in most cases. In 10% of patients, however, the right colic artery branches off of the superior mesenteric artery cephalad to the ileocolic pedicle, and in these cases the right colic artery will need separate ligation. Distal in its course, near the ileocecal junction, the ileocolic artery forms an arcade with the distal superior mesenteric artery; the ileal branch and accessory ileal branch, which can bleed if injured. Therefore, the dissection of the ileocolic artery should start in the avascular plane between the superior mesenteric vessels and the ileal branch.

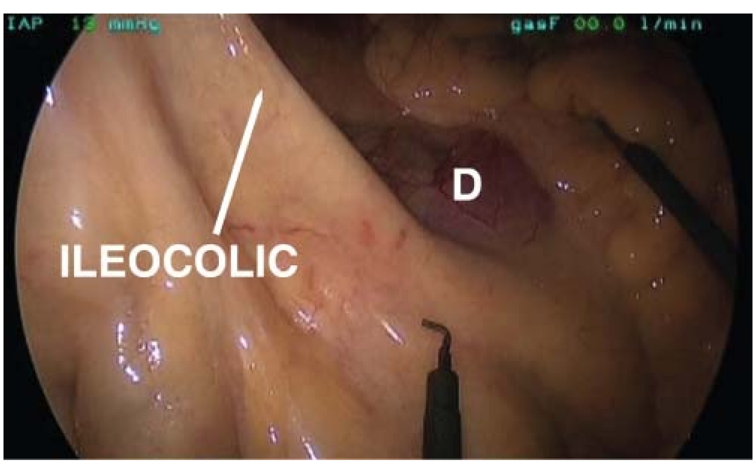


FIGURE 3-2 The ileocolic pedicle identified through the right colon mesentery. The duodenum (D)

should be identified, and the pedicle should travel clearly to the ileocecal junction.

A wide window is made in the peritoneum caudal to the ileocolic pedicle as the retroperitoneal structures are gently swept away in a posterior direction (Fig. 3-3). A mesenteric window is then made on the cephalad aspect of the ileocolic pedicle, and the pedicle is adequately isolated to allow for easy vessel division. The surgeon should clearly identify the duodenum to avoid injury (Fig. 3-4).

FIGURE 3-3 Beginning the dissection of the ileocolic pedicle in the avascular plane.

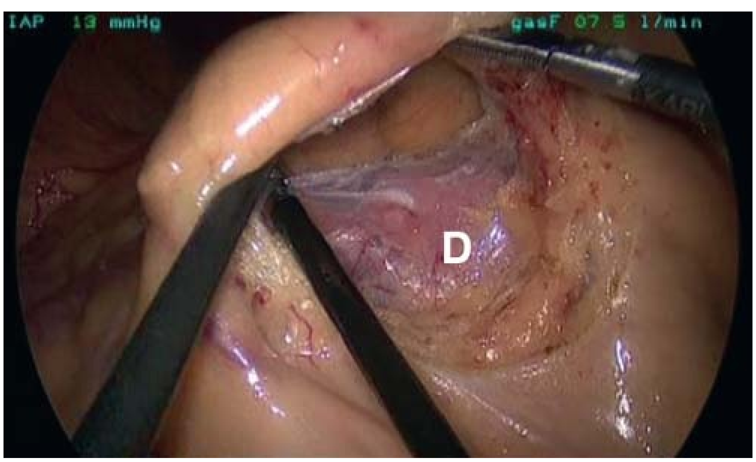


FIGURE 3-4 The dissection of the ileocolic pedicle with the duodenum preserved. D, duodenum.

The division of the ileocolic pedicle can be performed using a vessel-sealing energy device, a laparoscopic stapler, or clips. The level of division of this vessel will depend on the indication for surgery. For malignancy, this pedicle should be proximally divided so as to maximize lymph node harvest (Fig. 3-5). However, in patients with Crohn's disease where the mesentery may be thickened, the vessel is divided where it is soft, usually more proximal than distal.

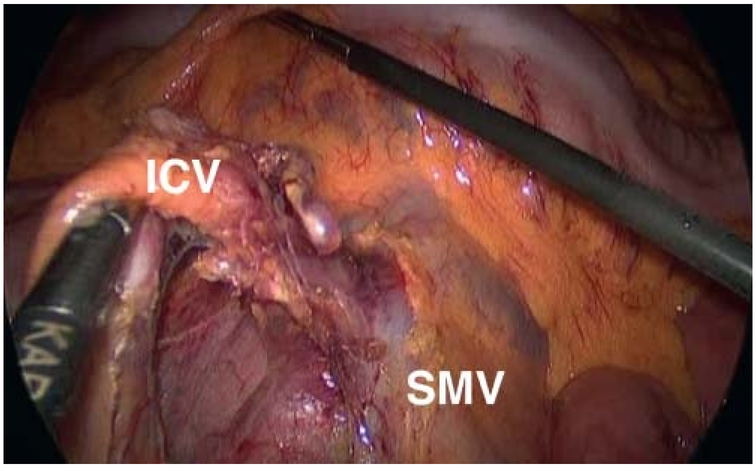


FIGURE 3-5 Proximal lymphadenectomy of the ileocolic pedicle. The ileocolic vein (ICV) is seen branching from the superior mesenteric vein (SMV), with the enlarged lymph nodes at the root of the ileocolic vessel cleared toward the specimen.

Right Branch of the Middle Colic Vessels

The next series of maneuvers will assist in the identification of the middle colic vessels. First, the previously cut leaf of peritoneum overlying the duodenum is lifted and the duodenum and head of pancreas are then swept posteriorly and separated from the right side of the middle colic vessels (Fig. 3-6).This step must be carefully and gently performed because excessive force will cause trauma to the pancreaticoduodenal or gastroepiploic vein, resulting in significant hemorrhage. This dissection is taken deeper in a cephalad direction, until the transverse colon is separated from the duodenum.

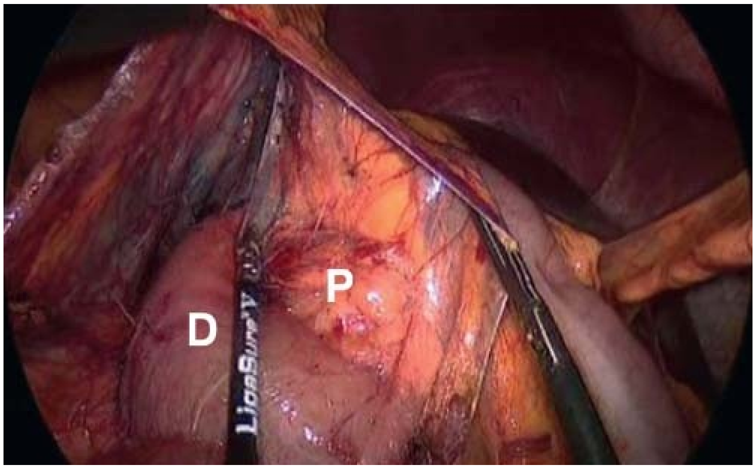


FIGURE 3-6 The duodenum (D) and head of pancreas (P) are swept away from the transverse mesocolon. Gentle blunt dissection is critical to avoid avulsion of veins at the head of the pancreas.

Once there is adequate space made to the right of the middle colic vessels, the middle colic pedicle is anteriorly lifted using two points of retraction, one to the right and one to the left of the pedicle (Fig. 3-7A,B). This maneuver is critical in the identification of the right and left branches of the middle colic vessels. The goal of the procedure is to divide the right branch of the middle colic vessels in order to harvest the lymph nodes draining the hepatic flexure and proximal transverse colon. The middle colic artery supplies the transverse colon and arises from the superior mesenteric artery at the inferior base of the pancreas. There may be one, two, or three branches off of the superior mesenteric artery, and the classic Y-shaped single trunk occurs in less than 50% of cases. An imaginary line is created from the base of the middle colic vessels toward the anticipated transaction point of the transverse colon (Fig. 3-8). The peritoneum of the transverse mesocolon is then divided along this line. The takeoff of the right branch is then identified and divided at its origin (Fig. 3-9). In addition to the middle colic vessels, one will encounter the right colic vein, located just to the right of the middle colic vessels from the head of the pancreas to the hepatic flexure. The right colic vein is isolated and divided, taking care not to injure the right gastroepiploic vein, which is its adjacent branch running on the surface of the pancreas toward the stomach (Fig. 3-10).

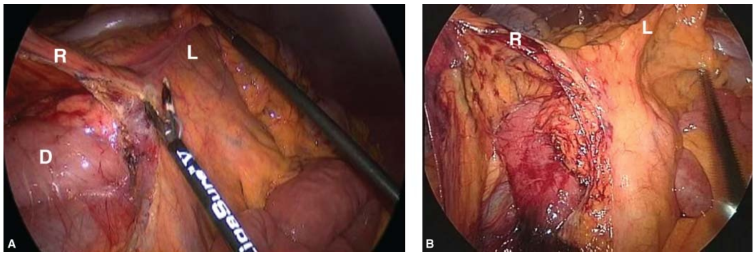


FIGURE 3-7 A,B. Two examples of the transverse mesocolon exposed. Identify the right (R) and left (L) branches of the middle colic vessels with adequate two-point retraction. D, duodenum.

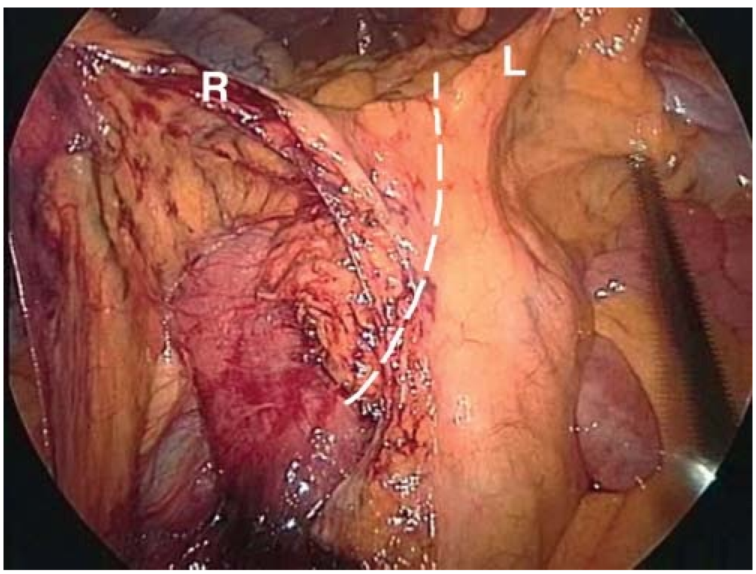


FIGURE 3-8 The dissection line to identify the origin of the right branch of the middle colic vessels (R). L, left branch.

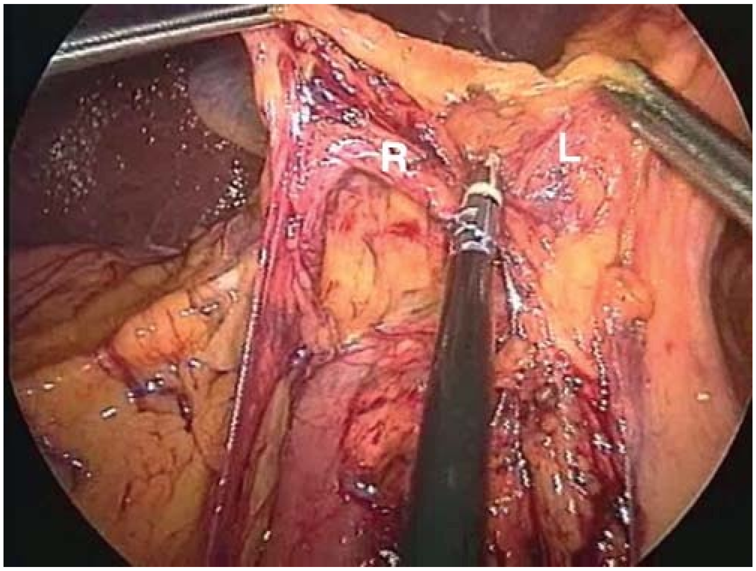


FIGURE 3-9 Division of the right branch of the middle colic artery at its origin. R, right branch, L, left branch.

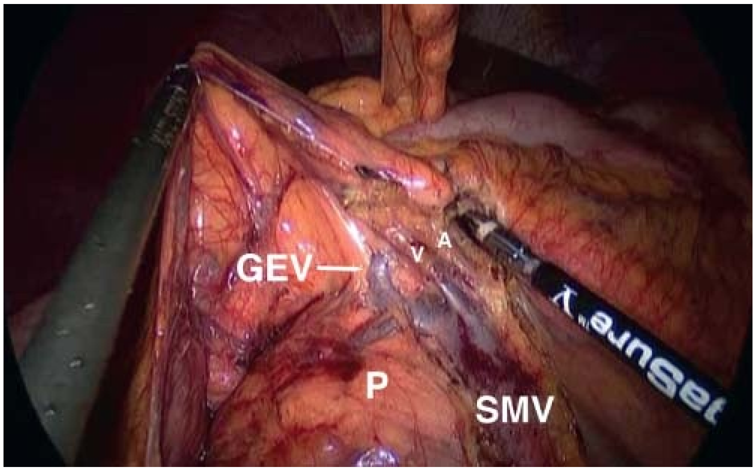


FIGURE 3-10 A high ligation of the middle colic vessels in locally advanced cancer. This anatomic variant shows an absent right colic vein, with a prominent right middle colic vein (V) that branches from the superior mesenteric vein (SMV). Running together is the right branch of the middle colic artery (A). Both will be ligated where visible. The right gastroepiploic vein (GEV) along the surface of the pancreas must be preserved. P, head of pancreas.

Retromesenteric Dissection

The right colon mesentery is then separated from the retroperitoneum in a medial-to-lateral direction. With the cut edge of the right colon mesentery anteriorly retracted, the retroperitoneal fascia, or white line of Toldt, is identified at its medial aspect, and bluntly separated from the mesentery. This plane is avascular, allowing retromesenteric dissection to be done underneath the hepatic flexure and ascending colon to the lateral abdominal wall (Fig. 3-11). This dissection should not be carried too dorsally, into or underneath Gerota's fascia. The true retroperitoneal plane is most easily detected near the duodenum, which should be the starting point for the retromesenteric dissection. This medial-to-lateral dissection leaves the hepatic flexure and a thin lateral ligament of the ascending colon as a natural retractor, keeping the floppy right colon in place.

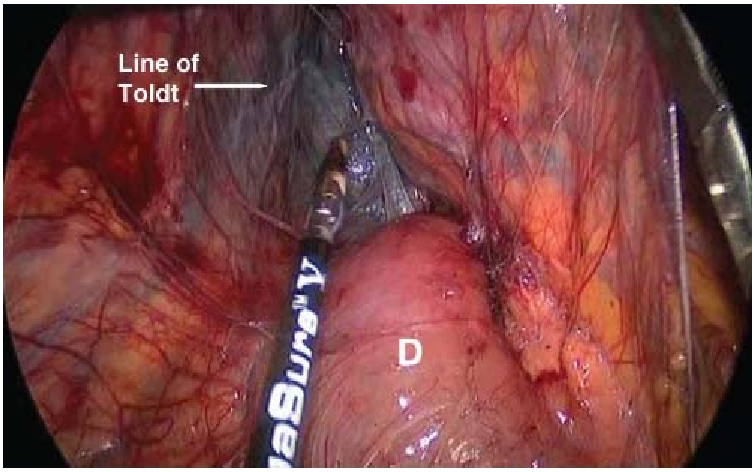


FIGURE 3-11 Medial-to-lateral retromesenteric dissection. The white line of Toldt is seen from the medial aspect, as this is bluntly separated from the right colon mesentery. A tattoo stains the region of dissection. D, duodenum.

Superior and Lateral Dissection

At the level of the falciform ligament, the gastrocolic ligament is opened. As the transverse colon is interiorly retracted, the lesser sac is dissected, and the congenital adhesions of the posterior omental leaf and the transverse mesocolon are undone. Adequate traction and tissue triangulation are necessary to identify the correct plane of dissection. Avoiding injury to the right gastroepiploic vessels, the previously dissected retromesenteric plane from the medial approach is then identified. With the transverse colon inferiorly retracted, from left to right, the hepatic flexure is liberated (Fig. 3-12). The lateral ligament of the ascending colon is divided superiorly to inferiorly, as the dissected colon is retracted into the pelvis, until the right psoas muscle and right iliac vessels are identified (Fig. 3-13). The retroperitoneal fascia is preserved, as the mesentery of the ileocecal region is widely dissected off of the retroperitoneum. It is often possible to identify the right ureter during this dissection, and this structure should be maintained underneath an intact retroperitoneal fascia if the dissection is properly performed.

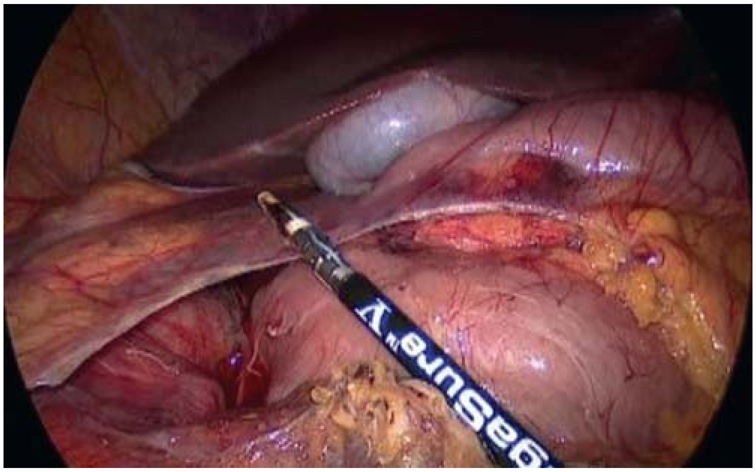


FIGURE 3-12 Takedown of the hepatic flexure from superiorly. The transverse colon is retracted inferiorly.

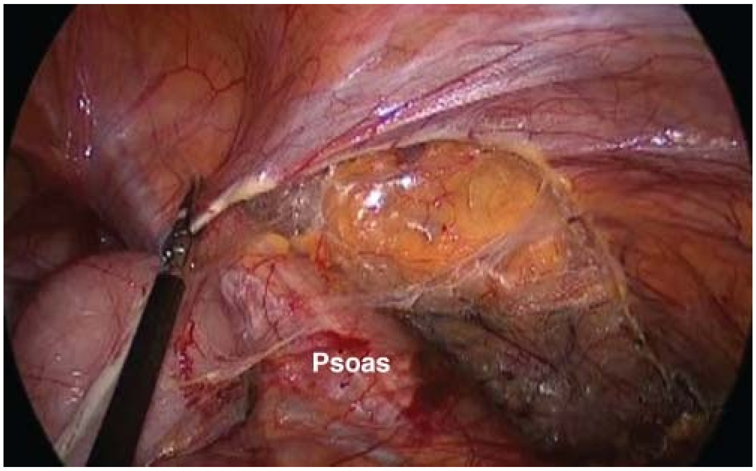


FIGURE 3-13 The lateral ligament of the right colon is dissected until the right colon is mobilized past the right psoas muscle.

Inferior Dissection

The final elements of the dissection are the ileal attachments to the retroperitoneum. The patient is then placed in a steep Trendelenburg position, as the dissected right colon is placed back into its original position. The small bowel loops in the pelvis are completely retracted in a cephalad direction (Fig. 3-14). With the distal ileum anteriorly and superiorly retracted, the ileal attachments to the retroperitoneum are released. Strong but gentle traction is needed to retract the tissues away from the right iliac vessels and to avoid injury to the right ureter. This dissection proceeds laterally around the appendix and cecum, meeting the previous superior dissection (Fig. 3-15). The medial extent of this ileal mobilization is the right iliac vessel; this level will assure adequate reach of the small bowel to the transverse colon for anastomosis.

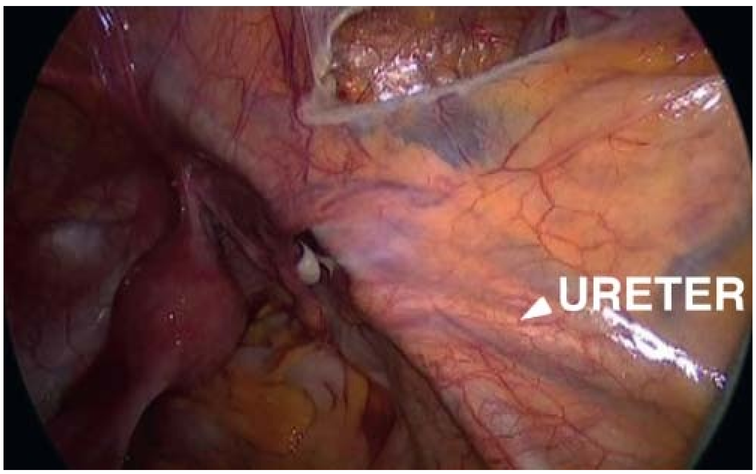


FIGURE 3-14 The ileum is retracted strongly in a superior direction to expose the mesenteric attachments to the retroperitoneum. The right ureter is visualized. Retract the small bowel out of the pelvis as much as possible.

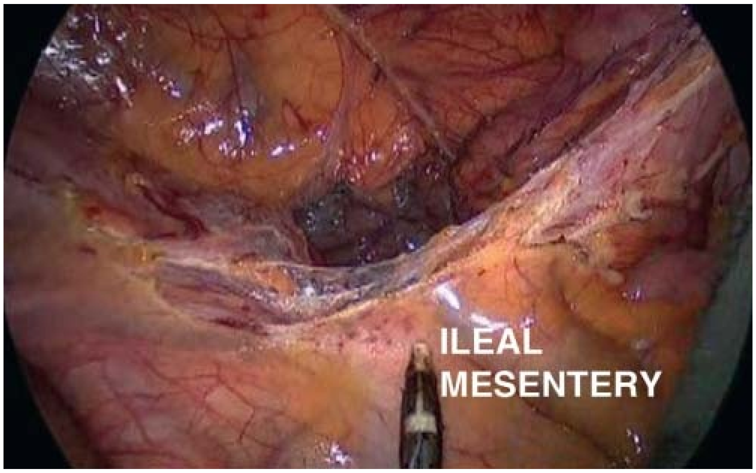


FIGURE 3-15 The ileal attachments to the retroperitoneum are divided, connecting with the dissection from superiorly. Continue this mobilization over the right iliac vessels.

Exteriorization, Bowel Division, and Anastomosis

After the intracorporeal dissection is complete, the right colon is ready for exteriorization, bowel transection, and extracorporeal anastomosis. Using a locking bowel grasper through the left lower abdominal port, the fat of the ileocecal region is grasped for identification through the small incision.

Before making the incision, one must ensure adequate reach of the mid transverse colon to the proposed incision site; if not, one risks an unnecessarily difficult anastomosis, or undue tension and tearing of the middle colic vessels. This incision is usually periumbilical, and extending the camera port incision around the umbilicus for 3–5 cm is generally adequate; however, the incision may need to be larger in obese patients and/or patients with large tumors (Fig. 3-16).

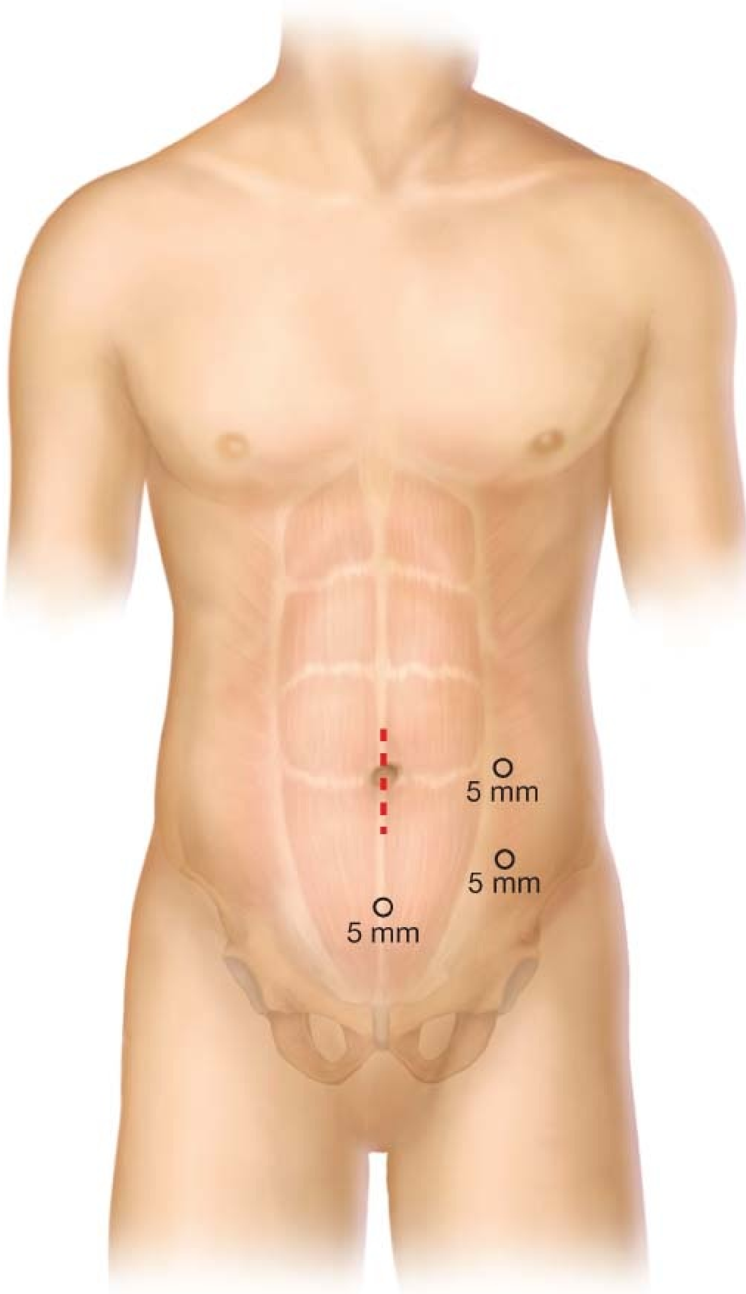


FIGURE 3-16 For the exteriorization of the specimen, a mini-laparotomy is usually created as a superior extension of a vertically placed infraumbilical port wound.

A wound retractor is placed to avoid a port site recurrence in cases of malignancy. The grasped ileocecal region is brought into view through the small incision, and the dissected right colon is exteriorized and placed in its native configuration (Fig. 3-17). The remainder of the ileal mesentery and marginal artery of the transverse colon are dissected toward the bowel wall. The bowel is divided and an ileocolic anastomosis is created. The type of anastomosis depends on surgeon preference: hand-sewn, stapled functional end-to end, or stapled end-to-side (Fig. 3-18).

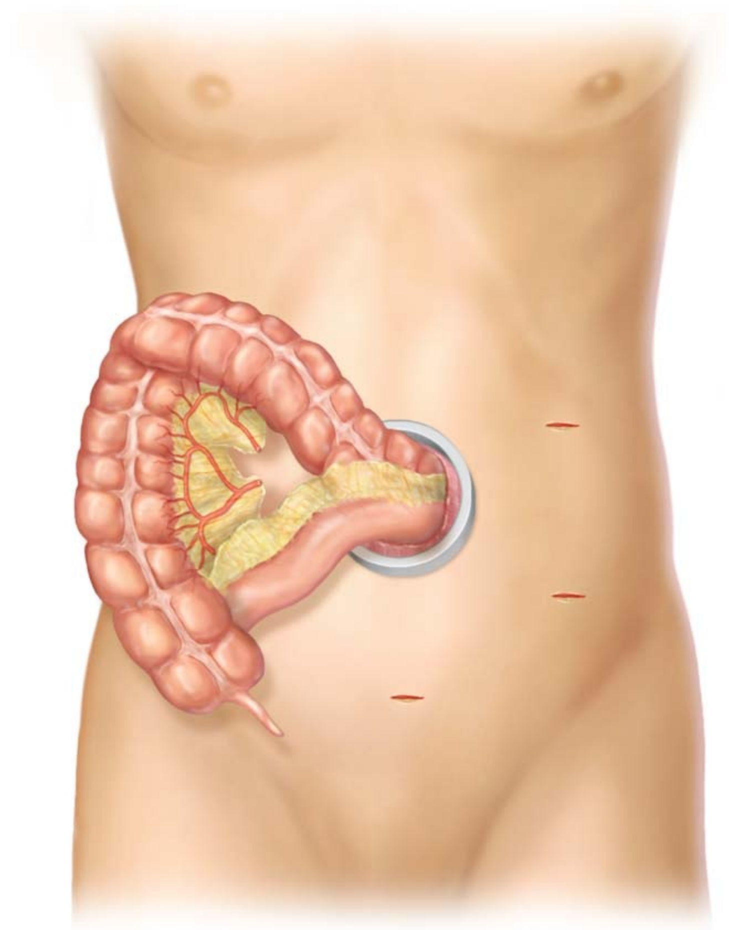


FIGURE 3-17 The exteriorized right colon laid out anatomically, ready for division and anastomosis.

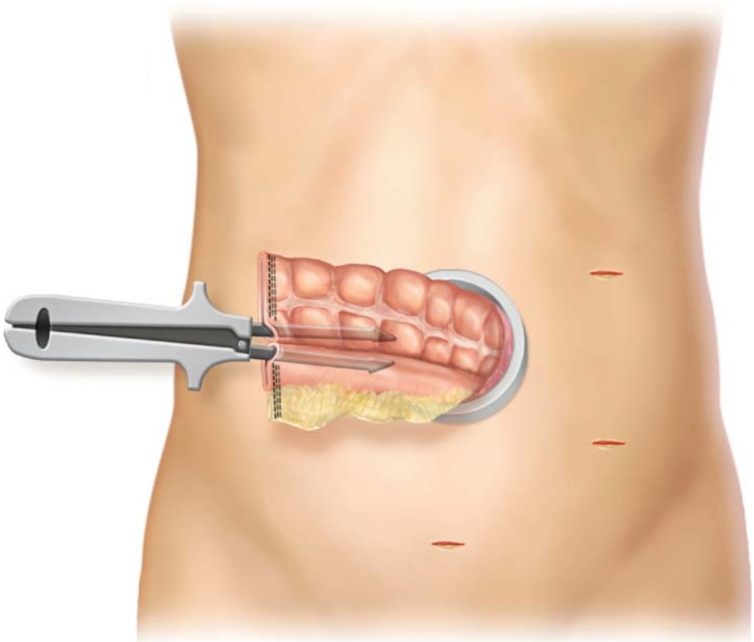


FIGURE 3-18 A functional end-to-end anastomosis. It is critical to keep the ileum from twisting 360 degrees around its mesentery.

After the anastomosis is intracorporeally reduced/returned, the fascia of the mini-laparotomy is closed. We routinely retain the ports during fascial closure, and then reinsufflate the abdomen for a “final look” after the mini-laparotomy is closed. This step assures hemostasis, no twisting of the anastomosis, and no migration of the small bowel into the mesenteric defect.

Common Pitfalls and Solutions

Difficulty in Identifying the Ileocolic Pedicle

The ileocolic artery exists in 100% of anatomic specimens, and always courses distal to the duodenum to the ileocecal area. The duodenal sweep must be identified through the thinned area of the transverse mesocolon. There is occasionally a congenital fusion of the transverse mesocolon and the right colon mesentery that needs to be first released. In obese patients, the amount of fat may obscure visualization of the duodenum. If the duodenum is hidden underneath thick fat, start the dissection of the ileocolic pedicle superior to it, and identify the duodenum. The ileocecal region must be placed on enough tension to tent up the pedicle through the thick mesenteric fat. For persistent difficulty, an inferior approach with the patient in a steep Trendelenburg position and the entire small bowel superiorly retracted may be useful. Underneath the ileal mesentery close to the midline, the duodenum should become visible, and from there dissect the ileal mesentery off of the retroperitoneum. The ileocolic pedicle will be freed from its attachment to the retroperitoneum with this maneuver, and should be identified readily from the medial approach.

Difficulty in the Dissection of the Middle Colic Vessels

The middle colic vessels need to be retracted away from the retroperitoneal structures using two points of retraction, as vertically as possible. Imagining a "Y" configuration of the middle colic vessels in one's mind is important. However, due to obesity or short length of the middle colic vessels, this medial approach may be difficult. A superior approach should then be undertaken. With the transverse colon retracted inferiorly, the gastrocolic ligament is opened, and the transverse mesocolon should be dissected free from the posterior leaf of the omentum. The right middle colic branch can then be identified and divided from the dorsal side of the transverse mesocolon, or the transverse colon can be placed back into its original position and a medial approach taken. By freeing the posterior (or dorsal) attachments of the middle colic vessels, the vessels are effectively elongated, allowing the right branch to be more readily identified. If this approach still is not adequate, use the "open book" method. The mid transverse colon is first divided using an intracorporeal stapler, and the transverse mesocolon is then divided in a central direction toward the bifurcation of the middle colic vessels as the two ends of the colon are separated.

Poor Reach of the Transverse Colon to the Umbilicus

This occurs most commonly in obesity, where the transverse mesocolon can be short. The options here are to take the dissection of the transverse colon further to the left to increase its reach, or to make a mini-laparotomy in the epigastric area close to the distal transection point of the transverse colon. It is simpler to alter the placement of the small incision to a more cephalad site.

Anastomotic Twisting and Mesenteric Hernia

After the ileal mesentery and ileum are divided, the ileum can be inadvertently twisted 360 degrees during the transverse colon division. Avoid any confusion by placing two stay sutures, one at the end of the ileum and one proximal to it, with the sutures clamped and separated. With this maneuver, it is even possible to place the ileum back into the abdomen without losing its correct orientation in cases where the transverse colon does not exteriorize well through the mini-laparotomy.

It is generally not necessary to close the mesenteric defect after a right hemicolectomy. Perhaps because the defect is large, it is uncommon that a mesenteric hernia develops resulting in incarceration; over time, this defect closes by reperitonealization. In a recent retrospective study of 530 patients, the incidence of complications associated with an unclosed mesenteric defect was 0.8%. By reinsufflating the abdomen after the anastomosis is completed, one can assess for any mesenteric twisting and/or small bowel herniation into the mesenteric defect.

POSTOPERATIVE MANAGEMENT

Postoperatively, patients are managed using an accelerated care pathway (ERAS pathway). Important ERAS elements include preoperative education, setting of expectations, limitation of surgical stress including minimally invasive surgery, early enteral feeding, early ambulation, judicious intravenous fluid resuscitation, aggressive postoperative nausea/vomiting prophylaxis, and opiate-sparing analgesia, with or without a peripheral μ-opioid antagonist.

The establishment of a meaningful and successful ERAS program is actually quite challenging and requires the dedicated coordination of a multitude of disciplines, including the surgical team, anesthesia team, pain management team, outpatient nurses, perioperative services, recovery room nurses, inpatient nurses, dietitian, pharmacy, and institutional leadership. When patients are compliant with pre-, intra-, and postoperative ERAS elements, discharge of patients on postoperative day (POD) 2 or 3 after elective colectomy becomes possible.

If utilized, the orogastric/nasogastric tube should be removed at the time of extubation. Urinary catheters should be removed within 24 hours of surgery. A clear liquid diet is started ad lib on the first POD, and patients are advanced to a transitional or solid diet on POD 2 in the absence of significant nausea or distension. Postoperative maintenance fluids are given judiciously (e.g., 1 ml/kg/hr), and stopped even on POD 1 if possible. Aggressive narcotic-sparing analgesia (which is actually started preoperatively) is continued, with the around-the-clock use of acetaminophen, gabapentin, and NSAIDs such as ketorolac (if without contraindications). Patients are discharged home when tolerating an oral diet, and having some return of bowel function (flatus or bowel movement) without significant nausea or distension, abdominal pain, or fever.

COMPLICATIONS

A 2009 comparison of laparoscopic and open colectomy of 8,660 patients utilizing the ACS NSQIP program showed that the use of laparoscopy decreased the incidence of risk-adjusted complications compared to open surgery. The overall complication rate for patients undergoing laparoscopic ileocolectomy was 15% compared with 24% for open ileocolectomy ($P < 0.05\%$). The rates of specific complications after laparoscopic ileocolectomy were sepsis (4–5%), wound complications (8%), cardiopulmonary complications (3%), vascular complications (1.5%), and neurologic/renal complications (3–4%).

RESULTS

There is variation in recovery after laparoscopic right colectomy according to the perioperative care pathway utilized and the criteria for discharge. In 2010, a prospective multicenter observational study of 148 patients was performed to determine the “benchmark” of recovery when patients undergoing laparoscopic right and left colectomy are managed with a standardized accelerated care pathway. The results specific to laparoscopic right colectomy were as follows: a conversion rate of 15%, mean time to gastrointestinal recovery as defined by passing stool and tolerating solid food of 4.2 days, and mean time to discharge order written of 4.5 days. Prolonged postoperative ileus occurred in 10.1% of patients, with 4.7% requiring a nasogastric tube. The readmission rate was 2%.

More recent modifications in ERAS pathways have further improved upon postoperative recovery by the incorporation of aggressive nonnarcotic analgesia, further limitations on intravenous fluids, and aggressive management of postoperative nausea/vomiting. A recent Mayo clinic report of patients (*n* = 541) undergoing laparoscopic colorectal surgery managed with such an ERAS pathway demonstrated a median length of stay of 3 days (interquartile range 2–5 days) after laparoscopic bowel resection, with 25.9% of patients discharged within 48 hours.

Laparoscopic surgery for malignancy is oncologically safe. Multi-institutional randomized controlled trials have demonstrated equivalency between the laparoscopic and open approaches for colon cancer. These include the Clinical Outcomes of Surgical Therapy Study Group (COST) trial (*n* = 872), European COlon cancer Laparoscopic or Open Resection (COLOR) trial (*n* = 1,076), and the UK Medical Research Council (CLASICC) trial (*n* = 794).

CONCLUSION

The medial-to-lateral laparoscopic right hemicolectomy allows for high-quality oncologic surgery, including early high ligation of mesenteric vessels. The lateral attachments act as an excellent natural bowel retractor, facilitating this approach. The surgical exposure is somewhat reversed compared with open surgery, where a lateral-to-medial mobilization is usually performed. Thus, surgeons will need to be familiar with the vascular anatomy and their relationship to the retroperitoneal structures to perform a safe operation. However, even for those beginning to learn laparoscopic colectomy, this operation will likely be one of the first to be attempted and learned. When patients are managed with a multidisciplinary and comprehensive ERAS pathway, discharge from the hospital within 48–72 hours becomes possible.

RECOMMENDED REFERENCES AND READINGS

Belimoria KY, Bentrem DJ, Merkow RP, *et al.* Laparoscopic-assisted vs. open colectomy for cancer: comparison of short-term outcomes from 121 hospitals. *J Gastrointest Surg* 2008;12:2001–9.

Cabot JC, Lee SA, Yoo J, Nasar A, Whelan RL, Feingold DL. Long-term consequences of not closing the mesenteric defect after laparoscopic right colectomy. *Dis Colon Rectum* 2010;53:289–92.

Clinical Outcomes of Surgery Therapy Study Group. A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med* 2004;350:2050–59.

Colon Cancer Laparoscopic or Open Resection Study Group. Survival after laparoscopic surgery versus open surgery for colon cancer: long term outcome of a randomized clinical trial. *Lancet Oncol* 2009;10:44–52.

Delaney CP, Marcello PW, Sonoda T, Wise P, Bauer J, Techner L. Gastrointestinal recovery after laparoscopic colectomy: results of a prospective, observational, multicenter study. *Surg Endosc* 2010;24:653–61.

Green BL, Marshall HC, Collison F, *et al.* Long-term follow up of the Medical Research Council CLASICC trial of conventional versus laparoscopically assisted resection in colorectal cancer. *Br J Surg* 2013;100:75–82.

Kennedy GD, Heise C, Rajamanickam V, Harms B, Foley EF. Laparoscopy decreases postoperative complication rates after abdominal colectomy: results from the National Surgical Quality Improvement Program. *Ann Surg* 2009;249:596–601.

Larson DW, Lovely JK, Cima RR, *et al.* Outcomes after implementation of multimodal standard care pathway for laparoscopic colorectal surgery. *Br J Surg* 2014;101:1023–30.

Liang JT, Lai HS, Lee PH. Laparoscopic medial-to-lateral approach for the curative resection of right-sided colon cancer. *Ann Surg Oncol* 2007;14:1878–9.

Slim K, Vicaut E, Launay-Savary MV, Contant C, Chipponi J. Updated systematic review and meta-analysis of randomized clinical trials on the role of mechanical bowel preparation before colorectal surgery. *Ann Surg* 2009;249:203–9.

Chapter 4

Laparoscopic Lateral-to-Medial Right Colectomy

Joshua H. Wolf and Ido Mizrahi

INDICATIONS/CONTRAINDICATIONS

The indications for performing a laparoscopic right colectomy can be divided into three groups:

Neoplasia

Endoscopically unresectable colonic polyps: Despite recent endoscopic innovations such as endoscopic mucosal resection (EMR) and endoscopic submucosal dissection (ESD), some colonic lesions are still found to be unresectable and necessitate colectomy.

Colonic/appendiceal cancer: Tumors in the appendix, cecum, ascending colon, or hepatic flexure are the most common indications for performing a right colectomy. Tumors in the transverse colon more commonly require an extended right colectomy.

Carcinoid: When this neuroendocrine tumor is found in the appendix, terminal ileum, or cecum, a right colectomy is needed.

Inflammation

Crohn's disease: Patients with Crohn's disease may present with inflammatory, fistulizing, or stricturing disease. These operations are typically more technically demanding than surgery for cancer. Intraoperative findings such as a large inflammatory mass, interloop abscesses, and fistulas to the sigmoid colon may pose technical difficulty and ultimately lead to conversion to open surgery. Strictures may be missed because of limited tactile sensation and the surgeon should consider extracorporeal palpation.

Right colonic diverticulitis (RCD): Although RCD has been reported to be a rare disease in Western countries, it is very common in East Asia and specifically in Korea, with an incidence of 1 case per every 2.9–17 cases of appendicitis. RCD is especially common among males in their relatively early years.

Other Indications

Ischemia: When ischemia is preoperatively suspected, the entire small and large bowel should be carefully inspected. Such cases are typically addressed with a laparotomy.

Pneumatosis intestinalis: When correlating with other clinical signs of nonviable bowel, pneumatosis intestinalis requires immediate surgery with resection of the affected section of the colon.

Iatrogenic perforation: The incidence of colon perforation during diagnostic and therapeutic colonoscopy ranges between 0.07% and 0.1%. The risk increases to 0.2% after EMR and is as high as 5% after ESD. It is reasonable to schedule an ESD in the operating room followed by surgery if the ESD has failed.

Cecal volvulus: This is a rare cause of intestinal obstruction caused by excessive mobility of the cecum.

Hemorrhage: Segmental colectomy for lower gastrointestinal hemorrhage is unusual because the bleeding source is difficult to localize. However, a right colectomy can be warranted if an arteriovenous malformation or other bleeding pathology is definitively localized to the right colon.

Incidental finding during laparoscopy for other etiologies: mass, ischemia.

There are no clear absolute contraindications for use of laparoscopy in performing right colectomy. Relative contraindications include the following:

Large mass requiring an incision for extraction

Adhesions from prior abdominal surgery

Limited surgeon’s experience

PREOPERATIVE PLANNING

Proper preoperative patient evaluation focusing on relevant history is crucial to help realize satisfactory surgical outcomes. Close attention should be given to factors that may alter surgical planning.

History and Physical Examination

Comorbidities: Attention should be given to connective tissue diseases and rheumatologic disorders requiring steroid treatment as these may impair anastomotic healing.

Medications

a. *Steroids:* The type, dosage, duration, and time of last dose should be clearly documented. Some patients may need a perioperative stress dose and a diverting loop ileostomy depending on tissue fragility.

b. *Biologics*: As for steroids, the type, dosage, duration, and time of last dose should be clearly documented. It is controversial whether a period of waiting before operating is necessary. It has been suggested to wait approximately 4–6 weeks between the last dose of biologic therapy and surgery.

c. *Chemotherapy:* Although neoadjuvant chemotherapy is not standard of care for colon cancer, some patients with metastatic disease may require neoadjuvant chemotherapy and surgery should be delayed approximately 4 weeks after the completion of treatment.

Previous surgery: All previous operative reports should be closely reviewed, with specific attention to the remaining length of bowel, type of anastomosis, and postoperative complications.

Family history: Family history should be reviewed for colitis, colorectal cancer, and any other relevant cancers that may suggest genetic predisposition to colon cancer.

Pathology: It is highly advisable to review the pathology slides at your own institution with a dedicated gastrointestinal pathologist if possible, specifically for patients with inflammatory bowel disease (IBD) or following resection of a malignant polyp.

Colonoscopy: Colonoscopy reports should be reviewed preoperatively and available at the time of the surgery. Findings should be discussed with the performing endoscopist. Tattooing should be done with India ink in multiple quadrants distal to the tumor to assure that the tattoo is visible on the serosal surface and not hidden by the mesentery. Make sure other areas have not been previously inked to minimize confusion at the time of surgery. When suspecting IBD, it is advised to take multiple biopsies of normal-appearing colon.

Physical examination: During the physical examination, the surgeon should be especially attentive to prior incisions, previous stoma sites, hernias, masses, lymph nodes, and body habitus with a calculated body mass index.

Labs/Imaging

Routine testing: Complete blood count and a comprehensive metabolic panel are routinely ordered. Coagulation studies should be ordered if indicated.

Cancer related: Baseline carcinoembryonic antigen (CEA) should be taken before surgery.

Nutritional status: Albumin and pre-albumin should be tested to assess the patient's nutritional status. Preoperative enteral or parenteral nutritional support should be considered in clinically malnourished patients.

Imaging: Computed tomography (CT) of the chest, abdomen, and pelvis with oral and intravenous contrast are mandatory for cancer patients. Prior imaging should be reviewed with a specialized abdominal radiologist with specific attention to the location of the lesion, involvement of lymph nodes, vascular and urinary abnormalities, and metastasis to other organs. Patients with IBD are better evaluated with CT or magnetic resonance enterography.

Selecting a Surgery: Lateral Approach or Medial Approach?

There is essentially no difference in surgical outcomes between the two approaches, as is reviewed in a later section of this chapter. Hence, the surgeon should choose the most familiar and comfortable approach based on prior training and experience. There are, however, some inherent advantages and disadvantages of each method. The advantages of the lateral approach (LA) are (1) early identification of key structures such as the right ureter and duodenum and (2) use of the same dissection as in the open technique. The advantages of the medial approach (MA) are (1) early ligation of the vascular ileocolic pedicle, theoretically preventing liberation of tumor cells into mesenteric circulation and (2) the preservation of the lateral colonic ligament until the end of the mobilization, which helps with right colon retraction and exposure. MA may not be feasible under conditions in which the right colon mesentery is fixed to the retroperitoneum, for example, in cases with significant malignant adenopathy involving the ileocolic pedicle or extremely thickened mesentery due to Crohn's disease or morbid obesity.

Mechanical Bowel Preparation with Oral Antibiotics

The role of mechanical bowel preparation (MBP) with oral antibiotics remains controversial. Some authors have shown no advantage, whereas others have shown that MBP with oral antibiotics reduces the rates of anastomotic leak, surgical site infection, and postoperative ileus. The authors advocate for routine use of MBP with oral antibiotics not only for the reasons mentioned but also for other technical reasons. The ability to "palpate" the bowel with laparoscopic instruments is limited without preparation. Furthermore, it is practically impossible to perform an intraoperative colonoscopy, if need be, without preparation. Lastly, if proximal diversion is unexpectedly required, MBP ensures that the remnant colon will be evacuated and clean rather than full of stool.

PREOPERATIVE COUNSELING

It is important to set realistic expectations with the patient regarding the length of the operation (approximately 2–3 hours), length of hospital stay (typically 2–3 days), recovery time (very individual, but approximately 1–2 weeks), and future bowel function, which should not be significantly altered in right colectomy. The authors counsel all patients regarding the possibility of a diverting ostomy, and practice bilateral stoma marking for all patients scheduled for an elective colectomy. Some may prefer to mark only patients at high risk for diversion, reducing workload from enterostomal therapists and anxiety from patients.

For certain patients, prophylactic cystoscopy and ureteric stents should be discussed as well. Although indications are not clearly defined, stents are generally used for reoperative cases, large tumors, previous radiation therapy (less relevant for a right colectomy), diverticulitis, fistulas, Crohn’s disease, and obesity.

SURGERY

Positioning

Secure patient positioning is essential for a successful laparoscopic right colectomy, which requires rotation of the surgical bed to several extreme angles. Foam padding must be carefully placed to avoid pressure injury, especially in obese patients. Appropriate time and focus should be dedicated to this portion of the case and the participating staff, including nursing and anesthesiology staff, should be oriented in advance. Before the patient enters the room, a gel pad/beanbag is placed on the operating table to avoid patient slippage during extreme tilt. The patient is placed on the pad and induced/intubated by anesthesiology. Lines and tubes are inserted, including any necessary arterial or venous catheters, an orogastric tube, a Foley catheter and, when relevant (as discussed earlier), ureteral stents. The legs are wrapped with knee-length sequential compression device sleeves and placed in Allen stirrups for modified lithotomy positioning, with extra padding inserted behind the leg. Both arms are secured at the sides by placing the beanbag to suction, and gauze padding is used to protect the skin from any lines or tubing. Foam and tape are placed across the chest to secure the upper body to the bed and shoulder rests are placed on a padded support that is secured to the table.

Modified lithotomy positioning is preferred by the authors over supine because of several distinct advantages. First, it allows the operating surgeon to stand between the patient's legs, offering a useful vantage for mobilizing the hepatic flexure. Second, it maintains the accessibility for intraoperative colonoscopy, which may be required to clarify unexpected findings, including polyps, fistulae, and diverticular disease. Intraoperative colonoscopy can also be used to help select an appropriate resection margin.

After positioning and securing the patient, it is important to test the bed in the various positions that will be used in the operation to reinforce any obvious areas of instability. Overhead lighting should be brought over the patient and laparoscopic monitors should be placed at the head of the patient and on the patient's right side. The patient's abdomen is then prepped with a betadine or chlorhexidine solution and draped in a standard manner. Cords for the light source, camera, suction, energy device, and Bovie cautery are bundled and secured on the side of the patient adjacent to the laparoscopic tower. A schematic of the room setup is shown in Figure 4-1.

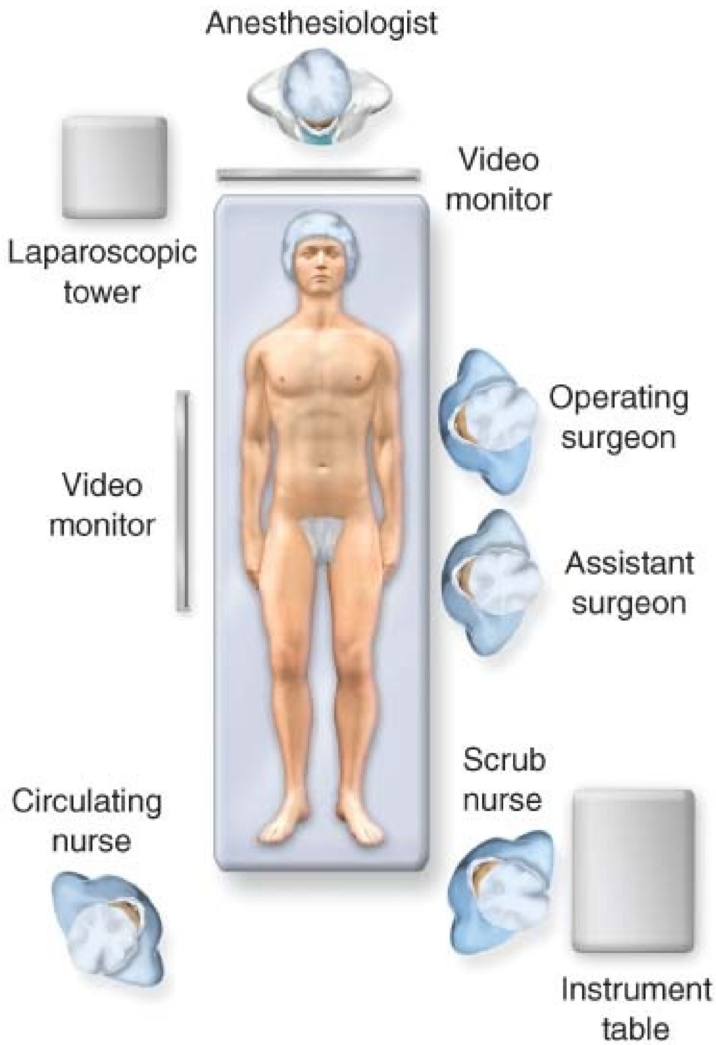


FIGURE 4-1 Arrangement of equipment and personnel. Numbers correspond to various components of the room setup: (1) anesthesiologist; (2) operating surgeon; (3) assistant surgeon; (4) scrub nurse; (5) circulating nurse; (6) OR table/patient; (7) instrument table; (8 and 9) video monitors; (10) laparoscopic tower. OR, operating room. The patient will be in the lithotomy position after endotracheal intubation.

Technique

The operative technique is divided into five stages:

Entry/exploration

Mobilization of right colon

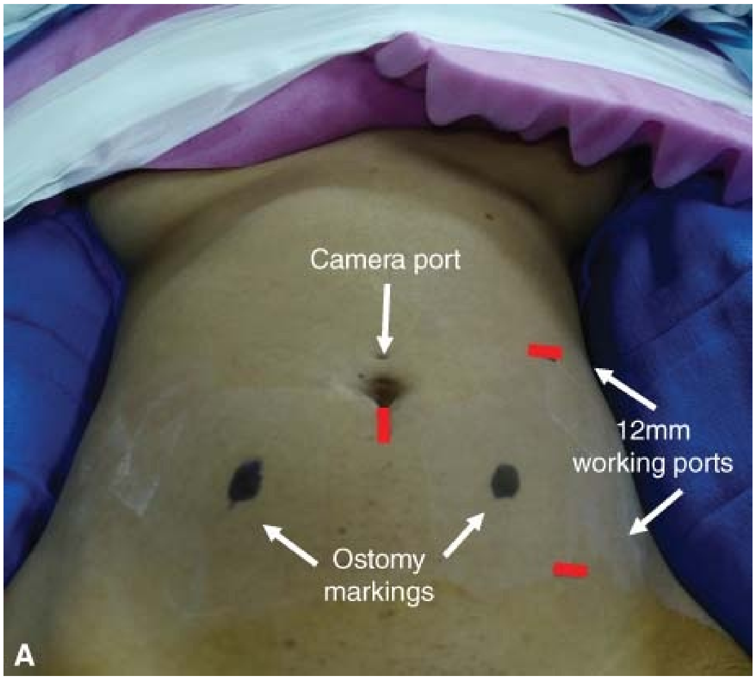
Mesenteric dissection and vessel ligation

Resection and anastomosis

Closure

Entry/Exploration

Optimal port placement is shown in Figure 4-2. Open Hasson technique is performed through an infraumbilical incision to insert a blunt 12-mm trocar as the camera port. In mid-transverse lesions or obese patients, a supra-umbilical incision can be used. After insertion, the abdomen is insufflated to a pressure of 15 mm Hg with careful attention to the patient's hemodynamics. A 30-degree angled laparoscope is placed and the abdominal cavity is inspected for any signs of traumatic port placement. Two additional left abdominal ports are inserted under direct vision. The left lower quadrant (LLQ) port is placed 2 cm medial and 2 cm superior to the anterior superior iliac spine. For proper triangulation, the LUQ port is placed a full hand-breath cephalad to the LLQ insertion site. It may be helpful to rotate the patient to the right to allow the small bowel and sigmoid to fall away from the area directly beneath the port insertion. If needed, additional ports may be placed in the suprapubic or epigastric positions. The authors prefer a uniform port size of 12 mm to allow for use of 10-mm energy devices and staplers.



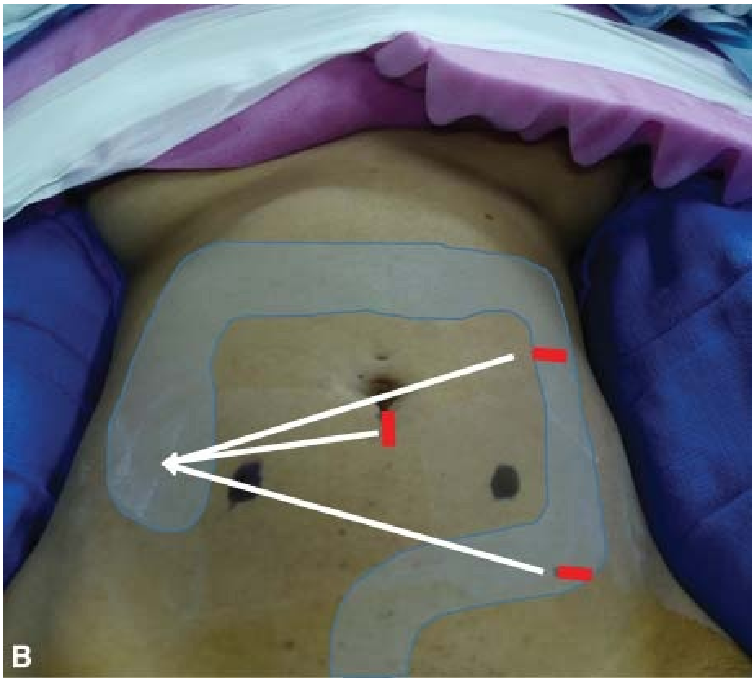


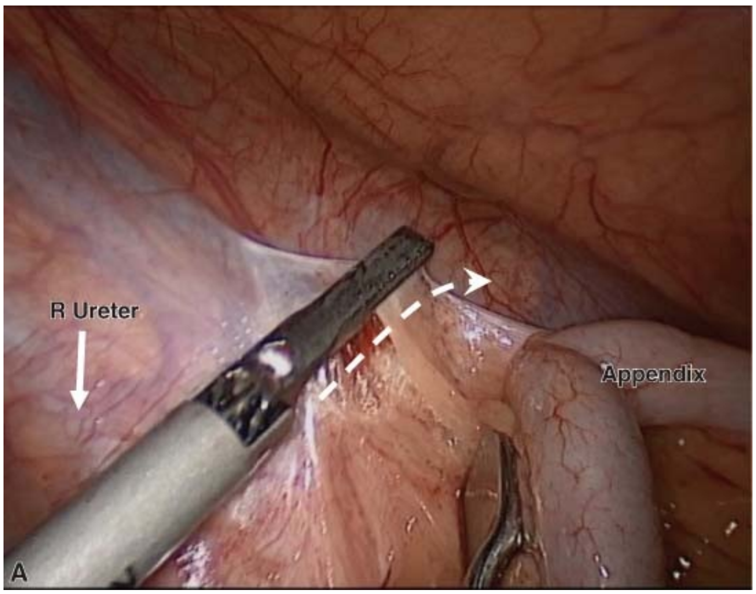
FIGURE 4-2 Port sites and triangulation. The standard port sites for laparoscopic right colectomy are shown. A camera port is inserted through an infraumbilical incision that will later be enlarged for specimen extraction, and two 12-mm working ports are inserted in the left abdomen (A). This arrangement allows triangulation to the right lower quadrant (B). Red line, port site; black circle, ostomy marking.

Once the two working ports are inserted, both the assistant and the operating surgeon move to the patient's left side. Before mobilizing the colon, the patient's abdomen is carefully explored for any evidence of malignant or metastatic disease on the peritoneal surfaces, on the liver, or on the small bowel. Suspicious lesions are biopsied and sent for frozen pathology.

Mobilization of the Right Colon

The table is repositioned in Trendelenburg and rotated to the left. The assistant is positioned to the right of the operating surgeon. Two bowel graspers are placed through the working ports and used to sweep the small bowel out of the right iliac fossa and expose the ileocolic angle. With anteromedial traction on the cecum, a harmonic scalpel is used to incise the peritoneum laterally and to advance the dissection plane cephalad along the white line of Toldt (Fig. 4-3).

The right ureter is identified early at the level of the pelvic brim as it crosses the iliac bifurcation (Fig. 4-4). As the colon is mobilized off the lateral abdominal wall, two landmarks must be properly identified: First, the plane between the colonic mesentery and Gerota's fascia should be visualized and used to guide the dissection toward the flexure. Failure to find this plane will result in medial rotation of the right kidney and risk a high ureteral injury. Second, the duodenum should be recognized and exposed as the colon is rotated medially. The lateral surface of the colonic mesentery is dissected from the duodenum for complete mobilization (Fig. 4-5).



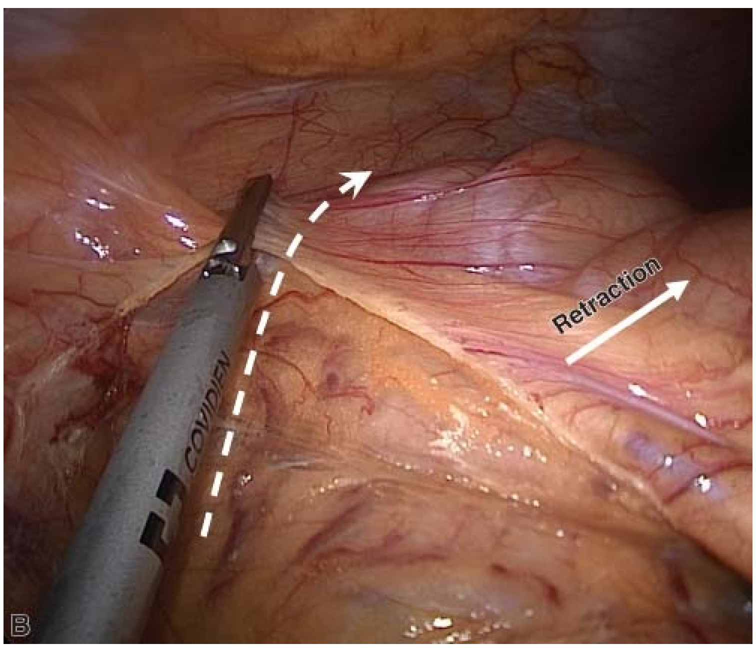


FIGURE 4-3 Lateral dissection along the white line of Toldt. The first step of colonic mobilization requires exposure of the ileocolic angle, retraction of the colon anteromedially and incising the white line of Toldt lateral to the cecum (A). This incision is carried cephalad toward the hepatic flexure, as indicated by the dashed white line (B).

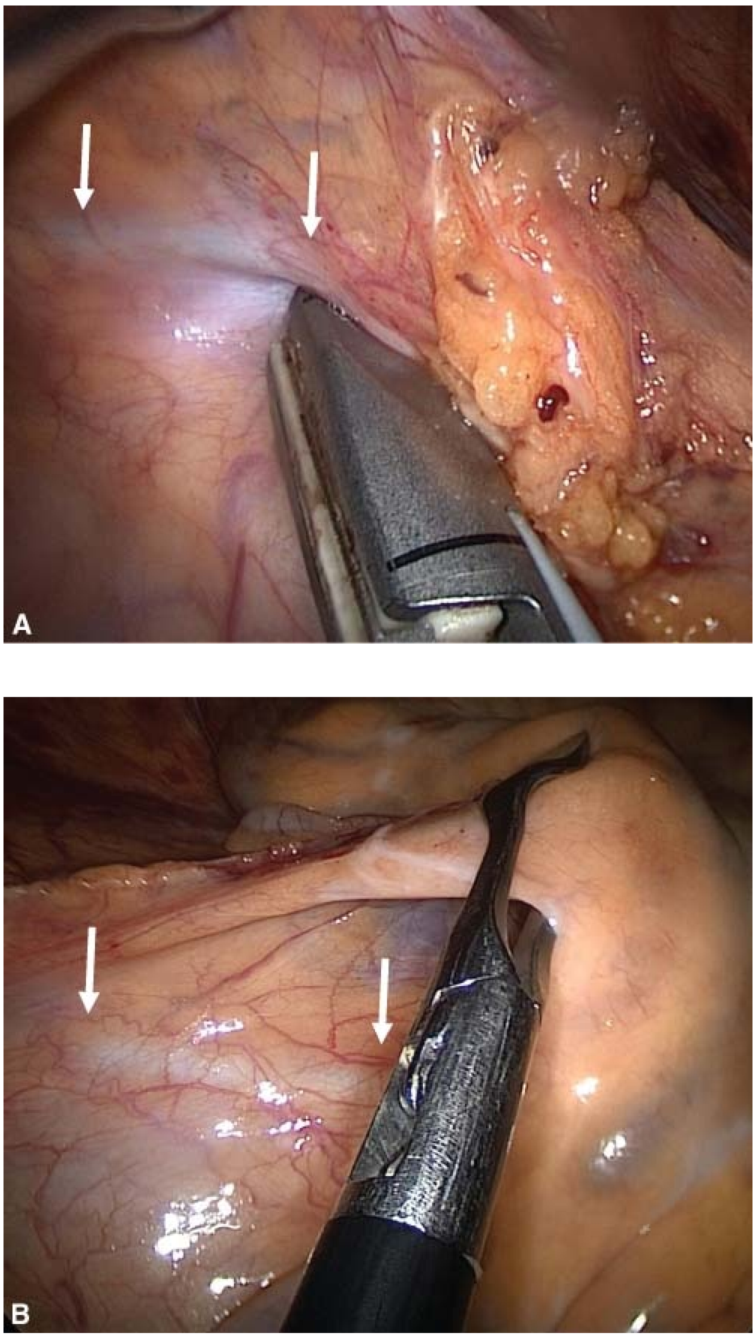


FIGURE 4-4 Identification of the right ureter. A.

The right ureter (white arrows) is visualized at the level of the iliac bifurcation. B. Lateral to the ileocolic angle as the cecum is retracted medially.

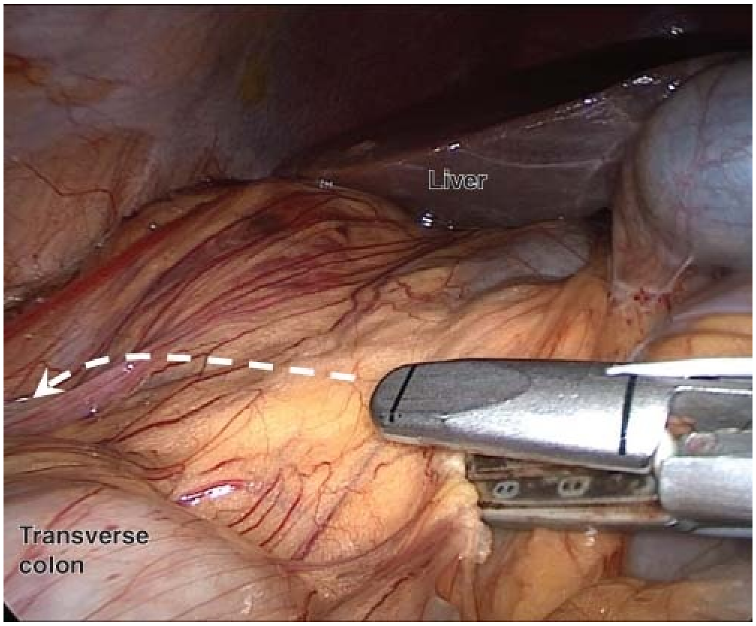


FIGURE 4-5 Mobilization of the proximal transverse colon. The gastrocolic and hepatocolic omentum are divided in a transverse dissection (dashed white line) that eventually joins the lateral mobilization at the hepatic flexure.

After laterally releasing the right colon, the table is tilted into reverse Trendelenburg position. The assistant moves to the left of the surgeon to center the laparoscopic camera on the right upper quadrant (RUQ). The transverse colon is retracted caudally and an energy device is used to divide the gastrocolic ligament, with care to protect the gallbladder, liver capsule, and duodenum as the dissection is continued laterally to the hepatocolic ligament (Fig. 4-6). Once the transverse and right-sided dissection planes are joined, the entire right colon can be retracted inferomedially out of the RUQ and any remaining attachments to the underlying duodenum can be lysed.

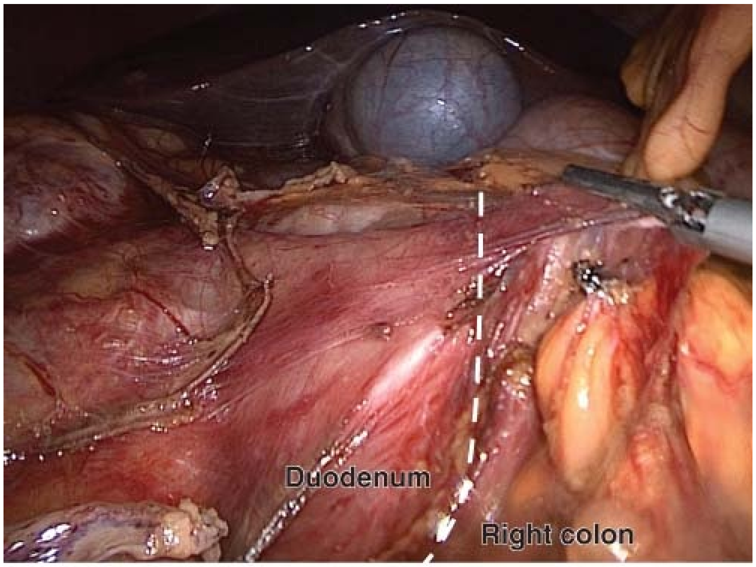


FIGURE 4-6 Duodenal attachments. The duodenum is exposed with medial rotation of the colon after releasing the lateral and omental attachments. The right colonic mesentery is dissected off the duodenum for full mobilization.

p. 30

p. 31

Mesenteric Dissection and Vessel Ligation

With the colon fully mobilized, the ileocolic vessels are exposed and ligated. The patient is placed back into Trendelenburg and the colon is displaced anterolaterally to identify the pedicle. Peritoneum overlying the mesentery is scored on either side of the vessels, creating a window through the mesentery into the lateral dissection space. The duodenum must be visualized through this opening to prevent injury. The vessels are cleared of surrounding fat down to the base of the colonic mesentery at the takeoff of the ileocolic vessels from the superior mesenteric vessels (Fig. 4-7). Intracorporeal ligation of the ileocolic artery and vein is then performed using a vessel-sealing energy device, clips, or a stapler with a vascular stapler. The mesentery is divided distally, to or, if indicated, including the right branch of the middle colic artery, and proximally, along the ileal mesentery to a point 10 cm from the ileocecal junction.

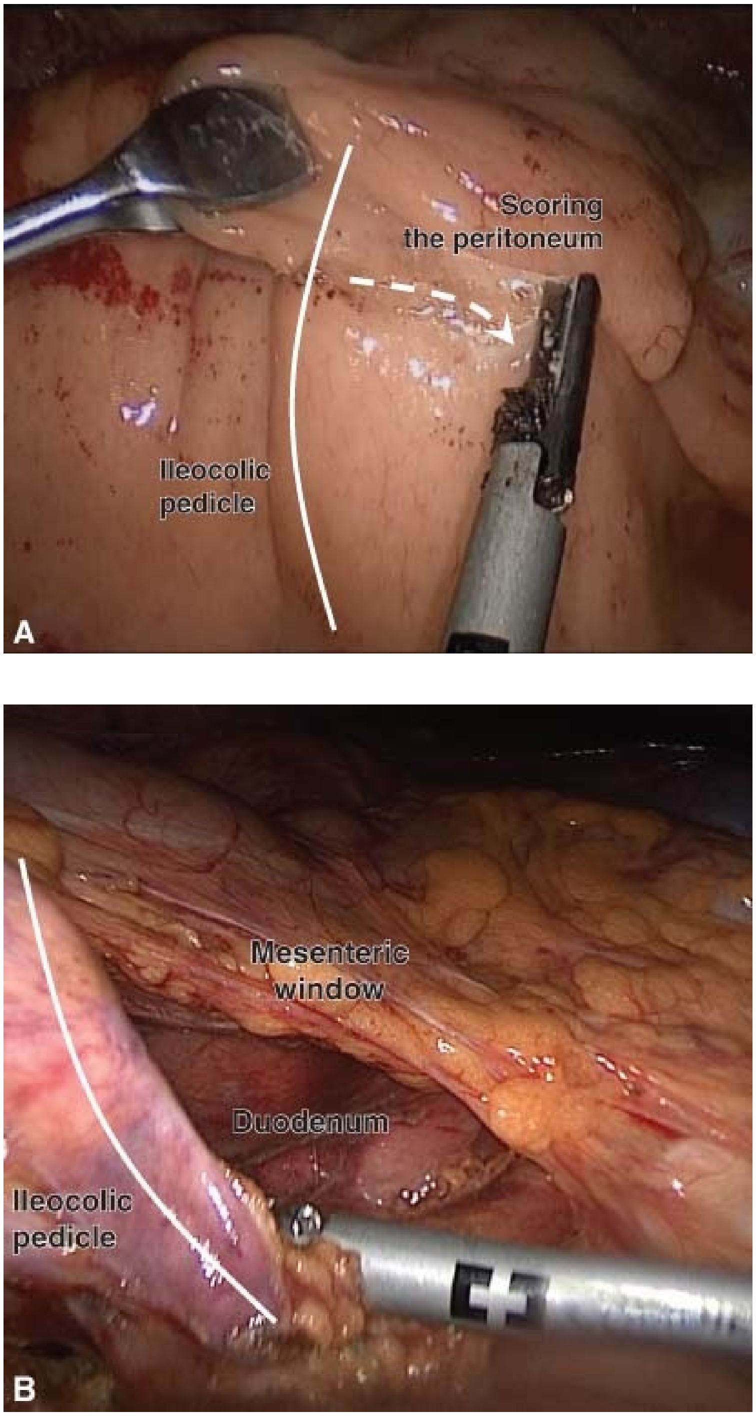


FIGURE 4-7 Isolation and division of the ileocolic pedicle. The ileocolic vessels are identified by retracting the mobilized colon anterolaterally, and the adjacent peritoneum is scored (A). The duodenum is visualized through the mesenteric window before division of the ileocolic vessels (B).

Resection and Anastomosis

The camera is moved to one of the lateral ports and a locking grasper is placed through the umbilical port to grasp the cecum. The infraumbilical incision is extended cephalad for a distance of approximately 3–4 cm, curving to the left of the umbilicus. A wound protector is placed around the grasper/port to reduce rates of infection and aid in specimen extraction. The bowel is delivered through the incision with the locking grasper. The bowel is divided with a stapler at the vascular demarcations caused by division of the mesentery. In the absence of any contraindication, a 100-mm gastrointestinal stapler is used to perform a stapled, functional end-to-end, anatomic side-to-side ileocolic anastomosis to restore bowel continuity. Pitfalls and solutions related to these technical steps are described in Table 4-1. Indocyanine green fluorescence perfusion assessment can be used to confirm vascularity before and/or after anastomotic creation.

TABLE 4-1 Pitfalls and solutions during lateral to medial laparoscopic right colectomy

Pitfall	Solution
Difficulty identifying vascular pedicle	Place pedicle under better traction
	Dissect further left on the transverse colon
Poor reach of the transverse colon to the umbilicus	Extend incision to epigastrium (mini-laparotomy)
	Intracorporeal vessel ligation, if not already performed
Anastomotic twisting	Maintain orientation by keeping bowel continuity
	Reinsufflate if any concern
Mesenteric hernia	Theoretical

Closure

The anastomosis is gently reinserted into the abdomen through the umbilical incision. The abdomen may be reinsufflated to verify hemostasis and close the two remaining ports laparoscopically with a suture passer. The midline incision is irrigated and closed with interrupted number one polydixanone sutures, and the skin incisions are closed with running 4-0 absorbable suture. Incisions are dressed with benzoin and adhesive strips, and covered with a padded adhesive bandage.

POSTOPERATIVE MANAGEMENT

Enhanced recovery after surgery protocols should be used for postoperative management when clinically appropriate. Patients are transferred to the regular surgical floor unless there was an intraoperative concern or comorbidity requiring additional monitoring. Orogastric tubes and ureteral stents are removed before the patient exits the operating room. Postoperative antibiotics are generally not administered unless there was a phlegmon or intra-abdominal abscess. Pain is controlled with multimodal therapy, including both patient-controlled analgesics with intravenous narcotics, as well as nonnarcotic analgesics such as acetaminophen, gabapentin, and ketorolac, intended to reduce narcotic requirements. Intravenous narcotics are weaned as quickly as possible, ideally by postoperative day 2.

Patients are placed on a clear liquid diet immediately following surgery and advanced to a low-fiber diet with passage of flatus. Early ambulation and use of an inspiratory spirometer is encouraged on postoperative day 1. Subcutaneous heparin is administered for deep venous thrombosis prophylaxis, and patients with additional risk are considered for extended prophylaxis with enoxaparin.

If the patient was on long-term preoperative steroids, a stress dose of hydrocortisone is administered during the operation and intravenous steroids are continued postoperatively. The patient is transitioned to oral prednisone once tolerating a solid diet and weaned slowly over a period of weeks to prevent adrenal insufficiency.

COMPLICATIONS

Complications for laparoscopic right colectomy are lower than those for open surgery. A meta-analysis conducted by Arezzo *et al.* reviewed 27 studies from 1991 to 2004 ($N = 3,049$) that compared laparoscopic to open right colectomy. Laparoscopic right colectomy had lower incidences of mortality (1.2% vs. 3.4%; $P = 0.031$) and overall morbidity (16.8% vs. 24.2%; $P = 0.007$), earlier time to first flatus (2.7 vs. 3.7 days; $P < 0.001$), reduced rates of wound complications (4.8% vs. 9.0%; $P = 0.011$), and a shorter length of hospital stay (7.4 vs. 10.2 days; $P < 0.001$). Differences between laparoscopic and open approaches were not statistically significant with respect to anastomotic leak rates (2.3% vs. 2.4%), urinary tract infections (3.6% vs. 4.3%), and pulmonary complications (2.4% vs. 3.7%).

These numbers are similar to those obtained recently from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database ($N = 6,521$). Overall morbidity and mortality were reported as 15% and 0.4%, respectively. Surgical site infections were found to be relatively uncommon (superficial—4.9%, deep—0.5%, organ—2.7%), and rates of anastomotic leakage were reportedly low (2.2%).

RESULTS

There are limited published results comparing laparoscopic LA and MA right colectomy. Study is hindered by inherent bias, because most surgeons strongly prefer a particular method. Retrospective comparisons between LA and MA may be confounded by uncontrolled surgeon-specific variables, and randomized prospective studies can be subject to selection or intervention-choice biases. A randomized-controlled trial that forces surgeons to operate using an unfamiliar approach will be confounded by differences in surgical skill.

Despite these difficulties, five studies aimed to compare LA and MA colectomy and were reviewed by Ding *et al.* in a meta-analysis. The five studies consisted of two randomized-controlled trials and three non-randomized retrospective studies, including a total of 881 patients (MA: 416; LA: 465). Several of the papers included mixed groups of right and left colectomies. When pooled together, MA had shorter operative time and lower conversion rate to open surgery, but LA had greater lymph node harvest. There were no differences in rates of complications, mortality, or recurrence. The authors were unable to draw firm conclusions owing to study heterogeneity with respect to methods and outcome measures.

CONCLUSIONS

Defining technical features of LA right colectomy include a lateral clockwise mobilization that begins at the ileocolic angle, and *precedes* the identification and ligation of the vessels. While there is no evidence-based indication for LA versus MA right colectomy, LA may be preferred because it has dissection planes similar to those of open surgery, and it is a safer approach when mesenteric planes are distorted by inflammatory or neoplastic conditions. Ultimately, the best approach is the one most familiar and comfortable for the operating surgeon and best suited for the individual patient.

RECOMMENDED REFERENCES AND READINGS

Arezzo A, Passera R, Ferri V, Gonella F, Cirocchi R, Morino M. Laparoscopic right colectomy reduces short-term mortality and morbidity. Results of a systematic review and meta-analysis. *Int J Colorectal Dis* 2015;30(11):1457–72.

da Silva G, Boutros M, Wexner SD. Role of prophylactic ureteric stents in colorectal surgery. *Asian J Endosc Surg* 2012;5(3):105–10.

Ding J, Liao GQ, Xia Y, *et al.* Medial versus lateral approach in laparoscopic colorectal resection: a systematic review and meta-analysis. *World J Surg* 2013;37(4):863–72.

Dolejs SC, Waters JA, Ceppa EP, Zarzaur BL. Laparoscopic versus robotic colectomy: a national surgical quality improvement project analysis. *Surg Endosc* 2017;31:2387–96.

Elarini T, Wexner SD, Isenberg GA. The need for standardization of colonoscopic tattooing of colonic lesions. *Dis Colon Rectum* 2015;58(2):264–7.

Guenaga KF, Matos D, Wille-Jorgensen P. Mechanical bowel preparation for elective colorectal surgery. *Cochrane Database Syst Rev* 2011(9):CD001544.

Haito-Chavez Y, Law JK, Kratt T, *et al.* International multicenter experience with an over-the-scope clipping device for endoscopic management of GI defects (with video). *Gastrointest Endosc* 2014;80(4):610–22.

Kiran RP, Murray AC, Chiuzan C, Estrada D, Forde K. Combined preoperative mechanical bowel preparation with oral antibiotics significantly reduces surgical site infection, anastomotic leak, and ileus after colorectal surgery. *Ann Surg* 2015;262(3):416–25; discussion 423–5.

Kopylov U, Ben-Horin S, Zmora O, Eliakim R, Katz LH. Anti-tumor necrosis factor and postoperative complications in Crohn's disease: systematic review and meta-analysis. *Inflamm Bowel Dis* 2012;18(12):2404–13.

Lee IK. Right colonic diverticulitis. *J Korean Soc Coloproctol* 2010;26(4):241–5.

Scarborough JE, Mantyh CR, Sun Z, Migaly J. Combined mechanical and oral antibiotic bowel preparation reduces incisional surgical site infection and anastomotic leak rates after elective colorectal resection: an analysis of colectomy-targeted ACS NSQIP. *Ann Surg* 2015;262(2):331–7.

Slim K, Vicaut E, Launay-Savary MV, Contant C, Chipponi J. Updated systematic review and meta-analysis of randomized clinical trials on the role of mechanical bowel preparation before colorectal surgery. *Ann Surg* 2009;249(2):203–9.

Chapter 5

Right Colectomy Robotic Resection

Jorge A. Lagares-Garcia and Cesar Santiago

INDICATIONS/CONTRAINDICATIONS

For the past 25 years, minimally invasive approaches to colon surgery have progressively increased in acceptance and use. Prospective randomized trials have shown oncologic parity adoption between open and laparoscopic colectomy. Adoption has progressively increased, but not all patients will receive this approach.

Robotic-assisted colectomy (RAC) has become more widespread in its application to segmental resection and proctectomy. The Xi platform (Intuitive Surgical, Sunnyvale, CA) offers a single rotational boom in the top of the frame that allows any kind of docking to the patient and less bulky instrumentation and camera. There is a lack of demonstrable superiority of the robot compared to the laparoscopic approach, although some studies have shown a lower conversion rate, especially in the obese population. Advantages include the facilitation of the performance of intracorporeal anastomosis, extraction of the specimen off the midline, decreased risk of incisional hernia, and potential decrease in the hospital length of stay.

Current indications for RAC are the same as laparoscopic surgery for benign and malignant conditions. The only absolute contraindication to RAC would be if the patient is medically unfit to undergo general anesthesia. Relative contraindications include the large size of the tumor or multiple prior laparotomies that preclude the entrance to the abdominal cavity. As with any other surgical approach, the surgeon should be aware of limitations and personal learning curve. RAC has demonstrated operative times similar to that of laparoscopic. Dedication and consistency at the console are prerequisites of excellent practice.

Advantages of the Robotic Approach

Regardless of the platform generation, the 3D vision enhances the surgeon’s ability to perform the procedure. With either second or third generations, the surgeon is able to use three arms and the camera.

The traditional improvements in tremor elimination, 7 degrees of wristing capabilities, and the motion scaling are also improvements from the laparoscopic approach. One of the unique features of RAC is the surgeon comfort owing to the ergonomic designed console. The surgeon can practice the use of instruments such as robotic stapler or suturing. Hand-sewing is greatly enhanced, enabling the operator to perform an intracorporeal anastomosis.

Limitations of the Robotic Approach

Haptic Feedback

There is a lack of tactile sensation. The surgeon is heavily dependent on the 3D vision and personal experience with each instrument to gauge the pressure and tension placed on the bowel, vessels, or other important structures. It is important for the novice robotic surgeon to avoid extreme forces and pulling, and use the graspers more as a retractor.

Cost

RAC cost is higher than that for laparoscopic or open surgery. The cost in the healthcare system may be mitigated if the conversion rate can be decreased, and complications are reduced. Intracorporeal anastomosis and higher ligation of the ileocolic pedicle may offer better cancer staging.

PREOPERATIVE PLANNING

Preoperative proper localization of the pathology is important in benign and malignant disease. It is our practice to request the referring endoscopist to place proximal and distal tattooing of the lesion. If the clear landmarks are lost during endoscopy, a very helpful approach is to place an endoscopic clip and get a plain abdominal X-ray. Do not perform a bowel preparation the day before the surgery. Patients receive oral antibiotics and clear liquid diet up to 6 hours before surgery following anesthesia protocol. Carbohydrate load has been shown to improve outcomes in colon surgery when associated with enhanced recovery protocols. Preoperative cardiopulmonary clearance is based on risk factors for general anesthesia. The night before the procedure, the patient is to shower with chlorhexidine. Deep venous thrombosis (DVT) prophylaxis and antibiotics are administered per institutional protocol.

SURGERY

Setup and Preparation

Si Robotic Platform

The patient is placed in supine position on a beanbag. Obese patients are taped over the chest to avoid sliding. Reverse Trendelenburg position of about 5–10 degrees and left side down about 5 degrees is helpful. It is important to always visualize the elbow of arm 3 on the platform because it may hit over the face or the shoulder of the patient. On right-sided lesions, the platform may enter on the right side; however, on hepatic flexure or proximal transverse lesions, the best approach is to dock from the right shoulder in an imaginary line between the right shoulder and the left iliac crest.

Xi Robotic Platform

The patient is placed supine on the operating room (OR) table, making sure that the short side to the table is toward the patient's head. The patient is secured to the table with the Opt-Shield SUPINE (BCG Medical, San Diego, CA), device to prevent sliding, and the table is airplaned right side up (roughly 15–20 degrees) there. There is no need for Trendelenburg or reverse Trendelenburg, although sometimes these positions are used to expose the duodenum, depending on the location of the transverse colon (Fig. 5-1). The robotic platform is brought over the right side at around the level of the axilla. Rotating the boom on the robotic platform allows for access to all four quadrants of the abdomen regardless of the robot docking location. The operating surgeon should sit at a location where he or she can see the robotic arms to correct external arm collisions, if necessary. Targeting of the lesion is performed following manufacture guidelines and optimal position of the arms is performed by the system to avoid collisions.

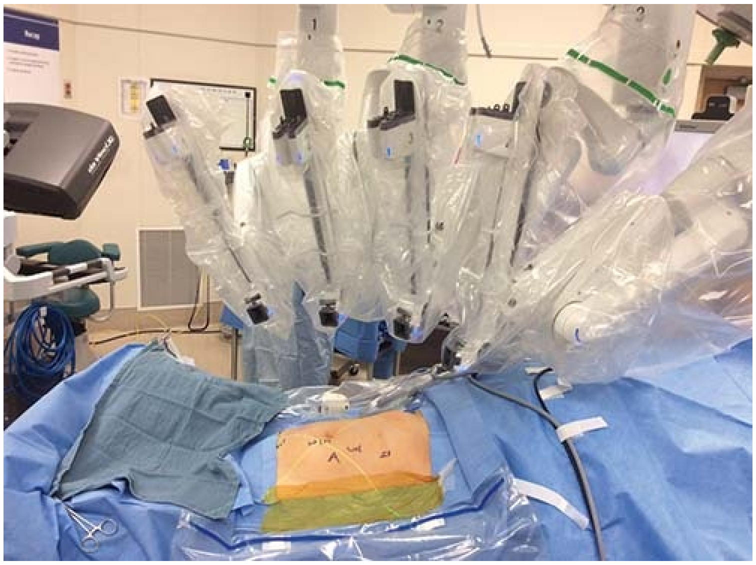


FIGURE 5-1 Robotic docking Xi system.

Patient Positioning

Lithotomy and supine position are both acceptable positions. The placement of the patient in lithotomy position may interfere with the arms and cause external collisions with the left leg. This problem may be more pronounced in the Si robotic platform; the arms have a slimmer profile in the Xi system, thereby minimizing this problem. The arms are placed on each side of the patient. Routinely, foam pads are used over the lateral aspects of the elbows, wrists, shoulders, and neck. Using the beanbag strapped to the operating table holds the individual. Placing the bag over the shoulders will secure the patient with minimal cranial displacement. This is not as important in right colectomy as it is in robotic low anterior resections, where the subject may slide cranially in Trendelenburg position. In right colectomy, the danger is the patient sliding down especially in lithotomy if steep reversed Trendelenburg is used. The patient is tested for safety and possible sliding before prepping and draping the subject.

Si System

Routine placement of the OR table is perpendicular to the anesthesia cart. Once the system is docked and the patient position is set, the platform cannot be moved; movement may cause an irrecoverable fault to occur that may require the rebooting of the entire system. Figure 5-2 shows the placement of the patient in relationship to anesthesia. Robotic docking is done from the right shoulder and Figures 5-3 and 5-4 show the docking from the view of the surgeon and the nursing staff, respectively.

FIGURE 5-2 Patient positioning.

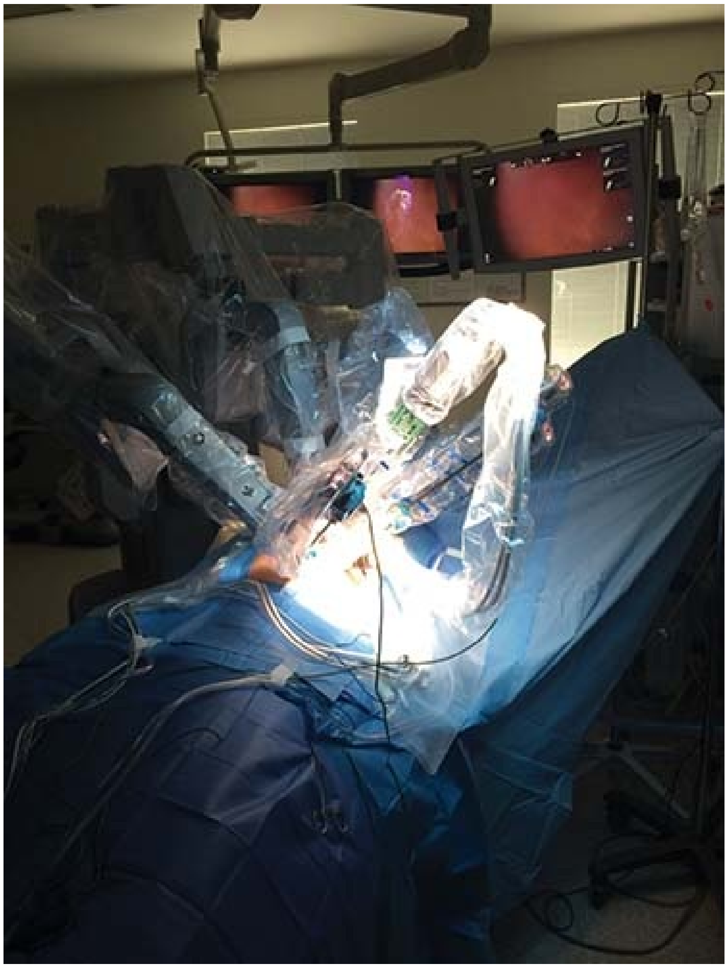


FIGURE 5-3 Si system docking.

FIGURE 5-4 Si system docking platform view.

p. 37

p. 38

Xi System

The patient is positioned supine on the OR table to prevent sliding. All pressure points are checked and corrected. The operating surgeon sits at a location in the room where he can visualize the robotic arms and can communicate using line of sight with the surgical assistant. The OR table is airplaned right side up slightly to displace the small bowel to the pelvis and the left upper quadrant exposing the duodenum and vascular pedicle. Anesthesia is usually located at the head of the table.

Port Placement

Si System

Several port placements can be used depending on the surgeon's preference. Our current port placement is set for intracorporeal anastomosis using the full benefit of all three arms and the camera. The camera port is placed in the supraumbilical portion of the abdomen. This placement may also be modified to about 2–3 cm below and to the left of the midline. This camera position allows a better reach and visualization of tumors over the hepatic and proximal transverse areas. The robotic stapler arm (arm 1) is located over the left upper quadrant. This position, in our opinion, helps in the firing of the stapler for transection of the terminal ileum and colon as well as the anastomosis (iso-or antiperistaltic). The retracting arm 3 is located over the subxiphoid area. Care must be taken upon docking the arm to make sure the face of the patient will not be hit with the arm and face foam padding is recommended. Arm 2 is located over the suprapubic area. Our instrument of choice are a hook or scissors (arm 1), a small grasping retractor (arm 2) and a fenestrated bipolar (arm 3). Figure 5-5 demonstrates the port placement form the assistant's point.

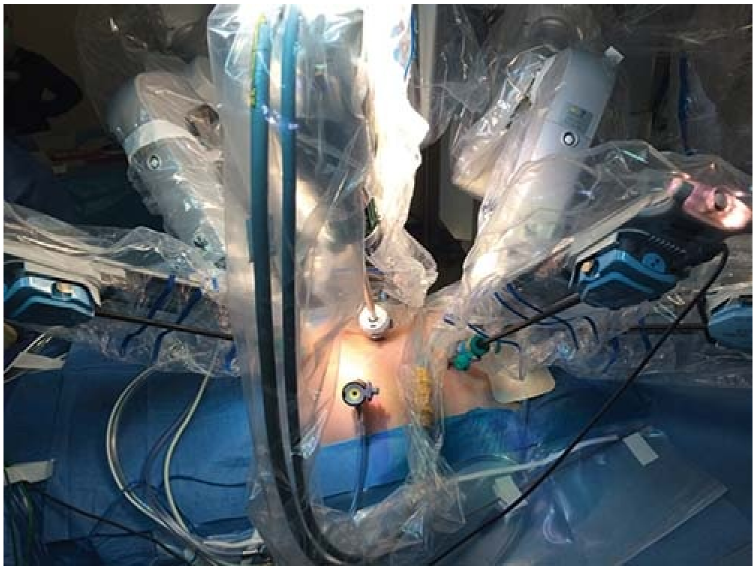


FIGURE 5-5 Port placement.

Xi System

There are two main trocar placement recommendations for a robotic right hemicolectomy. The first trocar placement is most commonly utilized for an extracorporeal anastomosis. One of the trocar sites can be placed at the level of the umbilicus and the incision can be extended to become the extraction site (supraumbilical area). The second trocar placement recommendation assumes that an intracorporeal anastomosis will be performed and the camera port is moved toward the left of the umbilicus, achieving a more panoramic view. This trocar setup prevents being too close to the target when performing the intracorporeal anastomosis. The extraction site is off the midline. This lowers the incisional hernia rate for right hemicolectomy patients (Fig. 5-6).

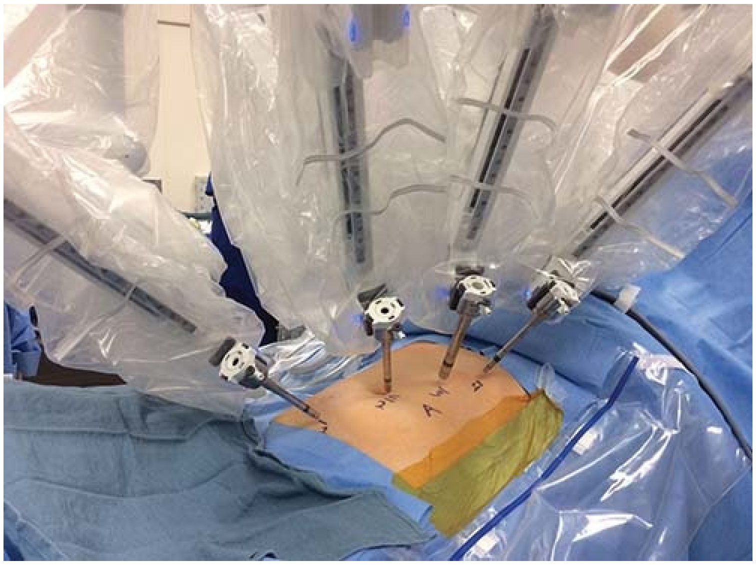


FIGURE 5-6 Xi port placement.

Procedure

Access to the peritoneal cavity is obtained using the 8-mm straight camera in the 12-mm optical view port. When this technique is utilized, it is important to point away from the midline, to avoid damage to vascular structures. An off-midline port placement to the left should allow the surgeon to see progressively the anterior rectus sheath, the muscle, and the posterior rectus before entering the peritoneal layer and cavity. The patient is placed at that time in slight reverse Trendelenburg and rotated to the left. The small intestine “falls” to the left side of the abdomen. The left upper quadrant (arm 1 in Si system) port allows a laparoscopic bowel grasper to further mobilize the viscera.

It is the surgeon’s choice to perform a medial-to-lateral dissection. For beginner robotic surgeons, our current recommendation is to perform whatever technique they are familiar with when performing a straight laparoscopic right colectomy.

Lateral-to-Medial Approach

The cecum is retracted cranially and to the left of the patient, exposing the ileocecal area. The fenestrated bipolar and the scissors or hook is used to create a small incision over the peritoneal surface at the most caudal fold of the line of Toldt (Fig. 5-7). The hook allows performing blunt dissection with its heel. The cecum is retracted by the assistant toward the left side of the abdomen until Gerota's fascia and the duodenum are exposed along the retroperitoneum. The right ureter and gonadal vessels are identified and protected. In cases where there is an inflammatory mass in the right lower quadrant, the use of stents is recommended. It is possible to inject indocyanine green (ICG) dye retrograde into the stent and use the near-infrared technology (Firefly, Intuitive Surgical, Sunnyvale, CA) to visualize the ureters.

FIGURE 5-7 Paracolic takedown.

The entire right colon is mobilized and brought to the midline. The colon and terminal ileum must be fully free and past the midline.

The hepatic flexure and gastrocolic ligament are released as the cecum is moved with caudal retraction to the left hip (Fig. 5-8). The omentum is lifted and the hook/scissors are used to enter the lesser sac. The second portion of the duodenum will be visible. The right branch of the middle colic vessel may be injured at its origin with forceful retraction. Bleeding will be brisk. The right branch may be controlled with vessel clips or a sealing device.

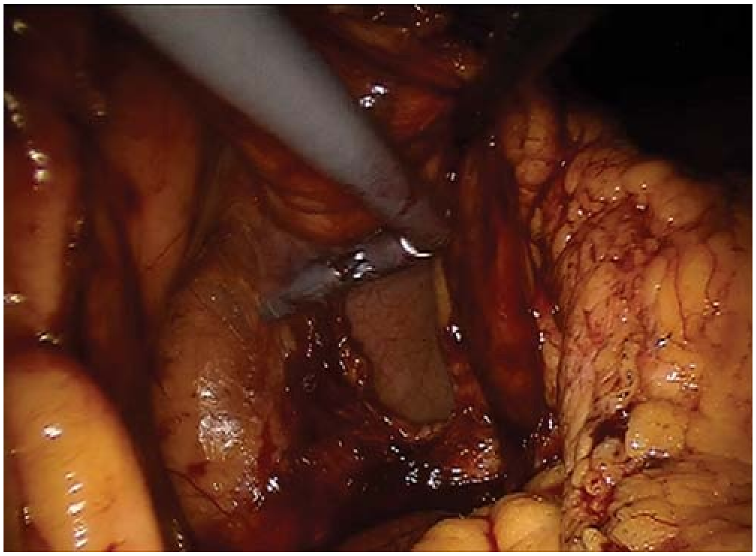


FIGURE 5-8 Hepatic flexure takedown.

Once full mobilization of the colon is performed, the decision to perform an intra-or extracorporeal anastomosis is left to the surgeon. Early reports indicate a possible advantage in length of stay and recovery by using intracorporeal anastomosis. Obese patients, especially, benefit from the intracorporeal technique.

Medial-to-Lateral Approach

Lifting the ileocolic pedicle allows venting into the areolar space behind the right colon mesentery and over the duodenum (Fig. 5-9). The dissection is continued cranially until the hepatic flexure is mobilized in a medial-to-lateral manner. The liver and gallbladder are visualized when the hepatic fixture suspensory ligaments are divided. Lateral attachments of the colon are divided last. Gerota's fascia and the retroperitoneal structures are protected throughout the dissection.

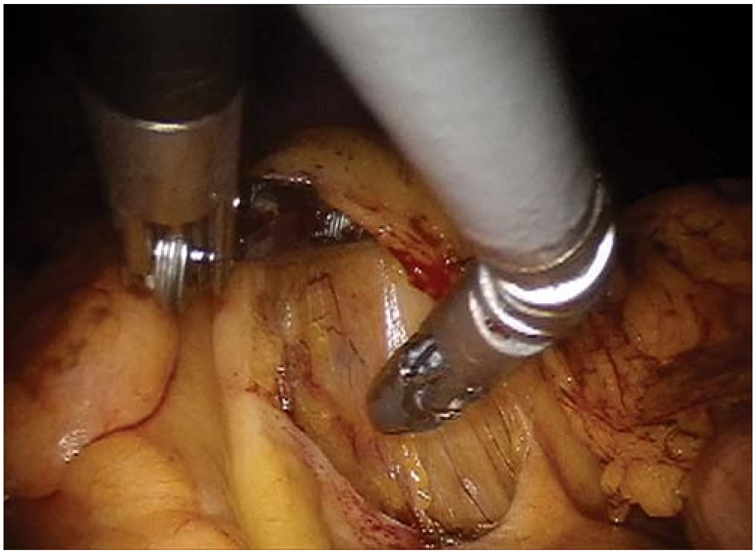


FIGURE 5-9 Ileocolic pedicle identification.

The ileocolic pedicle is skeletonized and divided. The avascular mesentery is then dissected to the right branch of the middle colic. Anterior tension on the mesocolon of the transverse colon exposes the middle colic pedicle. The right branch is divided with a sealing device or clips.

Intra-Versus Extracorporeal Anastomosis

The terminal ileum and colon are skeletonized and cleaned to the viscera, transecting them with the robotic stapler. An isoperistaltic anastomosis is lined up using a corner suture of 3/0 polydioxanone (PDS) between the end of the antimesenteric border of the terminal ileum and the antimesenteric taenia coli of the distal transverse colon. This suture is cut approximately 25 cm and left with the needle to close the enterotomy after the anastomosis is fashioned. The proximal portion of the transected staple line is also lifted and approximated to the proximal antimesenteric border of the ileum. To lift this area, a straight needle introduced in the right upper quadrant into the colon and small intestine and returned out of the abdominal cavity facilitates lifting and lining up the intestine for the firing of the stapler line (Fig. 5-10). An enterotomy is performed in the distal ileum and colon. The robotic stapler is introduced through the arm 1 port. Both ends of the intestine are entered and a single firing is done (Fig. 5-11). The stapler is replaced with the robotic needle driver and the 3/0 PDS suture is used to close the enterotomy in a running Lembert manner (Fig. 5-12). Before the anastomosis we verify the vascular flow of both ends of the intestine using 3.5 mg IV of ICG (Firefly, Intuitive Surgical, Sunnyvale, CA) and the near-infrared camera of the robotic platform.

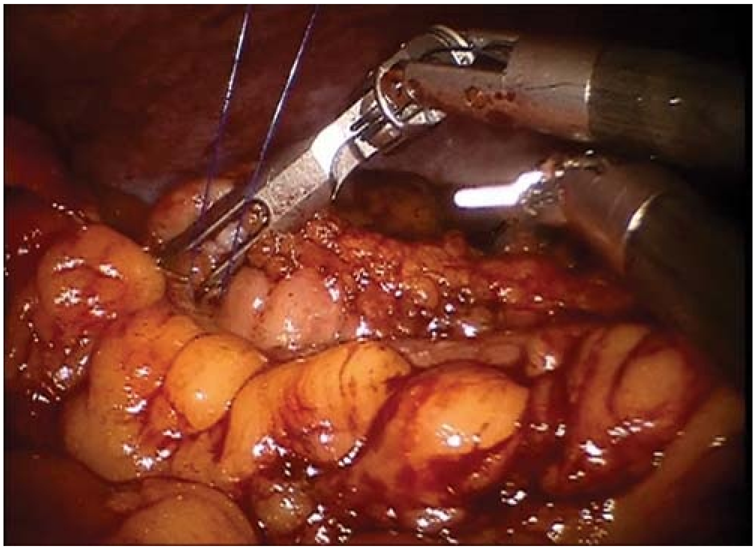


FIGURE 5-10 Isoperistaltic setup.

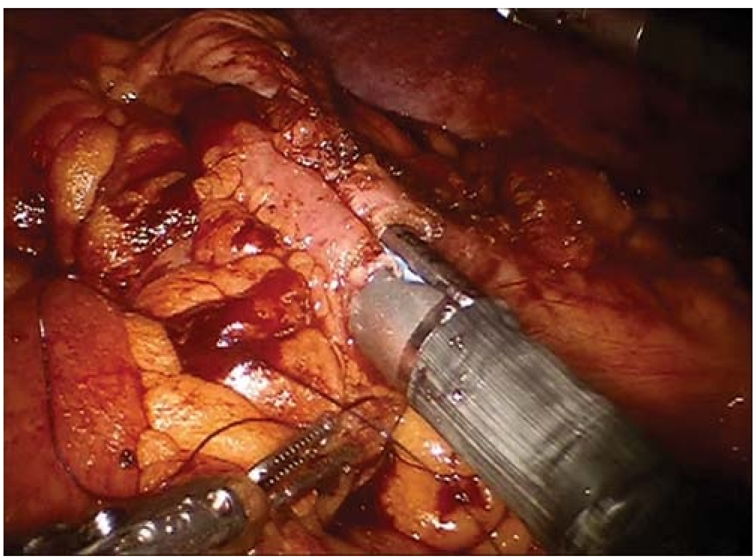


FIGURE 5-11 Isoperistaltic staple firing.

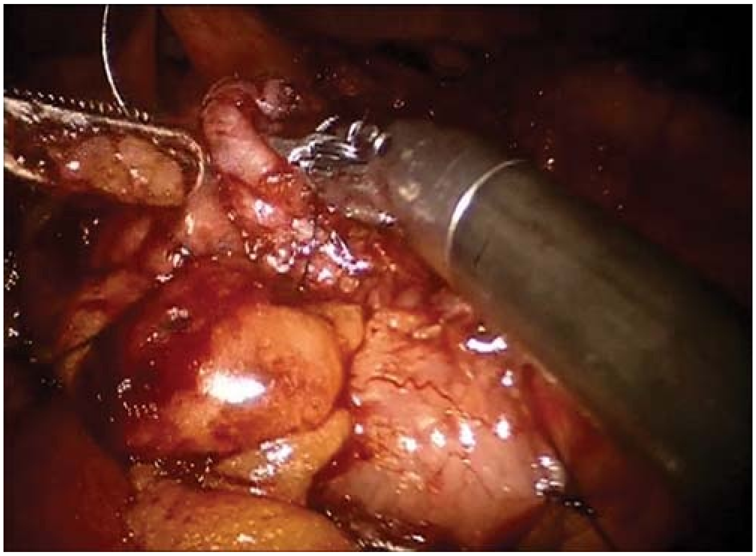


FIGURE 5-12 Closure enterotomy.

POSTOPERATIVE MANAGEMENT

Our unit currently uses an aggressive enhanced recovery protocol that stresses out ambulation and early feeding. The patient, after a short stay in the recovery room, is transferred to the surgical floor where within 2–4 hours he or she is mobilized and ambulated. The ambulation is continued on postoperative day 1 with walks in the halls at least six times daily.

Soft diet is given to the patient the night of the procedure. Routine medications, either oral or intravenous, for nausea are prescribed such as ondansetron and promethazine. Only if the patient has repeated episodes of nausea or vomiting the diet is stopped. The individual's home medications are also started that same night unless contraindicated by such anticoagulants.

Pain control is the main issue, especially in a culture where opiates are common. Our institution currently has several protocols for preemptive anesthesia that include transversus abdominal plane blocks in the preoperative area and for high-risk patients, such as those with inflammatory bowel disease, who have been on opiates. We currently have a continuous infusion of ketamine that gets started on a bolus dose given by the anesthesiologist intraoperatively and continued postoperatively until day 3 or 4 unless the patient is ready for discharge earlier.

Oral acetaminophen is given to the patient every 6 hours around the clock, unless contraindicated. Oral or intravenous opiates are prescribed only for severe pain on a pain score 8–10 and breakthrough, but overall they are discouraged and the nursing staff is instructed to try to avoid them. All patients will be given alvimopan 12 mg every 12 hours from the preoperative area until the day of discharge as a peripherally acting μ-opioid receptor antagonist.

Routine and strict DVT prophylaxis is followed using heparin 5,000 units subcutaneously every 8 or 12 hours depending on surgeon's preference or enoxaparin 40 mg daily. In certain high-risk patients with potential for low mobility upon discharge, an extended DVT prophylaxis protocol is used for 21 days postoperatively.

Routine nursing care of the patient is fairly straightforward, the incisions have been closed with a subcuticular suture and Dermabond Advanced (Ethicon, Cincinnati, OH), and within 24 hours of the surgery the patient may shower. The intravesical catheter is removed on the morning of postoperative day 1; and in patients with potential urinary retention, such as benign prostatic hypertrophy, a routine bladder scanning and straight catheterization are implemented if unable to urinate.

The patient will run an infusion of 5% dextrose and lactated Ringer's solution

The patient will run an infusion of 5% dextrose and lactated Ringer's solution postoperatively that will be stopped and heparin lock given intravenously on postoperative day 1. Dextrose solution is avoided in diabetics to avoid hyperglycemia in the postoperative period.

Our current length of hospital stay is 3 days; by that time the nursing case manager and discharge planner have already assessed the needs of the patient at home and safety in case that occupational and physical therapy consults have to be placed for discharge to a nursing facility.

RESULTS

Minimally invasive right colectomy surgery is safe and feasible. Application of robotic technology in the setting of a segmental colectomy has consistently failed to show any significant advantages. The learning curve for robotics seems to be faster than that for laparoscopic technique, possibly due to the 7 degrees of freedom, superior visualization, and stable third arm retraction of the robot. Our current approach to decrease the cost is basically targeted at the instrumentation use. The basic cost of robotic and patient draping, sutures, and disposable materials used in the operation are fairly standardized and fixed. The use of Hem-o-lock (Teleflex, Morrisville, NC, USA) clips instead of any diathermy device also is a large cost savings in the procedure. Reduction in firing reloads of robotic staplers can be achieved by dissection of the mesentery of the colon and terminal ileum to decrease the width of the tissue.

Significant debate has existed about the relative merits of a stapled versus hand-sewn ileocolic anastomosis. A Cochrane review of 1,125 anastomoses by Choy *et al.* indicated that stapled functional end-to-end ileocolic anastomosis is associated with fewer leaks than hand-sewn anastomosis. Currently, controversy exists over the performance of intra-or extracorporeal anastomosis. The incidence of hernia after a robotic or laparoscopic resection has been described (17.4% and 22.2%, respectively) in a large review from Widmar *et al.* Therefore, the potential to reduce the sequelae of this complication exists with the performance of an intracorporeal anastomosis with subsequent specimen extraction using a Pfannenstiel incision.

The performance of intracorporeal anastomosis robotic or laparoscopically may decrease the length of hospital stay and recovery despite the longer operative time. A retrospective review of National Quality Improvement Program by Miller *et al.* included 17,774 colectomies (11,267 laparoscopic vs. 653 robotic). Although the operative time in the robotic group was higher, the hospital length of stay was significantly decreased by 1 day in the robotic group. That difference was maintained in the right or left resections. No cost comparison was made in this study.

Robotic single incision or single port right colectomy (SPRC) has been reported and we have experience in the technique. We consider this technique as an advanced application of robotic technology and only selected centers have had experience with it. Juo *et al.* reported 59 right colectomies and concluded that the technique is safe and feasible to be used. During this advanced robotic procedure, the operator will cross the arms at the fascia level upon insertion of the single port. Retraction is limited and it requires significant use of “wristing” maneuvers to accomplish the dissection. Our experience for 3 years in SPRC (16 patients) compared to multiport robotic right (25 patients) offered lower operative times of 82 versus 110 minutes favoring the SPRC (probably related to the fact that we performed extracorporeal anastomosis) with similar length of hospital stay (4.2 vs. 4 days) and complications (25% vs. 36%) (unpublished data).

In the current era of cost containment and capitation per case, the surgeon must be aware of the expenses incurred in the OR. Our institution currently has implemented a system where the surgeon receives a score card with the total itemized cost of the procedure and the operative time. The use of equipment has been reduced and a constant effort to decrease the price has yielded a significant decrease from our average original cost of $3,927 per robotic colectomy; the cost is $1,813. As per the laparoscopic counterpart score card in 2011, the cost of a laparoscopic colectomy has decreased from $1,870 to $1,326 in 2015. Our institutional data clearly shows that the involvement of the surgeon improves the savings in a robotic program.

CONCLUSIONS

The application of robotic technology in right colectomy is still in its infancy because of multifactorial reasons that include adoption, learning curve, and cost. Preliminary data indicate safety and feasibility equivalent to the laparoscopic technique. Further investigation is needed in the use of intracorporeal or extracorporeal anastomotic techniques because the early data indicate improved short-term outcomes.

RECOMMENDED REFERENCES AND READINGS

Choy PY, Bissett IP, Docherty JG, Parry BR, Merrie A, Fitzgerald A. Stapled versus handsewn methods for ileocolic anastomoses. *Cochrane Database Syst Rev* 2011;(9):CD004320. doi:10.1002/14651858.CD004320.pub3.

de'Angelis N, Lizzi V, Azoulay D, Brunetti F. Robotic versus laparoscopic right colectomy for colon cancer: analysis of the initial simultaneous learning curve of a surgical fellow. *J Laparoendosc Adv Surg Tech A* 2016;26:882–92.

Grams J, Tong W, Greenstein AJ, Salky B. Comparison of intracorporeal versus extracorporeal anastomosis in laparoscopic-assisted hemicolectomy. *Surg Endosc* 2010;24(8):1886–91. doi:10.1007/s00464-009-0865-9.

Juo YY, Agarwal S, Luka S, Satey S, Obias V. Single-incision robotic colectomy (SIRC) case series: initial experience at a single center. *Surg Endosc* 2015;29(7):1976–81.

Lagares-Garcia J, O'Connell A, Firilas A, Robinson CC, Dumas BP, Hagen ME. The influence of body mass index on clinical short-term outcomes in robotic colorectal surgery. *Int J Med Robot* 2016;12:680–5. doi:10.1002/rcs.1695.

Matsuda A, Miyashita M, Matsumoto S, *et al.* Isoperistaltic versus antiperistaltic stapled side-to-side anastomosis for colon cancer surgery: a randomized controlled trial. *J Surg Res* 2015;196(1):107–12.

Miller PE, Dao H, Paluvoi N, *et al.* Comparison of 30-day postoperative outcomes after laparoscopic vs robotic colectomy. *J Am Coll Surg* 2016;223(2):369–73. doi:10.1016/j.jamcollsurg.2016.03.041.

Morpurgo E, Contardo T, Molaro R, Zerbinati A, Orsini C, D'Annibale A. Robotic-assisted intracorporeal anastomosis versus extracorporeal anastomosis in laparoscopic right hemicolectomy for cancer: a case control study. *J Laparoendosc Adv Surg Tech A* 2013;23(5):414–7. doi:10.1089/lap.2012.0404.

Trastulli S, Coratti A, Guarino S, *et al.* Robotic right colectomy with intracorporeal anastomosis compared with laparoscopic right colectomy with extracorporeal and intracorporeal anastomosis: a retrospective multicentre study. *Surg Endosc* 2015;29(6):1512–21. doi:10.1007/s00464-014-3835-9.

vanOostendorp S, Elfrink A, Borstlap W, *et al.* Intracorporeal versus extracorporeal anastomosis in right hemicolectomy: a systematic review and meta-analysis. *Surg Endosc* 2017;31:64–77.

Widmar M, Keskin M, Beltran P, *et al.* Incisional hernias after laparoscopic and robotic right colectomy. *Hernia* 2016;20(5):723–8. doi:10.1007/s10029-016-1518-2.

Chapter 6

Hand-Assisted Laparoscopic Right Colectomy
Brian T. Valerian

INDICATIONS/CONTRAINDICATIONS

Indications

The indications for hand-assisted laparoscopic (HAL) right hemicolectomy are predominantly the same as those for laparoscopic and open right hemicolectomy: benign and malignant processes that involve the distal terminal ileum, cecum, ascending colon, hepatic flexure, and proximal transverse colon. HAL offers surgeons the benefits of laparoscopic surgery including smaller incisions, less postoperative pain, shorter hospital length of stay, and more rapid return of bowel function while still allowing the surgeon tactile feedback provided with open surgery. Utilizing HAL, the hand can retract organs, dissect, and rapidly control bleeding.

HAL is more frequently used for left hemicolectomy or total colectomy and total proctocolectomy; it still offers advantages in certain situations for right-sided colectomies. Inflammation or friable tissues from inflammatory bowel disease, or thickened mesentery such as seen with Crohn’s disease are examples. A phlegmon from diverticular disease or inflammatory bowel disease or large bulky tumors or masses are other examples. Morbid obesity can make laparoscopic surgery challenging, but HAL can often allow for successful minimally invasive surgery to be performed. The hand can easily retract the colon or mesentery in an obese patient or aid with exposure that laparoscopic instruments may not be able to provide. HAL also allows palpation of a neoplasm within the colon, which may not be identified visually. The patients and procedures that gain the most benefit from HAL are those that require an extraction site or mini-laparotomy.

Specific indications for HAL right hemicolectomy include refractory Crohn’s disease, right-sided diverticular disease, colon polyps not amenable to endoscopic removal, malignancies and neoplasms, volvulus or cecal bascule, and arteriovenous malformations or other bleeding lesions.

Contraindications

Contraindications typically fall into two broad classifications—absolute and

Contraindications typically fall into two broad classifications—absolute and relative contraindications. Absolute contraindications are those general medical conditions that would preclude a minimally invasive approach that requires pneumoperitoneum such as chronic obstructive pulmonary disease, severe cardiac disease for which decreased venous return can be detrimental, inability to tolerate Trendelenburg position, hepatic disease, coagulopathy, and a moribund patient. Relative contraindications have decreased as surgeon experience and skill have increased. Morbid obesity, previous abdominal surgery, adhesions, and phlegmons are all relative contraindications, but skilled laparoscopic surgeons can often utilize minimally invasive techniques to safely complete operations in these patients. Early reports of port site metastasis in minimally invasive surgery for malignancy have been disproven, and multiple studies have shown that both HAL and laparoscopic surgery are safe and effective in patients with malignancies. There are certain other conditions that remain absolute or relative contraindications including bowel obstruction with massively dilated bowel and bowel perforation.

PREOPERATIVE PLANNING

A patient undergoing any colon surgery requires a complete evaluation. Patients being considered for minimally invasive techniques also require additional evaluations because the ability to palpate all abdominal structures such as the liver and peritoneal surfaces may be limited. Determining extent of disease involvement and localization of lesions, masses, and tumors facilitates surgery. Colonoscopy allows identification of polyps, tumors, masses, and lesions. Tattooing of smaller polyps and tumors or of flat lesions allows for visual identification at the time of surgery. India ink can be easily utilized to tattoo lesions by injecting in three or four quadrants around the lesion for future identification. Colonoscopy also ensures there are no other synchronous lesions throughout the remaining colon.

Preoperative imaging with computerized tomography allows for evaluation of local extent of disease and possible metastatic spread to other organs and structures in malignant lesions. In addition, it can help determine resectability and ensure there is no direct extension of lesions or invasion to adjacent structures, not only in malignant conditions but also in conditions such as Crohn’s disease.

In preparation for surgery, a patient’s suitability for surgery is determined. If the patient has any absolute contraindications to HAL, open surgery can be offered. The preoperative discussion and consent process must always include the possibility of conversion to an open procedure if it cannot be accomplished safely utilizing minimally invasive techniques. During the preoperative discussion, perioperative and postoperative expectations can be explained as well as risks, benefits, and alternatives. Managing perioperative expectations is paramount to good outcomes and patient satisfaction.

Standard mechanical bowel preparation is recommended because an empty colon is easier to manipulate and handle using minimally invasive techniques. The use of oral preoperative antibiotics is at the discretion of the surgeon. Prophylactic intravenous antibiotics at the time of surgery, venous thromboembolism prophylaxis, and perioperative initiatives and care are the same as those for any colectomy. Patients undergoing HAL colectomy are appropriate candidates for enhanced recovery protocols if those are utilized.

SURGERY

Positioning

The patient is placed supine on the operating room table. Other positions include modified low lithotomy position with the thighs at or slightly below the level of the hip to prevent interference with laparoscopic instrument mobility. Split leg positioners can also be utilized because these devices support the entire lower extremity, decreasing the chance of peroneal nerve injury and offer the surgeon access to stand between the legs should the need arise. The author's preference is to place the patient in split leg position. A restraint device can be placed across the patient's chest to help prevent slippage on the operating room table during manipulation of the table intraoperatively for positioning. The legs can be similarly secured if in split leg position. The left arm should be padded and tucked at the patient's side. Pneumatic sequential compression devices are placed to reduce the risk of deep vein thrombosis. A bladder catheter is inserted to decompress the bladder intraoperatively. Orogastric decompression can be accomplished by the anesthesia team. The surgeon and assistant stand to the patient's left and monitors are placed on the patient's right side. One or more monitors can be used if available. The scrub technician stands to the patient's right side (Fig. 6-1). Alternatively, the surgeon can stand between the patient's legs with the assistant to the patient's left side, while the scrub can remain on the patient's right side.

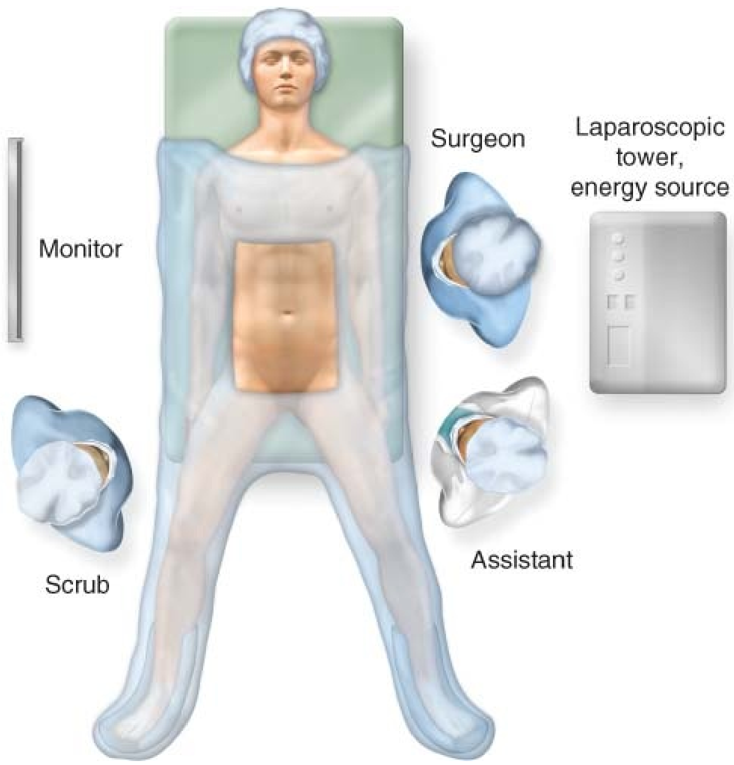


FIGURE 6-1 Operating room and patient positioning for hand-assisted laparoscopic (HAL) right colectomy.

Port Placement

Port placement and location of the hand-assist port vary based on patient anatomy, surgeon preference, and surgeon confidence in being able to complete the operation laparoscopically. Two options exist to initiate the operation—placement of a traditional laparoscopic port usually in the periumbilical location and then evaluation and placement of the hand-assist port or initial placement of the hand-assist port with subsequent laparoscopic port placement. The approach is often related to surgeon experience and certainty of the diagnosis.

Figure 6-2 demonstrates some of the more common ports and hand-assist device layouts. Parts A,B, and C demonstrate a 10-or 12-mm supraumbilical Hasson-type port with the hand-assist device in the right lower quadrant, vertical suprapubic location, and low transverse suprapubic location. An additional 5-mm port is placed in the left lower quadrant with the option to place an additional 5-mm port in the midepigastrum if required to assist with dissection or retraction. Figure 6-2D illustrates the hand-assist device in the periumbilical location with two additional ports on the left side of the abdomen, one for the camera and one for a working port. The placement of the hand in the midline/periumbilical location allows the most surgical versatility, but the hand can obscure visualization. Current hand-assist devices allow easy insertion and removal of the hand into and out of the peritoneal cavity while maintaining pneumoperitoneum. The size of the incision required for the hand-assist device is typically the same as the glove size of the surgeon in centimeters. Once the location is chosen and the incision is made, the wound retractor/protector is placed and secured. The hand-assist port is then secured to the base. The use of surgical lubricant on the back of the surgeon's gloved hand facilitates hand exchanges through the hand-assist port.

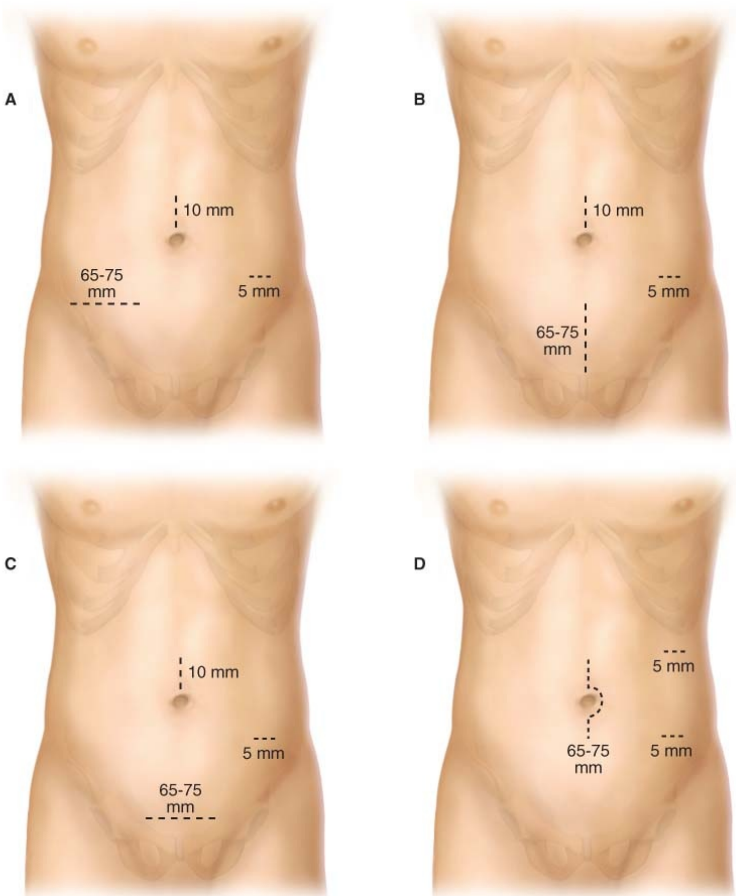


FIGURE 6-2 Hand port options for hand-assisted laparoscopic (HAL) right colectomy. A. Right lower quadrant. B. Supra pubic midline. C. Supra pubic transverse. D. Periumbilical midline.

Pneumoperitoneum is achieved using standard carbon dioxide insufflation and is typically maintained at 15 mm of mercury throughout the procedure. A 10-mm 30-degree laparoscope is utilized and placed through the periumbilical port mm 30-degree laparoscope is utilized and placed through the periumbilical port. Initial gross exploration of the peritoneal cavity is carried out to confirm the anatomy, confirm the diagnosis, ensure there are no severe dense adhesions, and to examine the surfaces of the liver and peritoneum. After completing initial evaluation of the abdominal cavity and contents, the procedure is initiated. In addition to the laparoscope and the hand-assist port, an energy device for dissecting and vascular pedicle control is also typically utilized. Five-millimeter versions of current energy device technologies can be utilized on the basis of surgeon or hospital preference, or standard electrocautery can be used for dissection with the use of clips, ties, or staples for control of vascular pedicles.

Mobilization of the Right Colon

The steps of the operation are the same as with an open right hemicolectomy. There are two approaches, the lateral-to-medial approach, which is the same operation that is taught and done using the open approach, and the medial-to-lateral approach. The medial-to-lateral approach first gains control of the vascular pedicle and uses the colon's attachments to aid in the dissection.

Medial-to-Lateral

The patient is positioned initially head down or in Trendelenburg position with right side up. The cecum is grasped and retracted anteriorly into the right lower quadrant, which places the ileocolic pedicle on stretch and allows for its identification (Fig. 6-3). The ileocolic pedicle is then isolated by scoring the peritoneum overlying it at its base and skeletonizing it from surrounding structures (Fig. 6-4). The duodenum can be identified just cephalad to this and is swept posteriorly out of harm's way. The ileocolic pedicle is then controlled and divided at its takeoff using an energy device, clips, ties, or a laparoscopic stapler —whichever the surgeon prefers. Once the pedicle is divided, the mesentery of the right colon is elevated off of the retroperitoneum in the avascular plane utilizing gentle blunt dissection (Fig. 6-5). The dissection is carried out lateral to the right sidewall, medial toward the midline, and cephalad to the inferior edge of the liver. During this dissection, the duodenum is swept posteriorly and protected. The right colic vessels can be sacrificed during this portion of the dissection. Next, attention is turned to the remaining lateral attachments of the right colon. The terminal ileum is elevated off of the right pelvic brim by incising the peritoneum and raising it off the right iliac vessels and right ureter. Mobilization of the terminal ileum is carried to the level of the duodenum. The dissection is continued along the cecum and right colon by dividing along the white line of Toldt using the surgeon's finger as necessary to dissect the correct plane and to fully mobilize the colon by completing the dissection that was carried from the medial side. This dissection is carried to the hepatic flexure. The patient is then positioned in reverse Trendelenburg and the omentum is elevated anteriorly and freed from the hepatic flexure, dissecting toward the mid transverse colon. The hepatocolic and gastrocolic ligaments are divided sharply until reaching the mid transverse colon. Care must be taken during this dissection to protect the duodenum. This dissection can be carried out with electrocautery or an energy device. This dissection should allow for adequate mobilization of the colon to be able to exteriorize it, or to allow intracorporeal division of the right branch of the middle colic vessels.

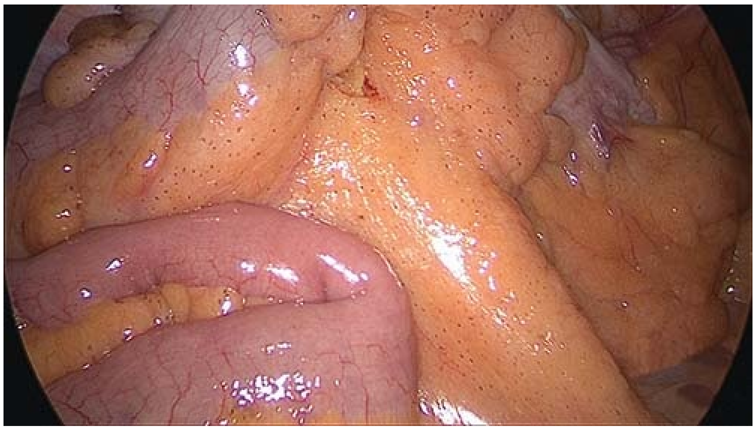


FIGURE 6-3 Ileocolic pedicle on stretch.

FIGURE 6-4 Relationship of duodenum to ileocolic pedicle.

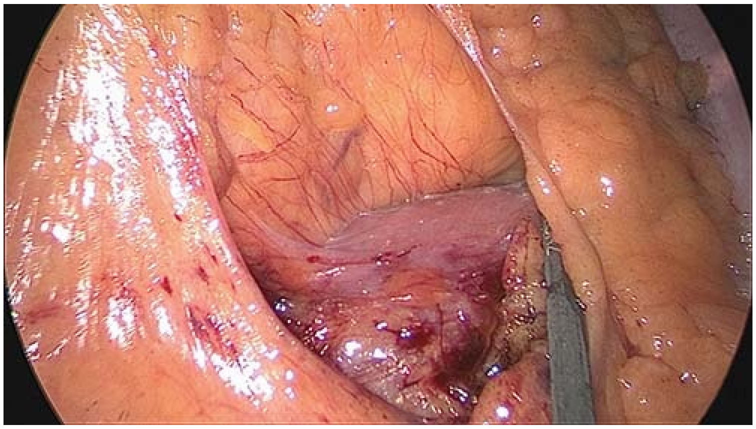


FIGURE 6-5 Dissecting right colon mesentery away from retroperitoneum.

p. 46

p. 47

Lateral-to-Medial

The lateral-to-medial approach follows the steps that most surgeons are typically taught during open right hemicolectomy and therefore familiar to most surgeons, including trainees. The patient is placed in Trendelenburg position with the right side up. The operation begins with mobilization of the terminal ileum and cecum by incising the peritoneum and retracting the cecum toward the left upper quadrant. The terminal ileum is elevated from the right pelvic brim, protecting the iliac vessels and right ureter during the dissection. The cecum and appendix are freed from retroperitoneal attachments. The dissection is continued along the ascending colon working toward the hepatic flexure by dividing along the white line of Toldt. The correct plane raises the right colon out of the retroperitoneum without disturbing retroperitoneal structures or tissue. The duodenum needs to be positively identified and swept posteriorly to avoid mobilizing it along with the colon. The terminal ileum and cecum are fully mobilized to the level of the duodenum. Further dissection is carried from the hepatic flexure toward the mid transverse colon by freeing the attachments of the omentum, gallbladder, and stomach, staying close to the colon, and working in the avascular plane. The transverse colon is further mobilized onto its mesentery so that the entire right colon is now mobilized onto its mesentery off of the retroperitoneum. The vascular pedicles and mesentery can be intracorporeally or extracorporeally divided. In obese patients, intracorporeal division is often easier as the mesentery can be fore shortened and difficult to exteriorize. Intracorporeal division is preferred for malignant diseases to ensure high ligation of the pedicles.

Extracorporeal Anastomosis

Once the colon is fully mobilized utilizing either the medial-to-lateral or lateral-to-medial approach, it can be exteriorized through the hand-assist port for the division of the bowel and the anastomosis (Figures 6-6 and 6-7). The patient can be returned to neutral position. The bowel can be divided utilizing techniques familiar to the particular surgeon. Typically, if a laparoscopic stapler was used to control the vascular pedicles, this can be used to perform bowel division and anastomosis. If a laparoscopic stapler was not utilized, an open stapler can be used to divide the bowel and perform the anastomosis. Any remaining mesentery or vascular pedicles can be ligated and divided. A side-to-side, functional end-to-end anastomosis is fashioned and the enterotomy created can be closed using a stapler or can be hand-sewn closed. Alternatively, a hand-sewn anastomosis can be performed if that is the surgeon's practice. The mesenteric defect can be left open or closed depending on the surgeon's preference. The anastomosis is then returned intracorporeally to the abdominal cavity and irrigation of the abdomen can be performed. The remaining laparoscopic ports can be removed. Any fascial defect larger than 8 mm should be re-approximated. The fascia at the hand-assist port is re-approximated in either an interrupted or running manner. Skin incisions are all irrigated with warned saline solution. Skin is closed utilizing an absorbable subcuticular technique or an alternative of the surgeon's preference.

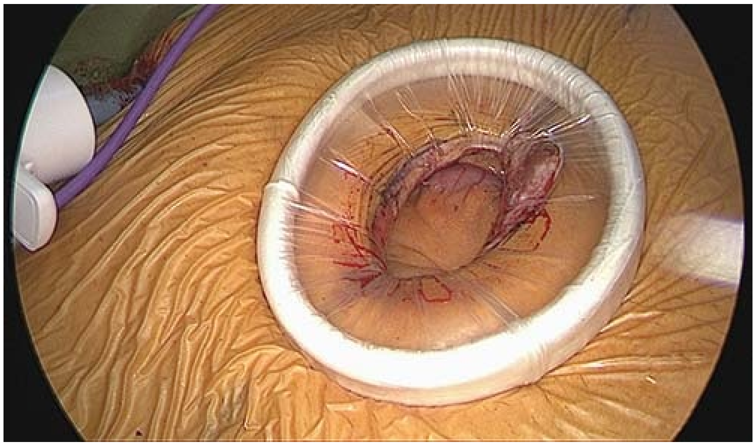


FIGURE 6-6 Hand port wound protector in the incision.

FIGURE 6-7 Terminal ileum, right colon and transverse colon exteriorized through incision for extracorporeal resection and anastomosis.

POSTOPERATIVE MANAGEMENT

Patients undergoing HAL right hemicolectomy can enjoy benefits similar to those appreciated by patients undergoing laparoscopic surgery including quicker return of bowel function, less postoperative pain, earlier discharge from the hospital, and sooner return to activities. Patients should be out of bed ambulating the same day as surgery, typically within 6 hours of the operation completion. Clear liquid diet is permitted when the patient is fully awake and diet advanced as tolerated. Non-opiate pain control is encouraged, whereas narcotics are reserved for pain not controlled by other modalities. Urinary catheter is removed on the first postoperative day. Discharge criteria vary by surgeon and institution, but typically include tolerance of diet, pain control, and passage of flatus. Activity can be as tolerated with the exception of heavy lifting or straining, which should be limited for the first several weeks according to the surgeon's practice.

COMPLICATIONS

Complications of HAL right hemicolectomy are similar to complications of open or laparoscopic right hemicolectomy and can be divided into intraoperative and postoperative complications. The main intraoperative complications include bleeding and injury to other intra-abdominal structures. Bleeding can result from lack of complete ligation of vascular pedicles, tearing of mesentery, or aggressive blunt dissection that is not carried out in an avascular plane. Immediate recognition and control of bleeding is mandatory, and there should be no evidence of ongoing bleeding before completing the operation. Injury to other structures such as enterotomies or colotomies can occur more frequently if adhesions are present. Thermal injury to bowel not being resected needs to be recognized intraoperatively, because delayed perforation can occur if not detected and repaired. Other intraoperative complications specifically related to laparoscopic techniques include hypercarbia, injury to bowel or vessels during port placement, and tearing or traction injuries from laparoscopic instruments. Ureteral or urinary tract injuries can occur during mobilization of the right colon as can duodenal injuries. Care must be taken to protect retroperitoneal structures.

Postoperative complications mirror those of open colectomies. Anastomotic leaks are the most serious complications, and optimal surgical techniques including ensuring appropriate blood supply, avoiding tension, good alignment of the bowel, and gentle atraumatic tissue handling must be adhered to. Wound infections or surgical site infections are a relatively common postoperative complication from colon resections. Preventative measures such as mechanical and antibiotic bowel preparation, perioperative prophylactic antibiotics, and intraoperative normothermia can help minimize the incidence of wound infection. In addition, HAL colectomy uses a wound protector as part of the hand-assist device, protecting the skin and subcutaneous tissues from contamination.

Venous thromboembolism and pulmonary embolism can and should be prophylaxed against typically utilizing chemical and mechanical methods. Early mobilization can also help prevent deep vein thrombosis and is encouraged. Incentive spirometry and early mobilization also help prevent pulmonary complications. Complications such as postoperative ileus and early postoperative bowel obstruction can prolong hospital stay. Minimizing narcotics, ambulating, gum chewing, and targeted, goal-directed fluid management can help minimize the chance of developing an ileus.

RESULTS

HAL colectomy has been compared to both traditional open colectomy and laparoscopic colectomy. Studies have shown that patients undergoing HAL colectomy retain the benefits of straight laparoscopic surgery, but allow the intraoperative use of the surgeon’s hand. The use of HAL techniques can help overcome some of the technical challenges of laparoscopic colectomy while still conferring the benefits of smaller incisions, less postoperative pain, earlier return of bowel function and earlier return to activity. Many studies investigating HAL colectomy have focused on left or total colectomies, but several studies have compared laparoscopic right colectomy to HAL right colectomy and have shown similar short term outcomes.

CONCLUSIONS

Hand-assisted right colectomy is a safe and feasible alternative to both open and laparoscopic right hemicolectomy. It offers the advantages of laparoscopic surgery, but allows the surgeon to use the hand to help retract, mobilize, palpate and dissect. Although traditionally HAL colectomy has been used for left and total colectomies, it may play a role in right colectomy for a more novice surgeon or a more difficult patient condition or pathology.

RECOMMENDED READINGS AND REFERENCES

Chang YJ, Marcello PW, Rusin LC, Roberts PL, Schoetz DJ. Hand-assisted laparoscopic sigmoid colectomy: helping hand or hindrance? *Surg Endosc* 2005;19:656–61.

Chung CC, Kei Ng DC, Chieng Tsang WW, *et al.* Hand-assisted laparoscopic versus open right colectomy: a randomized controlled trial. *Ann Surg* 2007;246:728–33.

Delaney CP, Marcello PW, Sonoda T, *et al.* Gastrointestinal recovery after laparoscopic colectomy: results of a prospective, observational, multicenter study. *Surg Endosc* 2010;24:653–61.

HALS Study Group. Hand-assisted laparoscopic surgery vs standard laparoscopic surgery for colorectal disease. *Surg Endosc* 2000;14:896–901.

Kang JC, Chung MH, Chao PC, *et al.* Hand-assisted laparoscopic colectomy vs open colectomy: a prospective randomized trial. *Surg Endosc* 2004;18:577–81.

Marcello PW. Hand-assisted laparoscopic colectomy: a helping hand? *Clin Colon and Rectal Surg* 2004;17:125–9.

Marcello PW, Young-Fadok T. Laparoscopy. In: Wolff BG, Fleshman JW, Beck DE, Pemberton JH, Wexner SD, eds. *The ASCRS Textbook of Colon and Rectal Surgery*. New York, NY: Springer, 2007:693–712.

Pendlimari R, Nelson H. Laparoscopic colorectal procedures. In: Zinner MJ, Ashley SW, eds. *Maingot's Abdominal Operations*. 12th ed. New York, NY: McGraw-Hill, 2013.

Targarona EM, Gracia E, Garriga J, *et al.* Prospective randomized trial comparing conventional laparoscopic colectomy with hand-assisted laparoscopic colectomy: applicability, immediate clinical outcome, inflammatory response, and cost. *Surg Endosc* 2002;16:234–9.

Vogel JD, Lian L, Kalady MF, de Campos-Lobato LF, Alves-Ferreira PC, Remzi FH. Hand-assisted laparoscopic right colectomy: how does it compare to conventional laparoscopy? *J Am Coll Surg* 2011;212:367–72.

PART II

LEFT COLON

Chapter 7

Open Medial-to-Lateral (Left Colon)

Mahmoud Abu-Gazala and Alon J. Pikarsky

INDICATIONS/CONTRAINDICATIONS

Left colectomy may be performed as a standalone procedure or as part of a more extended colectomy. The extent of dissection and resection is dependent on the specific etiology. Although benign diseases may dictate a more conservative resection, most left colectomies are performed for malignancies. Oncologic resection of malignant tumors of the left colon dictates complete mesocolic resection, where the entire nodal basin of the tumor is dissected and removed. Thus, tumor location dictates the anatomic margins of the resection. The blood supply to the left colon arises mainly from the inferior mesenteric artery (IMA) and from the arcades originating from the middle colic pedicle through the marginal artery of Drummond. In recent years, the minimally invasive approach for colon resection has been proved to be an adequate and safe alternative to the open approach both for benign and malignant etiologies. In our department, the percentage of laparoscopic colectomies performed either for malignant disease or benign etiologies has dramatically risen during the past few years. However, open left colectomy is still indicated for complex cases such as locally advanced colon cancer.

The approach for left colectomy is usually performed using the lateral-to-medial approach, in which the colon is first mobilized and then devascularization and resection are performed. However, medial-to-lateral dissection is sometimes indicated when mobilization of the colon from the lateral attachments could be difficult, for instance, when the abdominal wall is involved by the colonic pathology, due to malignant invasion or inflammatory response. This approach allows early control of the vascular pedicle and early identification and preservation of vital structures that might be damaged if the lateral-to-medial approach is chosen. In those cases where lateral mobilization of the colon might be difficult, access to the lateral vital structures (iliac vessels, ureter, renal pelvis, inferior mesenteric vein (IMV), ligament of Treitz, and splenic pedicle) through the mesenteric window may allow early identification and preservation.

The medial-to-lateral approach has primarily been described as a part of the "no-touch isolation technique" developed by Barnes and Turnbull in the 1950s. Their rationale was based on the work by Tyzzer in 1913 and Cole in 1954, who suggested that colon mobilization and tumor manipulation may seed cancerous cells into the venous drainage and worsen prognosis. Using the medial-to-lateral approach, the tumor is left in situ, whereas the vascular pedicle is ligated, thus preventing vascular tumor cell seeding. Turnbull operated on 460 patients with carcinoma of the colon using the “no-touch technique,” achieving an outstanding result of doubling the 5-year survival rate in those patients. Contraindications to the medial-to-lateral approach may include massive lymphadenopathy along the vascular pedicle, or significant fibrosis, thickening, or inflammatory conditions involving the mesenteric bed. In such cases, addressing the vascular pedicle first might be very complicated and potentially dangerous.

PREOPERATIVE PLANNING

Complete history and physical examination are mandatory. Special attention should be paid to cardiopulmonary diseases, with preoperative anesthetic evaluation ordered as required, and control and stabilization of patients' comorbidities before surgery. Knowledge of any prior abdominal surgery is of outmost importance.

Thorough evaluation of the colonic pathology should include additional studies as needed. Endoscopic study of the colon is mandatory in the evaluation of most patients, especially those suffering from malignancies. Evaluation of the entire colon is necessary for proper operative planning. The surgeon should exclude any synchronous malignancy or any other concomitant pathology.

Computed tomography is of great importance in the assessment of the locoregional significance of the colonic disease, thus aiding the preoperative planning. In malignant disease, evaluation of distant metastases is standard for patient management. Other imaging modalities such as magnetic resonance imaging or positron emission tomography-computed tomography may also be indicated in the preoperative workup in some cases.

SURGERY

Patient Preparation

Use of mechanical bowel preparation before surgery has been the subject of great controversy and focus of several randomized prospective trials. Results of trials range between beneficial effects for use of mechanical bowel preparation and increase in the rate of complications. Several trials have shown a significant decrease in surgical site infections in the mechanical bowel preparation group, when combined with both oral and systemic antibiotics, whereas other trials have shown a higher rate of wound infection in patients receiving a bowel preparation. Most trials, however, have shown no difference in complication rates with or without bowel preparation, including anastomotic leak rate and wound infections.

In the authors' department, the practice of most surgeons is to administer preoperative oral and parenteral antibiotics in addition to mechanical bowel preparation before any colon resection. A poor bowel preparation, where the bowel is full of watery stool that might readily spill, greatly increases the risk for postoperative surgical site infection.

Special situations that may deem bowel preparation necessary include laparoscopic resections for small non-readily palpable tumors or under conditions that may necessitate intraoperative colonoscopy. It is also beneficial to clear at least the distal bowel from fecal material before surgery, by means of an enema, when use of a circular stapler is expected.

It is the practice in most cases to administer a single dose of low-molecular-weight heparin subcutaneously on the evening before the operation day.

It is our routine to use a pneumatic compression device during all abdominal operations. Placement of an epidural catheter combined with anesthesia is recommended for all our patients when no specific contraindication is present. A nasogastric tube (NGT) is placed after anesthesia induction for all patients. A urinary catheter is routinely placed for all patients undergoing a colon resection. Ureteric stents are placed in cases of a bulky tumor invading the retroperitoneum or adjacent to the ureters as might be suspected during preoperative evaluation. Prophylactic parenteral antibiotics are administered, by the anesthesiologist, half an hour before skin incision.

Positioning

The patient is placed and secured in the modified lithotomy position using the Yellofin (r) Allen stirrups (Allen, Acton, MA). The patient's perineum is positioned a few centimeters below the tip of the operating table to allow for easy access during operation. A silicone pad is placed under the sacrum to reduce the risk of pressure sores. Both hands are usually positioned tightly against the body, and protective padding is used to prevent pressure sores and nerve damage. The patient is then prepped using soap and alcohol-based chlorhexidine solution for the abdomen. Iodine-based solution is used for the perineum. The patient is then draped superiorly over the chest, laterally over the anterior superior iliac spine, and inferiorly over the pubis.

Technique

Access to the abdominal cavity is gained via a midline incision. In the case of prior abdominal operations, all adhesions are lysed using sharp dissection with electrocautery or scissors. The falciform ligament is then ligated and divided, and the abdominal cavity is thoroughly explored and assessed for the presence of any metastatic disease or other pathologies. The correct placement of the NGT is confirmed. It is our preference to use the Bookwalter (r) retractor (Symmetry Surgical, Antioch, TN), which allows for adequate retraction and exposure of all the parts of the abdominal cavity. Four right-angle abdominal wall retractors are placed in all four quadrants, taking care not to injure the intra-abdominal structures. The small bowel is then encircled using two large pads and retracted to the right, to expose the base of the left colic mesentery and pelvic inlet.

At this stage it is very important to evaluate the primary colonic pathology, the condition and quality of the colon, and assess the extent of resection and amount of splenic flexure mobilization needed. Malignant pathologies dictate complete mesocolic excision with division of the vascular pedicles at their base, dependent on the exact location of the lesion. The borders of resection are then selected on the basis of the limits of devascularization necessary for an adequate oncologic resection. Diverticular disease may not necessitate high ligation of the vascular pedicle, but the distal resection margin should lie at or below the upper rectum, whereas the proximal margin depends on the quality of the remaining colon. Splenic flexure mobilization is usually undertaken. Intraoperative planning at this stage is of paramount importance to minimize intraoperative and postoperative complications.

The IMV is located just lateral to the ligament of Treitz at the base of the left colon mesentery. The IMV passes posterior to the tail of the pancreas to drain into the splenic vein. The IMA arises from the anterior surface of the aorta just superior to its bifurcation. The IMA and IMV can be further identified by lifting the mesentery of the left colon anteriorly, which tents the peritoneum overlying those vessels. IMA can be further identified aided by sensation of its pulse. There is an avascular plane lying at the base of the mesentery between the IMA and IMV, and also from the IMA inferiorly toward the sacral promontory, just anterior to the aorta and iliac vessels. The peritoneum is scored using electrocautery, alongside the base of the left colon mesentery, starting from the sacral promontory superiorly toward the IMV. This stage usually includes mobilization of the fourth part of the duodenum. Gentle traction should be applied to the colon and mesentery to allow for easier entry to the areolar plane at the base of the mesentery. This step is crucial for the correct dissection and identification of the lateral structures. Blunt and sharp dissection should commence in the areolar plane, at the level of the sacral promontory, where it is easiest to identify the ureter and the gonadal and the iliac vessels (Fig. 7-1). If the ureter is not readily identified, it is possible that the ureter has been lifted from the retroperitoneum and is still attached to the posterior aspect of the mesocolon. The ureter and gonadal vessels should be traced upward toward the kidney, mobilizing the mesocolon from the retroperitoneum and Gerota's fascia, keeping the ureter safe at the retroperitoneum. The avascular window at the base of the mesocolon superior to the IMA should also be dissected, thus allowing for clear identification of the IMV and IMA. Further dissection and isolation of the vascular pedicles is carried on using electrocautery, up to the origin of the IMA. The vessels are then divided using double ties.

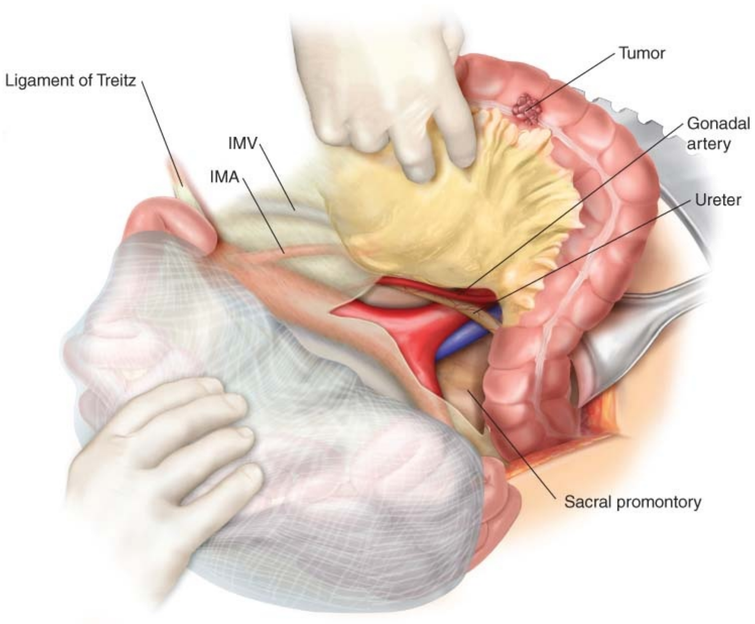


FIGURE 7-1 Left colon being retracted while the peritoneum at the base of the mesentery is incised, from the level of the sacral promontory upward, exposing the areolar plane. Dissection is continued, lifting the mesocolon from the retroperitoneum and exposing the ureter and the gonadal vessels. IMA, inferior mesenteric artery; IMV, inferior mesenteric vein.

The base of the mesocolon is thus free to be lifted, facilitating further lateral

The base of the mesocolon is thus free to be lifted, facilitating further lateral dissection in the avascular plane toward the line of Toldt. Special attention should be paid toward dissection near the tail of the pancreas and the lower pole of the spleen. At this point, the Toldt line is incised, allowing full mobilization of the left colon from its bed. The exact borders of colonic resection are evaluated again at this stage, and the extent of splenic flexure mobilization is addressed again to allow for a tension-free anastomosis.

When approaching the splenic flexure, we usually reposition the retraction of the small bowel to the right lower abdominal quadrant, to allow for easier access to the transverse colon. The lesser sac is entered by dividing the gastrocolic ligament near its attachment to the colon. This allows mobilization of the splenic flexure from both sides, which facilitates takedown and reduces the risk for splenic injury. Dissection in the areolar tissue is carried on using electrocautery, with division of the lienocolic ligament completed between ties. The splenic flexure is then further dissected along the avascular plane from the retroperitoneum to allow for a tension-free anastomosis. The colon is then divided distally and proximally depending on the primary pathology and quality of the remaining colon and blood supply. We verify that the proximal and distal ends may be brought together for a tension-free anastomosis. We usually elect to divide the colon using a linear stapler, with the mesocolon being divided at the level of bowel division, between ties or using any sealing device such as clips – LigaSure (tm) (Covidien, CO) or Enseal (R) (Ethicon Endo-Surgery, Inc., Cincinnati, OH).

The authors' preference is to perform a Baker (side-to-end) anastomosis when possible. The proximal staple line is reopened and the anvil is inserted through the lateral wall of the proximal colon about 3–4 cm from the staple line, which is now resealed using another linear stapler. A hemostatic running suture is then placed over the staple line. A circular stapler is introduced through the anus and guided up to the staple line and the trocar introduced through the middle of the staple line. The proximal colon is guided toward the anastomosis site, making sure that the mesocolon is not twisted, and the anvil is connected to the pin. The circular stapler may then be closed and fired under direct vision. After firing the stapler, the anastomosis is inspected and checked for leak. The proximal bowel is occluded while the anastomosis is inflated with betadine solution. The anastomosis is then submerged in saline solution and insufflated again using air. In the event of a leak, the anastomosis can be reinforced with sutures and may be diverted or resected and reperformed.

A surgical drain is left near the anastomosis for 3–4 days to evacuate a possible hematoma. Abdominal wall closure is performed in standard manner.

POSTOPERATIVE MANAGEMENT

Patients benefit from an accelerated perioperative care pathway aiming to enhance early recovery and shorten hospital stay. Patient education is essential for reduced postoperative complication rate and accelerated recovery. Most of our patients receive an epidural catheter for enhanced postoperative pain management via patient-controlled analgesia. If an epidural catheter is not installed, an intravenous pump is used for the first 3 days postoperatively and supplemented with peripheral nonsteroidal anti-inflammatory drugs when required. Antibiotics are discontinued 24 hours after surgery.

All patients should receive venous thromboembolism prophylaxis using pneumatic compression devices that are in place during the operation and subcutaneous fractioned heparin injections beginning1 day after surgery.

Postoperative respiratory complications are minimized using early ambulation, pulmonary physiotherapy, and incentive spirometry.

Surgical dressings are removed on postoperative day 2 and the patient is encouraged to shower.

NGT is not required routinely after the operation, except when the patient suffers from ileus. However, in the setting of a lengthy operation with significant adhesiolysis or bowel handling, we prefer to keep the NGT in place until the patient passes flatus. With return of bowel function, the diet is advanced from clear liquids to regular food.

Patients are discharged home when they are feeling well and able to tolerate enteral feeding.

RECOMMENDED REFERENCES AND READINGS

Chen M, Song X, Chen LZ, Lin ZD, Zhang XL. Comparing mechanical bowel preparation with both oral and systemic antibiotics versus mechanical bowel preparation and systemic antibiotics alone for the prevention of surgical site infection after elective colorectal surgery: a meta-analysis of randomized controlled clinical trials. *Dis Colon Rectum* 2016;59(1):70–78.

Guenaga KF, Matos D, Castro AA, Atallah AN, Willie-Jorgensen P. Mechanical bowel preparation for elective colorectal surgery. *Cochrane Database Syst Rev* 2005;25(1):CD001544.

Slim K, Vicaut E, Panis Y, Chipponi J. Meta-analysis of randomized clinical trials of colorectal surgery with or without mechanical bowel preparation. *Br J Surg* 2004;91(9):1125–30.

Chapter 8

Open Left and Sigmoid Colectomy—Lateral to Medial

William C. Chapman Jr and Matthew G. Mutch

INDICATIONS/CONTRAINDICATIONS

Left and sigmoid colectomy are most frequently performed for malignancy or diverticular disease. With either process, the location and extent of disease along with vascular anatomic considerations predicate the extent of required resection. Diverticular disease, for example, often requires only a complete sigmoid resection, with dissection of the left colon performed to facilitate the primary anastomosis of the healthy rectum to soft descending colon. However, in the setting of malignancy, complete resection requires removal of both the tumor and the entire vascular and lymphatic tissue of the colonic portion in question. Because the left colon is proximally supplied by arcades of the middle colic pedicle, namely, the marginal artery of Drummond, and distally by the inferior mesenteric artery (IMA), both arteries and the inferior mesenteric vein (IMV) must be resected. The sigmoid colon, also perfused by the IMA, must therefore be taken out at times to facilitate complete removal of a left colon cancer. Finally, re-anastomosis of the left colon to the rectum sometimes requires mobilization of the splenic flexure and high ligation of the IMV.

Physiologically, resection of the left or sigmoid colon is easily postoperatively tolerated by most patients. Therefore, the only true contraindication to either procedure is the inability of the patient to tolerate general anesthesia.

PREOPERATIVE PLANNING

For a left or sigmoid colon resection, preoperative planning involves three typical considerations: additional screening for concomitant colorectal disease, the use of bowel preparation, and the initiation of pain management and venous thromboembolism prevention techniques. In addition, a neoplastic lesion must be accurately localized with endoscopic tattooing or imaging such as computed tomography or contrast enema.

In the setting of malignancy, preoperative axial imaging to adequately stage the cancer and exclude distant metastasis is a must. Colonoscopy, usually in the elective outpatient setting, should also be performed before any elective resection to tattoo lesions and ensure the remainder of the colon is disease free.

The appropriate role of mechanical and chemical bowel preparation is controversial and likely surgeon dependent. Widely recognized data have demonstrated no reduction in surgical site infections with the use of a mechanical preparation alone. However, more recent data from large population databases, such as the National Surgical Quality Improvement Program (NSQIP) and the Michigan Surgical Quality Collaborative, have demonstrated that combined mechanical and oral antibiotic preparations have reduced deep and superficial wound infections. In our practice, all patients scheduled for elective left and sigmoid resections undergo a combined oral preparation consisting of polyethylene glycol solution, neomycin, and metronidazole administered in the 12 hours before surgery. Once in the operating room, 1 g of ertapenem or intravenous (IV) ciprofloxacin and metronidazole in penicillin-allergic patients is given for perioperative infection prophylaxis.

A multimodal pain management program and venous thrombus prophylaxis is utilized in the preoperative period for all elective colon resections. Each patient receives a gram of oral acetaminophen and 12 mg of alvimopan, along with placement of an epidural analgesic infusion catheter by the anesthesia team. A dose of subcutaneous heparin is also administered before entering the operating room.

It is unusual to require proximal diversion after a left colectomy; but if the plan is to include a stoma, the preoperative marking of the site can improve functional outcomes for the patient.

The patient should be informed of the postoperative bowel function expected after segmental resection of the left and/or sigmoid colon. Bowel function is somewhat less than normal, influenced by the patient’s age and rejected by multiple bowel movements that occur rapidly and urgently.

Patients in whom dense adhesions or inflammatory processes are expected, cystoscopy and ureteric stent placement may be indicated typically at the start of the operation.

SURGERY

Our standard approach for standard open left or sigmoid colectomies is a lateral-to-medial colonic dissection combined with high ligation of the IMV and IMA.

Positioning

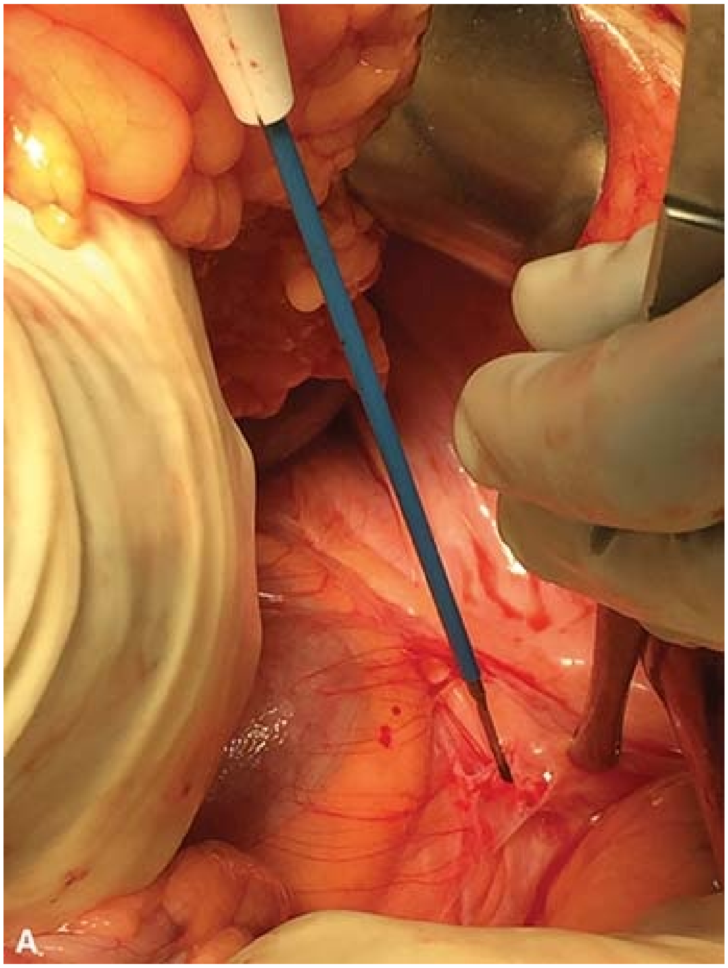
The patient is placed in modified lithotomy position using lithotomy stirrups with sequential compression devices in place. A bladder catheter is sterilely inserted, and the rectum is irrigated with a betadine solution to clear any remaining solid stool. The arms are placed with the left arm extended and the right arm tucked to allow for positioning of a Mayo stand over the patient's chest. Having the scrub assistant above the head allows a direct visual line into the operating field. If the Mayo stand is not placed above the head, both arms may be left out. The abdomen is clipped and prepped, and the patient is then draped in standard manner with sterile leg covers and body drape allowing for abdominal and perineal access.

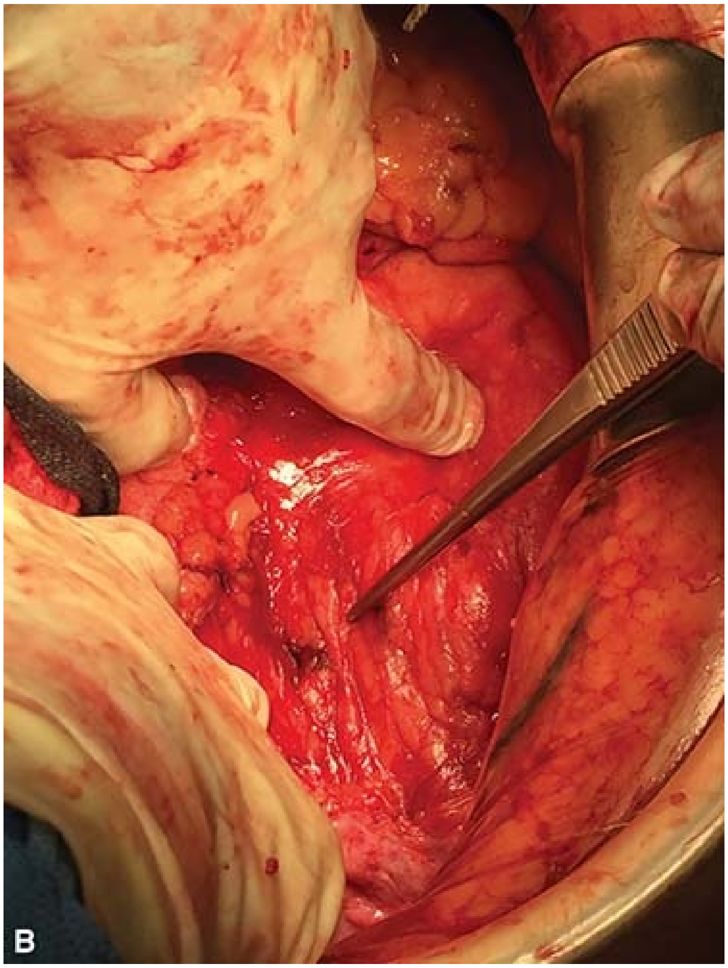
Technique

Mobilization of the Colon

The abdomen is entered through a vertical midline incision from pubis to as far above the umbilicus as needed to mobilize the splenic flexure, and a circumferential plastic wound retractor is placed. The Bookwalter self-retaining retractor is then secured over the laparotomy and opened widely. The small bowel is packed into the right upper quadrant using a damp laparotomy towel and retractors.

An incision is made at the base of the lateral aspect of the left colon mesentery along the white line of Toldt with the left colon retracted medially and anteriorly (Fig. 8-1A). The incision is extended from the pelvis to the left upper quadrant. Under tension, the colon and its mesentery are elevated anteriorly and medially while the retroperitoneal tissue is retracted laterally. The exposed areolar tissue plane anterior to the retroperitoneum is dissected off of the mesentery with electrocautery, exposing the ureter and gonadal vessels (Fig. 8-1B). This plane is extended medially to the base of the aorta and cephalad to the level of the splenic flexure, freeing the left colon from the anterior surface of the kidney (Fig. 8-1C).


A


B

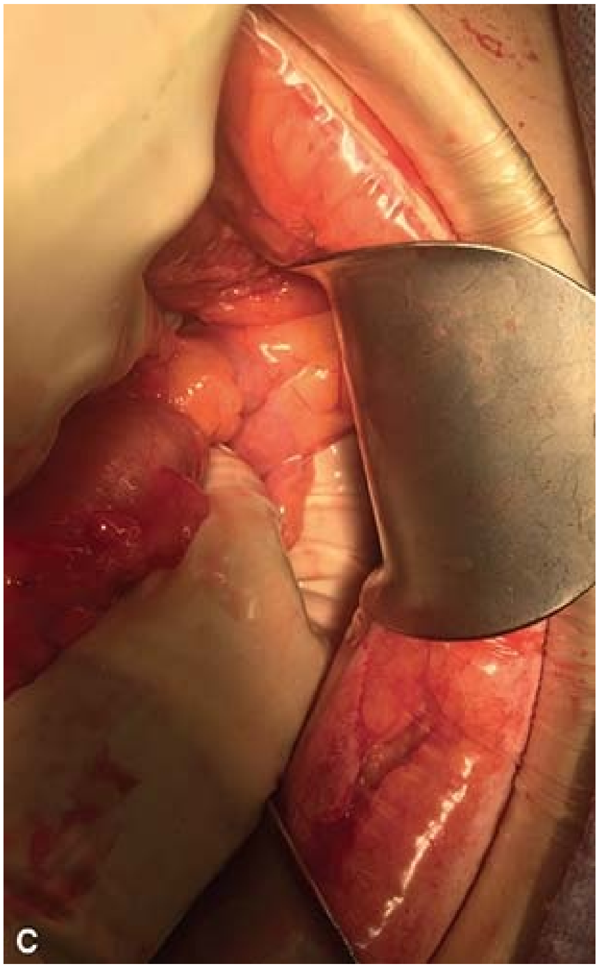


FIGURE 8-1 A. The descending colon is retracted medially as dissection carried through the white line of Toldt with an electrosurgical instrument. B. The colon and small bowel are reflected medially, revealing the left ureter highlighted by forceps in the retroperitoneum. The surgeon's left index finger indicates the left kidney. C. The splenic flexure of the colon is held on tension by the surgeon's right hand, while the index finger protects the colon and distracts the splenocolic ligament for transection with cautery.

To complete the release of the splenic flexure from the left upper quadrant, the omental attachments to the anterior surface of the transverse colon are incised through the midline. Beginning laterally, an incision is made on the peritoneal attachments of the splenic flexure, using the finger as a guide, with the intent to enter the lesser sac by separating the omentum from the transverse colon. Proceeding medially, the colon is released from the omentum. The key is to stay superficial, dividing only the peritoneal attachment between them. Once all of the omental attachments to the transverse colon mesentery are divided, the lesser sac is widely opened. The thicker portions of these attachments are clamped and suture ligated. To fully release the splenic flexure to the midline, attachments to the undersurface of the tail of the pancreas and the retroperitoneum must be incised to the midline toward the duodenum at the ligament of Treitz (Fig. 8-2). Accordingly, the splenic flexure is pulled down and the right hand placed into the retroperitoneum to expose the plane between the undersurface of the spleen tip and the lateral aspect of the abdominal cavity.

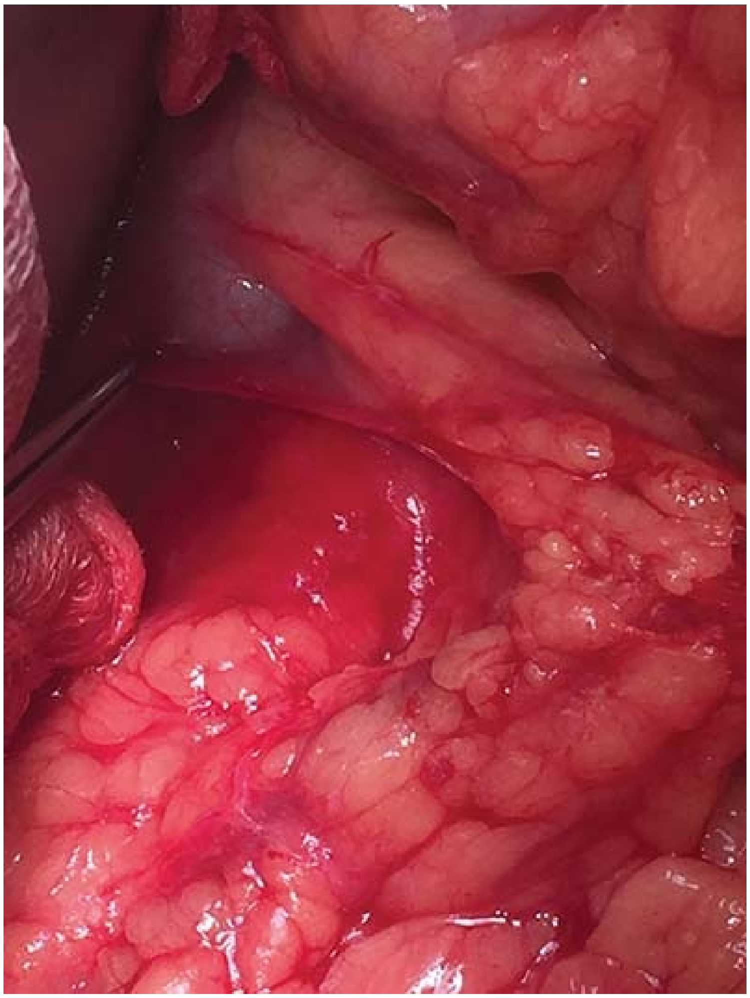
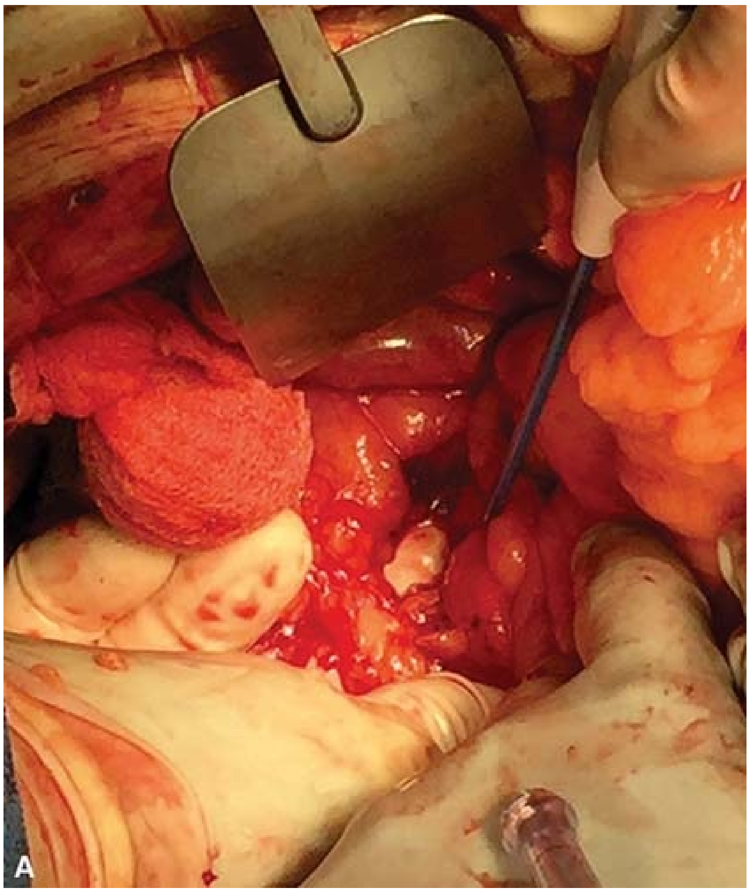
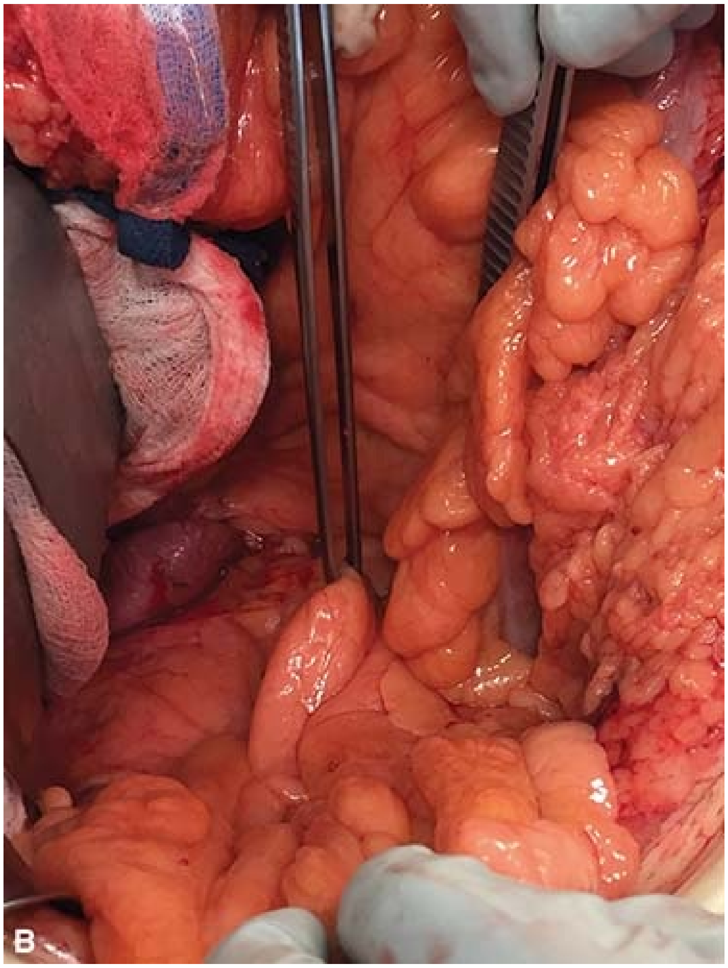


FIGURE 8-2 Forceps indicate colonic attachments to the ligament of Treitz; these must be completely incised to mobilize the transverse colon to the midline.

Excising the Specimen

The left colon is lifted from the abdomen and is pulled to the patient's left, exposing the medial aspect of the left colon mesentery over the sacral promontory. The peritoneum on the right side of the mesentery is incised along a course allowing access to the previously developed lateral plane of dissection. The superior rectal artery is elevated from the retroperitoneum, and the origin of the IMA is isolated at the aorta just above the bifurcation of the common iliac artery (Fig. 8-3A). The IMV is identified just lateral to the ligament of Treitz at the base of the mesentery of the left colon, typically above a window of clear peritoneum along the anterior surface of the aorta (Fig. 8-3B). It is then elevated off of the retroperitoneum and encircled near the inferior border of the pancreas. The IMA and IMV are then divided between ties after confirming the left ureter is safely in the retroperitoneum (Fig. 8-3C).




B

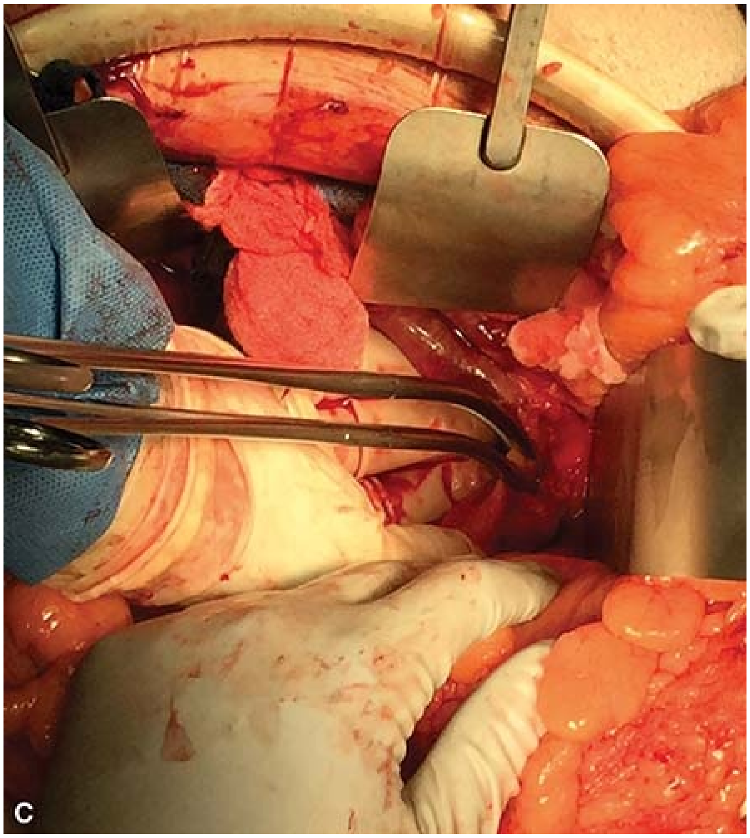
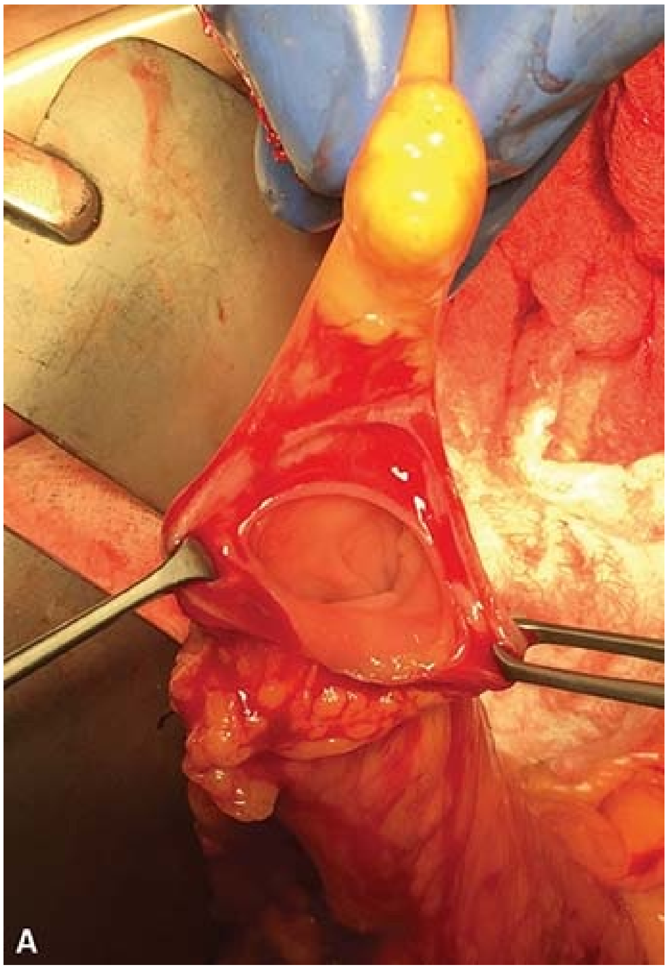


FIGURE 8-3 A. The inferior mesenteric artery (IMA) is dissected at the aorta and encircled prior to ligation, demonstrated here by the surgeon's index and middle fingers. B. The inferior mesenteric vein (IMV) is localized lateral to the ligament of Treitz and grasped with forceps in this image. C. Here, the IMV is doubly clamped at the splenic vein in preparation for ligation.

The left colon is then caudally delivered to the pelvis. If appropriately mobilized, the splenic flexure should reach the pelvic brim. The proximal point of transection is then chosen, taking care to remove adequate proximal and distal margins while leaving enough colon to accomplish a tension-free anastomosis. The mesentery is divided up to the colon, after which the marginal artery is isolated, divided, and then flashed to confirm pulsatile flow. If it is obvious that arterial bleeding is not present, then a more proximal transection site should be chosen. When possible, 5-cm margins are obtained.

The proximal portion of the anastomosis is prepared by placing purse string suture by hand or with an automatic instrument. The purse string is placed carefully to ensure adequate blood supply and prevent tension or twist in the colon. The circular stapler anvil and shaft are then secured in the purse string and reinforced with ties as needed to complete the donut around the base of the shaft (Fig. 8-4).



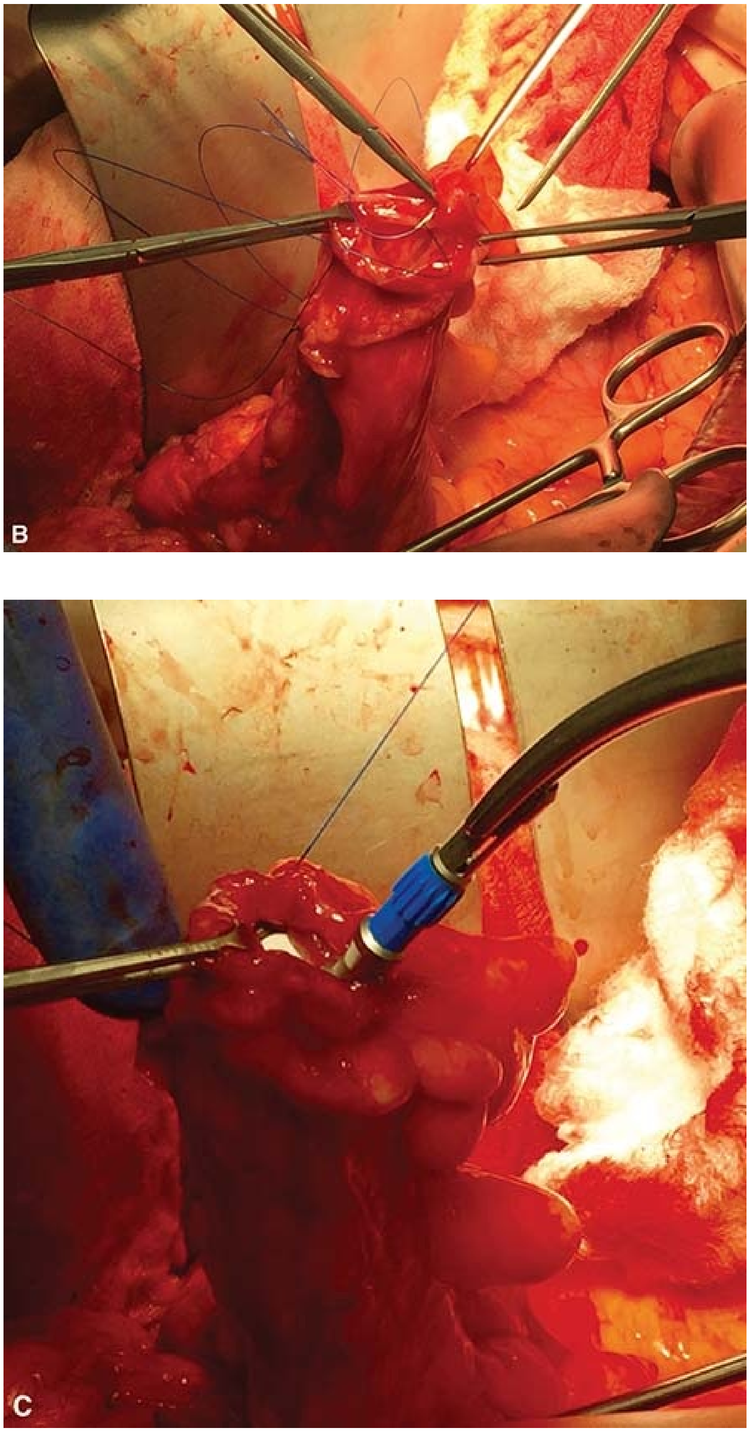


FIGURE 8-4 The proximal colotomy is inspected (A) and a purse string of Prolene suture is placed circumferentially (B). C. The anvil of the circular stapler is secured by tying the suture.

Colorectal Anastomosis

The sigmoid or rectum is then transected at the level of the upper rectum using either a linear cutting stapler or a transverse linear stapler to create the transverse staple line. The intervening mesorectum is then divided between clamps and ligated. The circular stapler itself is then introduced through the anal canal to the level of the transverse staple line, and the post is extended through the midportion of the rectal stump just anterior to the transverse staple line. Before deploying the spike, the stapler head must be flush and flat against the staple line in the rectal stump. At times, the circular stapler can become caught on a rectal fold, causing misfiring of the stapler. If the stapler cannot be maneuvered around this fold, then the rectum should be again divided below the fold, and the circular stapler reintroduced. The compromise of accepting an anterior rectal-to-end-colonic anastomosis is not the solution.

The left colon is brought into the pelvis without twisting its mesentery. The stapler post is then connected to the shaft of the anvil, and the device is closed under direct vision with the mesentery of the left colon directed posteriorly (Fig. 8-5).

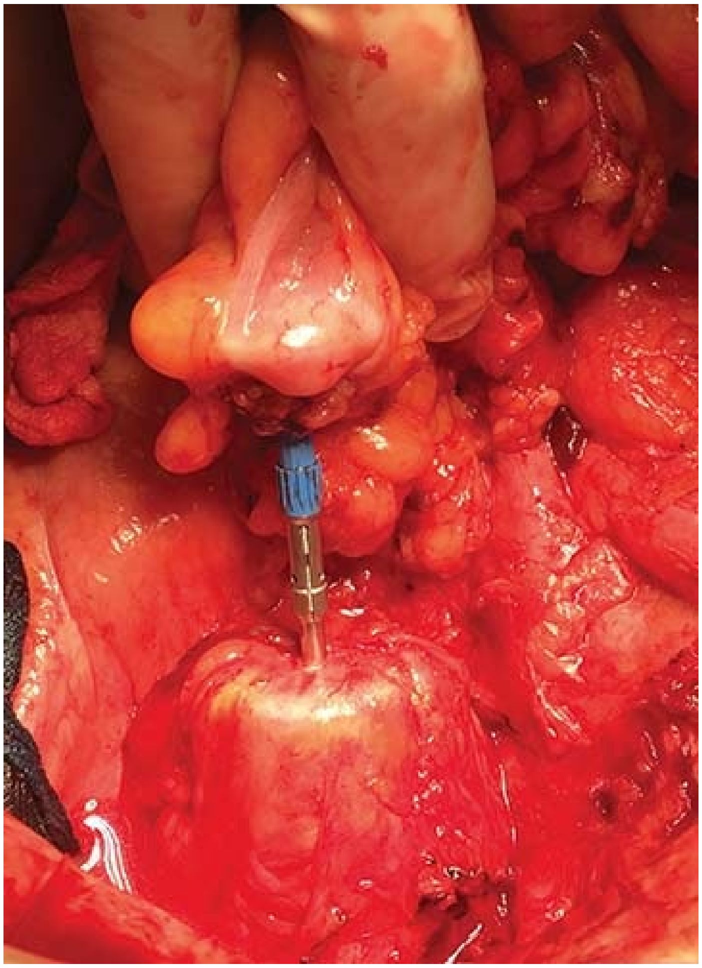


FIGURE 8-5 After deployment of the stapler rod through the rectal cuff, the anvil is coupled to the receptable post.

After firing, the stapler is removed from the anus and both donuts are checked for a complete, uninterrupted ring of full thickness bowel on both. The rings should be sent to pathology as true distal and proximal margins. The staple line may be oversewn with interrupted Lembert stitches based on surgeon preference.

The anastomosis is then tested for leak by insufflating air through a rigid proctoscope placed. First, the pelvis is filled with saline. With the bowel proximal to the stapled anastomosis occluded, air is pumped through the proctoscope into the colon (Fig. 8-6). Small "champagne"-type bubbles would indicate a leak at the staple line and should be addressed with Lembert sutures of 3-0 absorbable material or complete reconstruction of the anastomosis. Larger or more vigorous bubbling should prompt revision of the anastomosis or primary repair with proximal diversion.

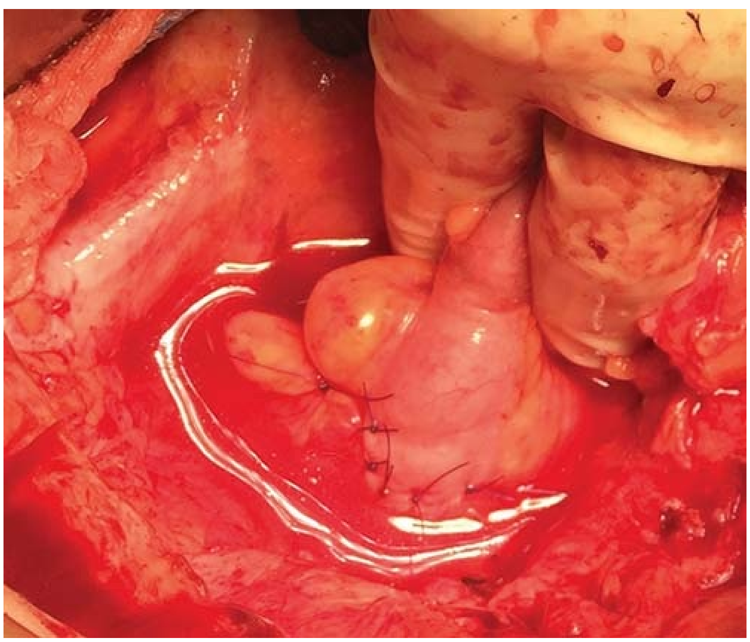


FIGURE 8-6 To test the anastomosis, the pelvis is filled with water. A large bolus of air is then injected via proctoscope; bubbles signify a leak.

At this point, the entire surgical team rescrubs and dons clean surgical garments while the operating room staff prepares a sterile tray of closing instruments. The abdomen is then closed after irrigation and returning the small bowel in gentle S-shaped curves. A drain is not typically left unless there is concern for urologic injury.

POSTOPERATIVE MANAGEMENT

At our institution, patients undergoing uncomplicated left or sigmoid colectomy recuperate under a standardized protocol designed to accelerate recovery. Of course, each patient is assessed for suitability before initiating this protocol, and changes are made as indicated throughout the postoperative course. The general components of our early recovery protocol are listed here. The typical hospital stay is 3–4 days.

Diet and intravenous fluids: On postoperative day 0, patients commence a clear liquid diet and IV fluids are limited to 2 L of dextrose with half normal saline. Thereafter, IV fluid replacement is administered only as necessary as we allow permissive oliguria. Solid food is given on postoperative day 1 and oral fluid replacement is encouraged. Nasogastric decompression is not typically required.

Pain control: Patient-controlled analgesia devices are started immediately after surgery along with scheduled oral acetaminophen and gabapentin. Epidural analgesia with bupivacaine is also initiated immediately. IV ketorolac is scheduled from postoperative day 1 for a total of 3 days. Typically, transition to oral narcotics occurs on the second postoperative day, and the epidural catheter is removed by postoperative day 3.

Ileus prophylaxis: Patients are ambulated as soon as postoperative day 1. They are also maintained on oral alvimopan until first stool.

Venous thromboembolus and infection prophylaxis: Subcutaneous enoxaparin is started immediately on the evening of surgery and continued, even after discharge, for a total course of 21 days. No further antibiotics are administered after the initial dose of perioperative ertapenem. If ciprofloxacin and metronidazole are instead given, this is typically continued for a total of 24 hours only.

COMPLICATIONS

Ileus, surgical site infections, respiratory insufficiency, and anastomotic leak are the most common postoperative complications associated with open left or sigmoid colectomy. Both intraoperative measures and alterations in our standardized postoperative management regime have significantly reduced the rates of these problems among our patient cohort.

Anastomotic leak is the most feared complication of any colectomy. The anticipated leak rate for a routine left and sigmoid colectomy with colorectal anastomosis is less than 4%. These complications can be conservatively managed with percutaneous drainage of fluid collection and bowel rest if the leak is contained. Re-exploration and takedown of the colorectal anastomosis with end colostomy creation should be performed only in the setting of frank peritonitis and diffuse fecal contamination.

Deep venous thrombosis and pulmonary embolus rates for those patients receiving chemo and mechanical prophylaxis perioperatively should be less than 1%. Thus, we advocate early prophylaxis with enoxaparin (or other anti-Xa compounds) for every colectomy patient unless otherwise contraindicated. Inferior vena cava filters are necessary only if the patient embolizes multiple times or cannot tolerate anticoagulation.

Surgical site infection (SSI) is one of the most common complications of colectomy. Because the procedure is at best clean-contaminated in nature, wound infections have been reported in excess of 20% of patients. Strict prevention of succus spillage, wound protection with incision barriers, and adoption of clean-closure techniques intraoperatively have resulted in drastic reduction of our own SSI rates to well below 10%. If deep subcutaneous wound infection does occur, local management of the wound—opening and packing or placement of vacuum-assisted therapy—along with antibiotics are essential.

Postoperative ileus is not uncommon after an open operation. Even so, the patient should trial clear liquids shortly after surgery, and nasogastric tubes should be avoided. Alvimopan, a peripherally acting μ-receptor antagonist, may also be used in the immediate postoperative period to facilitate bowel function. However, if the patient develops persistent nausea and radiographic ileus, bowel rest and nasogastric tube drainage should be considered. Ileus can be expected in 10–25% of patients.

Urinary tract infections are often a side effect of long-term indwelling bladder catheters. For this reason, early removal of the catheter should be performed except in cases of suspected bladder injury or extensive pelvic dissection. Recognition of ureteral injury may be facilitated by observation of a drain left in the pelvis. Should the drain volume increase rapidly, a creatinine level can be obtained on the drainage. A fluid creatinine level that is higher than the serum creatinine level would indicate a leak from the urinary tract itself into the abdomen. For the standard left colectomy, catheters are removed on postoperative day 1.

In-hospital pneumonia after abdominal surgery can almost entirely be avoided by encouraging routine incentive spirometer use and early ambulation. Of course, atelectasis is common, although infrequently significant following colectomy.

RESULTS

The open lateral-to-medial left colectomy is an excellent option for anatomic resection of the left and sigmoid colon. This approach makes wedge resection or small segmental resection unnecessary because the anatomic relationships are easily visualized, avascular planes are exploited, and a colorectal anastomosis can be accomplished without compromising quality of oncologic resection. In addition, wide resection of lymphatic and adherent retroperitoneal or abdominal wall tissues drastically reduces local recurrence rates of stages I through III colon cancers to less than 1%. Following such a resection, the most common cause of local recurrence is periaortic lymph node involvement.

CONCLUSIONS

The use of an open lateral-to-medial left colectomy should be the basic approach to left-sided colonic disease. This approach capitalizes on known avascular anatomic planes and access to vessels at their origin to allow for safe, oncologically superior resection. A low rate of complications and good long-term outcomes is expected in these patients.

RECOMMENDED REFERENCES AND READINGS

Botoman VA, M Pietro M, Thirlby RC. Localization of colonic lesions with endoscopic tattoo. *Dis Colon Rectum* 1994;37:775–6.

Chin CC, Yeh CY, Tang R, Changchien CR, Huang WS, Wang JY. The oncologic benefit of high ligation of the inferior mesenteric artery in the surgical treatment of rectal or sigmoid colon cancer. *Int J Colorectal Dis* 2008;23(8):783–8.

Fearon KC, Ljunggvist O, VonMayanfeldt M, *et al.* Enhanced recovery after surgery: a consensus review of clinical care for patients undergoing colonic resection. *Clin Nutr* 2005;24(3):466–77.

Kanemitsu Y, Hirai T, Komori K, Kato T. Survival benefit of high ligation of the inferior mesenteric artery in sigmoid colon or rectal cancer surgery. *Br J Surg* 2006;93(5):609–15.

Kim E, Sheetz K, Bonn J, *et al.* A statewide colectomy experience: the role of full bowel preparation in preventing surgical site infection. *Ann Surg* 2014;259(2):310–4.

Lipsett P. Preoperative bowel preparation. In: Cameron J, Cameron A, eds. *Current Surgical Therapy*. 11th ed. Philadelphia, PA: Saunders, 2014:147–8.

Spanjersberg WR, Reurings J, Keus F, van Laarhoven CJ. Fast track surgery versus conventional recovery strategies for colorectal surgery. *Cochrane Database Syst Rev* 2013;1–49.

Scarborough J, Mantyh C, Sun Z, Migaly J. Combined mechanical and oral antibiotic bowel preparation reduces incisional surgical site infection and anastomotic leak rates after elective colorectal resection: an analysis of colectomy-targeted ACS NSQIP. *Ann Surg* 2015;262:331–7.

Weiser M. Left hemicolectomy for treatment of malignancy. In: Fischer JE, Kirby I, eds. *Mastery of Surgery*. Philadelphia, PA: Lippincott Williams &Wilkins, 2007:1533–41.

Chapter 9

Laparoscopic Medial-to-Lateral Colectomy

Azah A. Althumairi and Jonathan E. Efron

INDICATIONS/CONTRAINDICATIONS

Indications

The indications for laparoscopic left colectomy performed either by a medial-to-lateral approach or a lateral-to-medial dissection are diverse, including both malignant and benign conditions. Early in the history of laparoscopic colectomy, controversy existed as to the safety and feasibility of laparoscopic colectomy for cancer. This debate was secondary to early recurrence rates, primarily port site recurrences, which surgeons feared may be secondary to the technical aspects of laparoscopic colectomy, such as the pneumoperitoneum. Several prospective, randomized trials, however, have demonstrated equivalent recurrence and long-term survival rates between laparoscopic and open colectomies performed for cancer. Currently, malignancy is considered an optimal indication for laparoscopic colectomies.

Most benign conditions also lend themselves to laparoscopic resection by a medial-to-lateral approach. These conditions include diverticulitis, inflammatory bowel disease, and polyps. In complicated diverticulitis or Crohn's disease with an associated pericolonic abscess, the medial approach may allow early identification of the ureter and iliac vessels, allowing for a safer lateral dissection in the inflamed tissue. Conversely, if the intestinal mesentery is significantly thickened from Crohn's disease, approaching the dissection laterally may avoid injuring the mesentery and preventing excess bleeding or the formation of a mesenteric hematoma. Dividing thickened Crohn's mesentery is difficult with either vessel-sealing devices or intracorporeal staplers and this may limit the ability of the surgeon to perform a medial-to-lateral dissection because division of mesenteric vessels may not be possible.

Contraindications

Some relative contraindications for performing a laparoscopic colectomy for cancer may possibly include T4 cancers with extensive involvement of other abdominal organs, or tumors that are greater than 8 cm in diameter. Similarly, conditions such as sigmoid volvulus and rectal prolapse generally require conditions such as sigmoid volvulus and rectal prolapse generally require minimal sigmoid mobilization and therefore are not well served by a medial-to-lateral approach with high ligation of the inferior mesenteric vessels.

PREOPERATIVE PLANNING

Preoperative preparation before laparoscopic colectomy includes ensuring that the patient’s medical comorbidities are well controlled and that he or she is an acceptable candidate for surgery. Preoperative teaching of the patient and family should include instructions on the patient’s postoperative responsibilities. These instructions include early eating and ambulation, use of incentive spirometers, and expectations for early discharge. Implementing an enhanced recovery after surgery (ERAS) pathway, which is oftentimes utilized on patients having minimally invasive surgery, reduces hospital length of stay with morbidity and low readmission rates similar to those of patients treated off protocol.

Bowel preparation is a controversial practice for left colectomy. Multiple prospective randomized studies have been performed examining the outcome of elective colonic resections with and without bowel preparation. Reports have shown no difference in complication rates, including anastomotic leaks, whereas others have demonstrated a higher rate of wound infections in the patients who have received a bowel preparation. Reduced surgical site infections occur in patients who received mechanical and oral antibiotic bowel preparation. Intraoperative colonoscopy for localization of polyps or tumors during the surgery will require mechanical bowel preparation. It is the practice of the authors to prepare the patients with a mechanical and oral antibiotic bowel preparation for all colorectal resections. If no mechanical oral preparation is used for a laparoscopic left colectomy, the patient should perform two disposable phosphate enemas before entering the operating room to allow unimpeded transanal passage of a circular stapler.

Final preoperative preparation includes instillation of intravenous antibiotics, application of a warming preoperative warming blanket, administration of subcutaneous heparin, and application of sequential compression stockings. Placement of an epidural catheter is advocated by some surgeons for postoperative pain management to limit postoperative narcotic intake and to enhance recovery; however, for laparoscopic resections, placement of a transversus abdominal plane (TAP) block is preferred by the authors. Adequate intravenous access is obtained before positioning the patient in the operating room because both arms will be tucked at the patient’s side during the operation. A foam matt, or non-slip pad, is placed between the bed and the patient and after tucking both arms and placing the patient in the modified lithotomy position (or splitting the legs on a split table), the patient is secured to the table. These steps are necessary to prevent the patient from moving during the operation, because often steep Trendelenburg with the patient’s left side elevated are required to keep the small intestine out of the operative field.

SURGERY

When approaching a laparoscopic colectomy, standardizing the surgical technique helps facilitate the operation, allowing it to be performed in a quick and efficient manner. This method will decrease surgeon frustration and operative time. Each step must have specific targets and those targets should be reached in a timely manner. If the surgeon is not meeting those goals and the operation is failing to progress, early conversion is advocated and may reduce the risk of intraoperative complications. Just as standardization facilitates performing the procedure, instituting standardized preoperative and postoperative care pathways have shown to be safe and cost-effective, reducing patient length of stay and decreasing costs and complications.

Positioning

The patient is placed in the modified lithotomy position with carefully padded Allen stirrups and with thigh-high sequential compression stockings utilized. Positioning of the patient in the operating room should include tucking of the right (or both) arm(s) by the patient's side to allow full access to that side of the patient, because the conduct of the operation has the operating surgeon and assistant standing on the right side and also intermittently between the legs to facilitate splenic flexure mobilization.

The monitors should be positioned near the left shoulder and left hip area for maximal viewing capability of this multiquadrant operation. The patient needs to be padded to avoid any pressure injuries and secured to the bed to allow extreme positioning changes during the operation. In particular, steep Trendelenburg position is utilized and, therefore, gel pads placed above the shoulder or some other method of securing the patient (beanbag or foam padding underneath) are essential. These pads or beanbags must be thoroughly secured to the table. It is the practice of the authors to test the secure positioning of the patient by moving the bed into extreme position. Patient movement can be corrected before beginning the operation. The patient's abdomen is prepped and draped to the anterior axillary lines laterally, the rib cage superiorly, and the pubic area.

Technique

After draping, a 1-cm incision is made above the umbilicus in the midline. A 12-mm trocar is placed at the umbilicus incision and a pneumoperitoneum should be established to a pressure of 15 mm Hg. The authors utilize a 10-mm, 30-degree scope through the trocar throughout the procedure. Following that, three additional trocars are placed, one 5-mm size in the right upper quadrant, a 12-mm trocar in the right lower quadrant just medial and slightly superior to the anterior superior iliac spine, and a 5-mm suprapubic trocar. If necessary, a fourth

5-mm trocar can be placed in the left lower quadrant 2–4 cm superior and anterior to the anterior superior iliac spine depending on the size of the patient.

In the case of a cancer diagnosis, the initial steps are to perform a staging laparoscopy by first placing the patient in reverse Trendelenburg position to evaluate the liver and peritoneal surface and then returning to a slight Trendelenburg to evaluate the rest of the abdominal peritoneal cavity and the pelvis.

To begin the left colon mobilization, the patient is placed in steep Trendelenburg with left side tilted up; in this way, we utilize gravity as a retractor and sweep the small bowel out of the pelvis and away from the left colon mesentery and duodenum. The degree of the table tilt is dependent on the mobility of the small intestine. Not infrequently there are adhesions of the terminal ileum or cecum to the right pelvis or sigmoid mesentery that restrict the mobility of the small bowel; and these adhesions should be divided to ensure that the small bowel is fully mobilized and out of the pelvis and away from the left colon mesentery. Unimpeded visualization of the mesentery is the key to a successful medial-to-lateral mobilization. At this time, any attachments of the sigmoid colon to the left pelvis or lateral pelvic side wall are left in place because they help elevate and retract the colon out of the operating field.

The full length of the mesentery from the duodenum to the sacral promontory is visualized. The mesentery or the colon is gently grasped through the suprapubic port and, with tension elevating the mesentery anteriorly and inferiorly, the inferior mesenteric artery (IMA) is posed. The iliac vessels are often visualized at this time through the retroperitoneal surface, and in a thin patient the right ureter may also be obvious. Dissection is initiated at the sacral promontory caudal to the IMA. The IMA may be obvious when placed under tension in thin patients, because when the mesosigmoid is grasped and elevated anteriorly, the vessel is tented up and is quite prominent. In obese patients, it may not be so obvious.

The peritoneum overlying the dissection plane is scored along the sacral promontory into the pelvis and also cephalad toward the duodenum. Establishing this dissection plane is an essential first step; and often once the peritoneum is incised, the pneumoperitoneum will help open up the planes. The plane of dissection may be extended too deep into the tissue, thereby mobilizing the retroperitoneal structures off of the rectus with the colonic mesentery.

Dissection should be anterior to the iliac vessels and to the hypogastric nerves, and the left ureter is often quickly seen. Once this dissection plane is established, an atraumatic instrument can perform a blunt dissection freeing the mesentery off of the retroperitoneum. The left ureter should then be protected and allowed to remain in the retroperitoneum, and the dissection continued up to the origin of the IMA. If the ureter cannot be quickly and easily identified, the most likely the IMA. If the ureter cannot be quickly and easily identified, the most likely conclusion is that it has indeed been elevated along with the mesocolon. Once the ureter is identified and traced, dissection is continued on the peritoneal surface, scoring and dissecting out the IMA and inferior mesenteric vein (IMV). Inability to identify the left ureter should then lead the surgeon to mobilize the colon along the white line of Toldt to identify the ureter. Failure to identify the left ureter by both approaches may be an indication to convert to an open procedure.

Once the mesentery is freed from the retroperitoneum, the IMA is isolated and may undergo a high ligation or a selective ligation depending on the indication for the operation at the surgeon's preference. The artery is divided using either a vessel-sealing energy device or other techniques including clips and/or staples. The mesentery is further mobilized from the retroperitoneum extending toward the splenic flexure freeing it from Gerota's fascia. The IMV is the next vessel encountered and is isolated during this cephalad dissection and may be divided via a similar technique. If a low anterior resection is being performed, then division is recommended to allow adequate reach into the pelvis.

Once the mesentery is completely freed to the splenic flexure and down to the sacral promontory, the surgeon turns his or her attention toward the white line of Toldt. The colon is then medially and superiorly retracted and the peritoneum is incised, with an endoscopic scissors with or without cautery. The previously dissected plane is easily entered and the peritoneal attachments divided up to the splenic flexure. Care should be taken near the sacral promontory when performing this step because the ureter may still be attached to the peritoneum and may be injured. Typically, the retroperitoneum behind the lateral aspect of the sigmoid and descending colon is stained a purplish color, which is useful to identify the correct tissue plane. This staining is from the previous medial-lateral retroperitoneal dissection. The proximal line of resection is then selected largely on the basis of the mesenteric blood supply and location of pathology, but may also be determined by the quality of the sigmoid colon and the presence or absence of previous radiation therapy. In a case of diverticular disease affecting the sigmoid colon or in the face of previous radiation therapy, the authors prefer a descending colon to rectal anastomosis. This feature may affect the degree of splenic flexure mobilization necessary to result in a tension-free anastomosis.

Splenic flexure mobilization begins by putting the patient into a slight reverse Trendelenburg position with left side elevated. The omentum is grasped and elevated cranially while the colon is retracted inferiorly to identify the avascular plane between the transverse colon and the omentum. The omentum is mobilized off of the colon and the lesser sac is entered. The surgeon may choose to continue dissection around the splenic flexure from the later aspect of the colon to enter the lesser sac if the lateral plane is obvious. Care should be taken not to injure the pancreas during this mobilization because it can be difficult to identify at times. Alternatively, the splenic flexure can be posteriorly mobilized. Entering into the retroperitoneal tissue plane behind the mesocolon, the window over the tail of the pancreas is incised to enter the lesser sac extending up toward the spleen. The maneuver requires the use of a 45-degree angled or flexible tip laparoscope.

Once the splenic flexure is fully mobilized, the proximal site of planned resection is gently grasped and brought down into the pelvis to insure that there is adequate mobility for a tension-free anastomosis at the distal planned line of resection. This length should be adequate if the IMV was divided at the level of the pancreas. Full mobilization of the omentum from the transverse colon and incision colonic mesentery medially to the edge of the middle colic vessels may be needed to gain further molilety of the splenic flexural and site of proximal transection. Once mobilization of the colon is complete, the patient is placed back into Trendelenburg position and the distal level of resection in the colon or rectum is chosen, either based on anatomic landmarks or on endoscopic confirmation in the case of a neoplasm. Tattooing is of value but cannot be fully relied on because of the non-specificity of the exact location when dealing with rectal neoplasms and anticipated margins of 2 cm or even less. The authors strongly prefer CO_2 insufflation for their intraoperative colonoscopy for localization and confirmation of margins to avoid troubling colonic dilation, which can impair the conduct of the remainder of the operation. It is imperative to have adequate proximal clamping of the colon if intraoperative endoscopy is employed to prevent excessive colonic distension. For anterior or low anterior anastomoses, once the colon is completely mobilized and the resection margins defined, the colon mesentery is divided with a vessel sealer to the location of planned colon or rectal distal margin. The colon is divided using an endoscopic stapler placed through the left lower quadrant port. The distal staple line on the colon is then grasped with a ratcheted grasper to ensure it is not lost and the pneumoperitoneum is deflated through the trocars.

The location of specimen extraction is dependent on the preference of the surgeon. A left lower quadrant, a suprapubic Pfannenstiel incision, or a peri-umbilical incision is made and a wound protector is placed. The specimen is extracted through this incision and anastomosis is performed using a circular stapler. If a Pfannenstiel incision is made, the resection and anastomosis may be performed under direct vision. Any other incision requires returning the colon to the abdominal cavity, re-insufflating the pneumoperitoneum, and laparoscopically performing the anastomosis. Both a left lower quadrant and the Pfannenstiel incisions are believed to have lower incisional hernia rates. Whether performing the anastomosis under direct vision or with the laparoscope, it is important to ensure the colonic mesentery is straight and not twisted on itself. The colon should be carefully inspected and the taenia and cut edge of mesentery must be followed along the entire length of the colon before firing the stapler to avoid twisting of the colon. An air test is performed, with endoscopy (rigid or flexible) if available, to assess the integrity of the anastomosis. The surgeon then closes the facial incisions and skin according to personal preference.

POSTOPERATIVE MANAGEMENT

Implementation of the ERAS pathway aims to decrease postoperative ileus. With rapid recovery of gastrointestinal function, patients can transition to oral diet and hydration, oral pain medication, and early discharge. Preoperative education of the patient is an essential element of the ERAS pathway. Supplementary booklets or videos should be part of the patient's preoperative preparation. Education of the nursing staff caring for the patient is also required. Early oral feeding, early ambulation, standardized postoperative antiemetic agents, and limiting excessive fluid administration intra-and postoperatively have all been shown to enhance early gastrointestinal function recovery. Each of these items is usually incorporated into standardized postoperative care, or ERAS pathway. These perioperative care plans have shown significant improvement in postoperative prevention of ileus and decreasing length of stay. Other commonly included tactics include elimination of nasogastric tubes, limiting or eliminating narcotic intake with the use of nonsteroidal anti-inflammatory agents and epidural catheters or local blocks (TAP blocks) for pain control.

COMPLICATIONS

Anastomotic leak is the most dreaded complication following left colectomy whether it is performed by laparoscopic or open approach. To decrease the risk of anastomotic leak, it is critical to perform a tension-free, well-vascularized anastomosis. During surgery, a temporary diverting loop ileostomy should be considered if risk factors for anastomotic leak are high. Some of these risks include a low anastomosis, a history of radiation therapy to the rectum, prolonged use of steroids, malnutrition, presence of intra-abdominal sepsis, or the presence of significant comorbidities. If the surgeon questions the anastomotic integrity, the tension present, or the perfusion of the intestine involved, the anastomosis must be revised or redone.

RESULTS

Studies have shown that laparoscopic left colectomy was associated with longer operative time when compared to open procedure; however, it has been shown to result in earlier return of bowel function and shorter hospital stay. Furthermore, laparoscopic left colectomy results in similar oncologic outcomes in terms of number of lymph nodes harvested, negative margins, overall survival, and disease-free survival when compared to open procedures.

CONCLUSIONS

With adequate laparoscopic skills, laparoscopic left colectomy performed by a medial-to-lateral approach is extremely useful in the presence of inflamed tissue and allows early identification of the ureter and iliac vessels, allowing for a safer lateral dissection. It has been shown to be a safe and effective approach for left colon resection when compared to open procedures. Patients tend to have earlier return of bowel function and lower lengths of stay, but overall morbidity has never been shown to be different between the open and laparoscopic groups in most randomized controlled trials.

RECOMMENDED REFERENCES AND READINGS

Althumairi AA, Canner JK, Pawlik TM, *et al.* Benefits of bowel preparation beyond surgical site infection: a retrospective study. *Ann Surg* 2016;264(6):1051–7.

Bagshaw PF, Allardyce RA, Frampton CM, *et al.* Long-term outcomes of the Australasian randomized clinical trial comparing laparoscopic and conventional open surgical treatments for colon cancer: the Australasian Laparoscopic Colon Cancer Study trial. *Ann Surg* 2012;256(6):915–9.

Buunen M, Veldkamp R, Hop WC, et al; Colon Cancer Laparoscopic or Open Resection Study Group. Survival after laparoscopic surgery versus open surgery for colon cancer: long-term outcome of a randomised clinical trial. *Lancet Oncol* 2009;10(1):44–52.

Guillou PJ, Quirke P, Thorpe H, *et al.* Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomized controlled trial. *Lancet* 2005;365:1718–26.

Gustafsson UO, Tiefenthal M, Thorell A, Ljunggvist O, Nygrens J. Laparoscopic-assisted and open high anterior resection within an ERAS protocol. *World J Surg* 2012;36(5):1154–61.

Hewett PJ, Allardyce RA, Bagshaw PF, *et al.* Short-term outcomes of the Australasian randomized clinical study comparing laparoscopic and conventional open surgical treatments for colon cancer: the ALCCaS trial. *Ann Surg* 2008;248(5):728–38.

Jacob BP, Salky B. Laparoscopic colectomy for colon adenocarcinoma: an 11-year retrospective review with 5-year survival rates. *Surg Endosc* 2005;19(5):643–9.

Jayne DG, Guillou PJ, Thorpe H, *et al.* Randomized trial of laparoscopic-assisted resection of colorectal carcinoma: 3-year results of the UK MRC CLASSIC trial group. *J Clin Oncol* 2007;25:3061–8.

Liang JT, Huang KC, Lai HS, *et al.* Oncologic results of laparoscopic versus conventional open surgery for stage II or III left-sided colon cancers: a randomized controlled trial. *Ann Surg Oncol* 2007;14(1):109–17.

Nelson H, Sargent DJ, Wieand HS, *et al.* Clinical outcomes of surgical therapy study group of the laparoscopic colectomy trial: a comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med* 2004;350:2050–9.

Nelson RL, Gladman E, Barbateskovic M. Antimicrobial prophylaxis for colorectal surgery. *Cochrane Database Syst Rev* 2014;9:CD001181.

Patankar SK, Larach SW, Ferrara A, *et al.* Prospective comparison of laparoscopic vs. open resections for colorectal adenocarcinoma over a ten-year period. *Dis Colon Rectum* 2003;46(5):601–11.

Veldkamp R, Kuhry E, Hop WC, *et al.* Laparoscopic surgery versus open surgery for colon cancer: short-term outcomes of a randomised trial. *Lancet Oncol* 2005;6(7):477–84.

Vlug MS, Wind J, Van Der Zaag E, Ubbink DT, Cense HA, Bemelman WA. Systematic review of laparoscopic vs. open colonic surgery within an enhanced recovery programme. *Colorectal Dis* 2009;11(4):335–43.

Yamamoto S, Inomata M, Katayama H, *et al.* Short-term surgical outcomes from a randomized controlled trial to evaluate laparoscopic and open D3 dissection for stage II/III colon cancer: Japan Clinical Oncology Group Study JCOG 0404. *Ann Surg* 2014;260(1):23–30.

Chapter 10

Laparoscopic Lateral-to-Medial Colectomy

Robert D. Bennett and Jorge E. Marcet

INTRODUCTION

First described by Jacobs et al., laparoscopic colectomy has proved to be a safe and feasible approach for both benign and malignant surgical conditions of the colon. In fact, the laparoscopic approach has become standard for colon resections in most circumstances. Numerous studies have confirmed advantages of the laparoscopic approach when compared to an open procedure, including decreased postoperative pain, reduced incidence of ileus, enhanced recovery of pulmonary function, reduced immunosuppression, decreased length of hospital stay, improved cosmesis, and earlier return to work and normal activities. In addition, laparoscopic colon resection has shown equal or improved survival in the setting of malignancy. Laparoscopic techniques can be employed for the entirety of an operation or for specific portions. It is the authors' preference to perform a laparoscopic-assisted procedure in most circumstances. The dissection is completed in a laparoscopic manner, including division of the mesentery and complete mobilization of the affected colon, and the anastomosis being performed extracorporeal. Using this technique, the specimen is delivered through a small abdominal incision. A hand-sewn or stapled extracorporeal anastomosis can then be performed, or the anvil of a circular stapler secured in place in the proximal bowel in preparation for an intracorporeal anastomosis.

Laparoscopic left colon dissection has been described in both lateral-to-medial and medial-to-lateral manner. Open left colon resections were traditionally performed in a lateral-to-medial direction, and initial descriptions of laparoscopic left colon resections also involved lateral-to-medial dissection. Medial-to-lateral dissection was first described in 1994 by Milsom et al., and as surgeons have become more comfortable and adept with laparoscopic techniques, a medial-to-lateral dissection has become preferred in many situations. The advantage of a medial-to-lateral approach is that the natural peritoneal attachments of the right and left colon are left intact during central division of the vascular structures and mesentery near their origin and thus serve to keep the colon retracted laterally during the medial dissection. Although a statement issued by the European Association of Endoscopic Surgeons (EAES) in 2004 endorsed a medial-to-lateral approach as preferred, it was based on level

5 evidence and was a grade D recommendation. Despite this conclusion, the lateral-to-medial dissection continues to have utility and provides the surgeon flexibility in determining the optimal approach to a given clinical scenario.

This chapter has been written to discuss and illustrate technical tips employed by the authors to perform a laparoscopic lateral-to-medial left colon dissection, and indications for using these techniques.

INDICATIONS AND PATIENT SELECTION

Laparoscopic colon resection is superior to open resection and has become the current standard of care in colon resection for appropriately trained surgeons. Prospective randomized trials have also shown that laparoscopic colon resection yields at least equivalent oncologic results when compared to the open approach. As such, the laparoscopic approach is indicated in benign and malignant conditions alike.

There are no absolute indications or contraindications to a lateral-to-medial approach. One of the strongest indications to proceed with a laparoscopic lateral-to-medial dissection is surgeon familiarity and comfort with this technique. This logic cannot be overstated, because laparoscopic left colon resection is a complex procedure with a demonstrated steep learning curve.

The surgeon should always strive to obtain a broad area of mesenteric dissection to ensure an adequate lymphadenectomy (≥12 lymph nodes) during the resection of a colon cancer. A recent systematic review and meta-analysis suggests that the two approaches are no different in terms of number of lymph nodes harvested or cancer recurrence rates, suggesting that malignancy is not necessarily a contraindication to performing a lateral-to-medial dissection.

Benign conditions of the colon are ideally suited for a lateral-to-medial dissection because lymph node harvest is not a consideration. Exceptions to this statement would be surgery for endoscopically unresectable polyps or in case of inflammatory bowel disease with proven or suspected dysplasia. Diverticular disease is the most common indication for a left-sided colon resection. Diverticular pathology of the left colon can also be approached with a lateral-to-medial or medial-to-lateral dissection. In the setting of recurrent diverticulitis, the chronic inflammatory process surrounding the sigmoid colon often makes dissection very difficult. In this case, if a lateral-to-medial dissection presents itself as safer or easier, it should be taken rather than adhering to a rigid standard of medial-to-lateral dissection.

Another situation in which a medial-to-lateral approach may be preferred is when the operation is being done for inflammatory bowel disease where the base of mesentery is involved by the inflammatory process, encasing the vessels and obliterating the embryological dissection plane. This approach offers the advantage of avoiding injury to vessels or retroperitoneal structures.

PREOPERATIVE PLANNING

Whether the indication for laparoscopic left colectomy is a benign or a malignant condition, proper preoperative planning is essential. Axial, contrast-enhanced imaging studies are often obtained for diagnosis of diverticulitis or malignancy before an operation is undertaken. These imaging modalities can be invaluable in surgical planning to assist the surgeon in anticipating potential intraoperative difficulties. Although the ureter should ideally be intraoperatively visualized during all left colon resections, the location of the ureter relative to a planned resection may be ascertained by intravenous contrast-enhanced computed tomography scan allowing the surgeon to review specific anatomic details before embarking on a potentially difficult dissection. Oral contrast helps identify loops of the small intestine and can help distinguish between bowel and other structures, such as a tumor mass, blood vessel, or a fluid collection. Because oral contrast rarely reaches the left colon and rectum, rectal contrast is particularly useful in defining the lower gastrointestinal anatomy in patients undergoing left colon resection.

Accurate preoperative tumor localization is an important consideration when planning a successful laparoscopic left-sided colectomy for malignancy. In this setting, patients likely have undergone colonoscopic evaluation which led to the diagnosis. If endoscopy was performed remotely, it can be valuable to perform repeat colonoscopy or flexible sigmoidoscopy, when possible, the day before surgery, thus obviating the need for two separate bowel preparations. In preparation for resection for a colon tumor, the lesion should be marked with tattoo ink to aid in localization during surgery. India ink and other carbon-based inks are the most commonly used agents. Although endoscopic localization of right-sided tumors may be facilitated if the lesion is visualized close to the appendiceal orifice and ileocecal valve, there exist no comparable landmarks in the transverse, descending or sigmoid colon. If unable to visualize tattoo ink from previous endoscopic tumor localization, intraoperative colonoscopy can be performed if the site of the lesion is not obvious on inspection of the serosal surface.

Alternatively, or complementarily, preoperative contrast enema can be used to help localize colonic lesions.

SURGERY

Positioning

The patient should be securely strapped on the operating table in low lithotomy on a non-slip pad or with shoulder pads in place to allow for safe use of steep Trendelenburg and left side up positions. Using these positions allows for movement of the small bowel out of the operative field and for natural gravitational retraction of the left colon from its abdominal and pelvic side wall attachments, facilitating the lateral-to-medial dissection. Low lithotomy position allows for access to the pelvis and eventual colorectal anastomosis if appropriate. This position also allows for the surgeon or assistant to stand between the patient's legs and may be more ergonomically comfortable for dissection of the left upper quadrant and mobilization of the splenic flexure.

The operating surgeon will stand to the patient's right side for most or all of the operation. During port placement, the assistant may stand to the patient's left, but will move to the patient's right, cephalad to the operating surgeon, for the majority of the case. Laparoscopic monitors should be placed at the patient's left and at the foot of the operating table, at the surgeon's eye level. After obtaining laparoscopic access (see subsequent text) and positioning the patient in Trendelenburg with left side up, the table height should be adjusted to the operating surgeon's preference to maximize ergonomic benefit.

Port Placement

Laparoscopic left colon resection is typically performed via a three-port technique. Peritoneal access is obtained in the mid abdomen through a cutdown technique at the umbilical stalk. The umbilical stalk is grasped and directly incised at its base. Fascial stay sutures may be placed, depending on surgeon preference, and a 5-or 10-mm port inserted. Our preference is to use a 10-mm port for the camera port, because a larger port size will accommodate the linear cutting stapler. The 5-or 10-mm, 30-degree laparoscopic camera is introduced and the remaining ports, 5 mm in diameter, are then placed under direct laparoscopic visualization.

There are many different port site arrangements described for laparoscopic left and sigmoid colectomy. As a principle of all laparoscopic surgery, working ports should be triangulated to facilitate two-handed dissection, maximize ergonomics, and to avoid sword fighting of working instruments. The patient's body mass index and abdominal breadth should be taken into consideration as well when index and abdominal breadth should be taken into consideration as well when choosing port locations. When placing the suprapubic or right lower quadrant port to accommodate the endoscopic stapler, one must consider the angle that the stapler will achieve coming across the rectosigmoid. Instruments introduced through the right upper quadrant working port should be able to reach to the splenic flexure and also allow retraction of the sigmoid colon mesentery deep in the pelvis. Depending on the availability of and the need for a second assistant to hold the laparoscope, a four-or five-port setup can be utilized, but three ports are usually adequate. Once port placement is completed, the operation may proceed; ureteric catheters may be useful.

Surgical Technique

A general survey of the abdominal and pelvic cavity is performed evaluating all four quadrants. In the setting of malignancy, special attention should be paid to the liver and peritoneal surfaces to investigate for occult metastases, bowel injury from trocar placement, and the tumor site in the left colon.

The initial step in laparoscopic left hemicolectomy or sigmoid colectomy is mobilization of the left colon or sigmoid colon with early identification of the left ureter so as to avoid injury. To facilitate dissection, the patient’s left side is rotated upward. Trendelenburg or reverse Trendelenburg position is used as necessary to facilitate access to the pelvis or splenic flexure, respectively. This maneuver allows for movement of the small bowel out of the operative field and for ease of retraction of the left and sigmoid colon.

Incising the attachments of the visceral and parietal peritoneum at the junction of the proximal sigmoid and descending colon allows the colon and its mesentery to be retracted medially while gently pushing the retroperitoneum posteriorly. The peritoneum is first incised close to the lateral border of the colon, maintaining the pericolic fat intact, at the level of the proximal sigmoid. The pneumoperitoneum will often help establish this optimal dissection plane. A combination of sharp and blunt dissection, with occasional use of bipolar energy, is used to dissect in this mostly avascular plane. As the dissection progresses from lateral to medial, the left gonadal vessels are usually identified first, followed by the left ureter. These structures are gently pushed away from the mesentery posterior to the plane of dissection (Fig. 10-1).

FIGURE 10-1 Incision between visceral and parietal peritoneum along the edge of the mesocolon.

Some surgeons prefer to identify the ureter early on in the procedure through an incision in the rectosigmoid mesentery. This can be done by holding the sigmoid colon on anterior stretch and incising through the medial aspect of the mesentery, through the avascular area superior to the sigmoidal vessels. This creates a window into the retroperitoneum through the rectosigmoid mesentery through which the ureter may be identified. Once identified and swept down and away from the plane of dissection, the lateral-to-medial dissection is then undertaken. Once again, ureteric catheters may help facilitate and expedite ureteric identification.

A combination of sharp dissection and monopolar energy are used to dissect along the line of Toldt continuing cephalad along the descending colon toward the splenic flexure. Gerota's fascia is identified and the mesocolon is separated from the retroperitoneum at this level. Holding gentle retraction with a bowel grasper in one hand, the other hand utilizes a combination of blunt and sharp dissection to develop an avascular, areolar tissue plane between the colon mesentery and the retroperitoneum (Fig. 10-2). Atraumatic grasping instruments are used and the tissues are moved with gentle traction produced by pushing with the instrument. Thus, grabbing and pulling the tissue with an instrument is minimized, resulting in less potential trauma.

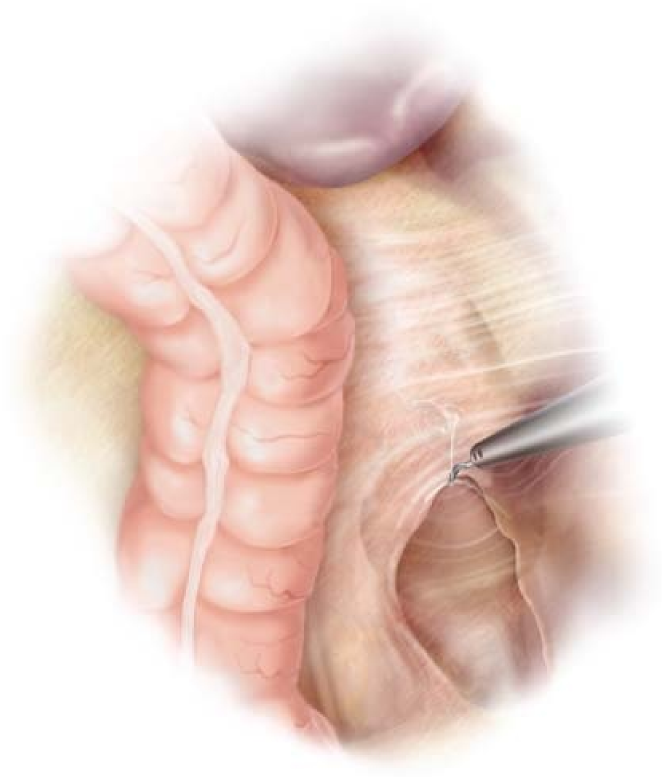


FIGURE 10-2 Colon mesentery is separated from Gerota's fascia and retroperitoneal plane.

p. 73

p. 74

The remaining peritoneal attachments are incised and effort is made to continue in the same plane of dissection staying anterior to the retroperitoneal tissues (Fig. 10-3). Dissection is carried caudally to the level of the upper rectum, entering the pre-sacral space while retracting the sigmoid colon in a cephalad and medial direction. The mesentery on the medial aspect of the rectosigmoid is then incised adjacent to the bowel at the anticipated level of distal bowel transection (Fig. 10-4). The perpendicular incision is carried laterally to join the lateral dissection plane. This creates a window for distal bowel transection.

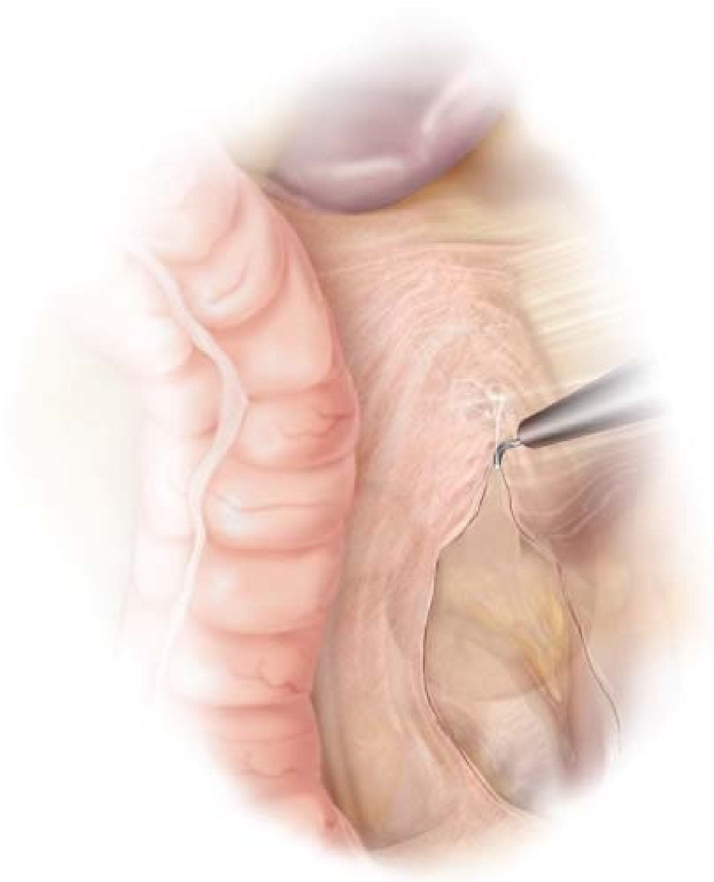


FIGURE 10-3 Separation of left mesocolon from retroperitoneal tissue plane.

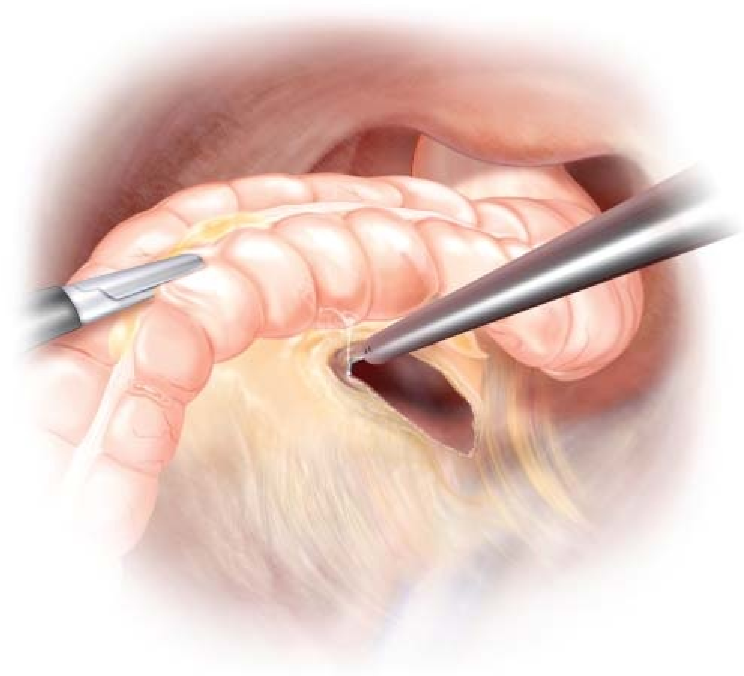


FIGURE 10-4 Incise through mesentery at site of distal colon transection.

In patients in whom a primary anastomosis is planned, adequate mobilization should be confirmed visually by demonstrating that the site planned for proximal colon transection reaches to the pelvis and the distal transection site without tension on the mesentery or the bowel.

Laparoscopic mobilization of the splenic flexure may be necessary to mobilize enough of the proximal bowel for the creation of a tension-free anastomosis. This dissection is easier via a laparoscopic approach than in open operations due to the excellent visualization afforded by the 30-degree laparoscope. If a three-port technique has been used up to this point in the operation, a fourth port, placed on the patient's left side may be advantageous in completing the superior portion of the splenic flexure mobilization. The operating surgeon can move between the patient's legs to perform this dissection. With the descending colon retracted in a medial and caudal direction by the assistant using the right-sided instruments, the lateral peritoneal attachments at the splenic flexion are dissected with a combination of blunt and sharp dissection (Fig. 10-5). Care must be taken not to place excessive traction on the colon or omentum during this dissection to avoid an avulsion injury to the splenic capsule, which can result in significant bleeding. The attachments of the omentum to the colon are divided and the dissection proceeds from lateral to medial (Fig. 10-6). Once the lesser sac is entered, confirmed by visualization of the posterior surface of the stomach, the lienocolic ligament is divided and the mesentery of the splenic flexure is gently retracted medially and inferiorly. As this is done, the inferior border of the pancreas is identified and the peritoneum of the transverse mesocolon is divided just inferior to the pancreas toward the midline and middle colic vessels.

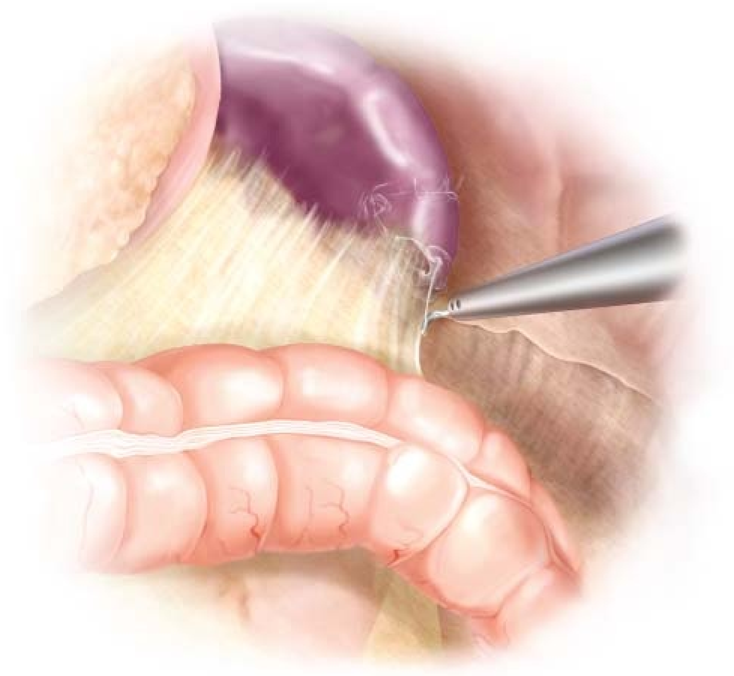


FIGURE 10-5 Division of lateral peritoneal attachments of splenic flexure.

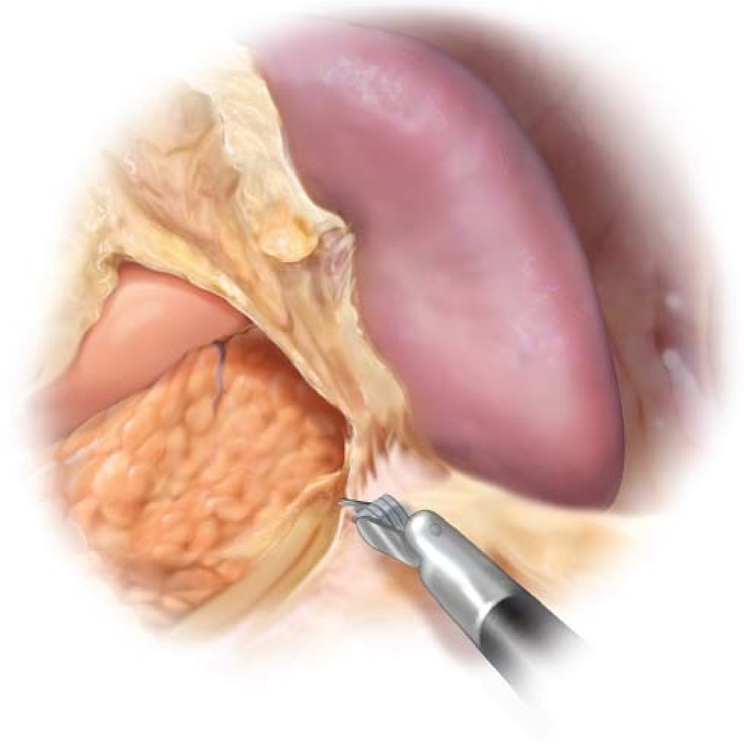


FIGURE 10-6 Lesser sac is entered, exposing the pancreas and posterior wall of the stomach.

The next step involves vascular ligation. With the sigmoid colon retracted in an anterior and caudal direction, the mesenteric vessels are identified. A decision is made with respect to proximal and distal colon transection points. In the setting of benign disease, the proximal and distal level of transection is done in an area where the bowel appears grossly healthy. If the operation is being performed for malignancy, the proximal and distal transection points must be determined on the basis of sound oncologic principles. Margins are thus determined by the primary arterial supply feeding the affected segment of the colon. Dissection is carried out in avascular planes on either side of the mesenteric vessels, which are then sealed and divided with a bipolar energy device. The level at which the inferior mesenteric artery is divided depends on the clinical scenario. If the operation is being performed for malignancy, then an effort is made to obtain a wide lymphadenectomy, and a high ligation of the vessel, near its origin, is done to facilitate adequate lymphadenectomy. If performed for diverticular disease or other benign conditions, then high ligation is not necessary, and the vessels can be taken closer to the bowel wall. Division of any remaining left colon or sigmoid mesentery is then undertaken with the bipolar vessel-sealing device.

At this point, transection of the distal portion of the specimen can be performed, typically with a linear cutting staple. The stapler is passed through the 10-mm port and the bowel is transected under direct laparoscopic visualization (Fig. 10-7).

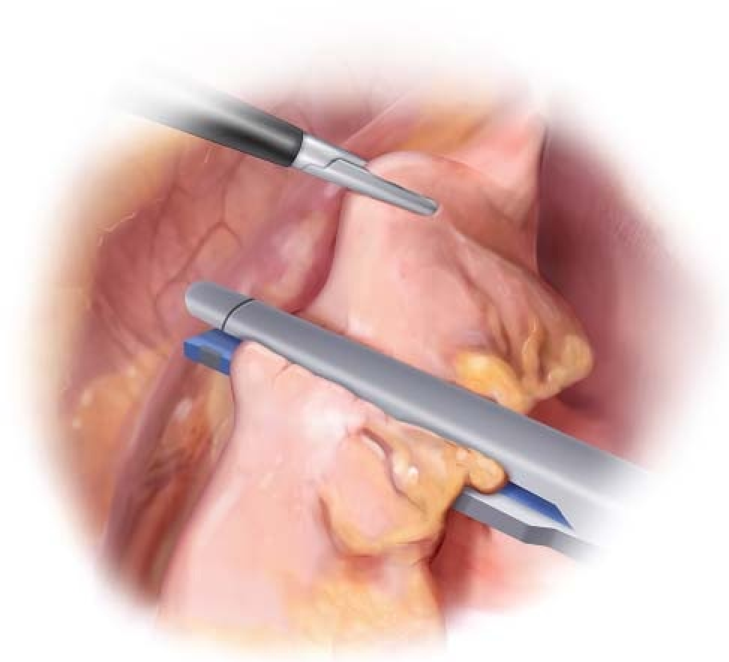


FIGURE 10-7 Laparoscopic intestinal stapler is used to divide at the distal point of transection.

The specimen may be exteriorized through a wound protector with relative ease. During initial port placement, consideration should be given to the anticipated size of the specimen and potential extraction sites. We commonly use the umbilical port site for extraction so as not to create another incision, but any other port site could be used. Alternately, a transverse suprapubic incision could be created to allow for specimen extraction. The transected end of the specimen is secured with a bowel grasper in preparation for externalization. Insufflation is put on standby and the camera and camera port are removed. The umbilical incision is then extended inferiorly in the midline to approximately 3–4 cm in total length, depending on the specimen size. A wound protector is placed, clean operating room towels placed around the field, and the transected end of the bowel is presented through the protected wound. The specimen is gently delivered out of the abdomen and care is taken to not place traction on the proximal mesentery, which could inadvertently result in avulsion of a mesenteric vessel.

Proximal transection is then extracorporeally performed with sharp division of

Proximal transection is then extracorporeally performed with sharp division of the bowel. Adequate blood supply results in brisk bleeding at the cut surface of the bowel or mesentery. Alternatively, indocyanine green (ICG) perfusion assessment may be employed. The anvil of the circular stapling device is secured to the end of the bowel with a monofilament purse string suture.

The bowel is internalized once again and the wound protector is closed. Laparoscopic insufflation is reinitiated and an intracorporeal colorectal anastomosis is done under laparoscopic visualization (Fig. 10-8). The specimen should be inspected to ensure two complete rings of tissue after the anastomosis has been created. Once the anastomosis is complete, the pelvis should be irrigated and a leak test performed by submerging the anastomosis under water, compressing the proximal bowel, and insufflating the rectum (Fig. 10-9). Any evidence of bubbling during insufflation requires investigation and revision of the anastomosis. The anastomosis should also routinely be interrogated by direct proctosigmoidoscopic visualization. ICG may be utilized to identify mucosal perfusion.

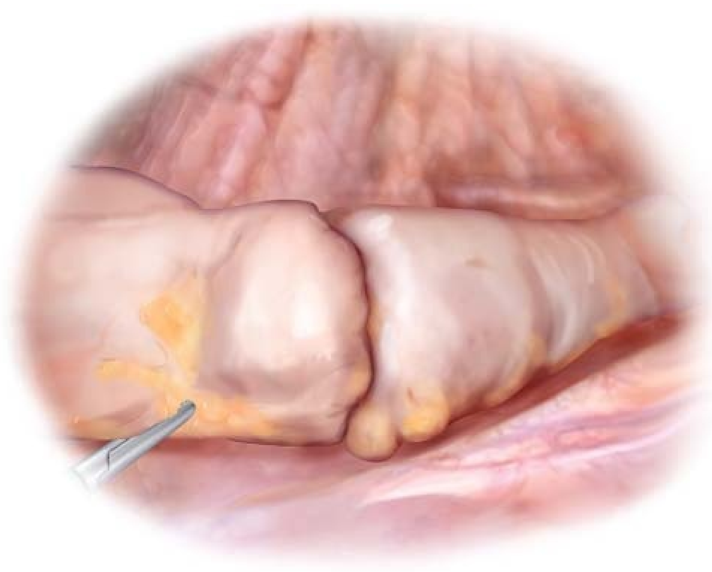


FIGURE 10-8 Completed colorectal anastomosis.

FIGURE 10-9 Anastomotic leak test is done by submerging the anastomosis under water or saline, compressing the proximal bowel and insufflating the rectum.

With a visually intact and airtight colorectal anastomosis confirmed, fluid should be removed from the abdomen and pelvis and a thorough visual inspection of the abdominal and pelvic cavities once again performed to ensure hemostasis and lack of injury to other structures. Working ports are removed under direct laparoscopic visualization to ensure hemostasis at port sites. Any 10-mm or greater working port sites are closed under direct visualization using a port closure device. Insufflation is then stopped and the camera and camera port are removed. The operating team changes gown and gloves and a separate closing instrument set is used to complete the closure of the abdomen.

POSTOPERATIVE MANAGEMENT

Postoperative disposition of the patient largely depends on patient comorbidities and intraoperative hemodynamic and pulmonary status. The majority of patients may be postoperatively admitted to a medical-surgical ward and an enhanced recovery pathway is followed. Intraoperatively placed nasogastric or orogastric tubes are routinely discontinued at the conclusion of the operation. Oral intake is encouraged as early as the evening of postoperative day 0, with advance to a soft diet by postoperative day 1 in most cases. In the absence of extensive low pelvic dissection, urinary catheters may be discontinued on the morning of postoperative day 1. Patients are expected to be ambulatory by postoperative day 1 as well. While laparoscopic colon resection has been demonstrated to result in less postoperative pain than in open procedures, analgesia remains a concern after laparoscopic surgery. Patients are routinely maintained on oral narcotic as well as non-opioid pain medications, in addition to a narcotic patient-controlled analgesia device. Attempts should be made to wean patients from narcotic pain medication as quickly as tolerable to avoid constipating side effects of opioid analgesics.

Other standard postoperative care principles for any patient also apply to patients undergoing laparoscopic left colon resection, including resumption of all cardiac, antihypertensive, or anti-hyperglycemic medications as early as possible and appropriate. Glycemic control is paramount to minimize the risk of surgical site infections, especially in the colorectal surgery population. Typical length of stay following laparoscopic left colon resection is 2–3 days. Standard criteria for discharge include being afebrile, hemodynamic and respiratory stability, return of bowel function, tolerance of oral intake, ability to spontaneously void, ambulatory status (barring preadmission debilitation), and adequate pain control on oral agents.

We recommend avoidance of strenuous physical activity for a period of 4–6 weeks, but patients may return to work on light duty, or with sedentary occupations, within 1–2 weeks.

CONCLUSIONS

Laparoscopic lateral-to-medial colon dissections have the advantage of surgeon familiarity from prior experience with open left colon resections. Although initial descriptions of laparoscopic left colon resections involved lateral to medial dissection, surgeons today have the option to do medial-to-lateral colon dissection. The advantage of a medial-to-lateral approach is that the natural peritoneal attachments of the right and left colon are left intact during the division of the vascular structures and mesentery near their origin and thus serve to keep the colon retracted laterally during the medial dissection. Despite this, the lateral-to-medial dissection continues to have utility and provides the surgeon flexibility in determining the optimal approach to a given clinical scenario.

RECOMMENDED REFERENCES AND READINGS

American Society of Colon and Rectal Surgeons. Position statement on laparoscopic colectomy for curable cancer. *Dis Colon Rectum* 2004;47:A1.

Bergamaschi R, Arnaud JP. Intracorporeal colorectal anastomosis following laparoscopic left colon resection. *Surg Endosc* 1997;11:800–1.

Bokey EL, Moore JW, Keating JP, Zelas P, Chapuis PH, Newland RC. Laparoscopic resection of the colon and rectum for cancer. *Br J Surg* 1997;84:822–5.

Chen HH, Wexner SD, Weiss EG, *et al.* Laparoscopic colectomy for benign colorectal disease is associated with a significant reduction in disability as compared with laparotomy. *Surg Endosc* 1998;12:1397–400.

Clinical Outcomes of Surgical Therapy Study Groups. A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med* 2004;350(20):2050–9.

Cohen SM, Wexner SD. Laparoscopic colorectal resection for cancer: the Cleveland Clinic Florida experience. *Surg Oncol* 1993;2(Suppl1):35–42.

Dunker MS, Stiggelbout AM, van Hogezand RA, Ringers J, Griffioen G, Bemelman WA. Cosmesis and body image after laparoscopic assisted and open ileocolic resection for Crohn's disease. *Surg Endosc* 1998;12:1334–40.

Feingold DL, Addona T, Forde KA, *et al.* Safety and reliability of tattooing colorectal neoplasms prior to laparoscopic resection. *J Gastrointest Surg* 2004;8:543–6.

Fielding GA, Lumley J, Nathanson L, Hewitt P, Rhodes M, Stitz R. Laparoscopic colectomy. *Surg Endosc* 1997;11:745–9.

Fowler DL, White SA. Laparoscopy-assisted sigmoid resection. *Surg Laparosc Endosc* 1991;1:183–8.

Franklin ME Jr, Berghoff KE, Arellano PP, Trevino JM, Abrego-Medina D. Safety and efficacy of the use of bioabsorbable seamguard in colorectal surgery at the Texas Endosurgery Institute. *Surg Laparosc Endosc Percutan Tech* 2005;15(1):9–13.

Franklin ME, Kazantsev GB, Abrego D, Diaz-E JA, Balli J, Glass JL. Laparoscopic surgery for stage III colon cancer: long-term follow-up. *Surg Endosc* 2000;14:612–6.

Franklin ME, Ramos R, Rosenthal D, Schussler W. Laparoscopic colonic procedures. *World J Surg* 1993;17:51–6.

Franklin ME, Rosenthal D, Abrego-Medina D, *et al.* Prospective comparison of open vs. laparoscopic colon surgery for carcinoma: five-year results. *Dis Colon Rectum* 1996;39:S35–6.

Franklin ME Jr, Rosenthal D, Norem RF. Prospective evaluation of laparoscopic colon resection versus open colon resection for adenocarcinoma. *Surg Endosc* 1995;9:811–6.

Greznlee RT, Murray T, Bolden S, Wingo PA. Cancer statistics, 2000.*CA Cancer J Clin* 2000;50:7–33.

Jacobs M, Verdeja G, Goldstein D. Minimally invasive colon resection. *Surg Laparosc Endosc* 1991;1:144–50.

Khalili TM, Fleshner PR, Hiatt JR, *et al.* Colorectal cancer: comparison of laparoscopic with open approaches. *Dis Colon Rectum* 1998;41:832–8.

Kockerling F, Reymond MA, Schneider C, *et al.* Prospective multicenter study of the quality of oncologic resections in patients undergoing laparoscopic colorectal surgery for cancer. The Laparoscopic

Colorectal Surgery Study Group. *Dis Colon Rectum* 1998;41:963–70.

Kockerling F, Rose J, Schneider C, *et al.* Laparoscopic colorectal anastomosis: risk of postoperative leakage: results of a multicenter study. Laparoscopic Colorectal Surgery Study Group (LCSSG). *Surg Endosc* 1999;13:639–44.

Kockerling F, Schneider C, Reymond MA, *et al.* Early results of a prospective multicenter study on 500 consecutive cases of laparoscopic colorectal surgery. Laparoscopic Colorectal Surgery Study Group (LCSSG). *Surg Endosc* 1998;12:37–41.

Lacy AM, Garcia-Valdecasas JC, Delgado S, *et al.* Postoperative complications of laparoscopic-assisted colectomy. *Surg Endosc* 1997;11:119–22.

Lord SA, Larach SW, Ferrara A, Williamson PR, Lago CP, Lube MW. Laparoscopic resections for colorectal carcinoma: a three year experience. *Dis Colon Rectum* 1996;39:148–54.

MacRae HM, McLeod RS. Handsewn vs. stapled anastomoses in colon and rectal surgery: a meta-analysis. *Dis Colon Rectum* 1998;41:180–9.

Milsom JW, Bohm B, Decanini C, Fazio VW. Laparoscopic oncologic proctosigmoidectomy with low colorectal anastomosis in a cadaver model. *Surg Endosc* 1994;8:1117–23.

Monson JRT, Darzi A, Carey PD, Guillou PJ. Prospective evaluation of laparoscopic-assisted colectomy in an unselected group of patients. *Lancet* 1992;340:831–3.

Phillips EH, Franklin M, Carroll BJ, Fallas MJ, Ramos R, Rosenthal D. Laparoscopic colectomy. *Ann Surg* 1992;216:703–7.

Puente I, Sosa JL, Sleeman D, Desai U, Tranakas N, Hartmann R. Laparoscopic assisted colorectal surgery. *J Laparoendosc Surg* 1994;4(1):1–7.

Schlachta CM, Mamazza J, Seshadri PA, Cadeddu M, Gregoire R, Poulin EC. Defining a learning curve for laparoscopic colorectal resections. *Dis Colon Rectum* 2001;44:217–22.

Stocchi L, Nelson H. Laparoscopic colectomy for colon cancer: trial update. *J Surg Onc* 1998;68:255–67.

Whelan RL. Laparotomy, laparoscopy, cancer, and beyond. *Surg Endosc* 2001;15:110–5.

Ziprin P, Ridgway PF, Peck DH, Darzi AW. The theories and realities of port-site metastases: a critical appraisal. *J Am Coll Surg* 2002;195:395–408.

Chapter 11

Robotic Left Colectomy

Garrett G. Friedman and Jose G. Guillem

INDICATIONS AND CONTRAINDICATIONS

Left colectomy may be indicated for a variety of benign and malignant conditions; however, the most common indications are carcinoma, polyps not amenable to endoscopic resection, and Crohn's disease. Other less common indications for resection include hemorrhage and ischemia. The robotic approach is generally indicated whenever laparoscopy is appropriate, when the surgeon is experienced and comfortable with the robotic platform. The standard contraindications for laparoscopy, including pulmonary disease precluding pneumoperitoneum, uncontrolled coagulopathy, and hemodynamic instability remain true for robotic surgery as well. Extensive intra-abdominal adhesions that may preclude safe minimally invasive entry into the abdominal cavity are a relative contraindication.

PREOPERATIVE PLANNING

Patients being considered for surgical management of malignancy should have careful review of preoperative imaging, which generally includes computed tomography (CT) scans of the chest, abdomen, and pelvis. Review of the preoperative imaging serves several important functions. First, it can assist in the localization of the tumor and confirm the location of malignancy in the left colon. Owing to the redundancy of the sigmoid colon, endoscopic length measurements and the impression of the endoscopist may not provide accurate tumor localization. Second, careful review of the imaging can sometimes reveal suspicious lymph node disease, which the surgeon should plan to include in the surgical specimen. Lastly, contrast-enhanced CT scans provide critical anatomic information that may affect surgical planning and can assist with dissection. We recommend careful review of the mesenteric vascular anatomy found on CT scanning before embarking on dissection, because this imaging provides a roadmap of the operation that lies ahead.

All endoscopy reports should be reviewed before surgery; and if there are questions regarding the location of the tumor, the original endoscopist should be contacted. If the lesion was not tattooed initially, we strongly advise that the patient be referred back to the original endoscopist for tattooing of the lesion.

The role of mechanical bowel preparation remains controversial. Our current practice is full mechanical bowel preparation for all patients, unless a contraindication exists. One important consideration regarding bowel preparation for robotic surgical cases being performed for malignancy is that the tactile sensation of the surgeons' fingers to palpate the tumor is diminished. If there is a question as to the location of the tumor, it can be very difficult to feel the mass robotically if the colon is filled with stool. For this reason, the authors and editors strongly recommend bowel preparation for minimally invasive operations whenever clinically feasible.

SURGERY

Positioning

The patient is generally positioned supine for robotic left colectomy, although the lithotomy position can be utilized if the surgeon is planning to perform intraoperative colonoscopy. The patient should be positioned on an anti-slip surface, such as a gel pad or an egg crate foam, for example. We recommend an atraumatic chest strap as well as leg strap to safely secure the patient to the operating table. Both arms of the patient are tucked and all bony prominences are carefully padded. The patient should then be placed in steep Trendelenburg with right side down before draping to ensure that the surgical table is functioning as expected and that the patient should ideally not slide when in this extreme position.

Room Setup

Proper organization and setup of the operating room is critical for the efficient performance of robotic surgery. For left colectomy, the patient cart of the surgical robot should be on the left side of the patient. We recommend the vision tower to be located on the left side of the patient for this operation, because it provides a direct view of the monitors for the bedside assistant located on the patient's right side. The availability of appropriate instruments should be confirmed before incision, including the robotic vessel sealer as well as the robotic stapler, if intracorporeal division of the bowel is planned. The operating room staff should ensure that the Table Motion feature, if available, is paired with the robot and correctly functioning.

Port Placement and Instruments

The camera port is generally placed in either a supraumbilical or slightly infraumbilical location, depending on the patient's body habitus. If more working room and a broader view of the abdomen are desired, the camera port can be placed off to the right side, at approximately the level of the umbilicus. The operation is typically performed using all three arms of the robot and one laparoscopic assistant port, although some surgeons do omit the use of the third arm at their own preference. If an intracorporeal anastomosis is planned, we strongly advise utilizing the third arm. The third arm is generally positioned cephalad to the camera port, just off the midline. One working arm is placed below the camera port and one above, spaced approximately 7 cm apart for maximum clearance. If intracorporeal division of the bowel is planned, it is often useful to place the 12-mm stapler port in the plane of the anticipated Pfannenstiel incision, to limit the number of fascial closures necessary. Several port placement options are pictured (Figs. 11-1 and 11-2), including configurations that do not utilize the third arm. The laparoscopic assistant port is typically positioned in the mid-right abdomen, far enough away from the robotic trocars to prevent interference of the arms with the assistant's hand.

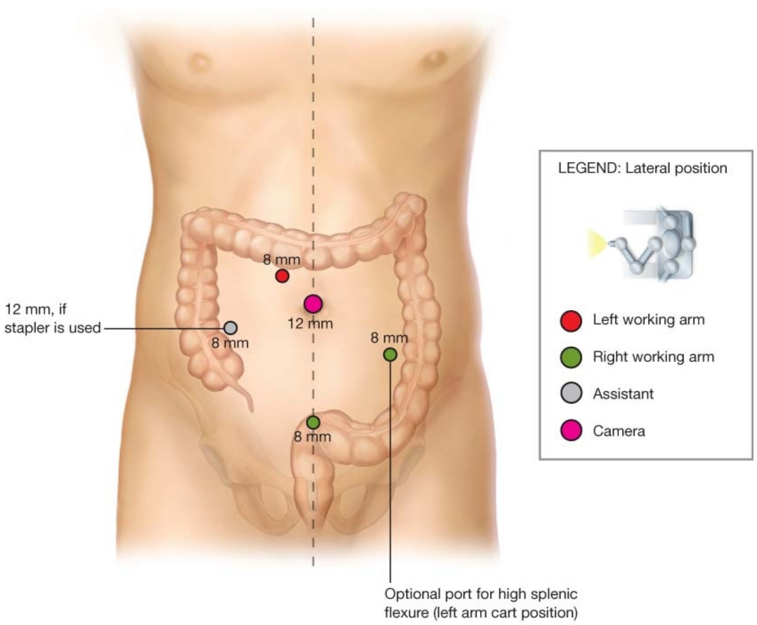
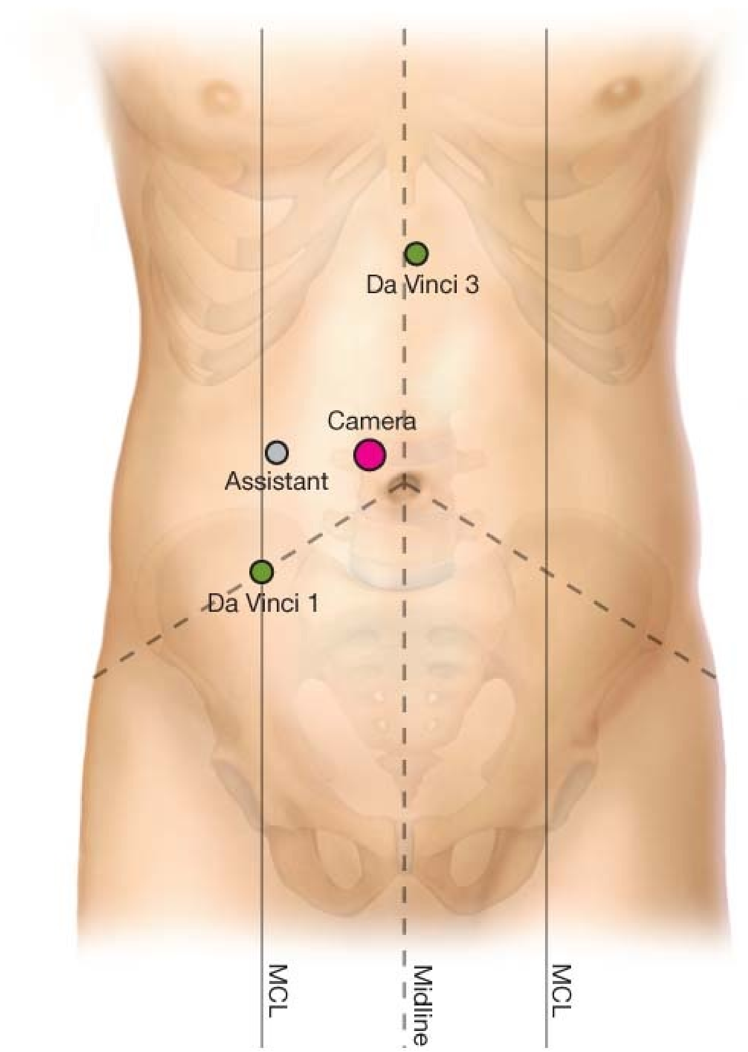


FIGURE 11-1 Port placement for left colon/sigmoid resection.

Upper Left Quadrant Set Up



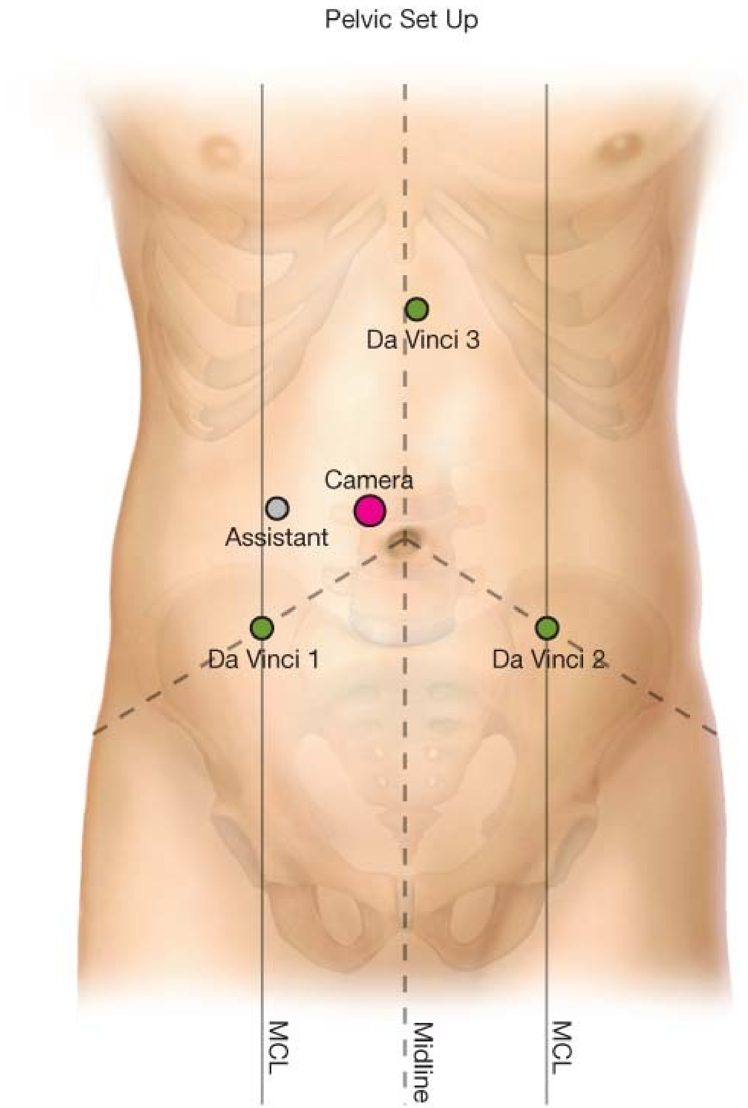


FIGURE 11-2 Port placement for one cart position low anterior resection (with permission, Hellan M, Stein H, Pigazzi A. Totally robotic low anterior resection with total mesorectal excision and splenic flexure mobilization. Surg Endosc 2009;23:447–51).

We recommend for the third arm a large, atraumatic grasping device such as the tip-up fenestrated grasper or the small grasping forceps because this arm is typically retracting delicate structures such as the colon or omentum to facilitate dissection. The Prograsp can also be utilized for retraction, but should be used with significant caution on the bowel, because this is not an atraumatic grasper. The instruments utilized for dissection on the other two arms are typically a fenestrated bipolar in the left hand and the robotic monopolar curved scissors in the right hand. Our preference is to utilize the monopolar curved scissors for their precision and ability to lyse adhesions sharply. The robot should then be docked in the usual manner; however, if the Xi model is being utilized, targeting should be performed toward the tumor location.

Technical Details—Initial Exploration and Exposure

An initial exploration of the abdomen should be performed to rule out carcinomatosis. After accomplishing this step, the tumor and tattoo should be identified. If there is any question as to the location of the lesion, the surgeon should have a low threshold for utilizing CO_2 colonoscopy for confirmation before proceeding further. After localizing the tumor, appropriate exposure should be obtained. The omentum should be flipped over the transverse colon and the small bowel positioned toward the right lower quadrant. We place the patient in approximately 15 degrees of right side down to facilitate exposure. Our preference is to initially identify the inferior mesenteric vein (IMV) as it exits below the inferior border of the pancreas, as well as the left colic artery. The IMV serves as a reliable and consistent anatomic marker and, as such, represents a safe location to begin dissection.

Medial-to-Lateral Dissection

An incision is made in the peritoneum underlying the IMV and dissection is continued in a medial-to-lateral manner, using a combination of cautery and blunt dissection, which continues until the abdominal wall is reached. This dissection is continued inferiorly to the level of the inferior mesenteric artery. Although tempting, it is advisable to refrain from taking down the white line of Toldt at this point, which provides useful lateral retraction of the colon (Figs. 11-3 and 11-4).

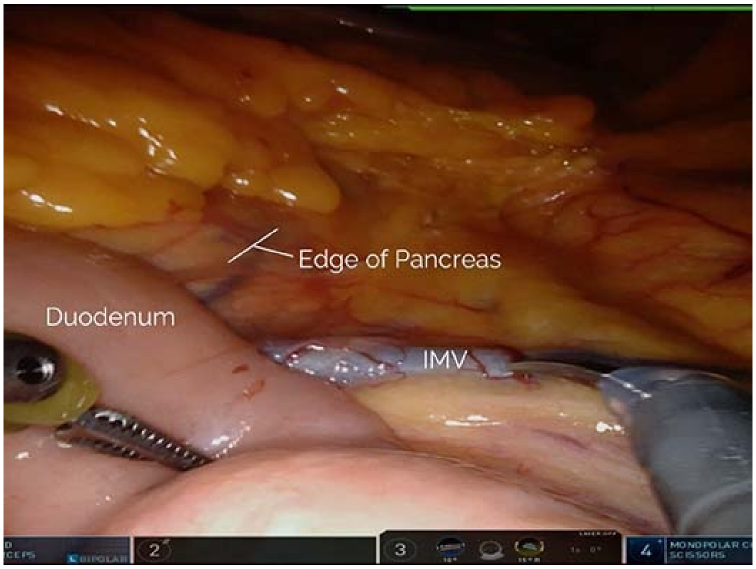


FIGURE 11-3 Initial exposure of inferior mesenteric vein (IMV).

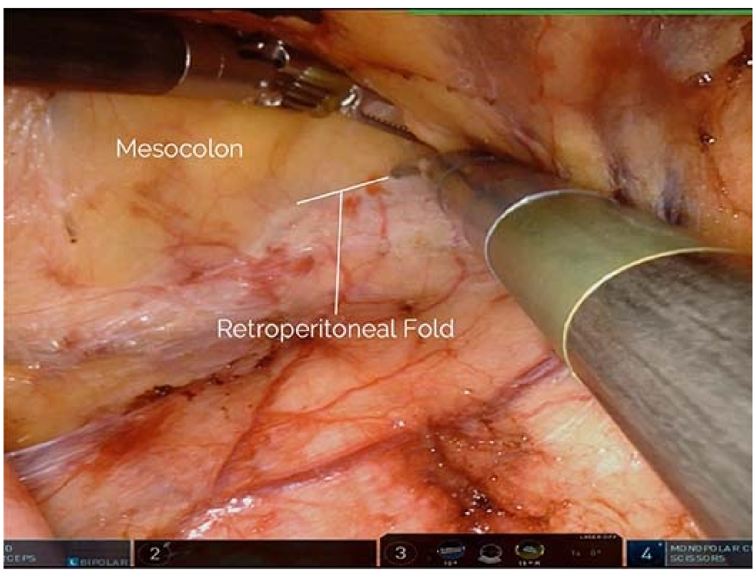


FIGURE 11-4 Medial-to-lateral mobilization. Note the upward retraction of the mesocolon with the left hand, exposing the retroperitoneal fold on tension for blunt dissection.

Mobilization of the splenic flexure is almost always required for left colectomy and can be performed in medial-to-lateral or lateral-to-medial manner, depending on surgeon preference. We typically proceed using a medial-to-lateral approach. The body of the pancreas should be identified, which can be difficult in the obese patient. A useful maneuver is to obtain a panoramic view and identify the duodenum, which will lead the surgeon to the head of the pancreas. The third arm can be utilized to place upward and slightly cephalad traction on the mesocolon to help expose the pancreas, which can often be identified as a fatty bulge in the retroperitoneum. In many instances, it is possible to elucidate a subtle difference in the character of the pancreatic parenchyma versus the mesenteric and retroperitoneal fat (Fig. 11-5).

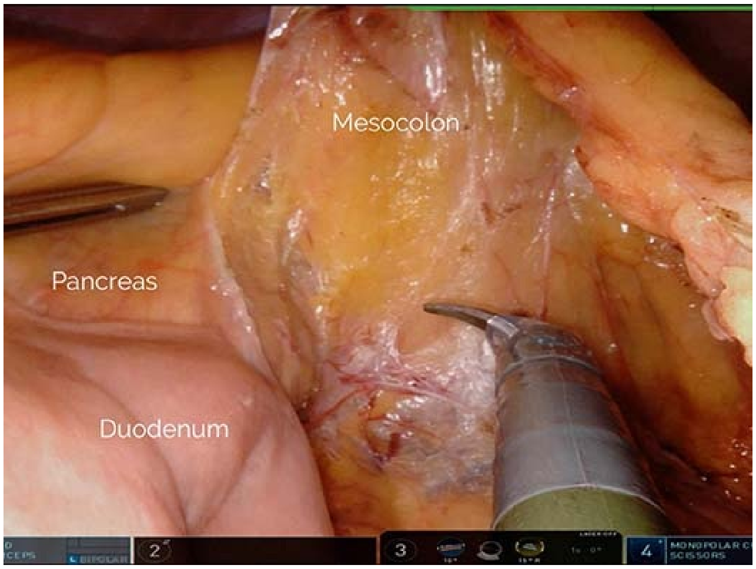


FIGURE 11-5 Initial exposure of pancreatic body during the medial-to-lateral approach.

An incision is then made just over the superior edge of the pancreas, and utilizing a combination of cautery and careful blunt dissection, the colon can be freed from the pancreas. A technical pitfall of the medial-to-lateral approach at this point that cannot be overemphasized is the correct identification of the pancreas. The retropancreatic plane will mobilize in a clean, medial-to-lateral manner, inadvertently leading the surgeon directly to the splenic vein. The inability to correctly and confidently identify the pancreas during this portion of a medial-to-lateral dissection requires conversion to a lateral-to-medial approach. Another technical pitfall at this point is inadvertent damage to the marginal artery by upward retraction. The surgeon must always be cognizant of the strength of the robotic instruments and gauge retraction appropriately. Once the colon has been mobilized away from the pancreas and the lesser sac entered, the splenocolic ligaments are divided and the omentum released from the transverse colon. The vessel sealer device can be helpful for maintaining hemostasis during division of the omentum (Fig. 11-6).

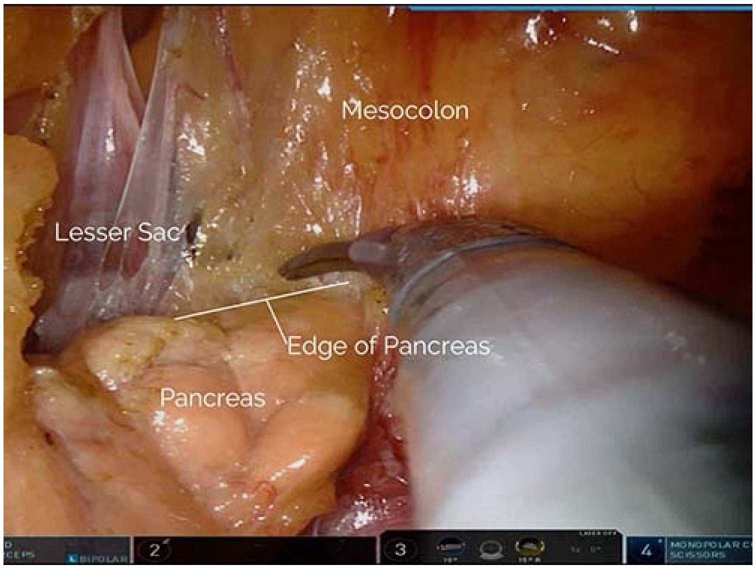


FIGURE 11-6 Medial-to-lateral mobilization of colon from distal pancreas.

Vascular division is the next step of the procedure. The left colic artery is identified and ligated at its origin using the vessel sealer device or vascular load of the Endowrist stapler. Alternatively, the vessel can be carefully skeletonized and ligated with the clip applier if desired. The left branch of the middle colic artery is divided in a similar manner.

Bowel Anastomosis

Bowel anastomosis can be accomplished via either an intracorporeal or extracorporeal anastomosis. Intracorporeal anastomosis provides the surgeon the freedom of utilizing any extraction site—Pfannenstiel, left-sided Rocky-Davis, or midline, for example. Utilization of the Pfannenstiel incision may confer the added benefit of a reduction in ventral incisional hernias versus midline extraction.

Intracorporeal Technique

After appropriate mobilization and vascular control of the specimen, the proximal and distal bowel can be divided. The points of transection should be chosen on the basis of oncologic factors to ensure adequate margins, blood supply, as well as appropriate length for anastomosis. The colon is then divided using the Endowrist 45-mm blue load stapler. Typically, two 45 mm stapler cartridges are required to transect each side of the bowel. The specimen should cartridges are required to transect each side of the bowel. The specimen should then be placed outside of the working field for later retrieval. For left colectomy, iso-peristaltic side-to-side positioning of the bowel limbs is typically the simplest and most anatomic orientation for anastomosis. The two limbs of the colon are then positioned in a side-to-side, anti-mesenteric manner and confirmed to be tension free and appropriately oriented. At least 4.5 cm of overlap between the two limbs should be achieved to ensure accommodation of at least one firing of the Endowrist 45-mm stapler. Appropriate vascular supply to the bowel can be confirmed at this point by utilizing indocyanine green angiography.

Once the limbs have been appropriately positioned, maneuvers to hold the bowel in the correct location and orientation must be undertaken. Myriad methods have been devised to accomplish this; however, the two most commonly used techniques are stay sutures or direct grasping of the bowel with the third arm. Stay sutures can be helpful, but may be time consuming to place and can lead to tearing of the bowel if not retracted carefully. If they are utilized, they should be placed in an anti-mesenteric position with adequate to prevent tearing. A simpler technique is to grasp both anti-mesenteric sides of the two limbs and bring them together using a large atraumatic grasper such as the small grasping forceps or the tip-up fenestrated grasper. This affords the surgeon unlimited opportunities to reposition as well as a lower risk of tearing the bowel with sutures.

Colotomies are then created in each limb of the bowel, positioned to allow for appropriate passage of the stapler to create an adequate common channel (Fig. 11-7). Gentle tension on the bowel allows for much easier entry into the lumen using electrocautery without excessive burning. Once the lumen has been entered, placing one blade of the scissors inside the lumen and lifting upward with a small amount of cautery will facilitate precise creation of a sufficiently large aperture to accommodate the stapler (Fig. 11-8). The Endowrist stapler is then gently inserted into the colotomies. It is usually easier to insert the limbs of the stapler one at a time and then advance the bowel into the proximal stapler after both colotomies have been cannulated; one or two stapler firings can be utilized (Fig. 11-3).

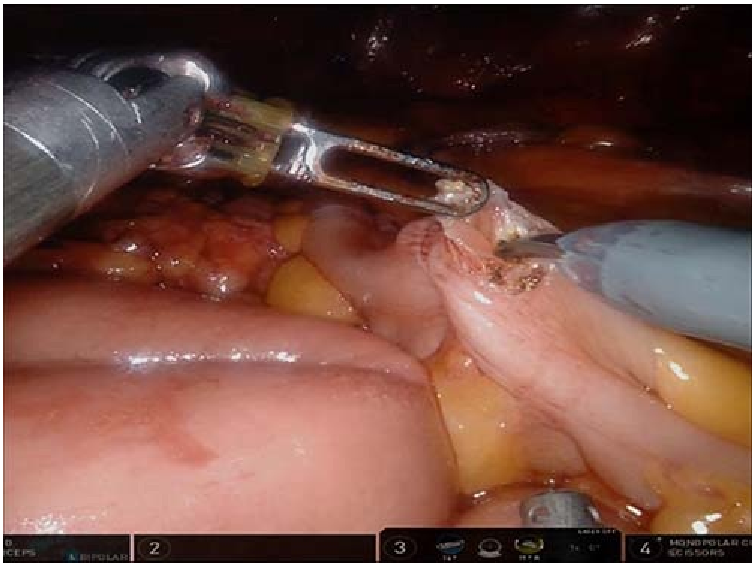


FIGURE 11-7 Creation of colotomy.

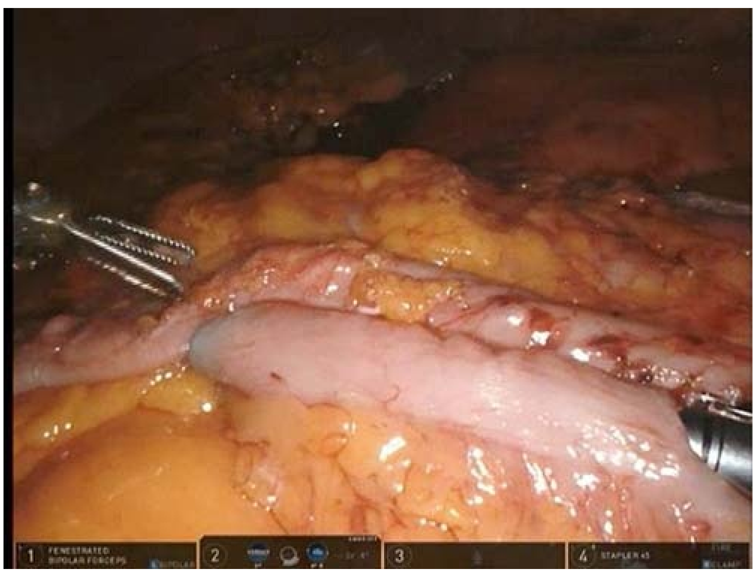


FIGURE 11-8 Insertion of stapler and positioning of limbs for intracorporeal anastomosis.

The colotomy should then be closed in a hand-sewn manner, in one or two layers, using suture material of the surgeon's preference. We typically close the defect using either a running 3-0 Vicryl or a running 3-0 V-Loc polydioxanone suture. A technical pearl to assist with closing the colotomy is to grasp the apex of the colotomy with the third arm and retract toward the abdominal wall, thus lining up the mucosal edges and crucially exposing the inferior aspect or "crotch" of the staple line. We advise beginning the closure at this inferiormost aspect, which can be difficult to see when suturing from superior to inferior, resulting in inadequate closure and leaks.

Extracorporeal Technique

Once the colon has been completely mobilized, the specimen can be exteriorized through a wound protector, either through a midline periumbilical incision or a left-sided transverse incision. It is not routinely possible to exteriorize through a Pfannenstiel incision for left colectomy. It is important to ensure length of colon has been mobilized before attempting to deliver the specimen, as excessive traction of the middle colic artery during exteriorization may lead to avulsion. After carefully delivering the bowel from the abdomen, proximal and distal transection points are chosen and the bowel is divided using staplers. The bowel can be positioned in either an iso-peristaltic or anti-peristaltic position, according to the preference of the surgeon. It is critical to ensure proper orientation of the bowel in an anti-mesenteric manner and ensure no twisting is present proximally or distally. The anastomosis is then performed in the usual manner, as for an open procedure.

Chapter 12

Hand-Assisted Left Colectomy

Joongho Shin and Sang W. Lee

INDICATIONS

The main limitation of laparoscopic surgery is loss of tactile feedback. Hand-assisted surgery provides many benefits of laparoscopic surgery, while allowing surgeons to retain tactile feedback, better retraction with a trained hand, and ability to do blunt dissection with fingers when needed. These advantages have been shown in randomized clinical trials as shorter operative time and less conversion with similar perioperative outcome measures compared with straight laparoscopy.

Indications for hand-assisted left colectomy are the same for laparoscopic left colectomy: colon cancer, diverticular disease, and Crohn’s colitis. When deciding laparoscopic versus hand-assisted approach, several factors are taken into consideration: body habitus, location, nature, and complexity of pathology, and extent of planned surgery. In obese patients with heavy intraperitoneal and pericolonic fat, adequate exposure and traction can be difficult. Hand port access can be valuable in this case. If the patient has history of complicated diverticulitis such as colovesicular fistula, and pelvic inflammation and fibrosis is expected, hand access gives surgeon ability to use fingers for blunt dissection. In elective sigmoid resection for diverticulitis, especially in complicated diverticulitis, hand-assisted sigmoidectomy has been shown to have lower conversion rate and shorter operative time, although having equivalent outcome. Conversion from straight laparoscopic to hand-assisted laparoscopic surgery rather than laparotomy, when intraoperative difficulty is encountered, is another utility of this approach.

Laparoscopic colectomy has been shown to have a long learning curve. Hand-assisted left colectomy can be a bridge between open colectomy and straight laparoscopic colectomy.

PREOPERATIVE PLANNING

Thorough history and physical examination is performed with attention to:

1. Medical history of pulmonary disease such as chronic obstructive pulmonary disease (COPD) and eye disease such as glaucoma. Patients with severe COPD are not likely to tolerate pneumoperitoneum. These patients need to be informed of high likelihood of early conversion to open procedure, if end tidal CO_2 started to increase after pneumoperitoneum was established. Steep Trendelenburg position during laparoscopic procedure has been shown to increase intraocular pressure in time-dependent manner. In patients without preexisting eye disease, this has been shown not to affect visual health, but in patient with known glaucoma, caution should be taken to minimize time in steep Trendelenburg position.
2. Surgical history and abdominal scars: patients with significant surgical history pose two types of challenges. First is altered anatomy that will hinder particular operative steps. For example, in a patient with distant history of gastric cancer and Billroth II gastrojejunostomy, taking down splenic flexure can be difficult. It is advisable to gather as much as information preoperatively from operative reports, if available, and any imaging study. Second is intra-abdominal adhesions. In a patient with history of multiple laparotomies or previous complex operation, it is advisable to use the old scar to create vertical hand port incision rather than a Pfannenstiel incision.

For patients with complicated diverticulitis (e.g., colovesicular fistula) or locally advanced sigmoid colon cancer, consider bilateral ureteral stent placement at the beginning of the case. It is our preference to use them selectively.

For patients with a large abdominal subcutaneous fat, it is prudent to mark the stoma site, in case unexpected intraoperative course necessitates creation of a temporary stoma. This is usually done in the preop holding area with patient standing up.

SURGERY

Room Setup and Patient Position

Typical room set up is shown in Figure 12-1.

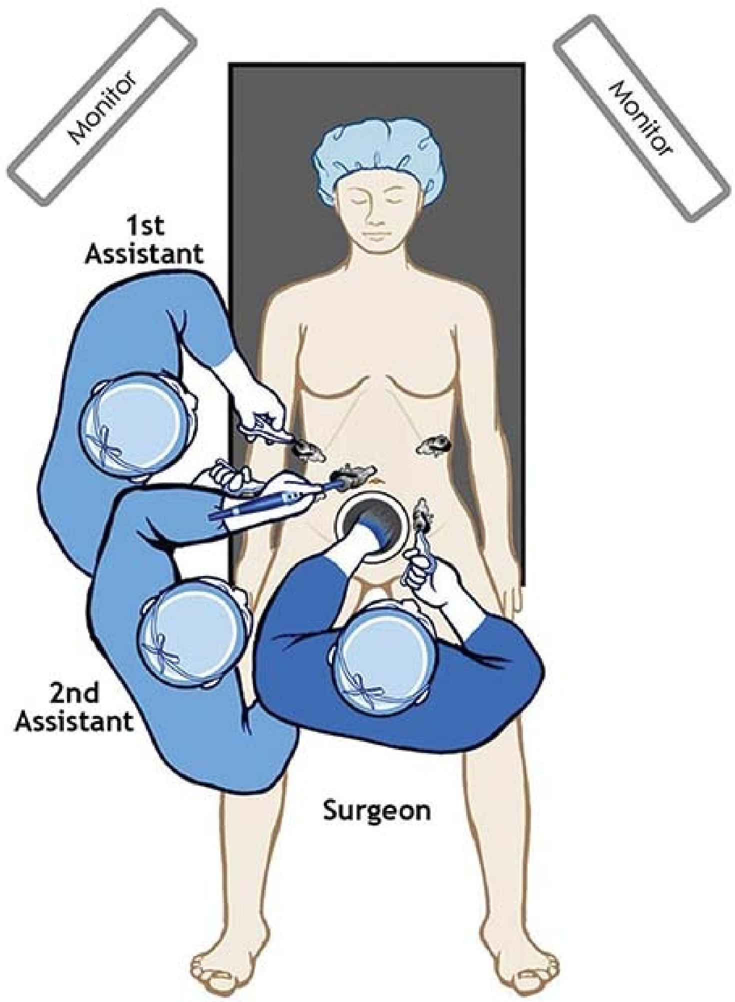


FIGURE 12-1 Typical room setup.

Gelpad or beanbag is used on the table to stabilize the patient during steep Trendelenburg position. Both arms are tucked, and hands are protected by foam pads or baby diapers. In heavy patients, it is wise to test the security by placing the patients in extreme positions before prepping. If necessary, heavy-duty tapes can be placed around the patient’s chest and the table.

The patient is placed in modified lithotomy position, with hip extended close to 180° relative to torso. This prevents the range of the surgeon's elbow from being restricted by patient's flexed thigh. Care should be taken not to hyperextend the hip.

Flexible sigmoidoscopy is ready and available throughout the case.

Surgeon stands between patient's legs, and the assistant (operating) surgeon stands on the patient's right side during laparoscopic portion.

Incisions and Port Placement

A Pfannenstiel incision is created two finger breadths above the pubic symphysis. If the patient has a natural skin crease slightly above or below, create the incision along the crease for better cosmesis. The length of the incision depends on surgeon's hand size, and it is typically 8 cm for 7½ glove size. The anterior fascia is opened transversely. The fascial incision is made with each end curved up, so that it avoids dividing the inguinal ligament inadvertently. The anterior fascia is separated from rectus superiorly and inferiorly. The posterior fascia is opened longitudinally, and peritoneum is entered sharply. Peritoneum is entered at superior aspect of the incision to try to avoid potential bladder injury. Once an adequate incision is created to permit the surgeon's hand, a supraumbilical trocar is inserted with hand guidance. Then, abdomen is insufflated. Three additional 5 mm trocars are placed with optional 5 mm trocar in left upper quadrant as shown in Figure 12-2.

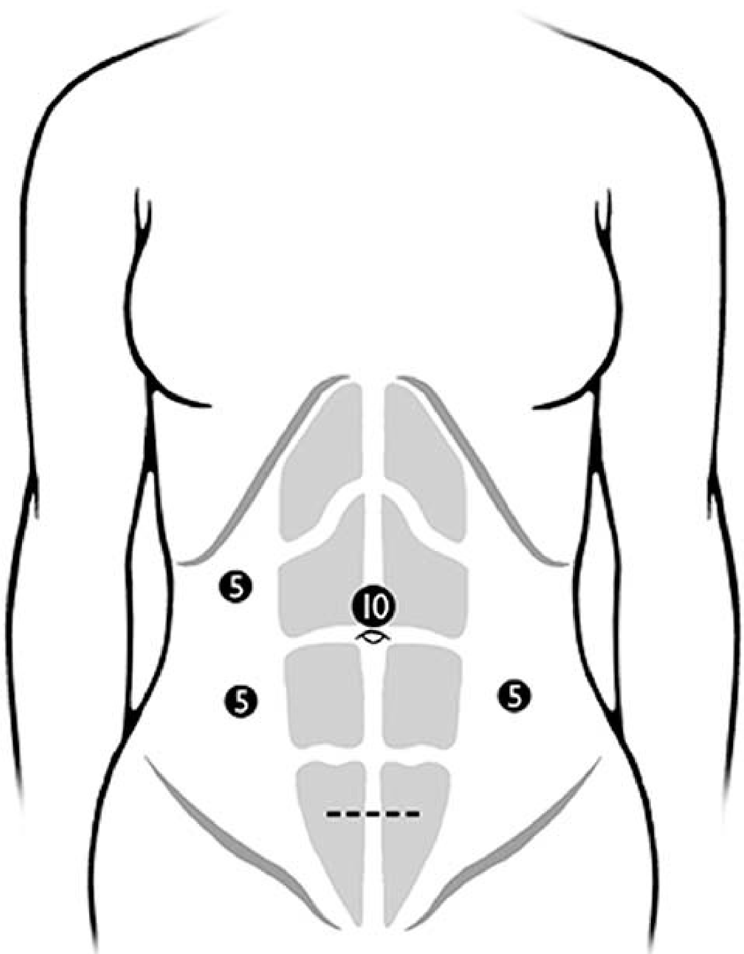


FIGURE 12-2 Port placement.

p. 86

p. 87

Operative Steps

Positioning the patient: tilt the patient to steep Trendelenburg with left side up position.

Creating mesenteric exposure: flip the transverse colon cephalad and sweep loops of small intestines out of the pelvis into patient's right side and right upper quadrant: in obese patients, moist laparotomy pad is helpful in packing the small intestines away from the operative field. Moist laparotomy pad can be used to clean the lens of the scope at the same time. Ideally exposure to the sacral promontory, left edge of aorta, and ligament of Treitz should be achieved as shown in Figure 12-3.

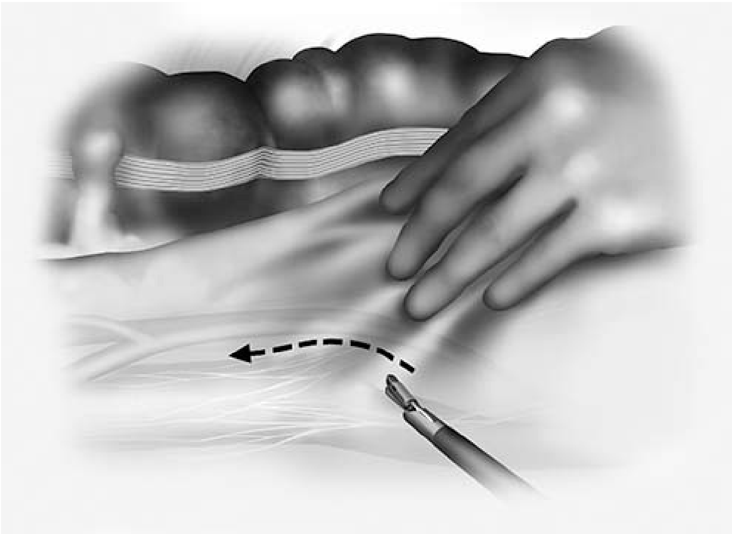


FIGURE 12-3 Initial exposure of sacral promontory and root of left colon mesentery. Arrow, refers to the direction of peritoneal incision.

Medial to lateral dissection: With a hand in supinated position, pinch and hold the sigmoid colon and mesentery and place them under anterior tension (Fig. 12-4). This maneuver separates the inferior mesenteric/superior hemorrhoidal artery from left common iliac artery, so that medial to lateral dissection can be achieved in the correct plane. When there is an experienced assistant available, the surgeon uses the left hand to retract. The surgeon's right hand can use an instrument such as a bowel grasper through left lower quadrant port for fine maneuvers. When the assistant surgeon is inexperienced, the surgeon places the right hand through the hand access device and uses the left hand to use the energy device from right lower quadrant port for a medial to lateral dissection and vessel ligation.

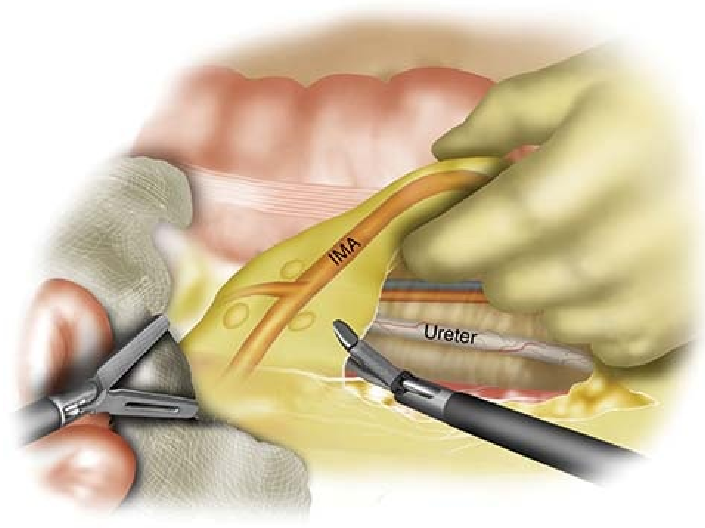


FIGURE 12-4 Elevating sigmoid mesentery with inferior mesenteric artery.

p. 87

p. 88

Open the peritoneum along the root of the left colon mesentery starting at the sacral promontory, where there is greatest separation between the inferior mesenteric artery (IMA) and Iliac vessels (dotted line in Fig. 12-3). Air dissection occurs when the peritoneal incision is made in the correct place. Once a wide window behind the IMA is created, blunt dissection separates mesentery from retroperitoneum as shown in Figure 12-5 ("purple goes down"). Once left ureter and gonadal vessel are clearly identified and separated from mesentery, attention is paid to isolate the inferior mesenteric pedicle. At this point, nerve fibers of superior hypogastric plexus can be felt being pulled up lateral to IMA. This needs to be swept down and preserved.

FIGURE 12-5 Medial to lateral dissection. Arrow, refer to direction of blunt finger dissection or traction.

IMA ligation: The inferior mesenteric artery can be ligated low (distal to left colic artery take-off) or high (proximal to left colic). In benign cases and elderly, low ligation is recommended. In cancer cases, high ligation is advisable, even though definite evidence of oncologic benefit is lacking. In a thin patient, the left colic artery can be seen coursing in a cephalad direction over the inferior mesenteric vein toward the splenic flexure. In obese patients with corpulent mesentery, the view is difficult to discern unless extensive dissection within the mesentery is done. The authors routinely use bipolar energy device to ligate mesenteric vessels. A surgical stapling device with vascular load is an option in patients with calcified vessels. When using bipolar energy device to ligate vessels, be prepared to manage a situation where the seal is not complete. This is rare even in calcified vessels. However, the operating room should be stocked with endoloop, laparoscopic clip applier, and laparoscopic stapling device.

In a sigmoid resection, ligation of the inferior mesenteric vein or left colic artery (when low ligation of IMA was done), in order to gain better reach of the proximal colon to a pelvic anastomosis, is not routinely necessary. In a low anterior resection, it may be necessary. When the inferior mesenteric vein is ligated proximally, medial to lateral dissection can be achieved to the inferior border of pancreas. When the inferior mesenteric vein is not ligated, medial to lateral dissection is achieved to the white line laterally.

Lateral mobilization of the descending colon toward splenic flexure. This step is greatly facilitated by completing medial to lateral dissection. Incise the lateral attachment medial to the white line of Toldt's, and the empty space, previously developed, will be encountered. The dissection continues cephalad toward the splenic flexure. The assistant pulls the proximal left colon medially and surgeon's left hand does the exposure (Fig. 12-6).

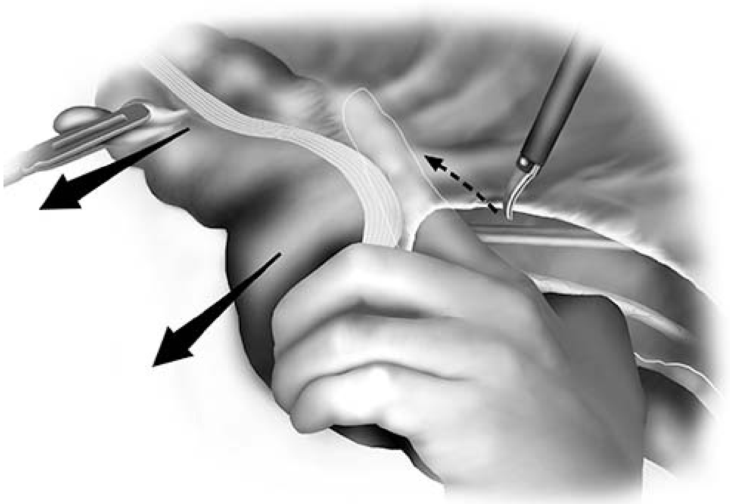


FIGURE 12-6 Mobilizing descending colon toward splenic flexure. Arrow, refer to the direction of traction on bowel or omentum.

Taking down splenic flexure by releasing the omentum from the transverse colon. The patient is placed in reverse Trendelenburg position for this step. Starting at the midpoint of the transverse colon, divide the fusion plane between the omentum and pericolonic fat. Once the lesser sac is entered (confirmed by visualization of the posterior wall of the stomach), continue to divide the attachments toward the splenic flexure. Once all the retroperitoneal attachment to spleen, pancreas, and kidney are divided, the splenic flexure should be free. During this step, a triangulation retraction between the omentum and the transverse colon protects the colon from thermal injury (Fig. 12-7).

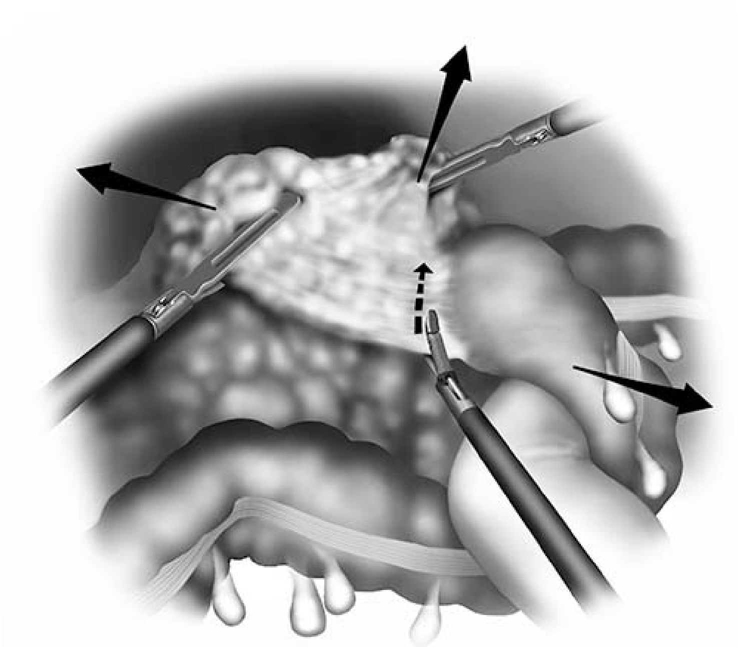


FIGURE 12-7 Correct exposure to avoid thermal injury to transverse colon. Arrow, refer to the direction of traction on bowel or omentum.

Resection and anastomosis Once the left colon is completely mobilized and adequate reach is confirmed, the patient is placed back into mild Trendelenburg position, and hand access port is opened. The proximal colon is divided with stapling device, and the intervening mesentery from this point down to IMA stump is divided with a bipolar energy device. The small bowel, the cecum, and the proximal colon are packed away using a moist lap pad. The sigmoid colon is mobilized, and the rectosigmoid junction is divided with a stapling device. The specimen is sent off, and an end-to-end anastomosis using the double stapling technique is created. Flexible sigmoidoscopy is performed to visualize the anastomosis and perform an airleak test. When perfusion in the proximal colon or the distal rectum is in question, indocyanine green–based fluoroscopy is a useful adjunct to ensure adequate perfusion to the each end of the anastomosis (Fig. 12-8).

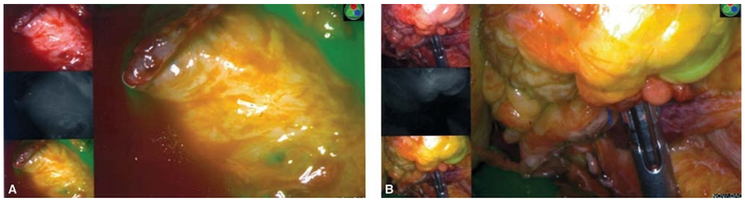


FIGURE 12-8 Perfusion assessment of distal rectum (A) and proximal colon with anvil (B) right

before anastomosis.

POSTOPERATIVE MANAGEMENT

There is no consensus regarding postoperative routine, but institutional enhanced recovery protocol is recommended. Early oral feeding, early ambulation, and minimal necessary narcotic pain medication use, complemented by routine use of non-narcotic pain medication such as nonsteroidal anti-inflammatory drugs, improve recovery. Foley catheter is removed on postoperative day 1 in most cases when patient is ambulating and otherwise clinically stable.

COMPLICATIONS

The most devastating complication after colectomy is anastomotic leak. The most important principle in managing anastomotic leak is early diagnosis and prompt fecal diversion and washout to minimize the inflammatory response of abdominal sepsis. When anastomotic disruption is limited, and the majority of the anastomosis is viable, washout and loop ileostomy along with placement of a pelvic drain is appropriate. Loop ileostomy creation is facilitated via a hand port incision. A rare but equally devastating complication after left colectomy is left ureteral injury. When ureteral injury is recognized intraoperatively and repaired over a stent, morbidity is in general minimal. Delayed diagnosis of ureteral injury is problematic. Every effort should be made to identify the left ureter clearly in every left colectomy case.

Missed bowel injury can manifest itself in the immediate postoperative period. A common mechanism of bowel injury is thermal injury from an energy device. This can happen to the small intestines as collateral damage or to the left colon while it is being mobilized. Full-thickness thermal injury–induced perforation usually manifests on postoperative day 2 or 3. High index of suspicion is required because imaging is neither sensitive nor specific to evaluate bowel injury.

CONCLUSIONS

The main advantages of hand-assisted laparoscopic left colectomy are (a) shorter operative time and (b) less conversion to laparotomy compared with straight laparoscopic left colectomy, while retaining many benefits of laparoscopic colectomy such as shorter hospital stay and less postoperative pain compared with open colectomy. In addition, hand-assisted left colectomy is a valuable tool in surgery for sigmoid diverticular disease, in morbidly obese patients, and in complex pathology of sigmoid colon.

RECOMMENDED REFERENCES AND READINGS

Cirocchi R, Trastulli S, Farinella E, *et al.* High tie vs low tie of the inferior mesenteric artery in colorectal cancer: A RCT is needed. *Surg Oncol* 2012;21(3):111–23.

Jafari M, Wexner S, Martz J, *et al.* Perfusion assessment in laparoscopic left-sided/anterior resection (PILLAR II): multi-institutional study. *J Am Coll Surg* 2015;(220):82–92.

Lee SW, Yoo J, Dujovny N, Sonoda T, Milsom JW. Laparoscopic vs. hand-assisted laparoscopic sigmoidectomy for diverticulitis. *Dis Colon Rectum* 2006;49(4):464–9.

Marcello PW, Fleshman JW, Milsom JW, *et al.* Hand-assisted laparoscopic vs. laparoscopic colorectal surgery: a multicenter, prospective, randomized trial. *Dis Colon Rectum* 2008;51(6):818–26.

Mondzelewski T, Schmitz J, Christman M, *et al.* Intraocular pressure during robotic-assisted laparoscopic procedures utilizing steep Trendelenburg positioning. *J Glaucoma* 2015;24:399–404.

Zhuang CL, Ye XZ, Zhang CJ, Chen BC, Yu Z. Enhanced recovery after surgery programs versus traditional care for colorectal surgery: a meta-analysis of randomized controlled trials. *Dis Colon Rectum* 2013;30(3):225–32.

PART III

LOW ANTERIOR RESECTION

Chapter 13

Low Anterior Resection—Open

Michael A. Valente

INDICATIONS/CONTRAINDICATIONS

Low anterior resection (LAR) is primarily performed for mid and low rectal adenocarcinoma. The definition of *low* anterior differs from an *anterior* resection in that the dissection in an LAR proceeds beyond the peritoneal reflection. Most often, LAR is for rectal tumors located within 10 cm from the anal verge. Sphincter-preservation surgery has become the standard of care for low rectal tumors; and in our experience, approximately 85% of all patients with rectal cancers can undergo sphincter preservation.

Contraindications to performing a LAR with colorectal or coloanal anastomosis include patients with extensive comorbid conditions and inability to achieve an oncologically sound surgery with adequate distal and circumferential resection margins, due to extensive adjacent organ/pelvic bony invasion and/or poor anal sphincter function. These patients are best suited for abdominal perineal resection or possibly just fecal diversion.

PREOPERATIVE PLANNING

LAR is primarily performed for mid and low rectal adenocarcinoma, and thus there is an extensive decision-making process that must take place for successful oncologic cure and for maximum functional quality of life after surgery.

The key components of evaluation begin with the fundamental principles of a detailed personal and family history, physical examination, histologic confirmation of the tumor, and a full colonoscopy. Essential elements in the multidisciplinary workup of rectal cancer include the following:

Patients’ age and medical comorbidities (physiological age; ability to undergo abdominopelvic surgery, and/or receive chemoradiotherapy)

Tumor location
Tumor stage (tumor, node, metastasis [TNM] classification)
Anal sphincter status (physiological function)

Obstetric history in women

Previous anal or pelvic surgery

History of radiation treatment
Patient’s wishes/expectations

Surgeon experience and skill

Accurate diagnosis and staging of rectal cancer is of the utmost importance to make a sound multidisciplinary decision for surgical treatment. Tumor location with respect to the anorectal ring (anorectal junction), anal verge and peritoneal reflection, TNM staging, and circumferential resection margins all need to be evaluated before treatment can begin.

A combination of both a digital rectal examination (DRE) and rigid proctoscopy is the most accurate method for localizing rectal tumors, especially in the low and mid level of the rectum; flexible endoscopy may potentially be less accurate. In both DRE and endoscopy, the anal verge is the anatomical landmark that is used as a reference point for accurate measurement. All rectal tumors should be noted according to their most distal edge measured from the anal verge and categorized as anterior, posterior, and right or left. Localization is absolutely mandatory for surgical decision making and to help determine whether sphincter preservation is feasible. When determining whether sphincter preservation can be accomplished, the examiner must assess the tumor’s lower edge in relationship to the anorectal ring. In addition, anal sphincter status must be evaluated with physical examination and potentially manometry to ensure adequate sphincter strength and function. Even patients with marginal sphincters and decreased mobility may have poor quality of life because of the inability to quickly reach the toilet and may be counseled to have a permanent stoma.

Depth of invasion and nodal status must be evaluated for the potential utilization of neoadjuvant chemoradiotherapy. The author suggests that endorectal ultrasound (EUS) and/or dedicated high-resolution rectal magnetic resonance imaging (MRI) should be performed on all mid and distal tumors and select upper tumors. There are advantages and disadvantages to both modalities and therefore can be considered complementary to each other. EUS, however, is not well suited for high tumors and/or bulky tumors (T4). In addition, stenotic tumors pose a technical problem, because the ultrasound probe may not be able to traverse the lesion for accurate staging. However, T3 lesions are well distinguishable from T4 lesions with the aid of MRI. The accurate diagnosis of T3 from T2 lesions is important, because T3 lesions of the mid and low rectum should receive neoadjuvant chemoradiation in most instances. In the authors’ experience, ultrasound may be better when looking anteriorly (invasion into prostate/bladder or vagina) and MRI is better for evaluating the circumferential margin. In terms of lymph node status, MRI is the recommended modality for diagnosis of nodal disease, despite an overall low sensitivity and specificity (66% and 76%, respectively). In general, at our institution, all patients with T3–

T4 and/or N+ mid-to-low rectal adenocarcinomas will receive neoadjuvant long-course chemoradiotherapy followed by radical excision 8–12 weeks after completion.

Metastatic evaluation should include preoperative carcinoembryonic antigen levels and computed tomography (CT) scans of the chest, abdomen, and pelvis. Dedicated MRI of the liver may be useful for equivocal lesions seen on CT scan. Brain CT and bone scans should be obtained for those with specific symptoms. Positron emission tomography (PET/CT or PET/MRI) should be used on a case-by-case basis and is not recommended as an initial staging modality, unless suspicious lesions are found on CT or MRI and positivity will alter the surgical plan.

A multidisciplinary team approach is compulsory at our institution. Every rectal cancer case, regardless of clinical stage, is discussed with the multidisciplinary team, which consists of medical oncology, radiation oncology, gastrointestinal (GI) pathology, GI radiology, colorectal surgeons, liver/thoracic surgeons, genetic counselors, and the other members of the nursing support staff. Treatment is built upon accurate staging, but tailored to each individual patient, based on age, physiological status, functional status, and a thorough understanding by the patient of the various treatment options that exist. This approach is also a standard with the American College of Surgeons Commission on Cancer National Accreditation Program for Rectal Cancer.

SURGERY

Preparation and Positioning

For all patients undergoing elective surgery, formal preoperative assessment is conducted, including cardiopulmonary evaluation, basic blood work, and appropriate imaging tests to prepare the patient for the operating room. Nutritional parameters are checked, including albumin and pre-albumen. All patients receive preoperative oral antibiotics (metronidazole and neomycin), a full mechanical bowel preparation, and are also provided a chlorhexidine body wash for the night before surgery. In addition, all patients see a member of the enterostomal nursing team to appropriately preoperatively mark the planned ileostomy/colostomy site (temporary or permanent). Appropriate education on ostomy care is given before the surgery and during and after the patient's hospitalization.

Patients are placed in the modified lithotomy position with Yellowfin or padded Allen stirrups (Allen, Acton, MA) and careful attention is paid to protect bony prominences to try to prevent nerve damage, especially to the peroneal nerve. We prefer to tuck both arms at the patient's sides for all abdominopelvic cases for easy access and ergonomic comfort for the surgeons performing the operation.

Guidelines for appropriate antibiotic use are strictly followed in all patients, which consist of 2 g of intravenous ceftriaxone and 500 mg intravenous metronidazole within 60 minutes of incision; penicillin-allergic patients will receive 400 mg intravenous ciprofloxacin and 500 mg metronidazole; routine postoperative antibiotics are not given. Bladder catheter and orogastric tube are routinely placed. Ureteral stents are very selectively placed to aid in identification of the ureters. Ureteral stents are generally reserved for complex reoperative cases with anticipated extensive fibrosis or inflammatory changes.

Deep pelvic surgery can be quite difficult because of inadequacies in lighting and improper exposure. We routinely use a self-retaining Balfour retractor with an associated C-arm attachment, which allows for packing of the small bowel contents out of the pelvis. The use of lighted St Mark's or Lloyd Davis retractors (Electrosurgical Instrument Company, Rochester, NY) proves quite useful for exposure within the narrow confines of the pelvis. For very narrow anatomic variations of the pelvis, the lighted Britetrac retractor (Vitalcor, Inc., Westmont, IL) proves quite beneficial as well.

Basic operative steps in open low anterior resection

Abdominal exploration

High ligation of inferior mesenteric artery (IMA) and inferior mesenteric vein (IMV)

Sigmoid and left colon mobilization

Mobilization of splenic flexure

Proximal colon transection
Total mesorectal excision (TME)

Distal rectal transection

Colorectal or coloanal anastomosis

Creation of diverting loop ileostomy

Abdominal Exploration

A midline incision is made from the umbilicus down to the level of the pubic symphysis. Upon entering the abdomen, a thorough exploration is performed to exclude metastatic disease. The peritoneum is inspected for tumor implantation and the liver is examined and palpated. Adnexal structures are examined in the pelvis for any signs of metastatic spread. Next, the pelvis is examined and feasibility of a sound oncologic resection is undertaken. Assessment of any lateral extension of the tumor or potential invasion into any adjacent structures is also addressed at this time.

High Ligation of the Inferior Mesenteric Artery and Vein

A medial-to-lateral approach is undertaken by the author for all cancer operations (open and laparoscopic). The peritoneum on both sides of the rectum is incised at the level of the sacrum promontory, with care to avoid the ureters and the sympathetic nerves. The dissection is undertaken under the superior rectal artery and the dissection is continued to the origin of the IMA off of the aorta. Branches of the hypogastric nerve plexus are identified and cautiously swept caudally toward the aorta. The left ureter should be identified at this time before any vessel is ligated. The IMA should be isolated and skeletonized and doubly clamped (Fig. 13-1). A suture ligature is applied to the artery.

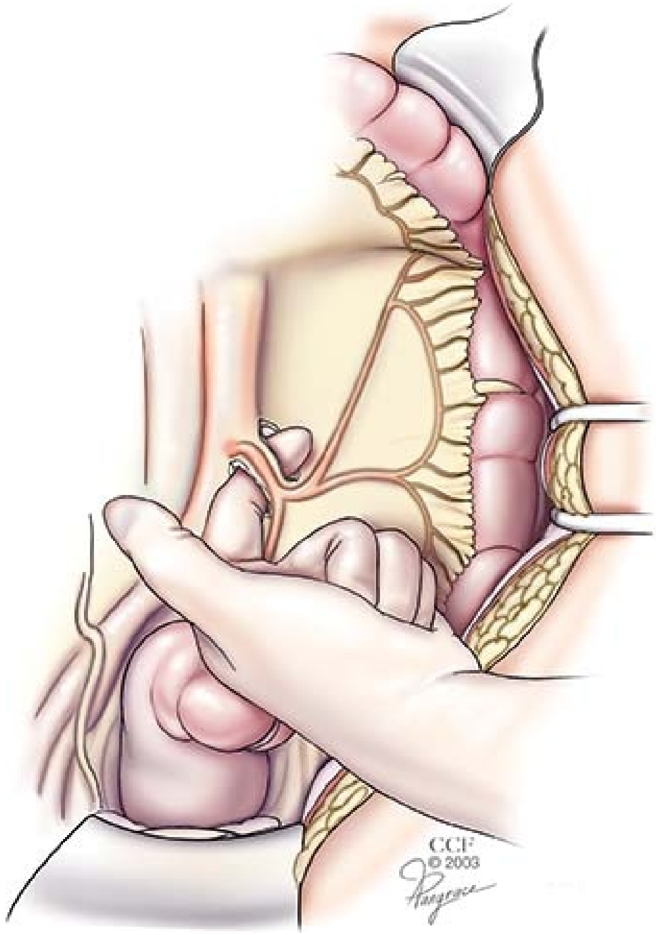


FIGURE 13-1 Isolation of the inferior mesenteric artery at its origin off of the aorta.

Preservation of the left colic artery is surgeon and case specific (high tie vs. low tie). The vast majority of cases at our institution and the preference of this author and the editors are to divide the IMA in a high-ligation manner at the takeoff from the aorta, thereby sacrificing the left colic artery (Fig. 13-2). Preservation of the left colic artery may result in a more predictable blood flow to the anastomosis, but may not give sufficient bowel length. After the IMA and IMV have been ligated at this level, dissection proceeds toward the fourth portion of the duodenum and ligament of Treitz. The IMV can be found just lateral to the duodenum and proximal to the inferior edge of the pancreas before it joins the splenic vein to become the portal vein. It is routine in our practice to ligate the IMV at this level to allow excellent reach of the colonic conduit into the pelvis for a tension-free anastomosis (Fig. 13-3 A to C). In the scenario where the IMA is ligated at its origin and the IMV is ligated at the pancreatic level, the proximal blood supply to the anastomosis is supplied via the marginal artery of Drummond by way of the middle colic vessels. When these high-ligation maneuvers are employed, it is rare that the colon will not adequately reach into the pelvis.

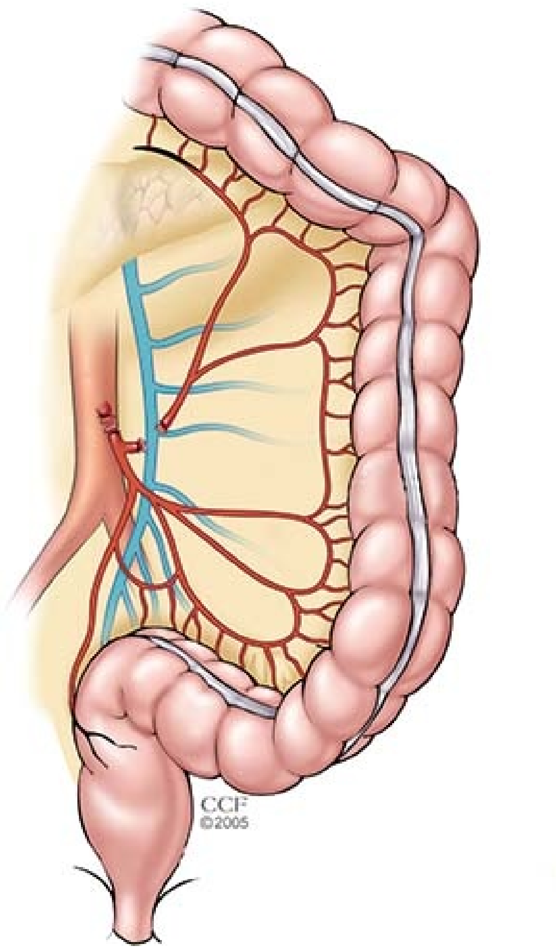
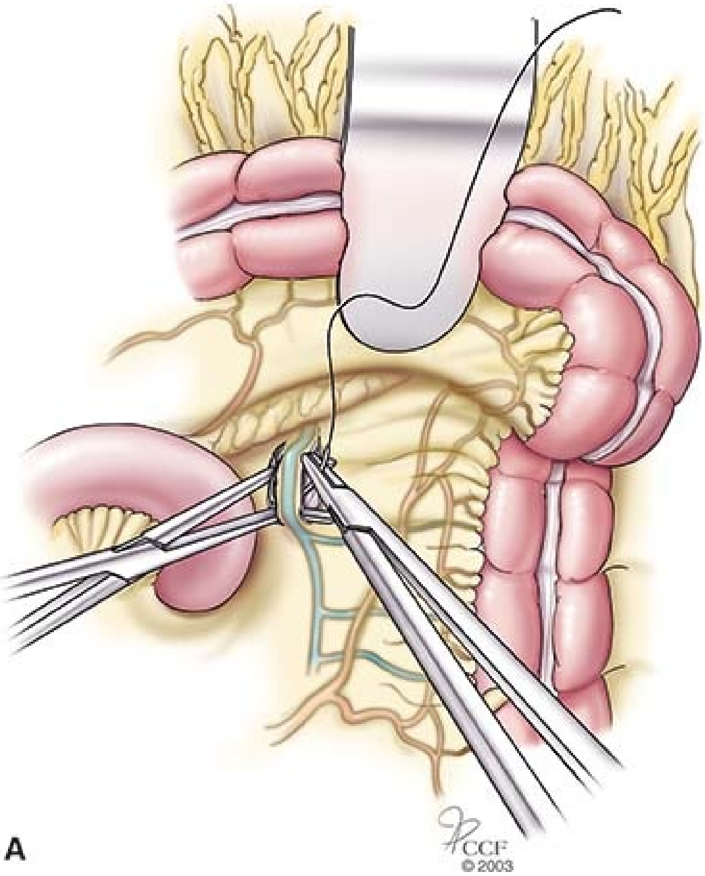
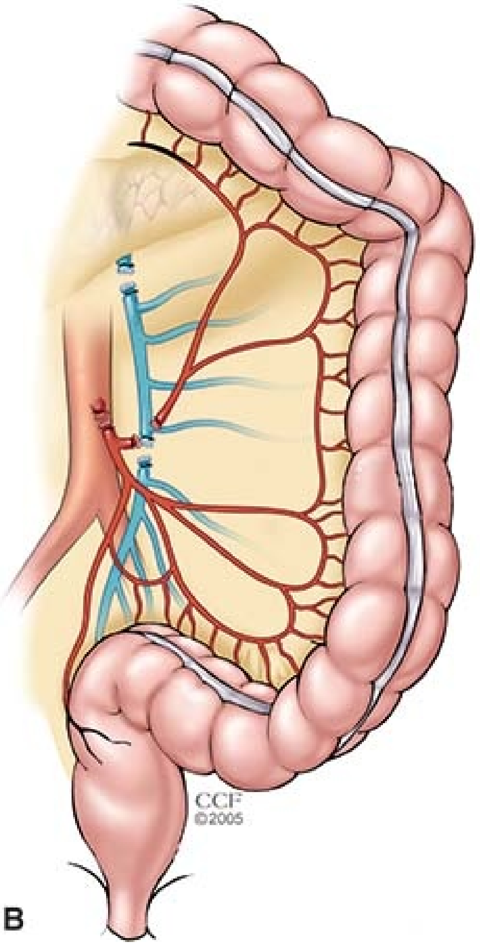


FIGURE 13-2 High ligation of the inferior mesenteric artery at the level of the aorta and ligation of the left colic artery.



A



B

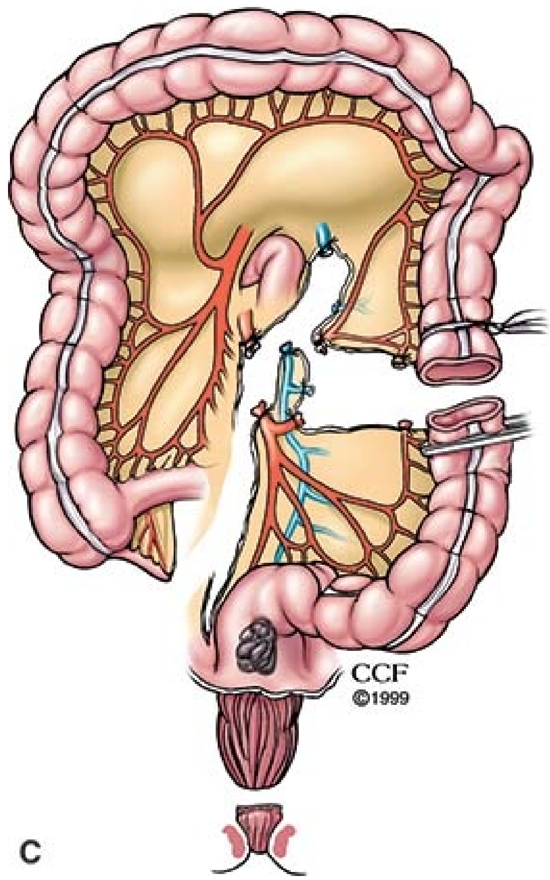


FIGURE 13-3 A. Isolation of the inferior mesenteric vein (IMV). B. High ligation of the IMV at the level of the pancreas, lateral to the ligament of Treitz. C. Low anterior resection for a mid-rectal cancer with high ligation of the inferior mesenteric artery and IMV and division of the left colic artery.

Left Colon and Splenic Flexure Mobilization

Medial-to-lateral dissection proceeds after the IMA/IMV have been ligated. Although the lateral-to-medial approach may seem to be less difficult in open surgery, for oncologic purposes this author utilizes a medial approach first for all cases. The retroperitoneal structures, including the ureter, gonadal vessels, and the psoas muscles are swept posteriorly and dissection is carried laterally to the abdominal wall, over Gerota's fascia/perinephric fat and toward the spleen. Next, lateral dissection begins at the iliac fossa and continues superiorly toward the splenic flexure. The dissection is carried 1 mm medial to the white line of Toldt (because the white line should stay with the patient) until the spleen is reached. The splenic flexure is carefully mobilized to try not to cause either splenic capsular tear or colonic wall damage. Gentle medial traction on the colon will allow for the splenocolic and retroperitoneal attachments to be safely and sharply dissected free (Fig. 13-4). If this approach becomes too difficult, we often will enter the lesser sac where the omentum attaches to the transverse colon and mobilize toward the spleen to meet up with the previous dissection plane. Routine separation in the avascular plane between the transverse mesocolon and the greater omentum is compulsory for proper reach into the pelvis.

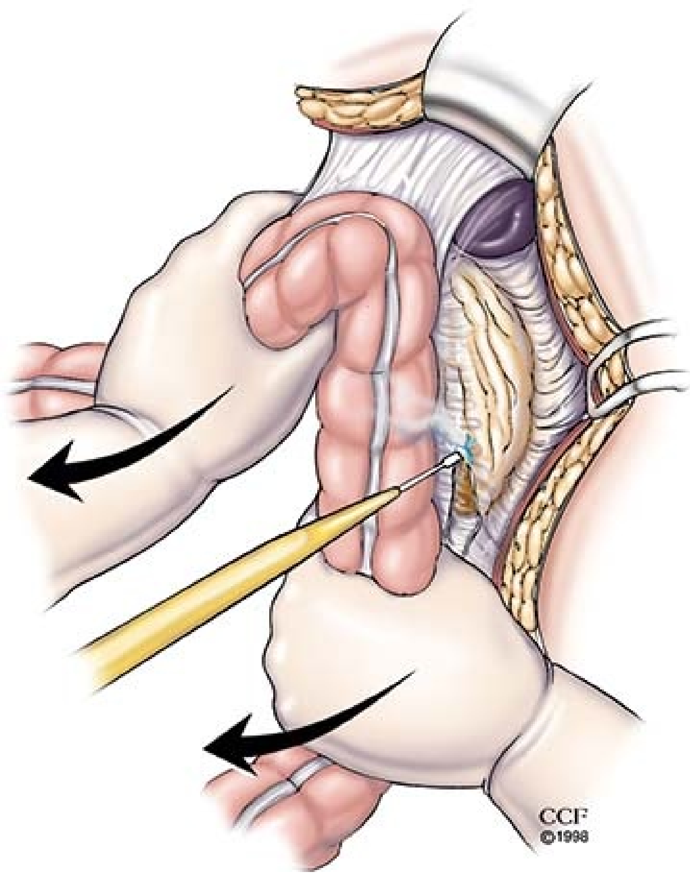


FIGURE 13-4 Mobilization of the splenic flexure. Gentle medial traction is placed on the colon and the peritoneal attachments are divided.

p. 94

p. 95

Total Mesorectal Excision

Adopted as the standard approach to rectal cancer surgery, TME is the sharp dissection in the avascular plane that lies between the fascia propria of the rectum and the presacral fascia. The fascia propria of the rectum contains the mesorectum and its associated lymph nodes and blood vessels, whereas the presacral fascia covers the anterior sacral surface and the hypogastric nerves (Fig. 13-5). A standard TME should be performed 5 cm distal to the most inferior aspect of the tumor. In cases of very low rectal tumors, a coloanal anastomosis may be used: a distal margin of 1–2 cm is considered adequate.

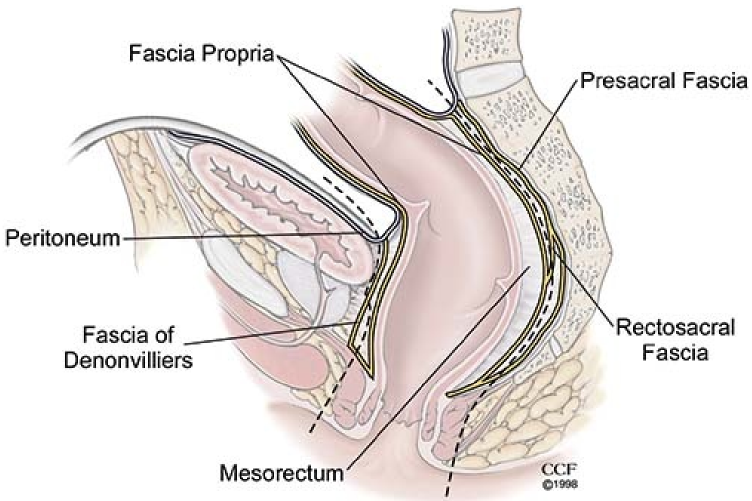


FIGURE 13-5 Fascia planes of the pelvis.

The descending colon/sigmoid colon junction is occluded between an atraumatic bowel clamp and a crushing bowel clamp and is sharply cut before the TME is undertaken. The sigmoid colon can be used as a handle to help facilitate the rectal dissection of the case. The mesorectal plane is entered by elevating the rectosigmoid colon superiorly and anteriorly and following the posterior aspect of the superior rectal artery until a shiny, filmy membrane is encountered at the pelvic brim. The sympathetic nerves are once again identified as they bilaterally course over the sacral promontory (Fig. 13-6). Posterior dissection is carried out through this filmy membrane as far as can safely be achieved with good visualization. At all times, this posterior dissection should be undertaken in a sharp manner without blunt maneuvers and the utilization of lighted, deep pelvic retractors is essential in this portion of the operation (Fig. 13-7). Avoidance of dissecting into the presacral space is compulsory, because the large and difficult-to-control presacral veins of the valve-less presacral plexus are located in this location. Proper dissection in the posterior plane is especially important when the concavity of the sacrum begins to straighten out as one approaches the anorectal junction, where the surgeon must anteriorly adjust the angle of dissection. Once the posterior dissection reaches the proper distal level (depending on location of the tumor), lateral dissection is undertaken.

Lateral dissection involves staying just lateral to the fascia propria without entering the pelvic sidewall with its associated neurovascular structures. The middle rectal vessels are bilaterally divided in the lateral stalks of the mid rectum (usually with suture or occasionally with only diathermy). The anterior dissection should be reserved for the last portion of the TME, because it is the most difficult. The anterior dissection is done just posterior to Denonvilliers' (retroprostatic) fascia in most cases, unless the tumor is anteriorly located, in which the surgeon must decide whether the dissection must include Denonvilliers' fascia (Fig. 13-8). This decision is an important one, because the parasympathetic nerves that supply the penile corpora and control erectile function in males lie just anterior to Denonvilliers' fascia and hence will undoubtedly be injured if this facial plane is violated. The anterior dissection extends beyond the inferior edge of the prostate in men and between the vagina and the rectum in females until the proper distal margin is obtained.

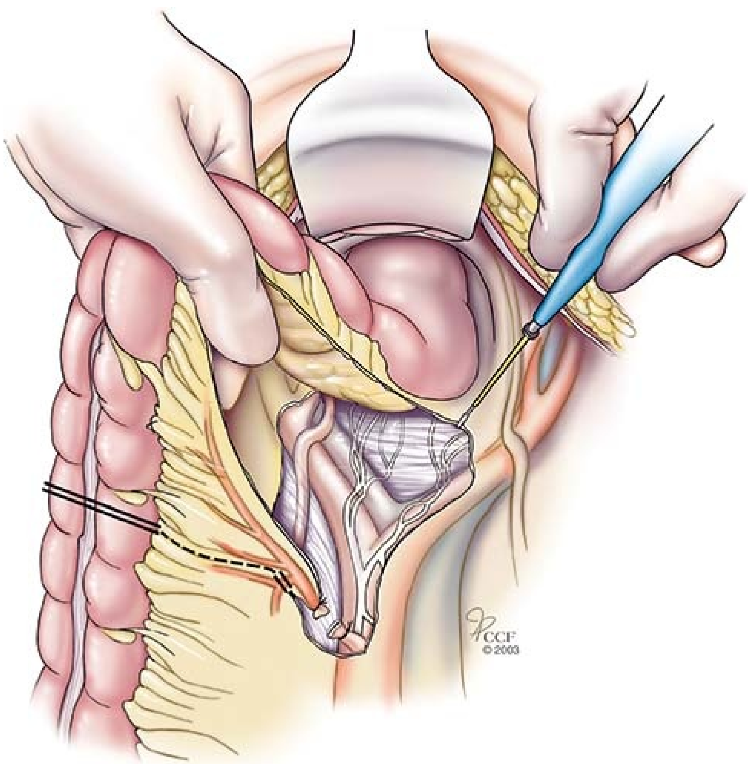


FIGURE 13-6 Entering into the mesorectal plane. Note the sympathetic nerves coursing over the sacrum and the ureter crossing the iliac vessels.

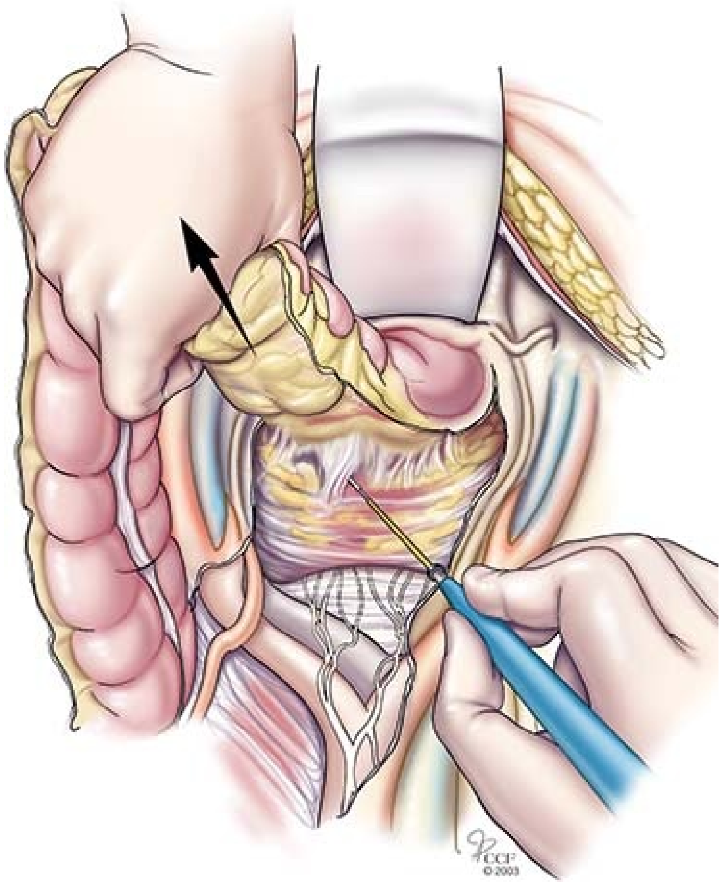


FIGURE 13-7 Total mesorectal excision: posterior dissection.

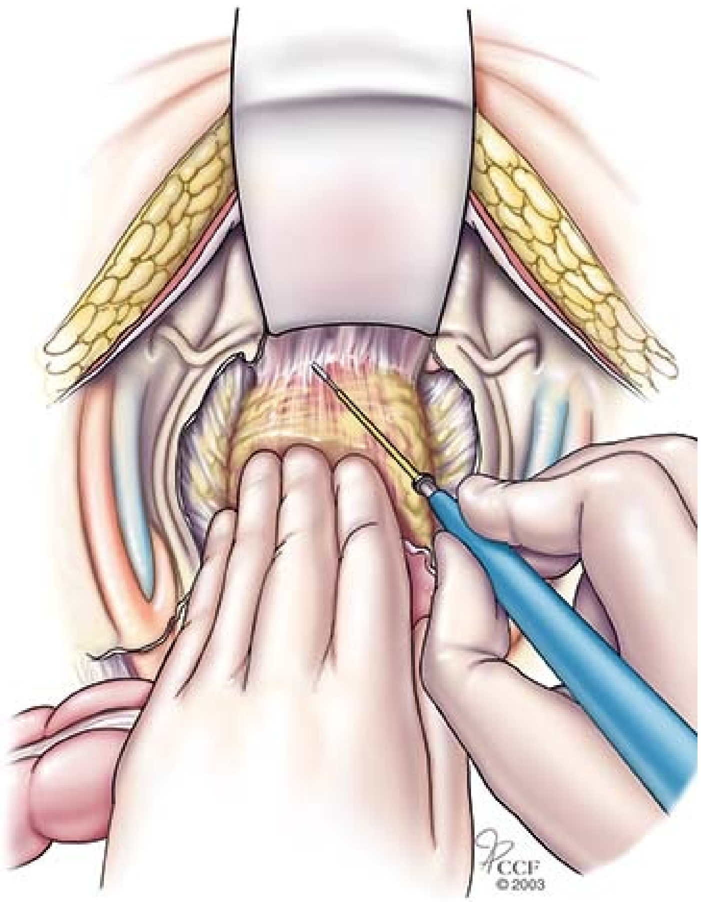


FIGURE 13-8 Total mesorectal excision: anterior dissection.

p. 96

p. 97

Rectal Transection and Preparation of the Proximal Colon

Once the desired distal transection site on the rectum has been established on the basis of the margin status, the use of a 30-mm linear stapling device is most often employed when performing a double-stapled anastomosis (Fig. 13-9). The PI-30 (Medtronic, Minneapolis, MN) is the stapler of choice because of its narrow design for reaching down very low in the narrow confines of the pelvis. The entire circumference of the transection site should be cleared of any mesorectum, lateral attachments, and anterior structures (especially the vagina). If too much material is placed in the stapler, it will not properly fire. Only one staple load should be needed, if proper dissection has been performed in this critical portion of the operation.

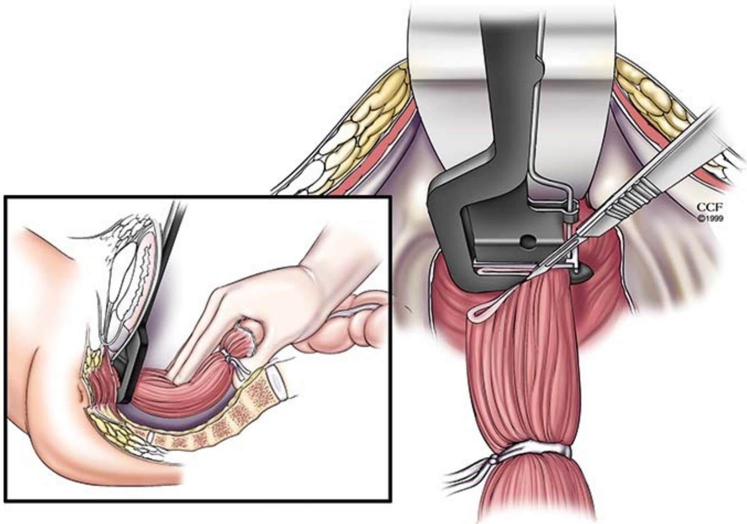


FIGURE 13-9 Distal transection of the rectum with 30-mm linear stapler.

It should be noted that at the beginning of the case, rectal irrigation with saline and betadine solution is used to mechanically clear any fecal debris in the rectum. Many of the surgical staff at our institution, including this author, use 40% ethyl alcohol (Turnbull solution) for their rectal cancer cases. After the 30-mm linear stapler is closed, the Turnbull solution (or alternative cytotoxic agent) is instilled into the rectum to potentially kill any cancer cells in the lumen, to perhaps decrease suture line or local recurrence, although this has not been proved in any large studies.

Before making a colorectal or coloanal anastomosis, the distal colonic conduit must have adequate perfusion. As mentioned previously, because the IMA has been divided in a high-ligation manner, the descending colon blood supply is based on the marginal artery via the middle colic artery. It is routine to sharply transect the marginal artery near the site of the future purse string suture to check for good vascular perfusion. Pulsatile bleeding from the marginal artery is best, but a good, steady flow is adequate. Essentially, if one has to clamp and ligate the marginal artery, it will provide adequate perfusion for the anastomosis. After assuring a well-perfused conduit, a hand-sewn purse string suture of 0-polypropylene monofilament is placed with careful attention to include the seromuscular layer of the bowel wall with shallow mucosal bites in order not to overwhelm the circular stapler. The appropriate size anvil for the double-stapled anastomosis is then placed in the lumen and tied snugly into place.

Colorectal or Coloanal Anastomosis

Colorectal or Coloanal Anastomosis

In cases where a colorectal anastomosis is performed, a traditional end-to-end double-stapled circular anastomosis is preferred. This default anastomosis is easily constructed with the use of circular staplers. In cases where an ultra-LAR is performed with a coloanal anastomosis, the surgeon may choose from several variations in anastomosis construction. Briefly, a colonic-J pouch, transverse coloplasty, or a side-to-end (Baker) anastomosis may be constructed to try and alleviate symptoms of LAR syndrome (urgency, clustering of evacuations, and incontinence). These anastomotic techniques are described in great detail in other chapters.

Regardless of the stapled anastomotic technique, the fundamentals of stapler use hold true for all reconstruction techniques. Upon gently placing the stapler per anus, it is carefully advanced past the sphincter mechanism to the rectal staple line. The trocar is advanced at or just posterior to the staple line to ensure that any anterior structures, especially the vagina, are carefully excluded from the anastomosis (Fig. 13-10). After care is maintained to ensure the colonic conduit is not twisted and there is there is no undue tension, and the anvil and the stapler is fired. The anastomotic rings are examined for completeness and an air leak test is performed with flexible sigmoidoscopy. The author prefers to use flexible endoscopy to clearly view the anastomosis intraluminally, to ensure hemostasis, integrity, and perfusion of the bowel both proximal and distal to the staple line. Positive air leak tests are controlled on a case-by-case basis. Small leaks are generally simply oversewn; large defects are either primarily repaired or the anastomosis may be completely redone. Surgical drains are used on a case-by-case basis, but most patients in whom a low colorectal or coloanal anastomosis has been constructed will receive a closed suction or irrigation/sump drain for the first 24–48 hours.

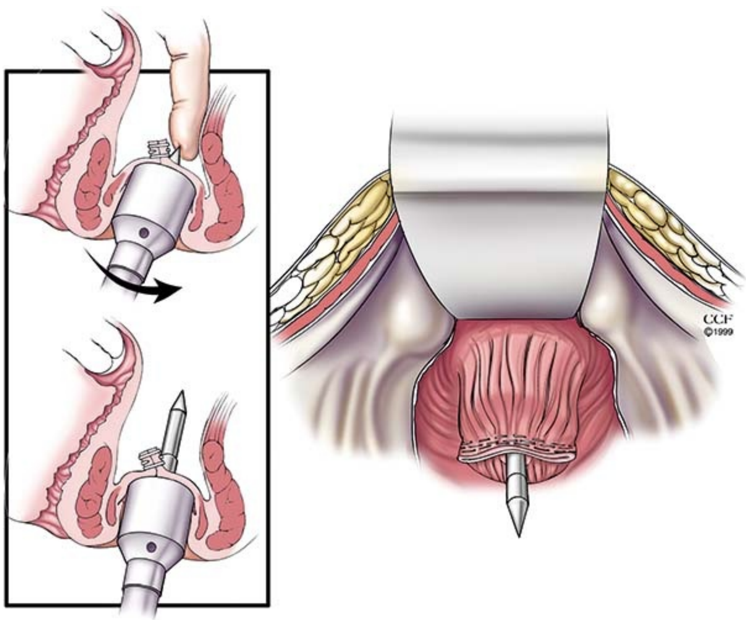


FIGURE 13-10 Proper stapler insertion and spike advancement. Note how the spike comes out posterior to the rectal staple line away from any anterior structures.

Adjunct Maneuvers for Difficulties in Reach

Proper reach of the colon into the pelvis may be difficult in certain cases, due to variations in anatomy, vascular supply, and body habitus. If, after high ligation of the vessels, complete and full mobilization of the left colon, and splenic flexure and removal of the omentum from the transverse colon, well-vascularized colon does not reach, several maneuvers may be employed to have a tension-free anastomosis. Because the IMA and IMV have been ligated at their origin, blood supply is based off the middle colic vessels. If reach is inadequate, a series of techniques can be employed. The first maneuver involves creating a retroileal, transmesenteric window through an avascular plane to the right of the superior mesenteric pedicle near the terminal ileum (Fig. 13-11). The colon can be placed through this window and into the pelvis. If this maneuver does not work, the surgeon must make the decision to transect the root of the entire transverse colon, with high ligation in the middle colic vessels. Mobilization to the hepatic flexure and removal of the entire omentum off the colon must be performed.

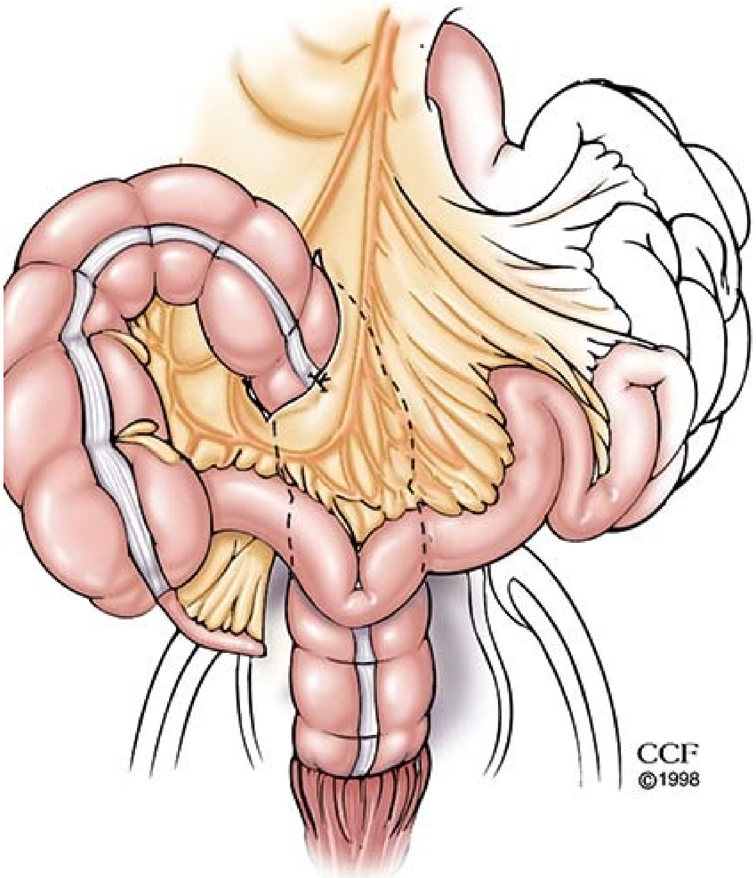


FIGURE 13-11 Retroileal window. A window is created to the right of the superior mesenteric artery (SMA) near the terminal ileum. The colon can be delivered to the anastomosis with the rectum/anus. Middle colic vessels may need to be ligated.

If this technique does not sufficiently provide the needed length, a complete 180-degree counterclockwise rotation of the right colon based off the ileocolic pedicle can be performed. The hepatic flexure and right colon must be completely mobilized and all attachments released. The right colic vessels and mesentery of the right colon are ligated and the colon is rotated so as to have the anterior wall of the cecum/right colon against the retroperitoneum; and if the cecum is in the right iliac fossa with the appendix pointing toward the hepatic flexure, it is not necessary to perform an appendectomy (Fig. 13-12).

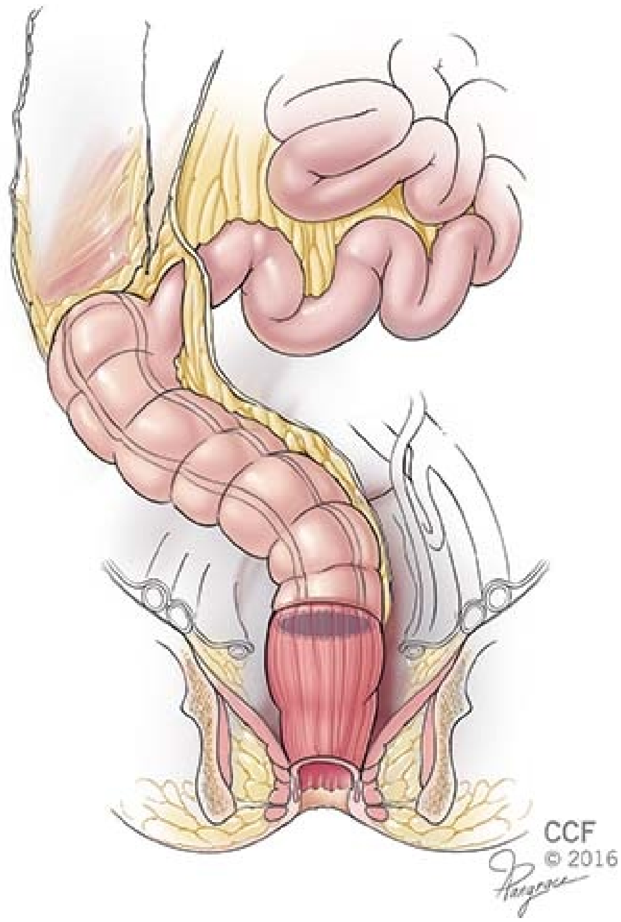


FIGURE 13-12 Deloyer's procedure. The right colon and hepatic are mobilized and all mesentery is divided except the ileocolic pedicle. The colon is rotated counterclockwise 180 degrees and a right colon anastomosis is performed to the rectum/anus.

If these maneuvers are unsuccessful, a cecal–rectal/anal anastomosis may be performed or, alternatively, a total colectomy with ileorectal anastomosis can be used. If all else fails for an anal anastomosis, an ileal-pouch anal anastomosis or an end ileostomy may be employed.

Fecal Diversion

Diversion of the fecal stream should be strongly considered for all patients undergoing TME for rectal cancer in the mid and low rectum. This caveat is especially true for those patients who received neoadjuvant radiotherapy to the pelvis and those whose colorectal anastomosis is <7 cm from the anal verge. It is routine practice at our institution to strongly consider construction of a loop ileostomy in these situations. After using this approach for several decades, we feel that fecal diversion has substantially mitigated the deleterious and possible lethal effects of pelvic sepsis due to an anastomotic dehiscence and has decreased reoperative rates. Although a temporary loop ileostomy can lead to significant problems such as dehydration from high output, the septic consequences of a leak can be lethal, particularly in frail, elderly patients. Therefore, even if a patient requires antidiarrheal medication or even intravenous fluid while the temporary stoma is in place, these temporary unwanted issues may be preferable to the consequences of a leak.

POSTOPERATIVE MANAGEMENT

Patients are placed on an enhanced recovery program for both open and laparoscopic cases. Antibiotics are not continued for 24 hours after surgery and patients are allowed clear liquids the first day after surgery. Ambulation the night of surgery is encouraged. Patient-controlled analgesia is instituted for 1–2 days postoperatively. Soft diet and oral analgesia are advanced as tolerated and Foley catheters are usually removed on postoperative day 2 (depending on the amount of pelvic dissection). Patients receive enterostomal teaching and care early after surgery and ostomy rods are removed after 2–3 days.

COMPLICATIONS

Complications are similar to those observed in other abdominopelvic operations and include bleeding, infectious (superficial and deep organ space), bladder/sexual dysfunction from nerve damage, prolonged ileus, and early and late complications of anastomotic leak.

Anastomotic leak rates are higher with the adoption of TME in low colorectal and especially coloanal anastomoses; leak rates in these patients can reach 20% in some series. These rates are influenced by the height of the anastomosis, technical factors (tension, blood supply), and patient factors (radiation exposure, obesity, male sex, immunosuppression, and other comorbid diseases). As previously mentioned, the rational use of fecal diversion has been shown to decrease the need for reoperation and helps mitigate the deleterious effects of the leak.

Sexual and erectile dysfunction is a well-recognized risk in patients undergoing LAR with TME. Intraoperative injury to the sympathetic and/or parasympathetic nerves may cause a wide array of symptoms. Sympathetic denervation around the IMA/aorta and pelvic brim may cause retrograde ejaculation; and, additionally, injury to the parasympathetic plexi anteriolaterally near the seminal vesicles and anterior to Denonvilliers’ fascia may result in temporary or permanent impotence in some patients. Bladder dysfunction varies and is reported in up 15% of patients undergoing LAR with TME. Most dysfunction is the form of temporary urinary retention due to the parasympathetic nerve injury. Permanent dysfunction mandating self-catheterization may occur in up to 5% of patients.

RESULTS

The use of TME (and neoadjuvant chemoradiotherapy regimen in selected patients) has been shown to both substantially decrease local recurrence rates and increase disease-free survival and overall survival when compared to conventional surgery. Most studies report an average of 10% local recurrence rate at 5 years and overall 5-year survival rates (stage dependent) of about 70–85% for locally advanced rectal cancer.

With increased local control and survival, comes a price to pay in the way of LAR syndrome. LAR syndrome consisting of fecal urgency, frequency, clustering, and fecal incontinence may occur after TME, in part, due to a loss of rectal reservoir. LAR syndrome occurs in at least 10–15% of patients after TME with sphincter preservation. Anal sphincter damage and physiological changes from radiotherapy may also influence these debilitating symptoms. Outcomes of various neorectum reservoir construction techniques are discussed in subsequent chapters.

LAR with TME in the open approach is the gold standard sphincter-preserving technique for mid and low rectal cancer patients. A variety of surgical approaches exist for performing a LAR, including laparoscopic, robotic, and hybrid procedures. Recent studies have documented no clear advantage (and inferiority) of laparoscopic TME versus open TME. Long-term oncologic data is still pending, but, nonetheless, every colorectal surgeon and trainee must be comfortable and facile at the open technique, because this is the foundation for rectal cancer surgery.

CONCLUSIONS

A combination of factors, including better understanding of the disease process, more accurate radiologic staging, multimodality therapeutic intervention, refined surgical technique with TME, and more detailed histopathologic reporting, have all contributed to improvements in the management and survival of patients with rectal cancer. LAR with sphincter-sparing proctectomy can be accomplished for the majority of mid-to-low rectal cancer with a variety of anastomotic techniques. Proper dissection along the anatomical planes ensures complete removal of lymph-bearing tissue in the mesorectum and preservation of vital nerves for sexual and bladder function.

RECOMMENDED REFERENCES AND READINGS

Brown CJ, Fenech DS, McLeod RS. Reconstructive techniques after rectal resection for rectal cancer. *Cochrane Database Syst Rev* 2008;(2):CD006040.

de Campos-Lobato LF, Geisler DP, da Luz Moreira A, Stocchi L, Dietz D, Kalady MF. Neoadjuvant therapy for rectal cancer: the impact of longer interval between chemoradiation and surgery. *J Gastrointest Surg* 2011;15(3):444–50.

Delaney CP, Zutshi M, Senagore AJ, Remzi FH, Hammel J, Fazio VW. Prospective, randomized, controlled trial between a pathway of controlled rehabilitation with early ambulation and diet and traditional postoperative care after laparotomy and intestinal resection. *Dis Colon Rectum* 2003;46(7):851–9.

Fazio VW, Zutshi M, Remzi FH, *et al.* A randomized multicenter trial to compare long-term functional outcome, quality of life, and complications of surgical procedures for low rectal cancers. *Ann Surg* 2007;246:481–8.

Monson JR, Weiser MR, Buie WD, et al; Standards Practice Task Force of the American Society of Colon and Rectal Surgeons. Practice parameters for the management of rectal cancer (revised). *Dis Colon Rectum* 2013;56(5):535–50.

Nesbakken A, Nygaard K, Bull-Njaa T, Carlsen E, Eri LM. Bladder and sexual dysfunction after mesorectal excision for rectal cancer. *Br J Surg* 2000;87(2):206–10.

Pokala N, Delaney CP, Kiran RP, Bast J, Angermeier K, Fazio VW. A randomized controlled trial comparing simultaneous intra-operative vs sequential prophylactic ureteric catheter insertion in re-operative and complicated colorectal surgery. *Int J Colorectal Dis* 2007;22(6):683–7.

Tan WS, Tang CL, Shi L, Eu KW. Meta-analysis of defunctioning stomas in low anterior resection for rectal cancer. *Br J Surg* 2009;96:462–72.

van de Velde CJ, Boelens PG, Borras JM, *et al.* EURECCA colorectal: multidisciplinary management: European consensus conference colon & rectum. *Eur J Cancer* 2014;50(1):1.e1–1.e34.

Wexner SD, Berho ME. The rationale for and reality of the new national accreditation program for rectal cancer. *Dis Colon Rectum* 2017;60(6):595–602.

Wibe A, Syse A, Andersen E, *et al.* Oncological outcomes after total mesorectal excision for cure for cancer of the lower rectum: anterior vs. abdominoperineal resection. *Dis Colon Rectum* 2004;47(1):48–58.

Chapter 14

Laparoscopic Low Anterior Resection

John Migaly and Harvey G. Moore

INDICATIONS/CONTRAINDICATIONS

The indications for a laparoscopic low anterior resection (LAR) are primarily for middle to low tumors of the rectum. Middle rectal tumors are defined as tumors between 5 and 10 cm from the anal verge and distal tumors are those tumors 5 cm or less from the anal verge.

Absolute contraindications for a laparoscopic LAR include systemic sepsis, unstable hemodynamics, and feculent peritonitis.

The decision to proceed with a laparoscopic approach to LAR is dependent on many factors that are surgeon specific and should guide the choice of operative approach. First, the surgeon should be an expert in the concept and performance of a total mesorectal excision (TME), because the conduct and quality of the TME is one of the more important determinants of oncologic outcome. Second, the surgeon should be an expert in advanced laparoscopy for colon resection, because the laparoscopic LAR is one of the more challenging resections in colon and rectal surgery.

Contingent on experience, a multidisciplinary approach should be strongly considered for patients in whom the tumor is felt to involve contiguous organs such as the vagina, uterus, bladder, and prostate, and in bulky tumors or in tumors that threaten the lateral resection margin.

Also contingent on expertise, potential relative contraindications to a laparoscopic LAR include morbid obesity, cirrhosis, coagulopathy, severe cardiac or pulmonary disease, intra-abdominal abscess, or phlegmon. Prior surgery is not a contraindication for laparoscopic LAR, and, when possible, a diagnostic laparoscopy should be performed to evaluate the extent of intra-abdominal adhesions and feasibility of a laparoscopic approach, including the anticipated time commitment required for the adhesiolysis.

PREOPERATIVE PLANNING

The essential principles involved in the preoperative planning of a laparoscopic LAR begin at the first visit. Complete history and physical examination are the mainstays of any evaluation, but, more importantly, the precise characterization of the tumor during digital rectal examination and direct visualization during proctoscopy and magnetic resonance imaging (MRI) are necessities. Digital rectal examination identifies tumor location and allows the surgeon to evaluate sphincter tone and function. There are no data to support the routine use of anal manometry to preoperatively evaluate the sphincter; thus, function and anal manometry is not any more useful than is physical examination. Proctoscopy is useful in characterizing the location of the tumor in relation to the upper portion of the anorectal ring and allows the surgeon to judge whether reconstruction is possible. In addition, the evaluation of the T and N stage allow for the addition of preoperative multimodality neoadjuvant therapy where appropriate. Current recommendations advocate the use of neoadjuvant chemoradiotherapy for T3 tumors with threatened margins or T4 tumors.

A complete blood count, chemistry assessment, liver function tests, and carcinoembryonic antigen are routinely collected. Computed tomography (CT) with contrast of the chest, abdomen, and pelvis complete the metastatic evaluation, possibly with a proton emission tomography (PET) scan. Patients should meet with the ostomy nurse in advance of surgery, to better prepare for and acclimate to the idea of a temporary diverting loop ileostomy (DLI) or possibly a permanent colostomy. Patients are marked for a stoma in advance of surgery. Internal medicine evaluation is scheduled before surgery, with pulmonary, cardiac, renal, or anesthesia assessment included, as necessary.

We routinely use a cathartic/purgative preoperative bowel preparation for surgery in addition to oral neomycin and erythromycin. Current population-based literature demonstrates that the addition of preoperative oral antibiotics reduces the rate of surgical site infection (SSI) and readmission.

Patients are given a carbohydrate drink immediately before surgery and a single dose of intravenous (IV) ertapenem before the incision is made. Heparin 5,000 U is subcutaneously administered immediately before intubation.

The authors also utilize goal-directed intraoperative fluid therapy to try to maintain ideal or maximal stroke volume while minimizing fluid resuscitation via esophageal Doppler or various other commercially available noninvasive hemodynamic monitoring devices.

SURGERY

The room setup, equipment, and personnel are essential to the success of this procedure. Three monitors are optimal for this procedure; one monitor should be over the patient's right shoulder, the second over the left shoulder, and the third near the left foot. Once the ports are placed, both the assistant and the surgeon stand to the patient's right side, with the assistant standing above the surgeon while controlling the laparoscope and assisting via the left-sided ports. It is usually unnecessary to have an additional assistant with this setup.

Positioning

The patient is placed in the supine position; and after intubation, the patient is placed into the low lithotomy position with both arms tucked. The knees should be no higher than the shoulders to minimize the potential for interference with the instruments during splenic flexure mobilization. The perineal area and buttocks should overhang the edge of the bed by about 3 inches so that access to the perineum and anus is not obstructed and so the stapler can be easily angulated upward or downward. The chest is secured to the bed to allow for the extreme Trendelenburg and lateral tilt required during a laparoscopic LAR.

Conduct of Procedure

After a bladder catheter is placed, the abdomen is prepped and draped in the usual sterile manner, a Veress needle is placed in the left upper quadrant, and the abdomen is insufflated with CO_2. After achieving pneumoperitoneum, the Veress needle is replaced with a 5-mm port. Diagnostic laparoscopy is then performed to ensure that there is no evidence of peritoneal carcinomatosis, liver metastasis, or other factors that may alter the operative plan. After exploration, the following ports are placed under direct laparoscopic visualization: a supraumbilical 12-mm trocar, a 5-mm left iliac fossa trocar, a 5-mm right upper quadrant port, and a 12-mm right iliac fossa trocar. The 5-mm camera is usually upsized to a 10-mm, 30-degree laparoscope because the 10-mm laparoscope provides a better quality image and requires fewer camera exchanges.

The sigmoid colon is placed on tension such that the inferior mesenteric artery (IMA) is clearly identified down to its origin. Electrocautery is used to incise the investing layer at the root of the rectosigmoid mesentery. The mesentery is scored at a point just above the sacral promontory but beneath the superior rectal artery and the incision is taken toward the root of the IMA. The loose areolar plane between the underside of the sigmoid mesentery and the retroperitoneum is identified and the dissection proceeds laterally with the goal of identifying the left ureter and the left gonadal vessels. The origin of the IMA is skeletonized and the ureter is once again identified before performing a high ligation of the IMA the ureter is once again identified before performing a high ligation of the IMA. The inferior mesenteric vein (IMV) is then ligated proximal to any branch point. The high ligation of the IMA and the IMV is necessary not only from an oncologic perspective but also to ensure that the left colon conduit can reach easily into the pelvis for a tension-free anastomosis.

The dissection is then continued underneath the sigmoid and the left colon mesentery until the left abdominal sidewall is encountered. The left/sigmoid colon is displaced and the white line of Toldt (now purple in color) easily taken with the scissors or an energy device.

The next task is to perform a complete laparoscopic mobilization of the splenic flexure. The lesser sac is entered and the splenic flexure is mobilized from the transverse colon side and from the left gutter. Attention is then turned toward the rectal dissection.

Rectal Dissection

The assistant carefully retracts the rectosigmoid junction toward the abdominal wall and slightly leftward. The operating surgeon retracts the rectum upward and toward the pubic symphysis to accentuate the plane between the presacral fascia and the fascia propria of the rectum; this plane is referred to as “the holy plane.” Posteriorly, the left and right hypogastric nerves are identified and kept out of harm’s way. The loose areolar fibers are posteriorly divided, identically in the manner of a TME, past the tip of the coccyx, dividing Waldeyer’s fascia until the superior portion of the levators are encountered. The lateral stalks are divided in the same manner down to the pelvic floor. Anteriorly, the plane between the rectum and the seminal vesicles/prostate or vagina must be carefully dissected so as not to injure the prostate/vagina or the sexual function controlling nerves that lie adjacent to Denonvilliers’ fascia. The rectum must be anteriorly freed down to the pelvic floor so that a stapler can be used to transect the rectum flush with or even distal to the levators. The rectum is carefully retracted upward out of the pelvis and leftward, and then a laparoscopic bowel stapler is brought in through the right iliac fossa 12-mm trocar and articulated so that the angle between the staple line and rectum is as close to 90 degrees as possible. If the pelvis is not wide enough to accommodate a 60-mm stapler, a 45-mm- or 30-mm-long stapler can be used. The stapler is advanced across the rectum as far as possible and is then fired. It is rare that the rectum can be completely transected with one staple fire; however, minimizing the number of fires will minimize the number of crossing staple lines and subsequently the likelihood of a staple line leak. Once the rectum is transected, the specimen is exteriorized through any one of a number of incisions such as a periumbilical incision, a left lower quadrant incision, or from the site that will be used for the ileostomy. After extracting the specimen, the colon is divided proximally at the sigmoid colon/left colon junction. Usually, if the exteriorized left colon can reach the pubic symphysis, there is sufficient length for a low colorectal anastomosis. Indocyanine green (ICG) perfusion assessment can be used to help verify blood supply.

A purse string is placed at the open end of the left colon and the anvil of the circular stapler is placed into the colon and secured with the purse string. The colon is reduced back into the abdomen and the abdomen is reinsufflated. The colon is grasped and extreme care is taken to ensure that the colon and mesentery are not twisted. An anvil grasper is used to lower the anvil into the pelvis. The assistant then transanally passes the stapler and engages it with the trocar under direct laparoscopic visualization. In female patients care must be taken to exclude the posterior wall of the vagina as the stapler is closed; a vaginal examination is helpful.

The stapler is then fired and the anastomotic donuts are examined for completeness. The pelvis is then filled with irrigant such that the anastomosis is under the water level. The colon proximal to the anastomosis is then occluded, pushing it against the sacral promontory, and the assistant insufflates the rectum using the rigid proctoscope or flexible sigmoidoscopy. In case of a positive air leak, many a time the air leak can be transanally repaired. ICG perfusion assessment can be performed before and/or after firing the circular stapler.

The creation of an ileostomy is recommended for patients who have had neoadjuvant chemoradiotherapy. Under laparoscopic visualization, an ileostomy is created by bringing out a loop of terminal ileum approximately 25–40 cm proximal to the ileocecal valve.

POSTOPERATIVE CARE

All patients undergoing open and laparoscopic colon and rectal resection at Duke University Medical Center (DUMC) follow a defined enhanced recovery after surgery (ERAS) protocol that emphasizes preoperative education, optimization of premorbid conditions and nutritional status, minimal preoperative fasting and carbohydrate loading immediately before surgery, goal-directed intraoperative fluid management, use of thoracic epidural analgesia, early initiation of oral diet, and early mobilization. The Duke Enhanced Recovery Program was based initially on the principles presented by the Enhanced Recovery After Surgery (ERAS) Society guidelines for elective rectal/pelvic surgery. The Duke colorectal ERAS protocol is summarized in Table 14-1.

TABLE 14-1 Synopsis of Duke Enhanced Recovery after Surgery (ERAS) Protocol

Phase of care	Intervention
Surgical planning	Routine preoperative screening/medical clearance Optimization of comorbidities

ERAS teaching and written information

Smoking cessation

Nutritional supplementation	
Immediate preoperative period	Full mechanical bowel preparation with PO antibiotics Chlorhexidine preoperative showers Fasting limited to 3 h preoperatively Carbohydrate drink 3 h before surgery
Day of surgery/intraoperative	

Thoracic epidural placement Venous thromboembolic (VTE) prophylaxis with 5,000 U SQ heparin Sequential compression devices (SCDs) Intravenous (IV) antimicrobial prophylaxis Goal-directed IV fluid therapy Removal of orogastric tube at conclusion of procedure	
Postoperative	Early initiation of PO intake (4 h postoperatively) Early ambulation including day of surgery Early removal of urinary catheter (postoperative day [POD] 1 or 2) Use of pro-motility medications (i.e., alvimopan), oral laxatives, chewing gum Conversion of epidural to PO pain control once good PO intake Use of adjunct pain medication (i.e., Neurontin, acetaminophen, nonsteroidal anti-inflammatory drugs (NSAIDs)) Continuation of low-molecular-weight heparin (LMWH) VTE prophylaxis post-discharge for total of 28 postoperative days

Following laparoscopic LAR, initial pain control is achieved with epidural analgesia. Intraoperatively placed orogastric tubes are removed at the conclusion of the procedure, and surgical drains are not routinely used. Patients are offered an oral ad libitum diet (postsurgical bland) starting 4 hours after surgery. Oral nutritional supplements may be added when clinically indicated. All patients receive multimodality prophylaxis against postoperative nausea and vomiting with antiemetic medications. Patients are encouraged to be out of bed for 2 hours on the day of surgery and for 6 hours on each successive postoperative day. Transurethral bladder catheters are typically removed on the morning of postoperative day 1, regardless of whether an epidural catheter is in place. Other adjuncts to minimize postoperative ileus include routine use of the peripherally acting μ-opioid receptor antagonist alvimopan (Entereg), judicious use of oral laxatives, and chewing gum. Once patients are tolerating PO, their epidural catheters are “paused” and they undergo a trial of PO pain medication. Patients whose pain is adequately controlled with PO pain medication have their epidural catheters removed. Adjunct analgesics including acetaminophen, nonsteroidal anti-inflammatory drugs (NSAIDs), and Neurontin are utilized to minimize the requirement for PO narcotics. Patients receive deep venous thromboembolism (VTE) prophylaxis before, during, and after surgery with low-molecular-weight heparin (LMWH). All colorectal cancer patients undergoing major abdominal/pelvic surgery are discharged with LMWH for a total of 28 postoperative days.

Institution of the Duke colorectal ERAS protocol has shown to result in a significantly decreased length of hospital stay (LOS), as well as a decreased incidence of urinary tract infections (13% vs. 24%) and readmission rate. In addition, the improvement in LOS was significant in the laparoscopic cohort as well (4 vs. 6 days), demonstrating the additive value of an ERAS protocol even in patients undergoing minimally invasive procedures. Others have reported similar findings. Within the ERAS setting, the addition of alvimopan has also been shown to have benefit with regard to faster return of bowel function, decreased incidence of postoperative ileus, and shorter LOS. Overall, utilization of an ERAS program for rectal surgery has been shown to reduce LOS by 3–5 days, without any increase in morbidity or mortality or readmission rates. Compliance with an ERAS protocol may also result in improved long-term oncologic outcome.

OUTCOMES

Morbidity and Mortality

Advantages of laparoscopic colon and rectal resection compared to open resection are well documented and include faster return of bowel function, decreased use of narcotic pain medications, and decreased LOS. Patients undergoing laparoscopic LAR have been shown to receive postoperative chemotherapy approximately 25 days sooner than those undergoing open LAR. However, laparoscopic rectal resection is associated with significantly longer operative times.

The safety of the laparoscopic approach for colon and rectal resection has been well established. Laparoscopic LAR can be performed by appropriately trained surgeons with low intraoperative conversion rates (1–16%) and equivalent perioperative morbidity and mortality compared to open LAR. In three large randomized controlled trials of laparoscopic versus open surgery for rectal cancer, perioperative morbidity was 18–40% in the laparoscopic group versus 14–37% in the open group (differences not statistically significant). Similarly, perioperative mortality also did not differ significantly between the laparoscopic (0–4%) and open (0–5%) groups. Laparoscopic rectal resection is also associated with decreased morbidity compared to open resection in morbidly obese patients.

Short-and Long-Term Oncologic Outcomes

Early randomized trials suggested that laparoscopic resection for rectal cancer results in an oncologically sound procedure. Distal and circumferential resection margin (CRM) status, lymph node yield, and completeness of total mesorectal excision.. Two recently published large prospective trials, however, have called into question the routine use of laparoscopic resection for rectal cancer. In both the American College of Surgeons Oncology Group (ACOSOG) Z6051 trial (United States) and the Australasian Laparoscopic Cancer of the Rectum (ALaCaRT) trial (Australia), the criterion for non-inferiority was not achieved for laparoscopic rectal resection with regard to CRM, completeness of TME, and overall successful resection (complete TME, negative distal resection margin and CRM). Both studies concluded that their findings do not support the routine use of laparoscopic resection for rectal cancer. Unfortunately, these identical conclusions were based on the use of non-validated composite endpoints.

However, recent updates from the Conventional versus Laparoscopic-assisted

Surgery In patients with Colorectal Cancer, the *C*omparison of *O*pen versus laparoscopic surgery for mid or low *RE*ctal cancer *A*fter *N*eoadjuvant chemoradiotherapy (COREAN), and the *CO*lorectal cancer *L*aparoscopic or *O*pen *R*esection II (COLOR II) trials demonstrate equivalent 3-, 5-, and 10-year disease-free survival, local control, and overall survival compared to open resection. Similarly, a pooled analysis of three randomized controlled trials from the Prince of Wales Hospital in Hong Kong with a median follow-up of 124.5 months reported equivalent 10-year locoregional recurrence, cancer-specific survival, and overall survival between laparoscopic and open surgical groups.

Most recently, analysis of over 14,000 patients in the National Cancer Database undergoing either minimally invasive (laparoscopic or robotic LAR) or open LAR revealed equivalent 3-year overall survival in the minimally invasive group. In addition, patients in the minimally invasive group had significantly decreased length of hospitalization. Despite these encouraging results, the final word on laparoscopic resection for rectal cancer awaits long-term results from the large randomized controlled trials. As such, laparoscopic rectal resection for cancer should probably be limited to the clinical trial setting or performed in specialty centers.

Functional Outcomes/Quality of Life

Genitourinary

Autonomic nerve injury with resulting sexual dysfunction (impotence and retrograde ejaculation in men; decreased vaginal lubrication, dyspareunia, decreased sexual arousal, and difficulty achieving orgasm in women), as well as bladder dysfunction, occurs in approximately 10–35% of patients undergoing proctectomy for benign and malignant conditions. Data from prospective trials of laparoscopic rectal resection indicate that autonomic nerve preservation can be achieved with laparoscopic rectal resection and that the incidence of genitourinary dysfunction is not significantly different compared with that of open rectal resection. Self-reported outcomes from the COLOR II randomized trial confirmed no significant differences in sexual and bladder function at 1 year postoperatively between laparoscopic and open resection for rectal cancer. In the COREAN trial, the incidence of micturition difficulty was less frequent in both men and women undergoing laparoscopic resection. The authors opined that the magnification provided by the laparoscope may have facilitated visual identification of the autonomic nerves.

Bowel Function/Defecation

Following restorative LAR, some degree of bowel dysfunction is reported by 70–90% of patients, often negatively affecting quality of life. The addition of preoperative chemoradiation greatly increases the likelihood of bowel-related quality of life impairment. Preoperative discussion of anticipated postsurgical function is crucial to managing expectations and making informed choices between primary anastomosis and a permanent colostomy in borderline cases. Many patients often suffer from a constellation of symptoms including incontinence, frequency and clustering of bowel movements, and urgency, collectively known as low anterior resection syndrome (LARS). The cause of LARS is likely multifactorial, including colonic dysmotility, surgery-and radiation-related sphincter injury and neorectal reservoir dysfunction, and pelvic nerve injury. Previous studies have shown that severity of LARS, assessed by LARS score, correlates significantly with overall quality of life after restorative rectal resection. Although there is no gold standard treatment for LARS, multimodality treatment algorithms include bulking laxatives, pelvic floor strengthening exercises, antimotility agents, sacral nerve stimulation, biofeedback, retrograde rectal irrigation, and conversion to a stoma for severe, refractory cases.

Compared to open surgery, patients undergoing laparoscopic rectal resection typically have at least equivalent bowel function and bowel-related quality of life. In the COREAN randomized trial, patients in the laparoscopic group reported significantly less severe gastrointestinal symptoms in general, as well as less severe defecation difficulties. The severity of LARS has not been shown to differ between patients undergoing laparoscopic and open LAR. The nature of the reconstruction (straight coloanal vs. colonic J-pouch) may however correlate with the defecation-related components of LARS. For this reason, we favor the use of a colonic J-pouch or an end-to-side anastomosis if technically feasible.

Other Quality of Life Outcomes

The laparoscopic group in one randomized trial reported better physical functioning and less fatigue at 3 months after surgery compared to the open surgery group, indicating that the recovery advantages of the laparoscopic approach extend between the immediate postoperative period.

COMPLICATIONS

Surgical Site Infections/Anastomotic Leak

Despite efforts to reduce their incidence, SSIs remain common following colon and rectal resection, occurring in up to 20% of cases. Overall, the incidence SSIs does appear to be lower following laparoscopic colorectal resection. A review of over 16,000 laparoscopic and open colon resections included in the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database revealed a 15.7% incidence of SSI in the open group compared to 9.4% in the laparoscopic group ($P < 0.00001$). At DUMC, the authors institute a preventative SSI bundle for all open and laparoscopic colon and rectal resections, which includes a preoperative chlorhexidine shower, mechanical bowel preparation with oral antibiotics, IV ertapenem 1 hour before the incision is made, chlorhexidine skin preparation, use of a wound protector, gown and glove changes before fascial closure, and a dedicated closure instrument tray. Use of this preventative SSI bundle has decreased the incidence of superficial SSI in our institution from 19.3% before implementation to 5.7% following implementation (Table 14-2).

TABLE 14-2 Management of Complications Following Laparoscopic Low Anterior Resection

Complication	Management
Low anterior resection syndrome (LARS)	

Preoperative

Postoperative	Consideration of colonic J-pouch, transverse coloplasty pouch, end-to-side colorectal anastomosis Bulking laxatives Pelvic floor strengthening exercises Antimotility agents Sacral nerve stimulation (SNS) Biofeedback

Retrograde rectal irrigation Conversion to a stoma for severe, refractory cases
Anastomotic leak

Preoperative

Postoperative	Consider diverting loop ileostomy (DLI) following preoperative chemoradiation and/or low coloanal anastomosis (<5 cm from anal verge) to limit morbidity secondary to anastomotic leak Based on severity of clinical presentation: Nontoxic, hemodynamically stable, no peritonitis: IV antibiotics ± percutaneous drainage of intra-abdominal collection Diffuse peritonitis, hemodynamic instability: Laparoscopy/laparotomy with diversion of anastomosis with DLI, drainage
Small bowel obstruction	

Adhesive	NPO, nasogastric tube decompression; Operative management for failure to resolve obstruction or development of peritoneal signs
Secondary to suspected volvulus of DLI	Prompt laparoscopy/laparotomy
Ureteral injury	

Preoperative

Postoperative	Consider use of lighted ureteral stents Intraoperative urological consultation Laparoscopic repair vs. conversion to open procedure based on available expertise Ureteroneocystostomy vs. spatulation and primary repair over a stent versus ureteroureterostomy based on level of injury

Anastomotic leak is one of the most devastating complications of restorative rectal resection and is associated with considerable morbidity and mortality as well as increased LOS and health care costs. The laparoscopic approach to TME and restorative rectal resection does not appear to increase the incidence of postoperative anastomotic leak. A recent meta-analysis including six randomized controlled trials did not find any significant difference in the incidence of postoperative anastomotic leak between open and laparoscopic LAR. The authors utilize mechanical bowel preparation with PO antibiotics on all LARs based on a study from the authors' institution of NSQIP data that found the incidence of anastomotic leak to be significantly lower in patients with a preoperative bowel prep compared to those with no bowel prep (2.8% vs. 5.7%). The authors also frequently utilize DLI for patients undergoing coloanal anastomosis, particularly after preoperative chemoradiation. Although the issue of whether DLI reduces the incidence of anastomotic leaks remains controversial, it seems clear the DLI lessens the clinical severity of anastomotic leak when it occurs. The evaluation and management of anastomotic leakage does not differ between laparoscopic and open approaches and has been well described elsewhere. Options may include IV antibiotics alone, CT-guided percutaneous drainage of pelvic fluid collections, and laparoscopic DLI if fecal diversion is required.

Small Bowel Obstruction

Small bowel obstruction (SBO) is a frequent complication following major abdominal surgery including colon and rectal resection. The incidence is probably higher in patients who have a DLI secondary to obstruction attributable to the ostomy. A recent study including over 69,000 patients from a state registry demonstrated that the incidence of SBO was significantly lower in patients following laparoscopic colorectal resection compared to that in patients who underwent open resection. The management of SBO following laparoscopic LAR is the same as that for postoperative SBO in general, most of which can be managed with nasogastric tube decompression and expectant management. In the case of SBO felt to be due to the small bowel wrapping around a loop ileostomy, prompt operative management is indicated.

Complications Related to Diverting Loop Ileostomy

DLI is often performed during laparoscopic LAR as a temporary fecal diversion for a distal colorectal/coloanal anastomosis, particularly after preoperative chemoradiation therapy. There is conflicting evidence regarding whether a DLI reduces the incidence of anastomotic leak; however, a DLI likely decreases the morbidity and mortality of anastomotic leak when it occurs. This benefit must be carefully weighed against the morbidity and mortality of an ileostomy, including the potential for dehydration and acute kidney injury, difficulties with pouching, leakage resulting in significant skin damage, prolapse, parastomal hernia, and SBO. In addition, the potential morbidity of ileostomy reversal must also be considered. Despite the ability to close most ileostomies without a laparotomy, the procedure is not trivial and is associated with a reported morbidity of 17%, a 0.4–0.6% mortality, a 4% incidence of conversion to laparotomy, a 7–15% incidence of SBO, and a 2% incidence of anastomotic leak.

Ureteral Injury

Fortunately, injury to the ureter during laparoscopic rectal resection is uncommon, occurring in 1 of 240 (0.4%) patients undergoing laparoscopy in the ACOSOG Z6501 trial. The use of lighted ureteral stents during laparoscopic cases may facilitate intraoperative identification of the ureters, help avoid injury to the ureters, and aid in prompt recognition of ureteral injuries. The ability to continually identify the ureter along its entire course undoubtedly allows the dissection to confidently and efficiently proceed. It is important to ensure that the left ureter is clearly identified before division of the primary vascular pedicle (IMA or superior rectal artery) with an endo-GIA stapler or energy device. Another potential point at which the ureters are at risk for injury is the point where they cross the pelvic brim. Management of ureteral injury has been well described elsewhere and options include ureteroneocystostomy, spatulation and primary repair over a stent, and ureteroureterostomy. The choice of repair depends on the level at which the injury occurs. The ability to perform these procedures laparoscopically depends on the expertise of the urologic surgeon, but there should probably be a low threshold for conversion to an open procedure in the case of a ureteral injury.

RECOMMENDED REFERENCES AND READINGS

Adam MA, Lee LM, Kim J, *et al.* Alvimopan provides additional improvement in outcomes and cost savings in enhanced recovery colorectal surgery. *Ann Surg* 2016;264(1):141–6.

Aimaq R, Akopian G, Kaufman HS. Surgical site infection rates in laparoscopic versus open colorectal surgery. *Am Surg* 2011;77(10):1290–4.

Aquina CT, Becerra AZ, Probst CP, *et al.* Patients with adhesive small bowel obstruction should be primarily managed by a surgical team. *Ann Surg* 2016;264(3):437–47.

Battersby NJ, Juul T, Christensen P, *et al.* Predicting the risk of bowel-related quality-of-life impairment after restorative resection for rectal cancer: a multicenter cross-sectional study. *Dis Colon Rectum* 2016;59(4):270–80.

Bonjer HJ, Deijen CL, Haglind E; COLOR II Study Group. A randomized trial of laparoscopic versus open surgery for rectal cancer. *N Engl J Med* 2015;372(14):1324–32.

Fleshman J, Branda M, Sargent DJ, *et al.* Effect of laparoscopic-assisted resection vs open resection of stage II or III rectal cancer on pathologic outcomes: the ACOSOG Z6051 randomized clinical trial. *JAMA* 2015;314(13):1346–55.

Guillou PJ, Darzi A, Monson JR. Experience with laparoscopic colorectal surgery for malignant disease. *Surg Oncol* 1993;2 Suppl 1:43–9.

Guillou PJ, Quirke P, Thorpe H, *et al.* Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomised controlled trial. *Lancet* 2005;365(9472):1718–26.

Gustafsson UO, Oppelstrup H, Thorell A, Nygren J, Ljungqvist O. Adherence to the ERAS protocol is associated with 5-year survival after colorectal cancer surgery: a retrospective cohort study. *World J Surg* 2016;40(7):1741–7.

Hua L, Wang C, Yao K, Zhang J, Chen J, Ma W. Is the incidence of postoperative anastomotic leakage different between laparoscopic and open total mesorectal excision in patients with rectal cancer? A meta-analysis based on randomized controlled trials and controlled clinical trials. *J Cancer Res Ther* 2014;10 Suppl:272–5.

Jeong SY, Park JW, Nam BH, *et al.* Open versus laparoscopic surgery for mid-rectal or low-rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): survival outcomes of an open-label, non-inferiority, randomised controlled trial. *Lancet Oncol* 2014;15(7):767–74.

Kang SB, Park JS, Kim DW, Lee TG. Intraoperative technical difficulty during laparoscopy-assisted surgery as a prognostic factor for colorectal cancer. *Dis Colon Rectum* 2010;53(10):1400–8.

Keenan JE, Speicher PJ, Thacker JK, Walter M, Kuchibhatla M, Mantyh CR. The preventive surgical site infection bundle in colorectal surgery: an effective approach to surgical site infection reduction and health care cost savings. *JAMA Surg* 2014;149(10):1045–52.

Lloyd GM, Kirby R, Hemingway DM, Keane FB, Miller AS, Neary P. The RAPID protocol enhances patient recovery after both laparoscopic and open colorectal resections. *Surg Endosc* 2010;24(6):1434–9.

Miller TE, Thacker JK, White WD, *et al.* Reduced length of hospital stay in colorectal surgery after implementation of an enhanced recovery protocol. *Anesth Analg* 2014;118(5):1052–61.

Nygren J, Thacker J, Carli F, *et al.* Guidelines for perioperative care in elective rectal/pelvic surgery: Enhanced Recovery After Surgery (ERAS((R))) Society recommendations. *World J Surg* 2013;37(2):285–305.

Scarborough JE, Mantyh CR, Sun Z, Migaly J. Combined mechanical and oral antibiotic bowel preparation reduces incisional surgical site infection and anastomotic leak rates after elective colorectal resection: an analysis of colectomy-targeted ACS NSQIP. *Ann Surg* 2015;262(2):331–7.

Stevenson AR, Solomon MJ, Lumley JW, *et al.* Effect of laparoscopic-assisted resection vs open resection on pathological outcomes in rectal cancer: the ALaCaRT randomized clinical trial. *JAMA* 2015;314(13):1356–63.

Sun Z, Kim J, Adam MA, *et al.* Minimally invasive versus open low anterior resection: equivalent survival in a national analysis of 14,033 patients with rectal cancer. *Ann Surg* 2016;263(6):1152–8.

Vargas GM, Sieloff EP, Parmar AD, Tamirisa NP, Mehta HB, Riall TS. Laparoscopy decreases complications for obese patients undergoing elective rectal surgery. *Surg Endosc* 2016;30(5):1826–32.

Chapter 15

Laparoscopic Low Anterior Resection with Transanal Anastomosis or Colonic J-Pouch Creation

W. Conan Mustain and Sharon L. Stein

INDICATIONS/CONTRAINDICATIONS

Chapter 14 reviewed the technique for multiport laparoscopic low anterior resection (LAR). This chapter emphasizes techniques involving a very low rectal resection requiring creation of a coloanal anastomosis, defined as anastomosis between the colon and the surgical anal canal. The surgical anal canal is defined as the tissue between the top of the anorectal ring and the dentate line. Virtually all LARs involve a "transanal" anastomosis, typically a double-stapled colorectal anastomosis with a transanally introduced circular stapler. However, when constructing an anastomosis at the level of the surgical anal canal, particular consideration must be given to the method of rectal transection, the configuration of the colonic anastomosis, and the technique used to create the anastomosis. This chapter describes various transanal surgical techniques and colonic reservoirs that may be used in combination with laparoscopic proctectomy for preservation of intestinal continuity after resection of the distal rectum.

The most common indication for laparoscopic LAR with coloanal anastomosis is cancer of the distal rectum. Occasionally, benign conditions such as rectovaginal or rectourethral fistula, or technical complications such as staple misfiring may require the use of a coloanal anastomosis to avoid permanent colostomy. Standard treatment for rectal cancer invading beyond the submucosa is en bloc resection of the rectum and mesorectum with negative distal and radial margins. Improved understanding of tumor biology has led to a decreased emphasis on distal margin, from 5 to 1–2 cm, and an increased appreciation of the importance of the circumferential radial margin with regard to local recurrence. This understanding has enabled surgeons to preserve intestinal continuity in all but the most distal rectal cancers while achieving satisfactory oncologic outcomes. Resections of this nature require technical expertise and the ability to employ techniques beyond the conventional double-stapled, end-to-end colorectal anastomosis.

The primary reason to employ transanal techniques during LAR is the inability to transabdominally divide the rectum and the mesorectum. This limitation may be secondary to technical difficulties and/or oncologic considerations. Technically, the space in the pelvis is limited and the pelvis distally becomes more narrow (Fig. 15-1). As dissection continues deep in the pelvis, the angle of instrumentation becomes parallel to the rectum in the pelvis. When choosing to transect the mesorectum or rectum, the ideal angle for transection is perpendicular to the rectum. Limited space in the pelvis may render this difficult or impossible. Techniques to accommodate this include anterior-to-posterior stapling, as well as newer transanal total mesorectal techniques, which modify angles and address prior limitations.

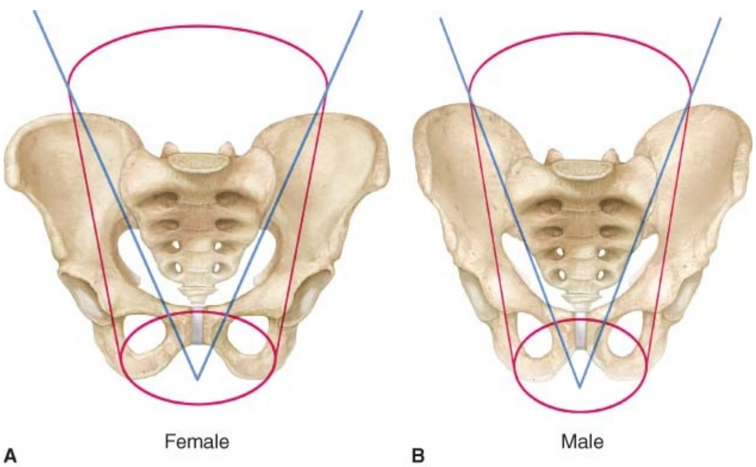


FIGURE 15-1 Demonstration of the (A) female (gynecoid) versus (B) male (android) pelvis. Differences include angle of pubis symphysis, sacral tilt, and the size of the pelvic outlet. These skeletal differences require adjustments during laparoscopic surgery to facilitate access deep in the pelvis for anorectal dissection, firing of staplers, and creation of anastomosis.

In addition, clear oncologic margins are vital to a successful operation. When distal tumors abut or invade the upper aspects of the anorectal ring or internal sphincter, transanal resection of a portion of the internal sphincter may be required to obtain adequate radial margins while preserving bowel continuity. A hand-sewn anastomosis is typically required after mucosectomy or transsphincteric resection. It is generally accepted that a stapled anastomosis is preferable when possible, because of time, simplicity, and likely superior functional results. Studies have shown lower rates of anastomotic stricture and decreased seepage after stapled anastomosis when compared to hand-sewn coloanal anastomosis.

Regardless of the technique of anastomosis, the proximal colonic segment may be configured end to end, side to end, or may be fashioned into a reservoir by creation of a colonic J-pouch or a transverse coloplasty. Although the decision to transect the bowel transanally is most often dictated by the anatomy, the configuration of the proximal colonic segment is generally at the surgeon’s discretion. Inadequate colonic length, a bulky mesocolon, or a narrow pelvis may preclude creation of a colonic J-pouch. The colonic J-pouch can be constructed through a transabdominal incision, including the eventual loop ileostomy site, or through the anus. After any rectal resection, there is an expected alteration of bowel function because the colonic portion of the anastomosis lacks the compliance, contractility, and distensibility of the normal rectum. In some patients, this change may result in life-altering dysfunction because of frequent stools, urgency, seepage, or incontinence. When performing very low anastomoses, the creation of a colonic reservoir will improve compliance of the pre-anastomotic segment and lead to better functional results, particularly during the first year after surgery. Several randomized trials and meta-analyses support the notion that a colonic reservoir or “neorectum” leads to better early functional results than a straight end-to-end coloanal anastomosis.

Contraindications to LAR and laparoscopic surgery, in general, are described in previous chapters and are identical for laparoscopic proctectomy with coloanal anastomosis. Very distal rectal resections can be technically challenging regardless of the operative approach, and anatomic factors such as obesity, a narrow pelvis, prostatic hypertrophy, or prior pelvic surgery increase the degree of difficulty. When any or all of these factors are present, the surgeon must be realistic about the likelihood of completing the pelvic dissection safely with laparoscopy. When dealing with rectal cancer, a successful oncologic outcome takes priority over the short-term benefits of minimally invasive surgery. In some situations, a hybrid approach may be used, where the abdominal portion of the case is done laparoscopically and the pelvic portion through an infraumbilical midline or Pfannenstiel incision. Anecdotally, in the authors’ experience, the use of a transverse linear stapler, such as the PI 30-3.5 (Medtronic, Minneapolis, MN) or the CONTOUR curved cutter stapler (Ethicon Endo-Surgery, Inc Cincinnati, OH), applied through a midline or Pfannenstiel incision with maximal upward pull on the rectum can gain an extra centimeter beyond that which can be laparoscopically achieved. That centimeter may mean the difference between a double-stapled or a hand-sewn coloanal anastomosis. The editor’s preference is to perform transanal total mesorectal excision (TATME) in these situations.

Consideration of preoperative sphincter function and continence is especially important when contemplating a very low anastomosis. Patients with poor baseline continence or severely impaired mobility are poor candidates for a coloanal anastomosis and should be offered a permanent colostomy. Transient impairment due to a bulky tumor or as a side effect of neoadjuvant radiation is not as worrisome if the patient had normal continence before diagnosis and normal sphincters. Tumors invading the external sphincter or a significant amount of levator muscle are best treated by abdominoperineal resection (APR).

PREOPERATIVE PLANNING

Before surgery, all patients should undergo appropriate staging for rectal neoplasia. Tumor depth, nodal involvement, and the presence of metastatic disease should be assessed. A pathologic diagnosis should be established by tumor biopsy and the proximal colon should be cleared by full colonoscopy whenever possible. Office-based digital rectal examination and rigid proctoscopy should be performed by the operating surgeon to evaluate tumor location, fixation, and sphincter function. Depth of tumor invasion and nodal status can be assessed using endorectal ultrasound (EUS) and/or magnetic resonance imaging (MRI). The choice of examination should be based on institutional expertise. Early, mobile tumors may be better evaluated by EUS. In more advanced tumors, MRI provides greater detail on circumferential margins and involvement of adjacent structures. For cancers of the distal third of the rectum, preoperative chemoradiotherapy is indicated for T3 and T4 tumors with threatened circumferential margins. In addition, very distal tumors for which APR would otherwise be required may be treated with neoadjuvant chemoradiation regardless of stage, in an effort to downsize the tumor and allow sphincter preservation. MRI has become the global preferred standard staging tool. Pretreatment MRI staging is a requirement of the Commission on Cancer National Accreditation Program for rectal cancer.

Metastatic evaluation includes contrasted computed tomography (CT) of the chest, abdomen, and pelvis and serum carcinoembryonic antigen (CEA) level. Although not routinely indicated, ^{18}F-fluorodeoxyglucose positron emission tomography/computed tomography (PET/CT) may be useful in the setting of a markedly elevated CEA without obvious metastatic disease on CT. The finding of stage IV disease is typically an indication for systemic chemotherapy before consideration of surgical treatment of the primary tumor. Exceptions to this may be bleeding from the tumor, and potentially obstruction, although a diverting stoma may be more appropriate than primary resection. All patients with rectal cancer should have all of the findings discussed in the multidisciplinary rectal cancer team conference.

The patient’s overall health and suitability for surgery should be assessed by a careful history and physical examination, routine laboratory work, and additional testing as indicated for specific comorbidities. A careful assessment of baseline continence should be established. Early symptoms of impaired continence including nighttime soilage or incontinence to flatus or liquid stool should be elicited and patients should be counseled that these symptoms will likely worsen after a coloanal anastomosis. Documentation of a Wexner/Cleveland Clinic Incontinence Score should be performed. A thorough discussion of the risks, benefits, and expected outcomes of sphincter-preserving surgery versus APR should be held and documented in the patient chart. Patients should be informed of the need for a temporary diverting ileostomy as well as the possibility of a of the need for a temporary diverting ileostomy as well as the possibility of a permanent colostomy should intraoperative findings differ from preoperative imaging. Patients should meet with a trained enterostomal therapist for counseling and marking for left-and right-sided stoma sites before surgical positioning.

Preoperative components of an established enhanced recovery pathway (ERP) should be initiated in the clinic with provision for patient education, specific instructions on preoperative fasting, and any preoperative prescriptions. Preoperative bowel preparation is controversial. Although data demonstrate that bowel cleansing may not be necessary in all colon surgery, bowel preparation avoids leaving a column of stool in the diverted colon. In addition, bowel cleansing provides the ability to perform intraoperative colonoscopy. The combination of mechanical and antibiotic bowel preparation has been shown to significantly reduce the rate of surgical site infection and other complications after colorectal surgery. The authors and editors routinely perform preoperative mechanical oral, cathartic, and antibiotic bowel preparation before LAR.

SURGERY

Essential equipment for successful laparoscopic LAR include a 5-or 10-mm 30-degree camera for adequate visualization in the deep pelvis, nontraumatic laparoscopic bowel graspers, laparoscopic scissors with electrocautery capability, a vessel-sealing energy device or endoscopic stapler for vessel transection, and a suction irrigator. A self-retaining retractor such as the LoneStar retractor system (CooperSurgical, Inc., Trumbull, CT) and lighted Hill-Ferguson anal retractors facilitate perineal dissection.

Prophylaxis and Positioning

In the preoperative holding area, patients are given chemical prophylaxis against venous thromboembolism in the form of subcutaneous standard or low-molecular-weight heparin. Sequential compression devices and antiembolic stockings are applied before transfer to the operating table. Intravenous antibiotics with appropriate anaerobic and aerobic coverage are given within 30 minutes of skin incision and redosed at appropriate intervals throughout the operation.

The authors position patients in modified lithotomy position in padded stirrups, with both arms tucked at the sides. Care should be taken to ensure that the lower leg is well protected to prevent injury to the peroneal nerve. An electric operating table is lined with either a gel pad or beanbag to reduce the risk of pressure injury and the patient is secured to the operating table to ensure no movement during periods of extreme tilt and rotation. A “test run” of positioning helps ensure patient position and prevent intraoperative injuries. For coloanal access, it is essential to leave 3 to 4 cm of the buttocks hanging off the edge of the table to allow adequate exposure for the transanal portion of the operation. An orogastric tube is placed for tube gastric decompression. Once positioned, a careful digital examination, proctoscopy, or anoscopy may be performed to confirm the preoperative assessment of tumor margin and ensure that sphincter preservation is feasible. Rectal irrigation is then performed with dilute povidone-iodine solution. Skin preparation of the abdomen, perineum, and perianal region is performed per standard protocol. A Foley catheter is placed after preparation to ensure the entire field is sterile.

Operative Steps

Port placement and abdominal exploration

High ligation of inferior mesenteric artery (IMA) and inferior mesenteric vein (IMV)

Splenic flexure takedown and left colon mobilization

Proctectomy with TME
Transanal rectal transection and perineal dissection
Specimen extraction and creation of a neorectum

Anastomosis

Diverting loop ileostomy

Port Placement and Abdominal Exploration

The abdomen is entered using an open technique and a 12-mm Hasson port is placed at the umbilicus. Two additional 5-mm ports are placed on the right side of the abdomen under laparoscopic guidance. Although ports are typically placed lateral to the rectus sheath, in a tall patient with a narrow pelvis, placing ports more medially may be helpful to prevent coning of the instruments in the pelvis. One of the ports may be placed through the planned ileostomy site, but often this site is not ideal for a working port. A third 5-mm port is typically required for retraction. This may be placed in the left lower quadrant, suprapubic midline, or upper abdominal midline. An upper midline port has the benefit of allowing the camera operator to stand to the left of the operating surgeon on the same side of the patient and easily retract the rectum or transverse colon with the left hand while controlling the camera with the right. This position is especially beneficial when performing a sub-IMV mobilization of the left colon and splenic flexure. The authors' typical port placement and operating room setup is shown in Figure 15-2.

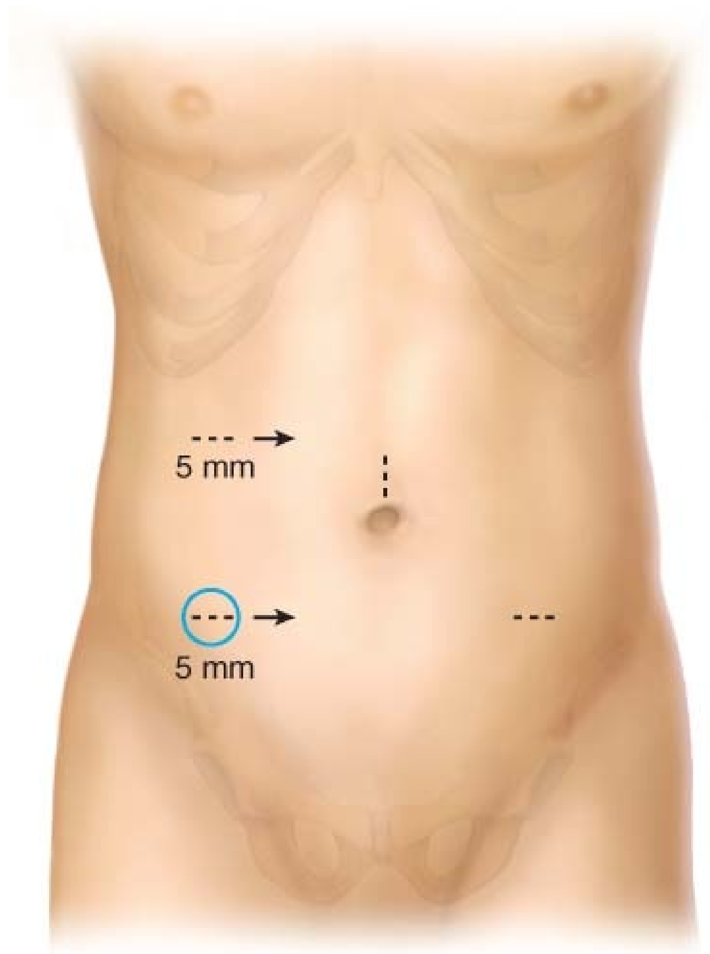


FIGURE 15-2 Port setup for laparoscopic proctectomy. Supraumbilical entry site, with two right-sided 5-mm ports. These ports can be moved more medially to facilitate reach deep in the pelvis in a large, or tall patient. The left lower quadrant site may be used as the extraction site, or a Pfannenstiel incision may be commonly used. This port is generally extended for placement of a 5-to 12-mm port to facilitate intracorporeal stapling. The stoma site (circle) may be used for a port site, if appropriate. A well-placed right lower quadrant port is essential for dissection, and operative dissection should not be compromised.

An initial evaluation is performed to determine the laparoscopic feasibility of the operation and to evaluate for metastatic disease. If significant adhesions from prior surgery exist, the surgeon must decide to attempt laparoscopic lysis or to convert to open surgery. The peritoneum is inspected for signs of tumor implantation in all four quadrants. The diaphragm is examined as is the capsule of the liver, including the inferior aspects by elevating the left and right lobes. The ovaries are inspected because there is a 3–8% incidence of ovarian

The ovaries are inspected because there is a 3–8% incidence of ovarian metastasis in colorectal cancer patients. The pelvis is assessed to evaluate for lateral extension of the tumor, although this may be difficult to determine until the pelvic dissection begins.

p. 114

---

p. 115

High Ligation of the Inferior Mesentery Artery and Inferior Mesentery Vein: Medial-to-Lateral Approaches

The patient is placed in the Trendelenburg position, with the right side down and the small bowel is reflected out of the pelvis. Occasionally, right-sided adhesions prevent retraction of the cecum and small intestines. Lysis of these adhesions helps provide a clear window into the pelvis and prevent small bowel migration into the operative field. The sigmoid colon is reflected anteriorly and to the left by the assistant to place the right side of the mesorectum on stretch. If the sigmoid is adhesed to the anterior pelvis, it may be necessary to free these attachments as well to provide adequate reduction of the sigmoid out of the pelvis. The peritoneum overlying the right side of the mesorectum distal to the IMA is opened over the sacral promontory. The superior hemorrhoidal vessels are elevated into the open space exposing the presacral vessels and nerves (Fig. 15-3). Branches of the hypogastric nerves lying between the aorta and the IMA are preserved and swept caudally toward the aorta. The left ureter is identified in its retroperitoneal position along the left pelvic sidewall beneath the vessels. If difficulty is encountered elevating the proximal rectum to perform this medial-to-lateral dissection, it may be beneficial to divide the lateral or anterior attachments to the sigmoid colon. The origin of the IMA is traced back to the aorta, just caudal to the ligament of Treitz, and is isolated circumferentially, preserving lymph nodes with the specimen. The IMA is transected using a stapler, clips, or an energy device. It is essential that the left ureter has been definitively identified and preserved before transection of the vessel.

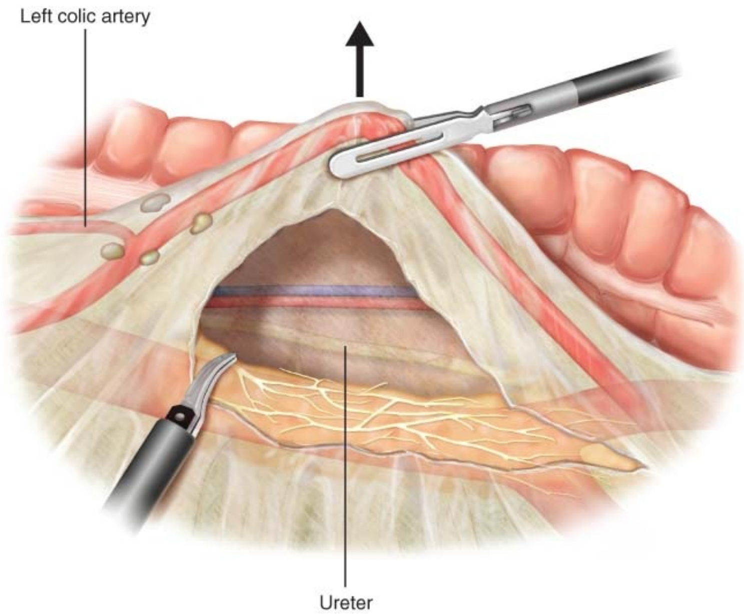


FIGURE 15-3 Dissection of the inferior mesenteric artery (IMA). At the level of the sacral promontory, the IMA is tented anteriorly toward the abdominal wall, allowing for dissection parallel and deep to the artery. Note the IMA is transected proximal to the left colic artery. Nerve fibers from the sympathetic plexus lie below the artery, and are swept down and preserved. Before transection, identification of the left ureter is vital to ensure it is not inadvertently transected with the vascular bundle.

The left colon mesentery is then further mobilized in a medial-to-lateral manner, lifting the mesocolon off of the retroperitoneum. The bare area of the left colon mesentery is divided cephalad from the IMA origin along the anterior surface of the aorta, medial to the IMV, elevating the IMV and the ascending left colic artery in the process (Fig. 15-4). High ligation of the IMV is essential for adequate length on the descending colon. The vessel should be isolated and divided near the inferior border of the pancreas where it dives posterior to converge with the splenic vein. The left colic artery may then be divided at the bifurcation of the left colic and superior hemorrhoidal, leaving the IMA origin and superior hemorrhoidal with the specimen and preserving any branches from the left colic artery to the descending colon.

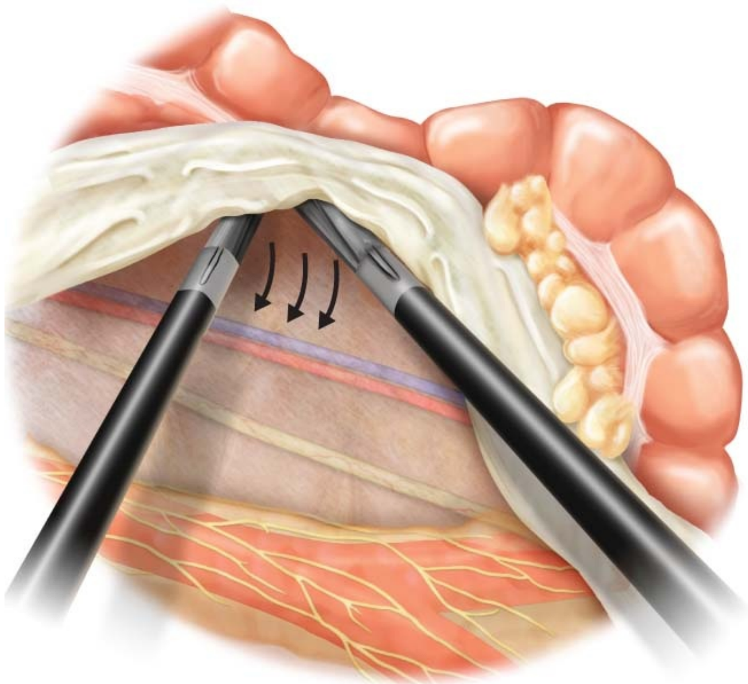


FIGURE 15-4 The assistant is located between the patient's legs or below the surgeon on the right side to enable him/her to work with the camera. The medial-to-lateral dissection is facilitated by reverse Trendelenburg with left side elevated. Retractors are placed under the mesentery to keep tension on the line of Toldt and retroperitoneum. Open bowel graspers elevate the mesentery in anterior direction allowing for a wider line of traction during the dissection. The surgeon can then dissect above the retroperitoneum to the lateral sidewall, superiorly toward the splenic flexure and inferiorly toward the iliac fossa. Care must be taken to ensure that the ureter and retroperitoneal structures remain with the retroperitoneum, and the plane of dissection does not veer under the distal edge of the pancreas.

Splenic Flexure Takedown and Left Colon Mobilization

Dissection proceeds in a medial-to-lateral direction, under the transected IMA and IMV. The retroperitoneum can be maintained intact and swept caudally, preserving the left ureter, gonadal vessels, and psoas muscle intact. This dissection continues from the pelvic brim inferiorly to the inferior border of the pancreas superiorly and laterally to the white line of Toldt. After mobilizing the left mesocolon off of the retroperitoneum, the colon is retracted medially and the lateral attachments are divided along the length of the descending colon. The plane of transection should be just medial to the white line of Toldt to leave the retroperitoneum undisturbed.

p. 115

p. 116

With the omentum reflected cephalad, the patient is placed in a neutral or slight reverse-Trendelenburg position and the transverse colon is retracted caudad. For a right-handed surgeon this step is easily accomplished by trading places with the assistant and lifting the omentum with the left hand and working through the upper midline port, while using monopolar scissors or energy with the right hand through the right upper port. The assistant retracts the transverse colon inferiorly through the right lower port (Fig. 15-5). Entering the lesser sac, the superior aspect of the transverse mesocolon is exposed and the omentum is dissected off of the colon around the splenic flexure in the avascular plane. The lesser sac is easiest to enter toward the midline and is confirmed by visualization of the posterior wall of the stomach. While approaching the spleen, care should be taken to avoid tension that may cause capsular tearing and bleeding.

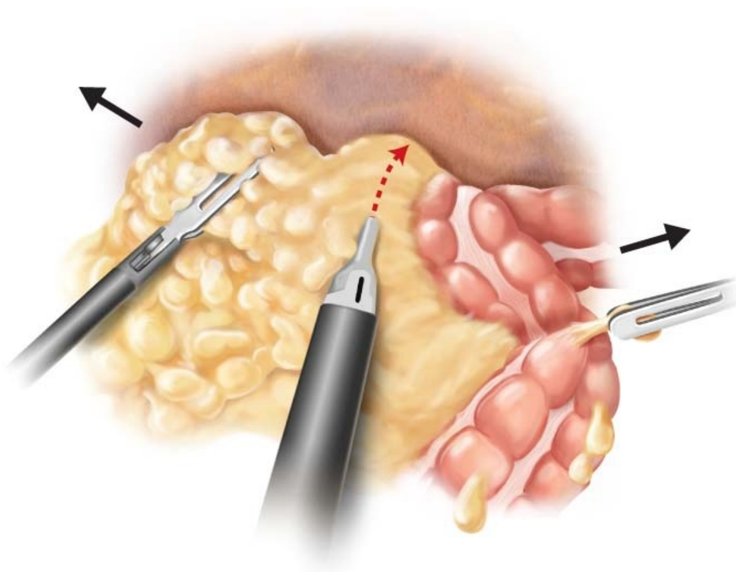


FIGURE 15-5 Mobilization of the splenic flexure. An avascular plane is present between the omentum and the epiploicae of the colon and indicated by subtle changes in the adipose tissue. Entry is facilitated in the midline, where the omental planes are fused. Proceed laterally toward the splenic flexure.

p. 116

p. 117

Sub-Inferior Mesenteric Vein Approach

Because complete splenic flexure mobilization and high ligation of the IMV is

Because complete splenic flexure mobilization and high ligation of the IMV is required virtually every time a coloanal anastomosis is performed, the authors frequently utilize a sub-IMV medial-to-lateral approach to mobilize the proximal left mesocolon and splenic flexure as the initial step in laparoscopic LAR. The patient is kept in a relatively neutral or slight reverse-Trendelenburg position and is rolled steeply to the right. The omentum is reflected cephalad and the small bowel is swept medially, exposing the duodeno-jejunal junction at the ligament of Trietz. There are frequently adhesions of the first few centimeters of the jejunum to the left colon mesentery, which are sharply divided. The IMV is identified just lateral to the ligament of Trietz and is grasped and elevated off of the retroperitoneum. An avascular window beneath the IMV is identified and opened with monopolar cautery. This incision is continued caudally along the anterior aspect of the aorta toward the origin of the IMA. A grasper is inserted behind the IMV and the mesocolon is elevated off the retroperitoneum. A medial-to-lateral mobilization is then performed heading toward the left upper quadrant and then continuing as far as possible toward the pelvic brim. Preserving the IMV initially will help identify the appropriate plane; but once it begins to limit visualization, it should be divided.

It is essential to remember that the IMV eventually courses *behind* the pancreas to join with the splenic vein. As a result, continuing the dissection cephalad along the posterior aspect of the vein will eventually lead behind the pancreas. With the upper aspect of the left mesocolon mobilized, the bulge of the body of the pancreas and the junction with the root of the transverse mesocolon become visible (Fig. 15-6). At this point, it is necessary to "step up" in front of the body of the pancreas and go through the avascular portion of the root of the transverse mesocolon to enter the lesser sac from beneath. When correctly executed, this dissection can continue into the lesser sac and will allow complete splenic flexure mobilization from beneath the colon. If at any point the plane becomes unclear, the lesser sac can be entered from above as described previously. Having completed the posterior mobilization, the plane between the root of the transverse mesocolon and the body of the pancreas is translucent and can be rapidly divided with sharp dissection. The transverse colon will then require separation from the omentum to complete the mobilization of the splenic flexure mobilization.

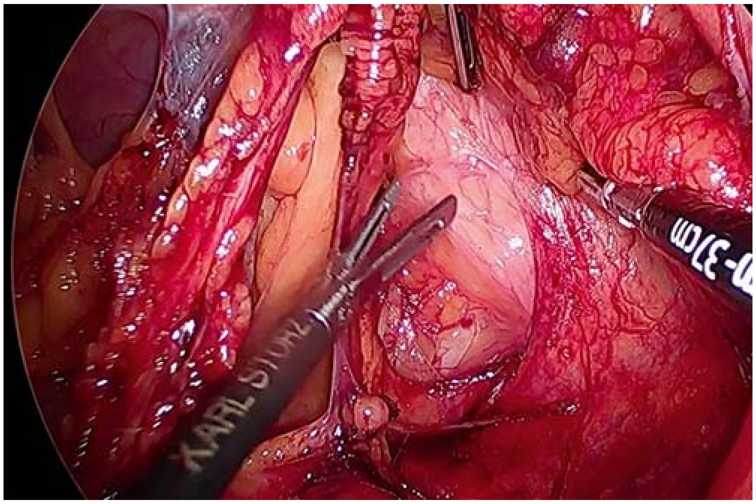


FIGURE 15-6 Sub-IMV dissection is continued laterally under the colon to the white line of Toldt, and superior to and above the pancreas. Care must be taken to ensure the dissection “steps up” over the pancreas to enter the lesser sac. IMV, inferior mesenteric vein.

Proctectomy with Total Mesorectal Excision

The patient is placed in steep Trendelenburg position with the right side down to allow the small bowel to retract out of the pelvis. After IMA division, the proper mesorectal plane is exposed by cephalad and anterior elevation of the rectosigmoid junction. The mesorectal dissection should be sharply performed sharply to prevent injury to the hypogastric and parasympathetic nerves. The hypogastric nerves, protected during IMA dissection at the sacral promontory, are preserved because they course laterally into the pelvis (Fig. 15-7). Mesorectal dissection is performed posteriorly, then laterally. Posterior dissection continues through the avascular plane outside the fascia propria to Waldeyer’s fascia and then to the levator muscles. Retraction on the mesocolon is critical to facilitate the dissection and should be anteriorly and cephalad to demonstrate the planes.

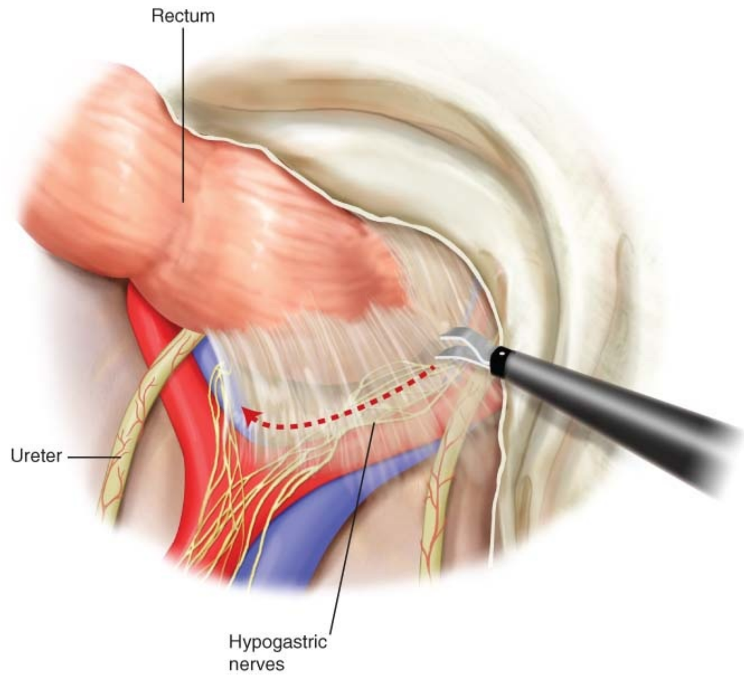


FIGURE 15-7 Entering the appropriate plane for mesorectal dissection is critical to oncologic resection. By elevating the rectosigmoid junction anteriorly and superiorly (out of the pelvis), a plane may be visualized deep to the mesorectum. Sharp dissection should be performed in this avascular plane.

As dissection continues, posterior retraction is limited by lateral retraction. When this problem occurs, the surgeon must take lateral, and eventually anterior, attachments to facilitate dissection in the plane just lateral to the fascia propria. Staying close to the mesorectum protects the lateral stalks, which are a site of potential injury to the nerves of the pelvic plexus (Fig. 15-8).

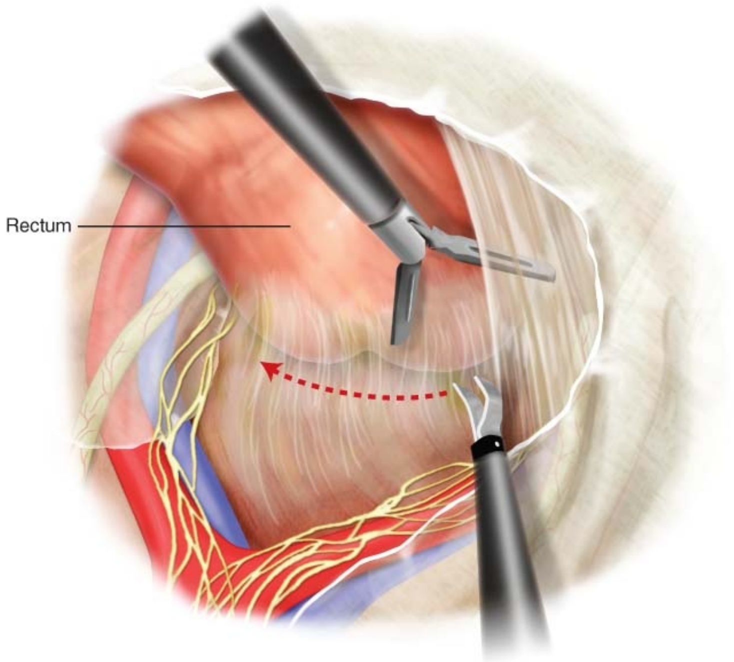


FIGURE 15-8 Continued tension on the rectum by lifting the rectum anteriorly and superiorly allows for visualization of the mesorectal plane. Posteriorly, the dissection plane should leave the nerves intact, with the presacral tissue. The plane creates a "U" shape, and travels anterior as it is developed laterally, to the lateral stalks. Unless there is tumor infiltration, preservation of the lateral stalks should be performed by staying close to the fascia propria of the rectum.

As the dissection continues, anterior dissection is necessary. Cephalad and posterior retraction of the rectum will place tension on the anterior planes. A second retractor can be used to place tension on the anterior pelvic structures. In male patients, care must be taken to avoid injury to the seminal vesicles. The very thin avascular plane of Denonvilliers' fascia exists between the anterior mesorectum and the seminal vesicles, and must be carefully dissected to avoid bleeding (Fig. 15-9). In female patients, a large uterus can obstruct visualization and the ability to appropriately retract the rectum. A 2-0 polypropylene suture on a Keith needle can be introduced through the suprapubic abdominal wall and used to fix the uterus to the anterior abdominal wall to alleviate this situation. If the patient has had a prior hysterectomy, the vagina may be fused to the anterior rectum. Dissection may be facilitated by having an assistant elevate the vagina with a sizer or with a transvaginally placed malleable retractor.

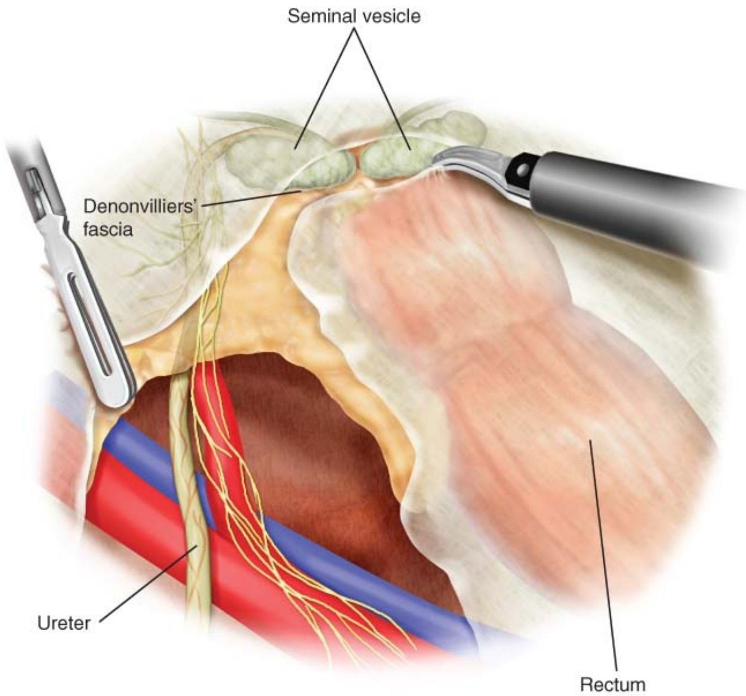


FIGURE 15-9 Anterior view of laparoscopic dissection. An open retractor elevates the anterior structures away from the dissection plane to allow for visualization of the appropriate plane. Care must be taken to preserve the seminal vesicles anterior and lateral to the prostate in a male or the rectovaginal septum anteriorly in a female.

After lateral and anterior dissection, the surgeon can return to the posterior dissection and obtain improved mobilization to reach deeper into the pelvis. When posterior dissection is complete to the levators, the mesorectum will dissipate, even in heavy patients. A decision to start the dissection from the perineal phase or to laparoscopically transect the rectum must be made.

For laparoscopic transection of the rectum, one port will be enlarged to a 15-mm port to insert the stapler. Many locations including stoma site (right lower quadrant), left lower quadrant, periumbilical (camera site), or Pfannenstiel incision have been used on the basis of individual surgeon preference. The authors generally use a left lower quadrant specimen extraction site and stapling port. The key to successful transection is a stapler placed perpendicular to the rectum (Fig. 15-10). This method minimizes the use of multiple staple lines and decreases the risk of devascularized rectum or dog ears at the anastomosis. Depending on the width of the pelvis, a transverse staple line may be possible, or the surgeon may have to use an anterior-to-posterior staple line to obtain correct angles.

FIGURE 15-10 Laparoscopic stapling of the rectum.The rectum should be stapled at a perpendicular angle; this is key to decreasing the use of multiple staple loads and has been shown to reduce the risk of anastomotic leak.

Transanal Rectal Transection and Perineal Dissection

The transanal dissection may be performed before, during, or after the abdominal portion of the procedure and continued proximally for a variable extent depending on staff and equipment availability and surgeon training. Further information on a so-called bottoms-up approach is provided in the chapter on TATME. For purposes of this chapter it is assumed that the rectal dissection has been completed to the fullest extent possible laparoscopically before beginning the transanal dissection. A separate chapter in this text is dedicated to the specific technical details of intersphincteric dissection for distal rectal cancers.

The patient's legs are lifted and spread in lithotomy stirrups to allow the operating surgeon and assistant to access the perineum. A separate set of operative instruments should be used to prevent contamination from the perineum to the abdomen. A small, sterilely draped Mayo stand can be positioned beneath the patient's buttocks to use as a working surface. The anus is effaced by use of the LoneStar (Cooper Surgical, Trumbull, CT) retractor or anal effacement sutures of 1-0 polyglactin. A lighted Hill-Ferguson retractor may be inserted into the anal canal to further flatten the mucosa and improve visualization, and rotated to expose the circumference of the lumen (Fig. 15-11).

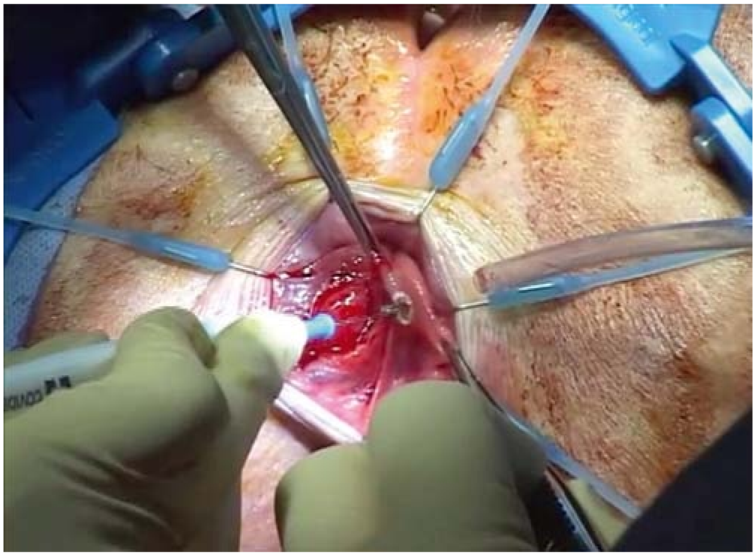


FIGURE 15-11 Perineal dissection: Dissection plane is begun at the dentate line using either a LoneStar retractor or effacement sutures. A lighted Hill-Ferguson retractor may help facilitate visualization. Dissection is carried proximally in a posterior, lateral, and then an anterior manner.

Dissection begins with a circular incision at least 1 cm distal to the furthest extent of the tumor. If necessary, the dissection will be in the intersphincteric plane to achieve an appropriate oncologic margin. This dissection is typically performed using electric cautery to minimize bleeding. A solution of 1/200,000 epinephrine can be used to elevate the mucosa and submucosa and to further decrease bleeding during the dissection. Operating in the posterior quadrant initially is preferred because it is easier to identify the intersphincteric plane in this location and avoids runoff from the superior and lateral dissection. Placing an Allis clamp on the cut edge of the rectum allows it be retracted distally for better exposure. Anteriorly, care must be taken to avoid injury to the vagina in females, or to the prostate and urethra in males. Toward that goal, a transvaginally placed finger can help elucidate the appropriate plane. Excessive bleeding may be a sign of inadvertent entry into the vaginal wall or prostate and the appropriate avascular plane should be reestablished. At the top of the anal canal, superior to the puborectalis, the dissection plane widens and enters the pelvis, through the full-thickness rectal wall to connect with the abdominal dissection. The plane is entered posteriorly initially, and then continued laterally. Dissection is directed just anteriorly to the coccyx, as palpated transrectally. This dissection will allow the surgeon to enter the mesorectal plane and join the laparoscopic and transanal portions of the surgery. Once the planes have been entered, a curved finger into the pelvis can help identify and isolate additional attachments.

Once the dissection is complete, the rectal lumen is sutured closed before a planned transabdominal extraction. If resection is performed laparoscopically, the rectum is pushed up out of the pelvis. A moist laparotomy sponge is placed in the pelvic space to prevent loss of insufflation before returning to the laparoscopic abdominal field.

If a hand-sewn anastomosis is planned, this period when the pelvis is empty is an excellent time to place the anastomotic sutures in the open rectal stump. Generally, six to eight sutures of 2-0 polyglactin are placed into the rectal mucosa and submucosa, incorporating some of the deeper sphincter muscle and exiting extraluminally above the cuff. These are tagged with hemostats, with the needle still on, to be used once the proximal segment is prepared and delivered.

Specimen Extraction

After completing the distal rectal transection and connecting the abdominal and transanal dissections, the specimen may be extracted through a variety of sites to allow extracorporeal proximal transection and preparation of the proximal colonic segment. Options for transabdominal extraction include extending the periumbilical or left lower quadrant port sites, creating the ileostomy aperture with vertical extension of the inferior aspect, or making a separate Pfannenstiel incision 2 cm above the pubic symphysis. The distal end of the rectum is laparoscopically secured with a locking grasper. The mobilized colonic segment is positioned into the pelvis to assure adequate reach. A mark may be placed with electrocautery on the planned point of proximal transection and the mesentery may be laparoscopically divided toward this point with an energy device. The marginal artery is preserved and extracorporeally inspected for bleeding. Maintaining insufflation while opening the extraction site can help prevent inadvertent injury to the viscera when entering the peritoneum. A wound protector is placed to flatten the abdominal wall, widen the incision, and prevent fecal or tumor contamination of the extraction site.

In some cases, the specimen may be delivered through the anus; yet a large tumor, bulky mesorectum or IMA pedicle, or a narrow pelvis will make this difficult and risk damage to the sphincter muscles. If transanal extraction is attempted, the entire IMA pedicle and an adequate length of descending colon should be drawn through the anus before transection. The mesentery to the proximal resection margin should be completely transected. Stay sutures may be placed to prevent the colon from retracting into the pelvis or twisting during construction of a neorectum and anastomosis.

The proximal resection margin is selected on the left colon based on an appropriate oncologic lymphadenectomy and confirmation of adequate blood appropriate oncologic lymphadenectomy and confirmation of adequate blood supply. The sigmoid colon is not typically used secondary to potential ischemia after high ligation of the IMA. The bowel wall is skeletonized and the marginal artery is isolated and checked for pulsatile arterial bleeding. The colon is transected with a linear cutting stapler. Fluorescence imaging perfusion assessment may be used to assist with selection of the proximal margin.

Creation of a Neorectum

Compared to straight end-to-end coloanal anastomosis, creation of a colonic J-pouch results in superior function in the first 6–18 months postoperatively, by decreasing frequency of bowel movements, urgency, and fecal seepage. Comparative studies of colonic J-pouch have shown similar results for transverse coloplasty and side-to-end (Baker) anastomosis, each of which may have benefits over end-to-end coloanal anastomosis. The authors prefer to perform a Baker anastomosis if reach is adequate; a coloplasty may be performed in patients without the necessary reach. However, the rates of postoperative anastomotic leak and pelvic sepsis are higher after coloplasty than after any of the other techniques. In males with narrow pelvis, or limited reach, a straight coloanal may be necessary. Any of these configurations may be used for a stapled or a hand-sewn anastomosis and the use of a neorectum should be considered with any anastomosis at the level of the anal canal, not only for those requiring transanal transection.

A colonic J-pouch is extracorporeally created with the distal 6 cm of sigmoid or descending colon folded upon itself (Fig. 15-12). An anchoring stitch of 3-0 polyglactin is placed to approximate the antimesenteric borders of the colon and to prevent twisting during manipulation. Pouch lengths greater than 6 cm have been correlated with increased evacuation difficulty. A 60-mm linear cutting stapler is inserted into an enterotomy created at the apex of the J. Care should be taken to staple along the antimesenteric border of the J-pouch to prevent bleeding from the staple line and preserve blood supply. The distal colotomy should be closed and the suture tagged before returning the pouch to the abdomen for anastomosis. Alternatively, a bladder catheter balloon may be inserted into the pouch and then pulled through the anus to guide the pouch into position. If a stapled anastomosis is to be performed, the anvil will be placed in the distal colon, before closure of the J-pouch, and secure into place with a 2-0 polyglactin suture. Transanal colonic J-pouch construction is another option, which is preferred by one of the editors (SDW).

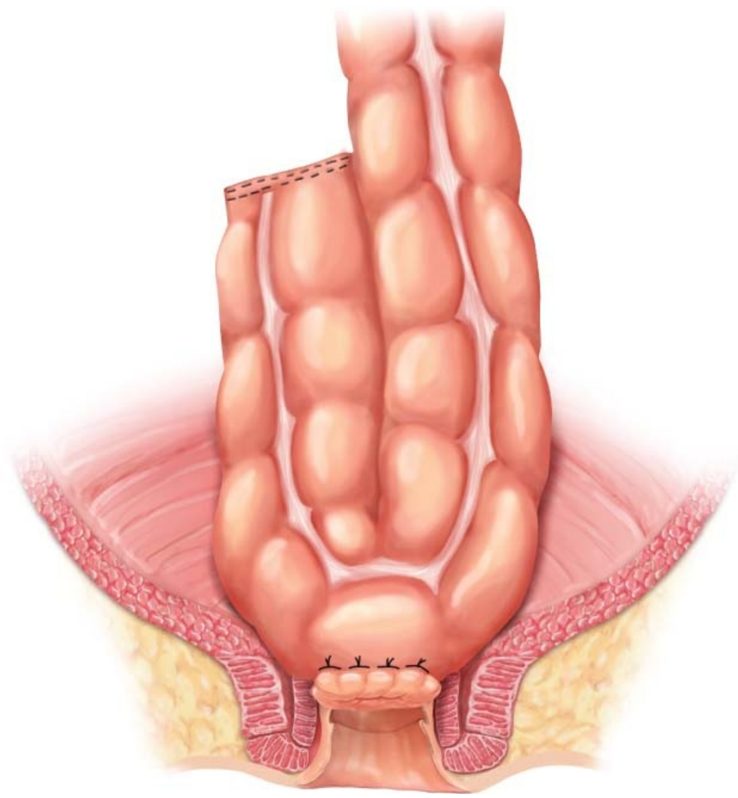


FIGURE 15-12 Colonic J-pouch: A colonic J-pouch is created on the antimesenteric side of the colon with a single firing of a linear 60-mm stapler. Pouch length should be limited to 60 mm to prevent difficulty with pouch emptying.

Coloplasty is constructed with a longitudinal incision approximately 4–6 cm from the distal resection margin, along the antimesenteric border. The incision is extended 8–10 cm proximally (Fig. 15-13). The longitudinal incision is closed transversely to enlarge the colonic reservoir in a manner similar to a Heineke-Mikulicz pyloroplasty. A single layer of 3-0 polyglactin sutures is typically used. As mentioned earlier, if a stapled anastomosis is to be performed, the anvil should be placed and secured before closure of the colotomy.

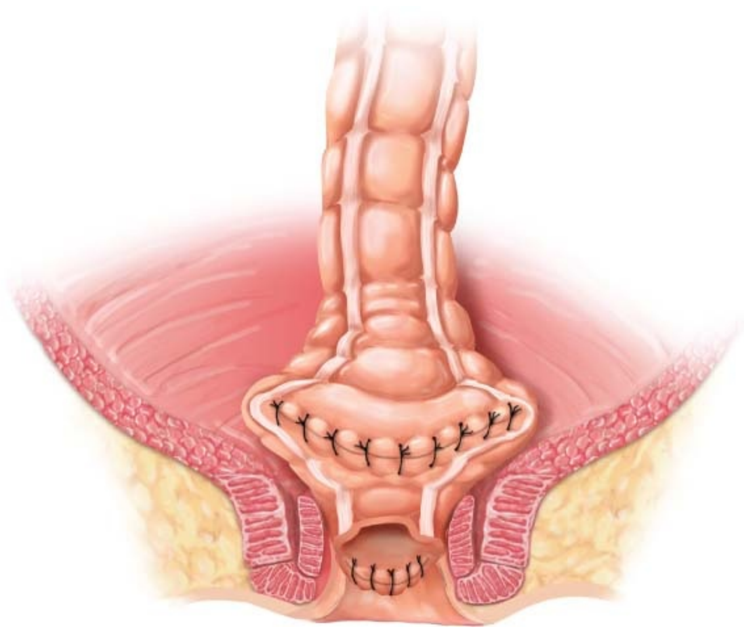


FIGURE 15-13 Coloplasty: A longitudinal colotomy approximately 8–10 cm in length starting 4–6 cm from the distal colon resection margin is closed with a single layer of polyglycolic acid sutures in an interrupted manner.

If the side of the colon reaches more distally into the pelvis, a side-to-end (Baker) anastomosis can be created (Fig. 15-14). This maneuver preserves blood supply to the anastomosis. If a stapled anastomosis is used, the anvil can be placed through the distal resection margin, and spike extruded approximately 4–5 cm proximal to the transection margin on the antimesenteric border. The anvil is secured with a 2-0 polyglactin suture, and the distal transection margin is stapled off. If a hand-sewn anastomosis is used, marking sutures may be placed on the antimesenteric border approximately 4–5 cm proximal to the staple line to help guide this segment into the anal canal and identify the appropriate site for colotomy.

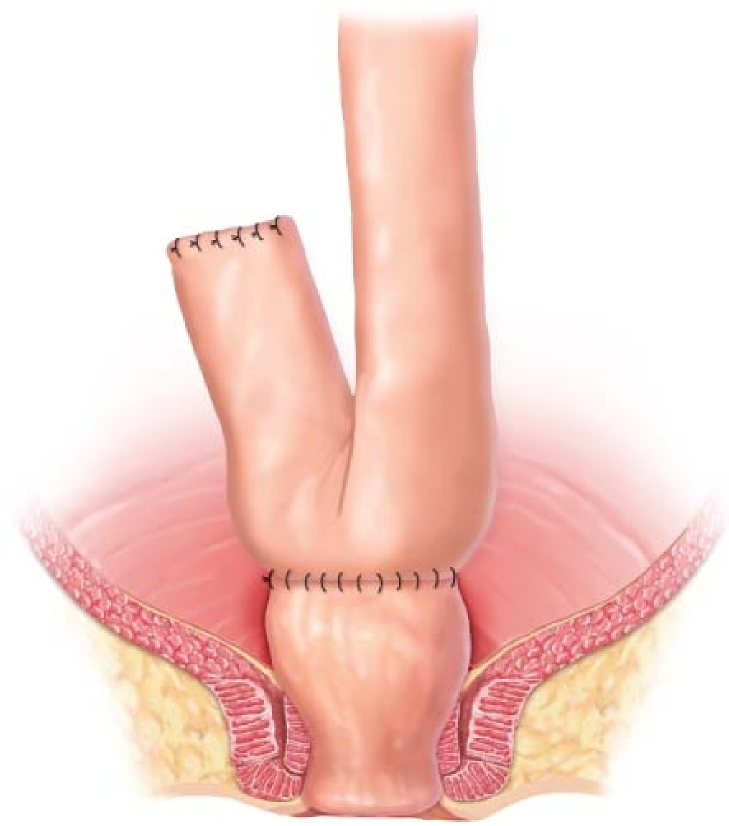


FIGURE 15-14 Baker anastomosis: A colotomy is created approximately 3–5 cm from the end of the colon conduit. If a stapled anastomosis is to be performed, the anvil will be placed before closure of the distal end of the colon.The anastomosis is made from the antimesenteric side of the colon to the anus.

Anastomosis

After extracorporeal abdominal preparation of the proximal colonic segment, the colon is returned to the abdomen. Pneumoperitoneum is reestablished by closing the specimen extraction site or occluding it by twisting the wound protector on itself and placing a large Kelly clamp to occlude the hole. A moist sponge may be wrapped around the wound protector to prevent leakage of gas. The patient is again positioned in Trendelenburg and the operative field is checked for hemostasis. Proper mesenteric alignment is ensured by identifying the medial cut edge of the mesentery near the ligament of Treitz and following it distally as a straight line. The small bowel should be swept medially and out from behind the colon. The colon is guided into the pelvis and the operator at the pelvis may assist by placing a ring forceps or Babcock through the anus into the pelvis to deliver the colon into the anal canal. It is essential to avoid twisting during the final pull through the anal canal.

The colotomy in the apex of the J-pouch is reopened (if it was closed) or the

Foley balloon is partially deflated. The previously placed transanal anastomotic sutures are brought through the outer muscularis of the colon into the lumen and tied intraluminally. If an end-to-end or coloplasty configuration was used, the proximal segment will still have a staple line in place. Care must be taken to ensure the orientation in an anterior-to-posterior direction at the time of specimen removal. In this case, the staple line is partially amputated beginning anteriorly, allowing the anterior sutures to be secured before completely removing the staple line and finishing the anastomosis.

p. 123

---

p. 124

If a stapled anastomosis is used, the anvil should be placed before closure of the proximal bowel. The rectum will have been stapled, just proximal to the anal canal. Because the staple line is so close to the anus, extreme care must be taken when placing the circular stapler to prevent distal stump disruption and sphincter damage. Digital sphincter dilatation helps prevent sphincter damage during stapler introduction and sphincter incorporation into the anastomosis. Specifically, after the stapler is gently passed through the sphincter muscles one must ensure that the circular ring is free of the anal canal. After a clear indentation of the ring of the stapler is laparoscopically confirmed, the stapler trocar is extended. Depending on the proximity of the vagina, and indentation, this trocar spike may be placed anterior, posterior, or through the linear staple line. Some surgeons prefer posterior extrusion to move the anastomosis away from the vagina, to prevent the possibility of fistulization with an exposed vaginal cuff.

The anvil is then guided into the pelvis. As discussed before, the orientation should be checked to prevent twisting around the axis of the mesentery. If a side-to-end anastomosis is used, the side stapler should be guided to the patient’s right, away from the anastomosis. The anvil is laparoscopically replaced over the receptacle trocar and the stapler is closed and fired. The surgeon should ensure that there is adequate length to create a tension-free anastomosis. Again, Indocyanine green fluorescence imaging can be used to confirm proximal and distal perfusion assessment.

A hydropneumatic leak test is then performed to check the anastomosis after the pelvis is filled with saline. The authors and editors prefer a flexible sigmoidoscope or rigid proctoscope to visualize the mucosa and the staple/suture line, and air leak; any ischemia, bleeding, or leak should be addressed. Alternatively, a hand-sewn distal purse string suture or a hand-sewn anastomosis can be performed from the perineal field.

Diverting Loop Ileostomy

For anastomosis below 5 cm from the anal verge, and for all patients who received preoperative radiation, the authors typically place a diverting ileostomy received preoperative radiation, the authors typically place a diverting ileostomy to minimize complications of anastomotic leak that may occur. The ileum is laparoscopically evaluated proximally from the ileocecal valve and to verify tension-free reach to the anterior abdominal wall. Ideally, the ileostomy is created at least 15 and 20 cm proximal to the ileocecal valve. Proximal and distal orientation is checked to ensure maturation of the ileum.

A trocar site on the right side is typically the premarked ileostomy site. The skin incision is enlarged to allow two fingers to reach into the abdomen. Generally, the subcutaneous and anterior fascia are sharply dissected using electrocautery. The muscle will be spread using two large Kelly clamps at right angles, and the posterior sheath is opened. Care must be taken to ensure the inferior epigastric vessels are not injured during dissection. The ileostomy is lifted laparoscopically to the anterior abdominal wall and pulled through the abdominal wall using a Babcock clamp. A supporting rod is placed under the ileum to prevent slippage of the posterior ileal wall into the abdomen allowing for passage of fecal stream before maturation. The ostomy is matured in a Brooke manner after closure of all port and specimen extraction sites. The authors use a Jackson-Pratt (CardinalHealth, Dublin, Ohio) drain selectively in cases below the peritoneal reflection.

POSTOPERATIVE MANAGEMENT

Patients are placed on standard postoperative accelerated recovery program after surgery. Soft foods and oral analgesia are started on postoperative day 1, and patients are encouraged to ambulate on postoperative day 0 or 1. The Foley catheter is typically removed at 48 hours for a low pelvic anastomosis. Patients should undergo postoperative enterostomal teaching for care of ostomy, and ostomy bars are removed after approximately 2–3 days in most patients.

COMPLICATIONS

Complications are similar to those of other abdominal surgeries and include bleeding, infection, and postoperative ileus. In addition, LAR with coloanal anastomosis increases risks of anastomotic leak and sexual and bladder dysfunction when compared to other colon surgeries.

Anastomotic leak rates for anastomoses below 5 cm from the anal verge are up to 18%. History of radiation, low anastomosis, immunosuppression, and technical difficulty has been associated with increased anastomotic leak rates. Creation of a diverting ileostomy helps lessen the severity of the complications of leak, but does not decrease the anastomotic leak rate. Postoperative morbidity rates are comparable between diverted and not diverted patients, but reoperative rates are lower when an ileostomy was created. In general, the authors employ the use of a diverting ileostomy for patients with low rectal cancer. However, patients with ileostomies have morbidity associated with a second hospitalization and operative intervention; a small percentage of patients may never undergo ileostomy closure.

Sexual and erectile dysfunction is increased in patients undergoing proctectomy with TME. Approximately 30% of males experience difficulty with erection or ejaculation following LAR secondary to intraoperative injury to the sympathetic or parasympathetic nerves. Dysfunction may improve with time and studies demonstrate some improvement with the use of sidafenil postoperatively. The rate of dysfunction increases with age, preoperative radiation, and poorer preoperative ejaculatory function. Rate of female sexual dysfunction is less well described, but women may have difficulty with pain, sensation, and orgasm.

Bladder dysfunction is a less common complication. Up to 15% of patients experience some temporary bladder dysfunction postoperatively, secondary to dissection in the pelvis or injury to parasympathetic nerves. Less than 5% suffer from permanent dysfunction when employing total mesorectal dissection techniques. Some patients may require replacement of the Foley catheter postoperatively.

RESULTS

Beyond the surgical complications mentioned, the primary outcomes of interest for laparoscopic LAR with coloanal anastomosis are oncologic results (local recurrence rate, disease-free survival, overall survival) and functional outcomes, including quality of life. Since the inception of laparoscopic colon and rectal surgery, there has been concern about the safety of laparoscopy for cancer. In 2005, the *CO*lorectal cancer *L*aparoscopic or *O*pen *R*esection (COLOR) trial reported decreased blood loss, pain, and length of hospital stay for patients randomized to laparoscopic versus open colectomy for cancer; nodal harvest and margin positivity were equivalent between the approaches. The 3-year disease-free survival for all stages was 74.2% (95% CI 70.4–78.0) for laparoscopic and 76.2% (95% CI 72.6–79.8) for open surgery. Although these differences were small and not statistically significant, the study was unable to demonstrate “non-inferiority” of laparoscopic colectomy with regard to the primary endpoint of 3-year disease-free survival because the upper limit of the 95% CI for the difference exceeded the predetermined threshold of 7%. The 3-year overall survival rates were 81.8% (95% CI 78.4–85.1) for laparoscopic and 84.2% (95% CI 81.1–87.3) for open surgery.

Three large, prospective randomized trials comparing outcomes of laparoscopic versus open surgery for rectal cancer were published in 2015. The COLOR II trial had as its primary outcome locoregional recurrence at 3 years after surgery, finding an overall rate of 5% in both treatment groups. Interestingly, locoregional recurrence after surgery for *low* rectal cancer was significantly higher in the open group (4.4% laparoscopic vs. 11.7% open; difference −7.3%; 90% CI −13.9 to −0.7). Disease-free and overall survival rates were not significantly different between the groups. Laparoscopy resulted in 1 day shorter length of hospital stay, with no differences in morbidity or mortality.

Two other trials found less favorable results for laparoscopic surgery for rectal cancer. In the American College of Surgeons Oncology Group (ACOSOG) Z6051 trial, a never before used non-validated composite pathologic outcome of distal margin, circumferential radial margin, and TME quality was used as the primary outcome. Four hundred and sixty-two patients (240 laparoscopic and 222 open) were analyzed. Of these, 76.7% underwent LAR and 23.3% underwent APR. Conversion rate of laparoscopic resections was 11%. Patients undergoing laparoscopic resection had their first bowel movement 1 day earlier but length of hospital stay was equivalent between the groups. Overall surgical success, defined as a negative distal and circumferential margin and a complete TME, was higher in the open arm (86.9% vs. 81.7%). The 95% CI of the difference failed to meet the defined criterion for non-inferiority with regard to non-validated composite pathologic outcomes, concluding that laparoscopic resections for rectal cancer were *not* “not-inferior” to open resections with regard to quality of the resection specimen.

The Australian Laparoscopic Cancer of the Rectum (ALaCaRT) trial, using the same non-validated composite pathologic outcome for adequacy of resection, also failed to demonstrate non-inferiority of laparoscopic resection for rectal cancer. The result was a consequence of slightly lower rates of circumferential resection margin negativity (93% vs. 97%) and completeness of TME (87% vs. 92%) in the laparoscopic arm, although neither of these differences was statistically significant in their own right. Patients undergoing laparoscopic resection had decreased blood loss and passed flatus 1 day earlier, but length of hospital stay was equivalent between the groups. Whether differences in pathologic outcomes will translate to differences in oncologic outcomes remains to be seen, and it is too early to declare a moratorium on laparoscopic surgery for rectal cancer based on these studies. However, given the strict inclusion criteria (no T4 tumors, no threatened margins, only expert surgeons with documented proof of competence), these trials certainly raise concern about the oncologic safety of laparoscopic LAR. Furthermore, the differences in short-term clinical outcomes were relatively small between laparoscopic and open resection. It is possible that in the era of standardized ERPs, the benefits of laparoscopy may be less pronounced than previously thought.

LAR with coloanal anastomosis modifies anorectal physiology. The proximal colonic portion of the anastomosis lacks the normal distensibility, compliance, and sensation of the normal rectum. The sphincters may be stretched, damaged, or even partially resected during a low rectal resection. Complications such as pelvic abscess, anastomotic leak, or stricture can further impact function. Radiographic and physiologic studies after LAR with coloanal anastomosis have demonstrated loss of the normal anorectal angle, decreased maximum tolerated volume, decreased resting anal sphincter pressure, and loss of the rectoanal inhibitory reflex. Many of these outcomes improve after the first year but the cumulative effect of these alterations may have a negative impact on patients' quality of life.

In some instances, alterations in defecatory function lead to significant dysfunction and a constellation of symptoms known as "anterior resection syndrome." Patients with anterior resection syndrome may experience varying degrees of fecal urgency, frequent stooling, soiling, incomplete evacuation, or fecal incontinence. The incidence of anterior resection syndrome is highest after ultralow colorectal and coloanal anastomoses, with rates approaching 20%. Creation of a neorectum with a colonic J-pouch has been shown in numerous randomized trials and meta-analyses to improve functional outcomes during the first 6–18 months after LAR compared with straight coloanal anastomosis. Patients experience decreases in stool frequency, urgency, and soiling. Some studies have reported improved quality of life, although many have not shown a studies have reported improved quality of life, although many have not shown a significant difference. Comparative studies of transverse coloplasty and side-to-end anastomoses with colonic J-pouch have shown similar functional outcomes.

CONCLUSIONS

LAR with transanal anastomosis provides restoration of intestinal continuity in patients who might otherwise be left with a permanent colostomy. Preoperative staging including proctoscopy, ultrasound, or MRI to evaluate depth of invasion and lymph node involvement, and full colonoscopy is essential for creation of an appropriate operative plan. In addition, total mesorectal resection and attention to margins are essential to maintaining oncologic standards and low recurrence rates.

Most patients are candidates for laparoscopic LARs. Patients who have had prior surgery, obese patients, and males with narrow pelvis may be assessed for laparoscopic approach and may benefit from minimally invasive techniques. Function may be worsened in patients following LAR with transanal anastomosis, with a large series demonstrating 2–4 bowel movements per day and up to 25% of patients having some degree of incontinence postoperatively. The degree of continence impairment is in part contingent upon the amount of intersphincteric resection and the anastomotic height. Transabdominal or transanal creation of a neorectum using a J-pouch, coloplasty, or Baker anastomosis may improve function, especially in the early postoperative period.

RECOMMENDED REFERENCES AND READINGS

Hallböök O, Påhlman L, Krog M, Wexner SD, Sjödahl R. Randomized comparison of straight and colonic J pouch anastomosis after low anterior resection. *Ann Surg* 1996;224(1):58–65.

Ho YH. Techniques for restoring bowel continuity and function after rectal cancer surgery. *World J Gastroenterol* 2006;12(39):6252–60.

Hüttner F, Tenchkhoff, S, Jensen K, *et al.* Meta-analysis of reconstruction techniques after low anterior resection for rectal cancer. *Br J Surg* 2015;102:735–45.

Jafari MD, Wexner SD, Martz JE, *et al.* Perfusion assessment in laparoscopic left-sided/anterior resection (PILLAR II): a multi-institutional study. *J Am Coll Surg* 2015;220(1):82.e1–92.e1. doi:10.1016/j.jamcollsurg.2014.09.015.

Person B, Vivas DA, Wexner SD. Totally laparoscopic low anterior resection with transperineal handsewn colonic J-pouch anal anastomosis for low rectal cancer. *Surg Endosc* 2006;20(4):700–2.

Tekkis P, Tan E, Kontovounisios C, *et al.* Handsewn coloanal anastomosis for low rectal cancer: technique and long-term outcomes. *Colorectal Dis* 2015;17(2):1062–70.

Ueno H, Mochizuki H, Hashiguchi Y, *et al.* Preoperative parameters expanding the indication of sphincter preserving surgery in patients with advanced low rectal cancer. *Ann Surg* 2004;239:34–42.

Chapter 16

Open Low Anterior Resection End-to-End and Side-to-End Anastomoses

Radhika K. Smith and Juan J. Nogueras

The two prevailing techniques used to maintain intestinal continuity after surgical treatment of low rectal disease are end-to-end anastomosis (EEA) and side-to-end anastomosis. Rates of sphincter preservation have increased through advances and adaptations of new surgical techniques such as intersphincteric resection, combined transanal transabdominal approaches, and transanal minimally invasive total mesorectal excision. Additionally, the more recent utilization of neoadjuvant chemoradiotherapy has allowed for downstaging with primary anastomosis.

Although the core principle of surgical management is achieving cure with low perioperative morbidity and mortality, consideration must also be given to postoperative urinary, bowel, and sexual function. Perhaps the most debilitating outcome after low anterior resection (LAR) is the development of low anterior syndrome. Low anterior syndrome is characterized by increased stool frequency, urgency, clustering of bowel movements, and incontinence and is felt to result from the loss of reservoir function of the rectum. Methods to reconstruct the neorectum in efforts to regain storage capacity have been developed to try to improve function. These options include side-to-end anastomosis, colonic J-pouch formation, and transverse coloplasty.

In this chapter, we review and compare preoperative considerations, surgical technique, and complications after LAR with EEA and side-to-end anastomosis.

INDICATIONS

Common indications for LAR with either EEA or side-to-end anastomosis include mid or low rectal cancer, endoscopically unresectable polyp, or inflammatory proctocolitis from Crohn’s disease.

CONTRAINDICATIONS

Patients with a threatened distal margin should not undergo LAR. A sound oncologic resection should always maintain priority over sphincter preservation.

Furthermore, any patient who undergoes a low colorectal anastomosis must have adequate preoperative continence and sphincter function. The increased stool frequency and urgency typical of low anterior syndrome can alter normal continence in physiologic conditions and can result in a highly morbid outcome with poor preoperative function.

Older patients or those with debilitating medical comorbidities who cannot tolerate the physiologic response or the additional interventions associated with anastomotic leak should not undergo these high-risk anastomoses.

PREOPERATIVE PLANNING

Preoperative optimization and informed consent are of central importance in all patients planning to undergo major abdominopelvic surgery.

All modifiable risk factors for operative morbidity should be optimized prior to surgery. Examples include obesity, anemia, malnutrition, immunosuppression, tobacco abuse, and chronic medical problems.

p. 127

---

p. 128

Informed consent for proctectomy should include the possibility of a permanent stoma. In patients where proximal diversion is planned or permanent stoma is a significant possibility, referral should be made to an enterostomal therapist for marking and counseling when possible.

Attention to preoperative sexual, urinary, and bowel function should be discussed and documented and patients should be educated on the risk of postoperative dysfunction.

Mechanical and antibiotic bowel preparation should be administered the day prior to surgery.

SURGERY

Patient Positioning

All patients should be placed in modified lithotomy with care to pad all pressure points to avoid traumatic peripheral neuropathy.

A bladder catheter and orogastric tube should be placed.

In laparoscopic approaches, the patient should be secured to the bed and the arms should be tucked to the side.

Preoperative ureteric catheters should be placed at the discretion of the operating surgeon and should be given strong consideration in the setting of large bulky tumors, preoperative radiation, inflammatory disease, or reoperative surgery.

Mobilization and Resection

After exploratory laparotomy, the small bowel is packed away in the upper abdomen.

The splenic flexure and descending and sigmoid colon are mobilized from their lateral attachments.

The ureter should be clearly identified.

High ligation of the inferior mesenteric artery and inferior mesenteric vein at the inferior border of the pancreas should be completed to ensure a tension-free anastomosis.

The patient should then be placed in steep Trendelenburg to allow unobstructed access to the pelvis.

Rectal mobilization should begin on the posterior aspect in the presacral space. Mobilization should be done using sharp dissection or electrocautery to the level of the pelvic floor. Care should be taken to avoid injury to the hypogastric plexus and the presacral veins.

This dissection is then laterally carried around the pelvis to free the peritoneal attachments on each pelvic sidewall. Vulnerable structures include the pelvic splanchnic nerves, the ureters, and the iliac vessels.

The dissection should anteriorly connect with care to try to prevent injury to the genitourinary structures.

Partial or total mesorectal excision is determined by the location of the tumor. Once the distal resection margin is chosen, the mesorectal fat should be circumferentially cleared to expose a bare muscular cuff of rectum.

A linear stapler is fired at a 90 degree angle, ideally with one fire of the stapler. This step can be performed using an Echelon (Ethicon, Cincinnati, OH, USA) or Endo GIA (Ethicon, Cincinnati, OH, USA) stapler or open using a Contour curved cutter (Ethicon, Cincinnati, OH, USA) or TA stapler (Coviden, Minneapolis, MN, USA).

End-to-End Anastomosis

The proximal margin of anastomosis is chosen. This colon should be free of inflammation and diverticular disease and must reach into the pelvis without any tension.

The remaining mesocolon is divided.

The colon should be transected at the proximal site with care to avoid spillage in the underlying wound edge by using a wound protector or disposable towels.

The specimen is removed and sent for pathologic analysis.

On the open proximal end of the anastomosis, a purse string suture should be sewn in a running fashion. Alternatively, prior to transection, a purse string clamp is placed on the intact colon and the colon is divided immediately distal to the clamp. A nonabsorbable monofilament suture such as a 2-0 Prolene on a straight needle can be passed through the clamp to more rapidly create the purse string suture to secure the anvil.

The circular anvil of a circular circular stapler stapler is introduced into the proximal bowel head first and the post is secured into place using the purse string suture.

The reach of the proximal colon should again be verified to ensure a tension-free anastomosis.

The orientation of the colon should be confirmed by following the cut edge of the mesentery and the antimesenteric tinea.

The stapler is transanally introduced until the top of the EEA reaches the most cephalad extent of the rectal stump.

Under direct vision the spike of the circular stapler should be deployed adjacent to the staple line (Fig. 16-1). The anvil should be seated on the spike and the stapler should be closed with attention not to entrap any additional tissue in the staple line including mesentery, epiploic fat, or posterior vaginal wall (Fig. 16-2). Once fired, the stapler should be partially opened and removed.

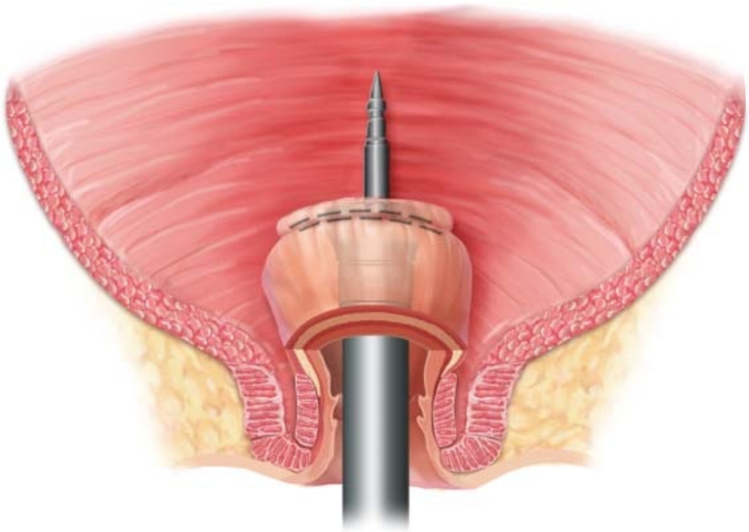


FIGURE 16-1 Schematic representation of the distal rectal stump with end-to-end anastomosis stapler introduced. This is used for both end-to-end and end-to-side anastomoses.

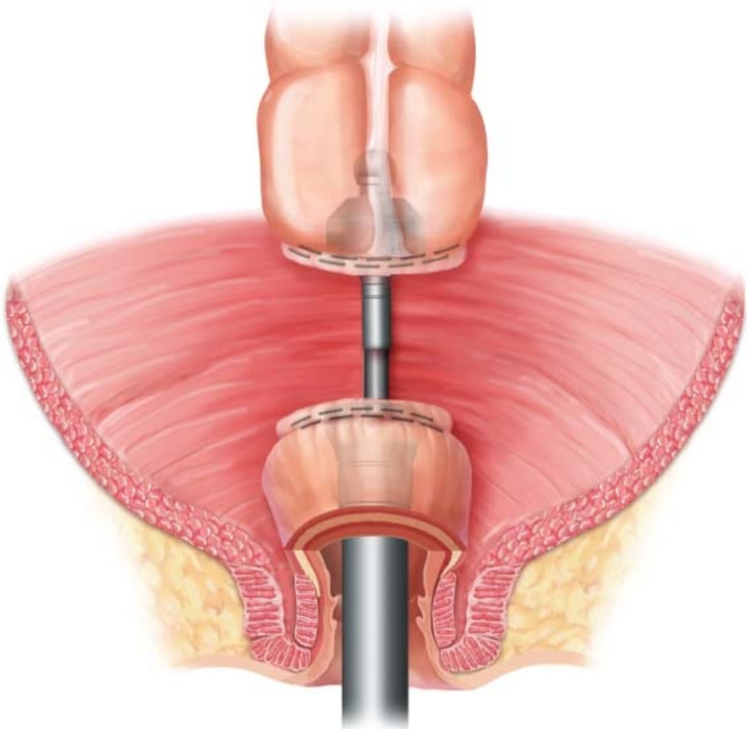


FIGURE 16-2 Schematic representation of proximal colon prepared for end-to-end anastomosis and placed in proximity to distal rectal stump ready for stapler to be mated.

Side-to-End Anastomosis

The proximal margin of anastomosis is chosen. This colon should be free of inflammation and diverticular disease and must reach into the pelvis without any tension.

The remaining mesocolon is divided.

The colon should be transected at the proximal site with care to avoid spillage in the underlying wound edge by using a wound protector or disposable towels.

The specimen is removed and sent for pathologic analysis.

The circular anvil of a 28–33 mm circular stapler stapler should be introduced into the proximal colon, leading with the post, and should exit the colon on the antimesenteric border 4–6 cm from the cut edge of the colon. This end should be closed using a linear stapler.

A purse string suture of a 3-0 monofilament suture should be sewn around the post to provide a buttress.

The reach of the proximal colon should be checked once more to make sure the anastomosis once constructed will be completely free of tension.

The orientation of the colon should be confirmed by following the cut edge of the mesentery and the antimesenteric tinea.

The stapler is transanally introduced until the top of the circular stapler reaches the most cephalad extent of the rectal stump.

Under direct vision the trocar of the circular stapler should be deployed adjacent to the staple line (Fig. 16-1). The anvil should be seated on the spike and the stapler should be closed with attention not to entrap any additional tissue in the staple line including mesentery, epiploic fat, or posterior vaginal wall (Fig. 16-3). Once fired, the stapler should be partially opened and removed.

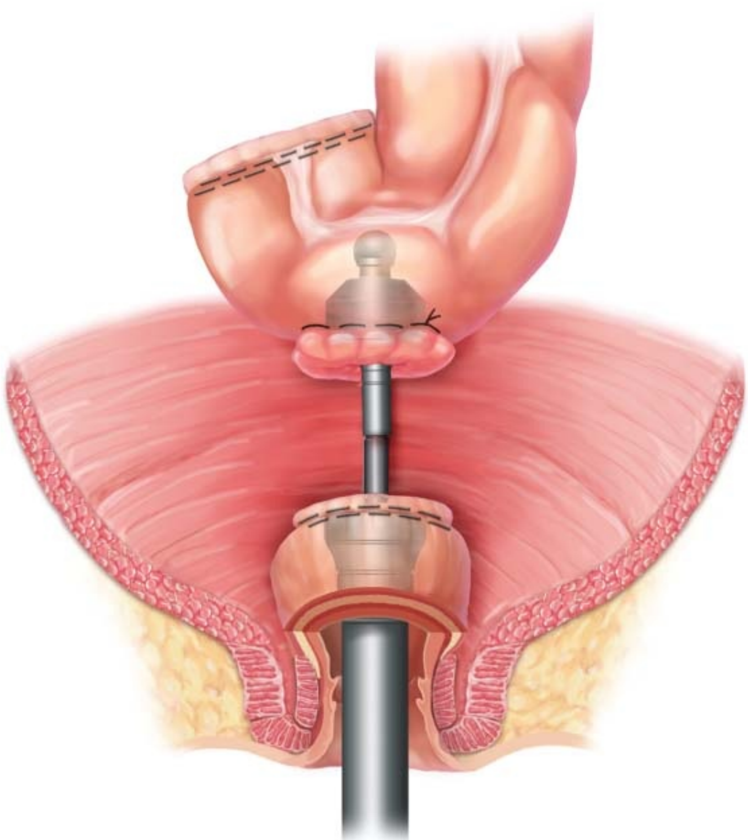


FIGURE 16-3 Schematic of the ends of bowel when the end-to-end anastomosis stapler is mated in fashioning an end-to-side anastomosis. Note the side limb should be about 3 cm.

Testing the Anastomosis

The anvil and spike are separated on withdrawal of the stapler, and the resected ends of the anastomosis should be inspected to confirm the muscular wall is intact.

The colon proximal to the anastomosis should be gently occluded with an atraumatic clamp, the pelvis should be filled with saline, and the anastomosis should be gently submerged.

p. 130

p. 131

Using flexible sigmoidoscopy, the anastomosis should be directly visualized to confirm an intact staple line, hemostasis, and viable distal and proximal mucosa. The pelvis should be checked for extravasation of air from the leaks in the anastomosis into the saline-filled pelvis.

Fluorescence imaging technology can also be used to assess perfusion to the anastomosis. Intravenous indocyanine green is injected and the anastomosis is externally and transanally visualized. A change of tissue color to green through fluorescence angiography can confirm perfusion. In a recent trial, this technology was found to change operative plans in 8% of patients with findings of inadequate perfusion. There were no anastomotic leaks in these patients.

Drain Placement

The use of pelvic drains is controversial.

Although initially thought to decrease the risk of anastomotic complications by preventing the accumulation of fluid and blood in the pelvis, this has not been borne out in the literature. Most randomized controlled trails and meta-analyses have not shown any harm or benefit in the prophylactic placement of pelvic drains.

These authors routinely drain all low pelvic anastomoses.

POSTOPERATIVE MANAGEMENT

The last 10 years have seen marked advances in the postoperative management of colorectal patients undergoing major abdominal resection. The routine use of the advanced recovery pathway has reduced length of stay by more than 30% and decreased postoperative complications by up to 50%.

Factors of perioperative care that demonstrate benefit include:

- Avoidance of nasogastric tubes
- Premedication to avoid nausea and vomiting
- Limitation of intravenous fluid
- Nonopioid analgesia including the use of nonsteroidal anti-inflammatory drugs, mu opioid antagonist, and gamma-aminobutyric acid antagonists
- Midthoracic epidural anesthesia
- Early removal of indwelling urinary catheters
- Early oral intake on postoperative day 0
- Early and aggressive ambulation
- Stimulation of gut motility though the use of medications such as magnesium oxide
- Audit of compliance and outcomes to advanced recovery measures

COMPLICATIONS

Postoperative complications are usually related to technical factors or patient-related factors. All attempts should be made to assess and optimize these factors before and during surgery. Care should be taken to create a tension-free anastomosis and divert proximally when indicated.

Anastomotic Bleeding

Postoperative bleeding can present on a spectrum ranging from insignificant hematochezia to severe hemorrhage with hemodynamic instability. Patients will usually complain of blood per rectum following the first bowel movement and may experience a drop in serum hemoglobin. Typically, bleeding is self-limited and will stop within 24–72 hours. Rarely, bleeding can be massive and require transfusion in which case endoscopic or transanal control should be attempted. Endoluminal maneuvers may include injection of the anastomosis with 1:10,000 epinephrine, cauterization, clip application, or suture ligation. These authors favor flexible sigmoidoscopy after completion of any anastomosis to check for hemostasis and suture ligate or clip areas of significant bleeding under direct visualization.

Anastomotic Leak

Anastomotic leak is a devastating complication that occurs in approximately 5–8% of all anastomoses, with an incidence of over 20% in low pelvic anastomosis.

Randomized head-to-head comparison of EEA and side-to-end anastomosis has shown a significantly lower leak rate with a side-to-end anastomosis (29.2% vs. 5%). Although not proven, this is felt to be related to a more reliable blood supply of the side-to-end anastomosis. Similarly, colonic J-pouch has been found to have the lowest leak rates when compared to both end-to-end coloanal anastomosis and transverse coloplasty.

The presentation of leaks occurs on a spectrum and management requires a thoughtful approach by the surgeon. Clinical manifestations and radiographic findings can vary widely among patients, and treatment should be based around these findings.

Diagnosis should be suspected with the development of abdominal pain, ileus, fever, tachycardia, leukocytosis, or enteric contents from incision sites or drains. Computed tomography scan should be obtained looking for abscess formation

Computed tomography scan should be obtained looking for abscess formation, phlegmon, sinus, free fluid, free air, or contrast extravasation.

Patients with contained leaks defined as a perianastomotic phlegmon, sinus, or abscess with no evidence of peritonitis can be treated with broad spectrum IV antibiotics and serial examinations. All intra-abdominal collection amenable to percutaneous intervention should be drained under image guidance. Patients with peritonitis or systemic sign of sepsis such as hemodynamic changes, multiorgan system failure, and metabolic acidosis should be considered for operative intervention after resuscitation and administration of antibiotics. Operative intervention can include washout with drain placement and proximal diversion, revision of the anastomosis, or Hartmann's colostomy. Leaks can also be asymptomatic in the acute setting most commonly seen with prophylactic diverting loop ileostomy and may present late in the postoperative period with strictures or fistulas.

Prevention of leaks should be the primary aim in the construction of any anastomosis. Techniques to reduce tension on the anastomosis include complete mobilization of the proximal colon from the lateral attachments and high ligation of the inferior mesenteric artery and vein at the inferior border of the pancreas. Ensuring good blood supply to anastomosis is of paramount importance. Pulsatile bleeding from the marginal artery should be demonstrated through palpation or Doppler signal. Endoscopic examination should also confirm viability of the bowel by revealing pink and well-perfused mucosa. Patient-related factors that have been associated with leak include malnutrition, exposure to radiation, immunosuppression, smoking, and anemia.

RESULTS OF LONG-TERM FUNCTIONAL OUTCOMES

The literature includes multiple comparisons of EEA with different reconstructive techniques after LAR including colonic J-pouch, transverse coloplasty, and side-to-end anastomosis.

In 2016, a randomized controlled trial of 86 patients aimed to compare surgical, functional, physiologic, and quality of life outcomes after LAR with side-to-end or straight colorectal anastomosis. Outcome measures included number of bowel movements, nocturnal incontinence, urgency, Wexner score, fecal Incontinence Quality of Life Scale, and the use of antidiarrheal medicine, laxatives, enemas, and pads. Physiologic assessments using anal manometry and volumetric analysis were also performed. Overall morbidity of each group was equivalent, and at 6 months of follow-up, the only benefit of side-to-end anastomosis was a lower number of bowel movements.

Similarly, meta-analysis has shown colonic J-pouch to be superior to EEA in frequency, urgency, and fecal incontinence, with a decreased use of antidiarrheal medications. However, there was no significant difference found when comparing colonic J-pouch to transverse coloplasty or side-to-end anastomosis.

The optimal length of the side limb of the side-to-end anastomosis has also been studied. A randomized study examining function after short (3 cm) versus long (6 cm) side limbs showed similar clinical results but an increase of evacuatory dysfunction seen of defecography in the long limb group.

It is important to note that patients who undergo APR have an equivalent quality of life when compared to patients who undergo coloanal anastomosis, and electing for permanent stoma should not be considered failure in patients whose expected postoperative function may be compromised.

CONCLUSION

A side-to-end low colorectal anastomosis is a simple alternative technique to a straight EEA that may be used preferentially to improve function. Important preoperative counseling, advanced recovery initiatives, and the early identification of postoperative complications are all key components to quality surgical care.

RECOMMENDED REFERENCES AND READINGS

Besson R, Christidis C, Denet C, *et al.* Management of postoperative bleeding after laparoscopic left colectomy. *Int J Colorectal Dis* 2016;31:1431–6.

Brisinda G, Vanella S, Cadeddu F, *et al.* End-to-end versus end-to-side stapled anastomoses after anterior resection for rectal cancer. *J Surg Oncol* 2009;99:75–9.

Brown CJ, Fenech D, McLeod RS. Reconstructive techniques after rectal resection for rectal cancer. *Cochrane Database Syst Rev* 2008;(2):CD006040.

Digennaro R, Tondo M, Cuccia F, *et al.* Coloanal anastomosis or abdominoperineal resection for very low rectal cancer: what will benefit, the surgeon's pride or the patient's quality of life? *Int J Colorectal Dis* 2013;28:949–57.

Jafari MD, Wexner SD, Martz JE, *et al.* Perfusion assessment in laparoscopic left-sided/anterior resection (PILLAR II): a multi-institutional study. *J Am Coll Surg* 2015;220:82–92.

Jesus EC, Karliczek A, Matos D, Castro AA, Atallah AN. Prophylactic anastomotic drainage for colorectal surgery. *Cochrane Database Syst Rev* 2004;(4):CD002100.

Rybakov EG, Pikunov DY, Fomenko OY, Chernyshov SV, Shelygin YA. Side-to-end vs. straight stapled colorectal anastomosis after low anterior resection: results of randomized clinical trial. *Int J Colorectal Dis* 2016;31:1419–26.

Steele SR, Hull TL, Read TE, *et al.* Anastomotic complications. In: Umanskiy K, ed. *The ASCRS Textbook of Colon and Rectal Surgery*. Arlington, IL: Springer International Publishing, 2016:161–71.

Tilney HS, Heriot AG, Purkayastha S, *et al.* A national perspective on the decline of abdominoperineal resection for rectal cancer. *Ann Surg* 2008;247:77–84.

Tsunoda A, Kamiyama G, Narita K, Watanabe M, Nakao K, Kusano M. Prospective randomized trial for determination of optimum size of side limb in low anterior resection with side-to-end anastomosis for rectal carcinoma. *Dis Colon Rectum* 2009;52:1572–7.

Urbach DR, Kennedy ED, Cohen MM. Colon and rectal anastomoses do not require routine drainage: a systematic review and meta-analysis. *Ann Surg* 1999;229:174–80.

Varadhan KK, Neal KR, Dejong CH, Fearon KC, Ljungqvist O, Lobo DN. The enhanced recover after surgery (ERAS) pathway for patients undergoing major elective open colorectal surgery: a meta-analysis of randomized trials. *Clin Nutr* 2010;29:434–40.

Zhang HY, Zhao CL, Xie J, *et al.* To drain or not to drain in colorectal anastomosis: a meta-analysis. *Int J Colorectal Dis* 2016;31:951–60.

Chapter 17

Hybrid Robotic and Fully Robotic Procedure

Cigdem Benlice and Emre Gorgun

INDICATIONS/CONTRAINDICATIONS

Since the introduction of laparoscopic colectomy, colorectal surgery practice has dramatically changed over the past three decades by growing use of minimally invasive techniques. Minimally invasive techniques have improved postoperative recovery and reduced morbidity and length of hospital stay after colorectal surgery compared to open surgery.

Surgical resection remains the most important treatment modality in the management of rectal cancer in terms of curative resection, staging, prognosis, and subsequent therapeutic decisions. However, rectal cancer surgery is technically challenging because of the limited boundaries and the complex nature of the pelvis with close proximity to the presacral veins and autonomic, sexual nerves and organs. Challenges during rectal surgery, however, are likely magnified when the additional difficulties of the laparoscopic technique are added to the procedure because of the ergonomic limitations of the instruments. The laparoscopic surgeon is required to undertake the same multi-quadrant operations as open surgery but with limited tactile feedback under the two-dimensional visualization that reduces in-depth perception as well as hand–eye coordination.

Accordingly, two recent randomized trials, the American College of Surgeons Oncology Group (ACOSOG) Z6051 and Australasian Laparoscopic Cancer of the Rectum (AlaCaRT), failed to prove non-inferiority of the laparoscopic technique for rectal cancer. Interestingly, Fleshman *et al.* stated in the discussion of the ACOSOG trial that one explanation for their findings is that proctectomy is challenging at baseline, and it can be even more difficult to work in the deep pelvis with in-line rigid instruments from angles that require complicated maneuvers to reach the extremes of the pelvis. They also continued to state that it is possible that modification of instruments or a different platform such as robotics will improve efficacy of minimally invasive techniques. Furthermore, they indicated that wristed instruments may provide the needed control in the deep pelvis and placement of instruments in line with sidewalls of the pelvis and remote control of these instruments provide ergonomic feasibility to perform minimally invasive resection. Essentially, these are characteristics of the existing robotic platform and this justifies further investigation in the field.

Indeed, the robotic approach is an emerging technique in the setting of colorectal surgery. Three-dimensional visualization, endo-wristed instrumentations, tremor reduction, ergonomics, and physical comfort for the surgeon are several advantages of robotic surgery (RS) over laparoscopy.

There is still debate whether this technology will translate into clinical efficiency and value of care. This chapter discusses the role of robotic approach on low anterior resection by focusing on rectal cancer surgery and describes various approaches in robotic restorative proctectomy.

PREOPERATIVE PLANNING

Proper patient selection is crucial to preoperative planning, and patients should be both medically fit and able to tolerate minimally invasive surgery. All patients should undergo a detailed history and physical examination. Preoperative full colonoscopy is recommended for all patients with rectal lesions, especially for identification of tumor location and possible synchronous colorectal lesions. As part of the preoperative preparation for rectal surgery, patients should undergo a mechanical bowel preparation with oral antibiotics. In our practice, mechanical bowel preparation and oral antibiotics are compulsory to sustain low postoperative surgical site infection. Preoperative broad-spectrum intravenous antibiotics are given within 60 minutes of the incision time, to ensure adequate concentration at the outset. Deep venous prophylaxis should include the use of sequential compression devices, as well as chemical prophylaxis (preoperative heparin).

Preoperative antibiotics are administered on the basis of the Surgical Care Improvement Project–related measures. Rectal irrigation and washout with saline is performed in rectal cancer cases. A Foley catheter and an intraoperative orogastric tube are placed in all cases during the operation.

SURGERY

The da Vinci Surgical System (Intuitive Surgical Inc., Sunnyvale, CA, USA), first introduced in 1999, is the sole robotic surgical system currently commercially available in the United States. It was first approved by the Food and Drug Administration for use in the United States in 2001. The initial prototype had three arms; in 2003, the company introduced a newer version with a fourth arm. Since then there has been three generational upgrades: the da Vinci S in 2006, the da Vinci Si in 2009, and the latest generation, the da Vinci Xi, which was introduced in 2014 (Fig. 17-1).

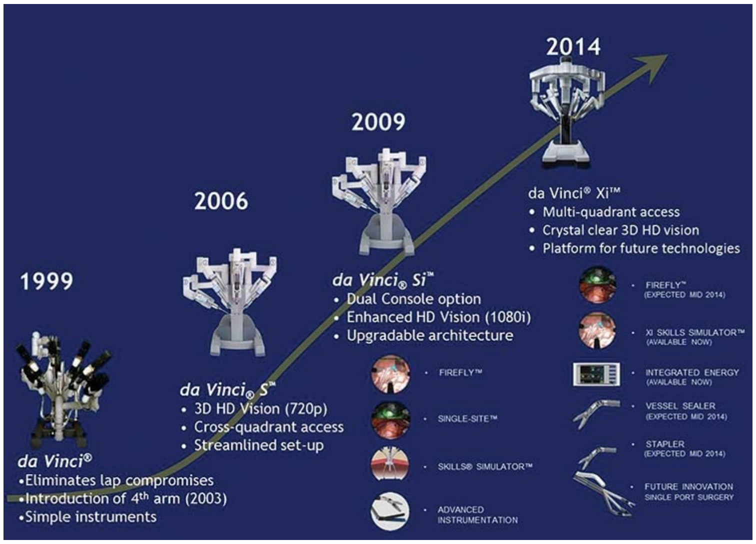


FIGURE 17-1 Evolution of the robotic da Vinci Surgical System. ©2016 Intuitive Surgical, Inc. Used with permission.

The system is comprised of three main components (Fig. 17-2):

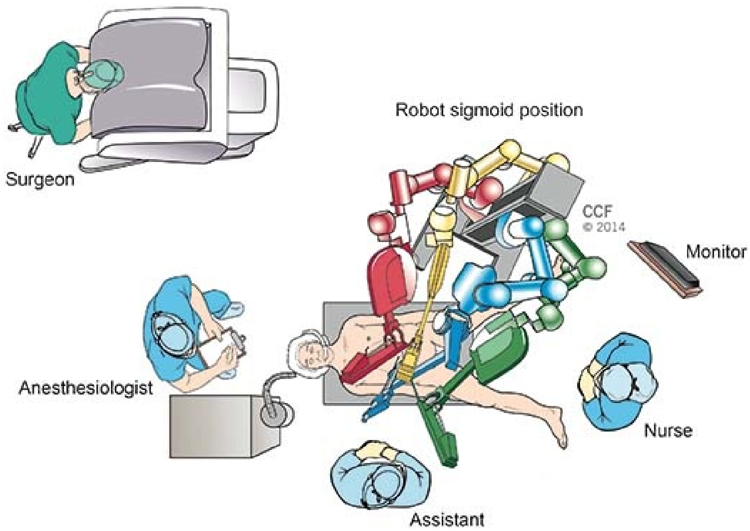


FIGURE 17-2 Operating room setup for robotic rectal surgery.

Surgeon’s console

A patient-side robotic cart with four robotic arms (one for the camera and three for surgical instruments) that are manipulated by the surgeon at the console

High-definition three-dimensional vision system, controlled by the operating surgeon

Robotic systems were originally designed to allow dissection in confined spaces and have been widely used for prostatic surgery with good outcomes. Thus, the robotic approach became attractive in colorectal pelvic surgery explicitly in the management of rectal cancer surgery. Because restorative proctectomy requires a tension-free anastomosis, splenic flexure mobilization is generally required. The need for colonic mobilization separates robotic rectal surgery from prostatectomy, where extension of the operative field is required outside the confined pelvic space. However, limited range of motion of the robotic arms and surgical field compromising multiple quadrants challenge adeptness and efficiency of robotic rectal surgery, especially when using the previous robotic platforms such as the da Vinci S and da Vinci Si systems. To overcome these limitations, several techniques have been described for robotic restorative proctectomy: **hybrid** (with laparoscopic splenic flexure mobilization), **fully robotic with single docking** ([da Vinci Si: generally exchanging the second and third robotic arms for different parts of the surgery] or [da Vinci Xi]), or **fully robotic with double docking** (first docking from the left upper quadrant for splenic flexure mobilization and then docking to the left lower quadrant for the rest of the procedure) (Fig. 17-3A and B).

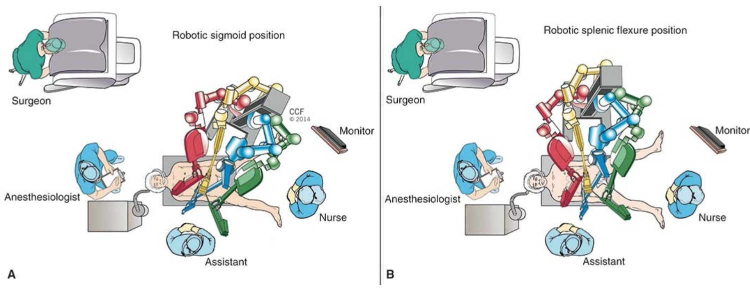


FIGURE 17-3 Operating room setup for (A) rectal surgery and (B) splenic flexure mobilization.

p. 136

---

p. 137

Operating Room Setup

Using both da Vinci Si and Xi Surgical Systems for the robotic restorative proctectomy, the patient is placed in a modified lithotomy position using adjustable lithotomy stirrups. The assistant surgeon remains on the right side of the patient to assist the console surgeon through one or two additional laparoscopic assistant ports. The operating room design during robotic splenic flexure mobilization is shown in Figure 17-3B. For procedures requiring pelvic dissection, the robot is typically docked at a 45 degree angle from the patient's left side.

Patient Positioning

The patient should be correctly positioned on the modified lithotomy position, which allows access to the anus for the numerous purposes including intraoperative CO_2 colonoscopy and/or using circular stapling device. Intraoperative flexible sigmoidoscopy with CO_2 has been used in our practice for both tumor location and anastomotic evaluation. The lithotomy position provides additional space for the surgical team, especially when operating in the upper quadrants of the abdomen, by standing between the patient's legs (Fig. 17-4). Padded stirrups or yellow fins are used and attention is given to preventing peroneal nerve injury. Both arms are tucked at the patient's sides. A gel pad on the operating table can provide additional decubitus support and stability against extremes of table tilting. Changes in operation table position and subsequent patient sliding can lead to the stirrup applying pressure to the posterior aspect of the lower extremity and constitutes risk for nerve injury. Thus, we prefer to secure patients on the operating table with a strong tape anteriorly surrounding the chest to prevent them from sliding during steep table positions.

FIGURE 17-4 Demonstration of the modified lithotomy position in robotic rectal surgery.

p. 137

p. 138

Port Placement and Docking

To perform robotic restorative proctectomy, five to six ports are required, including camera and assistant ports. Figure 17-5 shows the port placement for three robotic arms, camera, and assistant ports. When using the S or Si generations, a 12-mm camera port is placed in the supraumbilical area with an open technique. An 8-mm port is placed in the left lower quadrant lateral to the umbilicus 10 cm apart; two additional 8-mm ports are placed, one in the right upper and one in the right lower quadrant. One assistant port is inserted on the right lateral to the robotic ports and in equal distance from the right upper and lower quadrant trocars. A right upper quadrant robotic port (port 3) is used for the splenic flexure mobilization and left colectomy. An additional robotic port (port 3P) is placed in the left-mid abdomen, lateral to the edge of the rectus muscle. This port, 3P, is used for pelvic dissection (anterior resection, low anterior resection, abdominoperineal resection procedures). The assistant port can be used for small bowel/colon retraction and suction irrigation. After the da Vinci patient cart is docked as described, the arms are arranged according to Figure17-2. For the purpose of the splenic flexure mobilization, monopolar curved scissors (da Vinci Surgical System, Intuitive Surgical, Sunnyvale, CA) is inserted through right lower quadrant port (port 1). A bipolar grasper (da Vinci Surgical System, Intuitive Surgical, Sunnyvale, CA) is inserted from the right upper quadrant port (port 3). A Cadiere grasper (da Vinci Surgical System, Intuitive Surgical, Sunnyvale, CA) is placed at port 2 left to the camera port. Typically, the assistant instrument is entailed of a laparoscopic bowel grasper or suction.

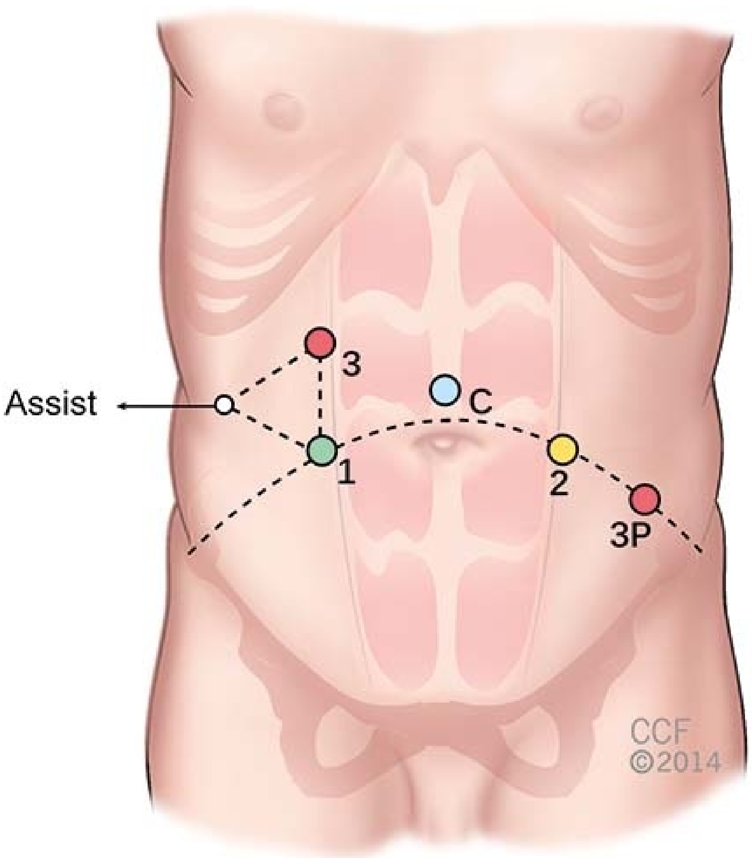


FIGURE 17-5 Demonstration of the trocar placement in robotic rectal surgery.

Technique

Following pneumoperitoneum, the camera is inserted and additional trocars are placed under direct vision. The robot is docked using the two right-sided robotic trocars (8 mm and 8 mm) and two left-sided robotic trocars. The patient then is positioned in the right side down and slight Trendelenburg to facilitate displacement of the small bowel and the cecum out of the pelvis. At first using the robot, a medial-to-lateral mobilization of the left colon is accomplished and this is our preferred approach. However, depending on the comfort level of the surgeon, a lateral approach can also be utilized.

Important Steps for Mobilization of the Splenic Flexure and the Left Colon (Applies to Both Hybrid and Total Robotic Approaches)

Video 17-1: Medial-to-Lateral Total Robotic Splenic Flexure Mobilization Technique

We perform medial-to-lateral dissection and mobilization using embryologic planes between the mesocolon and the retroperitoneum **(Video 17-1)**. The next steps in our novel splenic flexure takedown technique are as follows:

High ligation of the inferior mesenteric artery (IMA) at 1–1.5 cm away from the aorta

After the paraaortic peritoneum is incised, the IMA is exposed; local tissue is cleared from around the artery at its origin from the aorta without injuring the hypogastric plexus. For the ligation, we use endoscopic Hem-o-lock clips (Fig.17-6). The operation is started under the origin of the IMA, as originally described by Fazio *et al*. High ligation of the IMA allows for additional lymph nodes to be retrieved during colorectal cancer surgery.

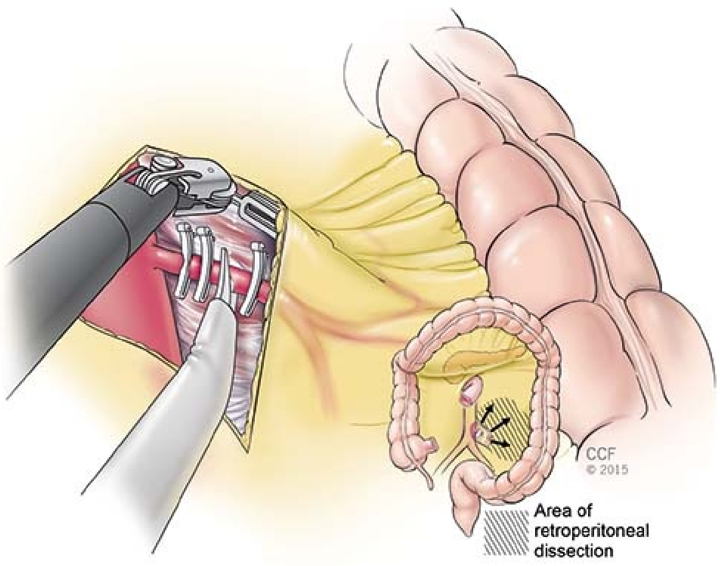


FIGURE 17-6 Demonstration of the high ligation of the inferior mesenteric artery with endoscopic Hem-o-lock clips. (Hem-o-lok(r) MLX polymeric clips, NC, USA)

Isolation and ligation of the inferior mesenteric vein (IMV) at the inferior border of the pancreas

The high ligation of the IMV with endoscopic Hem-o-lock clips facilitates further mobilization through the mesocolon (Fig.17-7). Usually, the IMV is near the ligament of Treitz and passes below the border of the pancreas to join to the splenic vein.

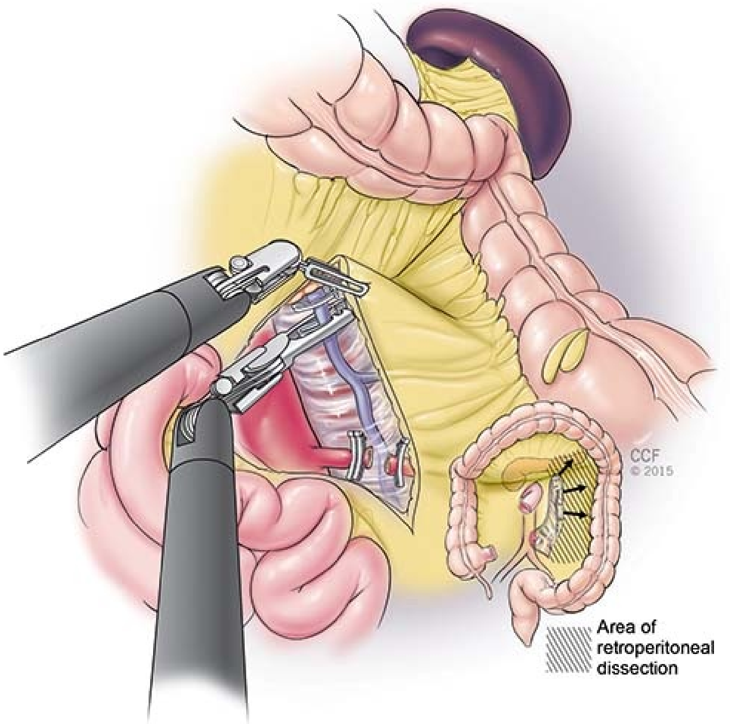


FIGURE 17-7 Demonstration of the high ligation of the inferior mesenteric vein at the inferior border of the pancreas.

Medial-to-lateral mobilization of the left colon through the space between the mesocolon and Gerota's fascia along the Toldt line

Entrance to the lesser sac (omental bursa) by dissecting through the anterior border of the pancreas

This is the most important step in our surgical technique. To facilitate this entry, we start the dissection 1 cm lateral and anterior to the ligated IMV stump. The posterior wall of the stomach, pancreatic body, and tail are clearly visualized in Figure 17-8.

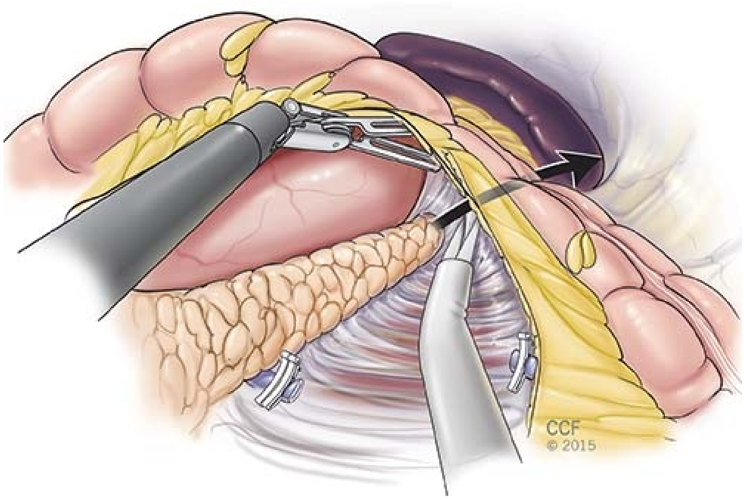


FIGURE 17-8 Demonstration of the entrance to the lesser sac by dissecting through anterior border of the pancreas.

Takedown of the lateral attachments and mobilization of the descending colon

Detaching the omentum from the distal transverse colon
The final step is carrying this dissection across the splenic flexure and toward the distal transverse colon. At this point, the mobilization of the splenic flexure is completed by dissecting the splenocolic ligament and lateral attachments of the descending colon. Entering the lesser sac earlier makes this step much easier. Ultimately, a fully mobilized distal transverse and splenic flexure is achieved.

Once the medial-to-lateral dissection is completed and adequate left colonic mobilization achieved, the right upper quadrant robotic arm is flipped from the right to the left side and the pelvic dissection is started. At this point, mesorectal excision begins at the sacral promontory below the plane of the superior hemorrhoidal artery, in the avascular plane that exists between mesorectal envelope and endopelvic parietal fascia. Dissection is carried down all the way to the levator muscle with careful preservation of both the hypogastric nerve plexuses including the erigent pillar and entirety of the mesorectal envelope. Classically, we divide the rectum using reticulating robotic stapling devices, often with one or, occasionally, two fires of robotic staplers. At this point, there is also an unconventional technique described, which includes transecting the rectum under direct vision using a cautery hook and then purse string suture of the rectal cuff followed by circular stapler (EEA) (Covidien EEA Stapler, Medtronic, Inc, Minneapolis, MN, USA). The specimen is then exteriorized from the right lower quadrant incision where the potential ileostomy is going to take place using a wound protector (Fig.17-9). As defined in the laparoscopic surgical approach, natural orifice specimen extraction (NOSE) through the anus has also been reported in patients undergoing total mesorectal excision (TME).

FIGURE 17-9 Demonstration of the specimen extraction through the ileostomy site.

p. 139

p. 140

The Hybrid Robotic Technique

The hybrid technique is a laparoscopic-assisted robotic technique. This eliminates repeated movements to reposition the robotic system and thus decreases overall operative time. Also, it is easier to mobilize the splenic flexure laparoscopically and then shift to robotics during the pelvic dissection for TME. Two monitors on both sides of the table should be routine in laparoscopic surgery and robotic high-definition vision system is positioned side by side the laparoscopic monitor for the bedside assistant. This setup is also helpful in hybrid procedures where part of the operation is performed using the laparoscopic approach (Fig.17-10).

FIGURE 17-10 Robotic setup for ligation of the inferior mesenteric artery and vein and mobilization of the splenic flexure.

The da Vinci Si system is designed to work better in the pelvis; thus, double docking to take down the splenic flexure facilitates the approach. On the other hand, re-docking increases operative time and affects the flow of the operation. Further attention is necessary in the positioning of ports, with consideration given to the range of dissection required within the abdomen as well as the potential for external collisions of the robotic arms. Decision making for port locations is gradually and accurately perfected on the basis of individual experience. Whether totally robotic or hybrid technique will be employed should depend on surgeon discretion. Although totally robotic rectal procedures have been reported with acceptable safety results, various hybrid procedures likewise offer benefits associated with the robotic approach. For the hybrid technique, variations depend on onset of RS either by ligating the vessels or followed by laparoscopic splenic flexure mobilization. In all conditions, a minimum distance of “one hand’s breadth” is required to avoid external collisions of the robotic arms. Limitations of this technique are that the surgeon has to be well trained in laparoscopic colorectal surgery. However, with the advent of the new da Vinci Xi, a totally robotic TME seems both technically feasible and efficient, which is discussed further in this chapter.

Total Robotic Technique

This technique has the advantage of using the robot for completion of the whole procedure. It is reported that a surgeon who is inexperienced in laparoscopy can still perform a minimally invasive colorectal procedure using this technique. However, the authors of this chapter believe that both approaches require advanced laparoscopic experience. The senior author uses the single-docking approach and flips arm 3 from the right upper quadrant trocar to the left lateral trocar for the pelvic part when using the da Vinci Si platform. In this approach, the robot does not need to be moved or repositioned, except for the described arm change/flip. After the colon has been completely mobilized, the bowel distal to the pathology is transected with a laparoscopic or robotic linear-cutting stapler. Endocutter stapler can be introduced through the right lower quadrant trocar after upsizing to a 12-mm port. This site can ultimately be used as the specimen extraction as well as the stoma location in cases where a diverting ileostomy is needed. Usually, one firing of the stapler is satisfactory to staple and cut across the bowel depending on the level of the transection. This step can also be achieved using the robotic EndoWrist (Intuitive Surgical Inc. Sunnyvale, CA, USA) 45-mm stapler, as discussed earlier. This is a 54-degree-wristed articulating robotic stapler and may provide advantage in confined spaces such as deep in the pelvis. After specimen extraction, the extraction site is sealed and peritoneal access regained. In this approach, maintenance of the pneumoperitoneum can be achieved in different ways: our general preference is to use the Alexis bundle wound protectors with “a cap” (Alexis laparoscopic system with Kii Fios First Entry, Applied Medical, Rancho Santa Margarita, CA, USA) or wound protector combined with an inch Penrose drain and penetrating towel clamps. In 2014, Intuitive Surgical marketed a new platform, the da Vinci Xi system, that addressed a few limitations of its predecessor. The da Vinci Xi comes with a lightweight camera that facilitates its control and is interchangeable between ports. One of the major advantages is that it allows for a much more superior multi-quadrant surgery and thus splenic flexure mobilization becomes less challenging. Therefore, flipping robotic arms between the ports are generally not required (Fig.17-11).

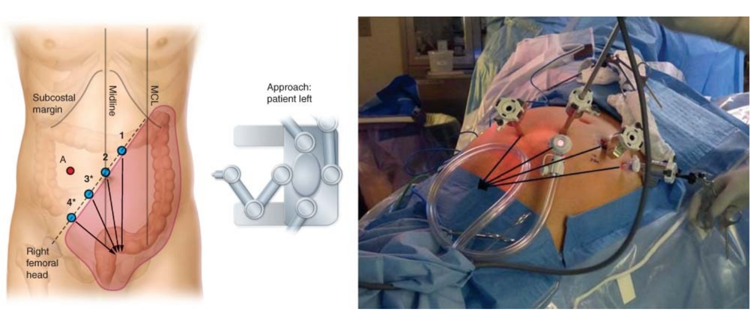


FIGURE 17-11 Demonstration of the da Vinci Xi port placements: Left-sided approach port placement of da Vinci Xi. Right: abdominoperineal resection port placement. MCL, midclavicular line.

POSTOPERATIVE MANAGEMENT

Postoperative management after robotic restorative proctectomy is similar to that for laparoscopic procedures for rectal cancer. The patient is kept on deep vein thrombosis prophylaxis until discharge, and encouraged to ambulate and use an incentive spirometer. Enhanced recovery pathways are routinely used in our practice and patients are placed on solid diet the same day after surgery.

COMPLICATIONS

Anastomotic Leakage

Anastomotic leakage is one of the most dreaded complications after colorectal surgery. Kim et al.'s systematic review of available literature reported an anastomotic leakage rate post robotic colorectal surgery of up to 21%. A review of literature on anastomotic leakage following RS compared to laparoscopic surgery seems to show no significant difference between both. Baek *et al.* reported 8.6% leakage rate for RS compared to 2.9%, but their findings were not statistically significant. Whether future literature will support or refute the current data remain to be seen, yet it is worth mentioning that the near-infrared camera of the robotic platform allows visualizing the vascular structure of the colon after Indocyanine green injection. That technology might positively impact rates of anastomotic leak in the future.

CONVERSION RATES

By far the most significant potential advantage of robotic versus the laparoscopic technique is the lower conversion rate to open. Over the past two decades, the laparoscopic technique has been continuously evolving and surgeons' experience has been increasing; however, the *CO*lorectal cancer *L*aparoscopic or *O*pen *R*esection II trial reported a conversion rate of 17%. Furthermore, 20 years later, there has been no significant change in the rate of early postoperative complications, except for a decrease in positive surgical margins noted in the past 3 years. Although this could be somewhat frustrating, it also gives room to anticipate better results with a newer technique if one would consider that laparoscopic surgery has offered the maximum that it could possibly achieve.

GENITOURINARY FUNCTION AFTER ROBOTIC RECTAL SURGERY

In the authors' opinion, robotic rectal surgery offers better optics and visualization of the autonomic nervous plexus in the pelvis, which would consequently help surgeons preserve the nerves and thus preserve genitourinary function postoperatively. Total robotic technique supporters believe that the robotic technique allows for preservation of both pelvis and periaortic nerves, which would translate into less postoperative sexual/bladder dysfunction.

OPERATIVE TIME

Most studies report longer operative time with robotic rectal surgery, which concurs with our institutional data where mean operative time was 172 minutes for laparoscopic surgery versus 267 minutes for RS, *P*<0.0001. In a systematic review by Mak et al., mean operative time of RS was 281 minutes compared to 242 minutes for laparoscopic surgery. Most authors identified the longer time taken with RS to be due to docking and changing of the robotic arms, a limitation that could perhaps be overcome by the introduction of the da Vinci Xi system. The authors also anticipate that as surgeons and operating room staff gain experience with the robotic technique, this would very likely reduce operative time in the future.

COST

One of the major drawbacks of RS is the cost. Data from our institute comparing cost of proctectomy between open, laparoscopic, and RS procedures concluded that RS costs 30% more. However, these data included surgeon's learning curve and multiple procedures that were bundled in the analysis. A Nationwide Inpatient Sample (NIS) study by Juo *et al.* from Johns Hopkins found a statistically significant higher overall hospitalization cost of robotic versus laparoscopic colectomy ($14,847 vs. $11,966). Yet, Halabi *et al.* in their review of NIS from 2009 to 2010 demonstrated an increase in robotic rectal surgery cases performed from 1,188 cases in 2009 to 2,380 cases in 2010. One would wonder why? Why incur an additive cost on the institution especially with the current era of health reform when there are cheaper, equally effective, and also minimally invasive techniques at hand? Here, we highlight again that the anatomy of the human pelvis is one of the most challenging to a colorectal surgeon and colorectal surgeons grasp any validated improved outcome. In a retrospective review of 488 proctectomies for curative intent by our institution, patients were grouped by surgical approach (open, laparoscopic, and robotic). All groups had similar demographics, characteristics, and treatment details. Although significant outcome differences were found in operative and anesthesia time for the robotic group, one should give credit when credit is due arguing that these patients had a shorter hospital stay and less overall complications compared to the open group. In a propensity-score-match analysis, Kim *et al.* concluded that RS had similar short-term perioperative outcomes compared to laparoscopic surgery and at a higher cost, as one would expect. Results of a cost-conscious approach study done by the senior author of this chapter showed that when we compared restorative proctectomies done open and robotically, after the first year robotic cases done by high-volume surgeons, the cost in both groups was comparable ($P = 0.02$ for the first year, then $P = 0.14$). However, owing to the fact that the technique is still in its infancy, literature is lacking on long-term outcomes. We believe that until long-term outcomes prove non-inferior, the argument of higher cost cannot be totally validated, at least not on a surgeon's frontier.

RESULTS

Generally, when laparoscopic and robotic anterior resections are compared, the robotic approach is associated with a significantly longer operative time. Comparing operative times between approaches is difficult because of the lack of a uniform study design and learning curve. However, we believe that the presence of a trained and experienced surgical team in the operating room is important, as is the experience of the surgeon.

Reported blood loss and conversion rates during robotic cases were comparable with those of laparoscopic left colectomy. On the other hand, either a comparable or shorter length of hospital stay was reported for robotic left colectomy for cancer. Similarly, outcomes in terms of blood loss and length of hospital stay were comparable between robotic and laparoscopic left colectomy for benign and malignant disease of the colon.

No severe complications or mortalities were reported after robotic anterior resection for rectal cancer, and postoperative morbidity and mortality rates were similar to those of the laparoscopy group. Similarly, a 92% overall and an 89% disease-free 3-year survival rate were detected after robotic anterior resection, which were comparable to those in the laparoscopy group.

IMPACT OF OBESITY ON ROBOTIC SURGERY

It is not uncommon for colorectal surgeons to anticipate hardship when operating on obese patients. In our institutional review, we concluded that in a comparable group of patients (carefully case-matched group for patient demographics, body mass index [34.9 ± 7.2 vs. 35.2 ± 5.0 kg/m^2, $P = 0.71$], comorbidities and surgical and tumor characteristics between robotic and laparoscopic groups), RS was associated with an earlier return to bowel function and shorter hospital stay by 2 days ($P = 0.02$).

THE CLEVELAND CLINIC EXPERIENCE

Our initial institutional experience published late 2015 included our first 57 cases using the da Vinci Si. As of date, we have performed over 400 robotic procedures, of which 215 were for malignant diseases. Since the introduction of the da Vinci Xi system, our institute has performed 69 colorectal procedures using the new technology. The senior author has previously described his experience using the da Vinci Si robot system. The da Vinci Si system is designed to work better in the pelvis and requires double docking to take down the splenic flexure. Thus, re-docking increases operative time and affects the flow of the operation because this requires repositioning the entire platform. In 2014, Intuitive Surgical marketed a new platform, the da Vinci Xi system, that addressed a few limitations of its predecessor. Although it addressed limitations of the previous platform, the technology is still in its infancy. One of the disadvantages we noted in the Xi system is that in the new port placements recommended by Intuitive Surgical, there is a trend of the ports coning toward the pelvic dissection, as seen in Figure 17-11. Deep in the pelvis, the instruments become quite parallel as opposed to the Si system where all the arms are coming from a wider angle. Therefore, the triangulation effect is somewhat compromised. To overcome this limitation, different port placements could be tried.

In a pilot study that included ten patients in either group, Morelli *et al.* published a case-matched comparison of short-term outcomes of the da Vinci Xi and Si surgical systems in robotic TME. The da Vinci Xi group had a statistically significant shorter overall operative time (257.8 vs. 353.5 minutes, $P<0.01$); however, there was no difference in mean docking time (19.8 vs. 21.0 minutes). Also, their study results showed a significantly shorter length of hospital stay in the da Vinci Xi group (6.3 vs. 8.7 days, $P<0.01$). There was no significant difference in short-term oncologic outcomes, namely, lymph node harvest (19.0 vs. 17.5 nodes), distal margin (17.6 vs. 15.3 mm) and quality of mesorectum (complete in all patients). Although the study is limited by the small number of patients, it will encourage further similar studies from experienced minimally invasive colorectal surgeons that will help shed light on the advantages of the new platform.

FUTURE DIRECTIONS

As the surgical community eagerly awaits long-term results of the *RO*botic versus *LA*paroscopic *R*esection for *R*ectal Cancer trial, the authors believe that the debate on the value and cost-effectiveness will continue when it comes to RS. If the literature continues to show non-inferiority, it might be difficult to justify in the future the use of a more expensive technique with no added benefit; however, if more data becomes available on a superior incidence of negative circumferential margins and long-term superior oncologic outcomes, it will be time to give credit to a technique where credit is due, because “the money” is invariably in a technique that results in better oncologic outcomes.

Natural Orifice Robotic Surgery

Surgeons strive to avoid large incisions, which serve to benefit both cosmesis and improved postoperative pain. NOSE spares a traditional 4-to 5-cm incision needed for specimen extraction in either laparoscopic or robotic colorectal surgery. Further literature on the topic is anticipated.

CONCLUSIONS

In the scope of restorative proctectomy for cancer, RS seems to offer short-term outcomes that are comparable to those of conventional laparoscopy in terms of length of hospital stay, morbidity, and mortality. In addition, robotic proctectomy can be performed without compromising oncologic principles, but data for long-term outcomes are still limited. Prolonged operating time, increased costs, and learning curve are the major drawbacks. In addition, the robotic arm and equipment are large and may have limited intracorporeal range of motion. Therefore, it poorly fits in efficient traction of the colon and multi-quadrant operations.

Innovation in surgery will continue to evolve, so will scientific evidence of the benefit of such innovations. Robotic rectal surgery is a promising frontier despite limitations of cost and probable prolonged operative time, which could arguably improve with learning and competition in the market.

RECOMMENDED REFERENCES AND READINGS

Aly EH. Robotic colorectal surgery: summary of the current evidence. *Int J Colorectal Dis* 2014;29(1):1–8.

Baek J, Pastor C, Pigazzi A. Robotic and laparoscopic total mesorectal excision for rectal cancer: a case-matched study. *SurgEndosc* 2011;25(2):521–5.

Benlice C, Gorgun E. Using NSQIP data for quality improvement: the Cleveland Clinic SSI experience. *Semin Colon Rectal Surg* 2016;27(2):74–82.

Bosio RM, Pigazzi A. Emerging and evolving technology in colon and rectal surgery. *ClinColon Rectal Surg* 2015;28(3):152–7.

Carlsen E, Schlichting E, Guldvog I, Johnson E, Heald RJ. Effect of the introduction of total mesorectal excision for the treatment of rectal cancer. *Br J Surg* 1998;85(4):526–9.

Decanini C, Milsom JW, Böhm B, *et al.* Laparoscopic oncologic abdominoperineal resection. *Dis Colon Rectum* 1994;37:552–8.

Fleshman J, Branda M, Sargent DJ, *et al.* Effect of laparoscopic-assisted resection vs open resection of stage II or III rectal cancer on pathologic outcomes: the ACOSOG Z6051 randomized clinical trial. *JAMA* 2015;314(13):1346–55.

Gorgun E, Ozben V, Costedio M, Stocchi L, Kalady M, Remzi F. Robotic versus conventional laparoscopic rectal cancer surgery in obese patients. *Colorectal Dis* 2016;18(11):1063–71. doi:10.1111/codi.13374.

Gorgun E. Essentials and future directions of robotic colon surgery. In: *Essentials of Robotic Surgery*. New York, NY: Springer, 2015:81–93.

Halabi WJ, Kang CY, Jafari MD, *et al.* Robotic-assisted colorectal surgery in the United States: a nationwide analysis of trends and outcomes. *World J Surg* 2013;37(12):2782–90.

Jacobs M, Verdeja JC, Goldstein HS. Minimally invasive colon resection (laparoscopic colectomy). *Surg Laparosc Endosc* 1991;1(3):144–50.

Juo Y, Hyder O, Haider AH, Camp M, Lidor A, Ahuja N. Is minimally invasive colon resection better than traditional approaches?:first comprehensive national examination with propensity score matching. *JAMA Surg* 2014;149(2):177–84.

Kim CW, Baik SH, Roh YH, *et al.* Cost-effectiveness of robotic surgery for rectal cancer focusing on short-term outcomes: a propensity score-matching analysis. *Medicine (Baltimore)* 2015;94(22):e823.

Kim CW, Kim CH, Baik SH. Outcomes of robotic-assisted colorectal surgery compared with laparoscopic and open surgery: a systematic review. *J Gastrointest Surg* 2014;18(4):816–30.

Kwak JM, Kim SH, Kim J, Son DN, Baek SJ, Cho JS. Robotic vs laparoscopic resection of rectal cancer: short-term outcomes of a case-control study. *Dis Colon Rectum* 2011;54(2):151–6.

Lacy AM, García-Valdecasas JC, Delgado S, *et al.* Laparoscopy-assisted colectomy versus open colectomy for treatment of non-metastatic colon cancer: a randomised trial. *Lancet* 2002;359(9325):2224–9.

Mak T, Lee J, Futaba K, Hon S, Ngo D, Ng SS. Robotic surgery for rectal cancer: a systematic review of

current practice. *World J Gastrointest Oncol* 2014;6(6):184–93.
Memon S, Heriot AG, Murphy DG, Bressel M, Lynch AC. Robotic versus laparoscopic proctectomy for rectal cancer: a meta-analysis. *Ann Surg Oncol* 2012;19(7):2095–101.
Morelli L, Guadagni S, Di Franco G, *et al.* Use of the new Da Vinci Xi® during robotic rectal resection for cancer: technical considerations and early experience. *Int J Colorectal Dis* 2015;30:1281–3.
Pigazzi A, Hellan M, Ewing DR, Paz BI, Ballantyne GH. Laparoscopic medial-to-lateral colon dissection: how and why. *J Gastrointest Surg* 2007;11(6):778–82.
Silva-Velazco J, Dietz DW, Stocchi L, *et al.* Considering value in rectal cancer surgery: an analysis of costs and outcomes based on the open, laparoscopic, and robotic approach for proctectomy. *Ann Surg* 2017;265(5):960–8.
Stevenson AR, Solomon MJ, Lumley JW, *et al.* Effect of laparoscopic-assisted resection vs open resection on pathological outcomes in rectal cancer: the ALaCaRT randomized clinical trial. *JAMA* 2015;314(13):1356–63.
van der Pas MH, Haglind E, Cuesta MA, *et al.* Laparoscopic versus open surgery for rectal cancer (COLOR II): short-term outcomes of a randomised, phase 3 trial. *Lancet Oncol* 2013;14(3):210–8.

Chapter 18

Hand-Assisted Low Anterior Resection

Eric G. Weiss

INDICATIONS AND CONTRAINDICATIONS

Laparoscopic surgery for colon cancer is widely accepted as an equivalent oncologic procedure for the management of colon cancer based on numerous prospective randomized trials. Increasingly, laparoscopy is being utilized as the standard of care option for colon cancer. Several international and one US trial have looked at the use of laparoscopy in rectal cancer. The US rectal cancer trial, the American College of Surgeons Oncology Group (ACOSOG) Z6051, showed that using a non-validated composite pathologic assessment laparoscopic rectal cancer pathologic specimens may not be equivalent to those specimens produced using an open technique.

Hand-assisted surgery was first introduced in the 1990s. Since that time improved devices and surgeon experience have allowed its selective adoption by surgeons for performance of colorectal surgical operations. Similar benefits of standard multiport laparoscopy, with the added benefit of shorter operative time, have been reported in multiple series.

Hand-assisted surgery has multiple potential benefits in rectal cancer surgery that may allow advantages similar to those of laparoscopic surgery for the abdominal portions of the procedure, with added theoretical benefits in the pelvis similar to those of open surgery. Philosophically, many surgeons do not accept hand-assisted surgery as “real laparoscopy” and consider it “cheating.” However, emotions aside, patient outcomes and oncologic outcomes are the true measure of a technique. Hand-assisted low anterior resection has a role in the management of rectal cancer. In recent years, other techniques such as robotic-assisted low anterior resection and transanal total mesorectal excision provide other alternatives that may or may not ultimately have benefits over standard laparoscopy.

Hand-assisted surgery allows any or all of the traditional steps in laparoscopy to be done intracorporeally or allows some parts to be done in an open manner through the hand-assist device. For low anterior resection, the use of the hand as a retractor in the pelvis gives broad, wide tension, creating a retraction that is often difficult using multiport laparoscopy. In addition, transacting the rectum in the pelvis with a standard single firing of a stapler is more cost-effective and avoids tangential overseeing placement of multiple endoscopic staple lines across the rectal stump. The end result is a lower anastomotic leak rate.

Any operation considered acceptable for laparoscopy is acceptable procedure for hand-assisted surgery and, similarly, contraindications would be the same.

PREOPERATIVE PLANNING

Most low anterior resections are performed for rectal carcinoma. A standard preoperative evaluation is performed by most surgeons. Other indications include large rectal polyps not amenable to endoscopic or transanal approaches, completion proctectomies for inflammatory bowel disease, and redo pelvic operations for prior failed anastomoses.

Regardless of indications, certain preoperative considerations are necessary for all patients and conditions. Because the rectal reservoir will be removed completely or in part, the status of the anal sphincters is important. This issue can be addressed by preoperatively questioning the patient regarding bowel function and continence and assessing sphincter tone by digital rectal examination and by anal manometry.

Rectal reservoir replacement should be considered and discussed with the patient. Postoperative function can be improved by the addition of a colonic J-pouch. Otherwise, use a side-to-end anastomosis in patients with less than 5 cm of rectum remaining after low anterior reaction. The major impact on function is seen in the first 2 years after the operation.

At or below 4 cm, the colorectal anastomotic leak rate is as high as 16–25% and a diverting ileostomy should be discussed and an enterostomal therapy consult and informed consent obtained.

If the patient has a rectal cancer, preoperative local staging, with a high-resolution, small-field pelvic magnetic resonance imaging is recommended. Local staging with endorectal ultrasound is still acceptable. Preoperative considerations for neoadjuvant chemoradiotherapy should be based on National Comprehensive Cancer Network guidelines. Presentation before a multidisciplinary tumor board as noted in the Standards Manual of the American College of Surgeons Commission on Cancer National Accreditation Program for Rectal Cancer should be undertaken. Staging for metastatic disease with carcinoembryonic antigen blood testing and a computed tomography scan of the chest, abdomen, and pelvis should also be utilized in all patients.

Prior pelvic surgery, remote use of radiation therapy, a large mass overlying a ureter, or involvement of other pelvic structures should lead one to consider cystoscopy and ureteral stent placement in an effort to reduce and identify ureteral injuries.

Thorough discussion and informed consent regarding cancer-specific outcomes, functional outcomes, sexual and urinary function following surgery, adjuvant therapy, and other complications should be held at the time of informed consent.

consent.

SURGERY

Preoperative preparation includes full oral antibiotic and mechanical bowel preparation, prophylactic intravenous antibiotics, deep vein thrombosis prophylaxis with standard unfractionated heparin, and pneumatic antiembolism stockings. Positioning, padding, and operative preparation are the same in hand-assisted surgery as with multiport laparoscopy. Patients are positioned in lithotomy position on the operating room table using Allen (Allen Medical Systems, Inc. Acton, MA) or Yellowfin (Allen Medical Systems, Inc. Acton, MA) stirrups. Both arms are tuned on foam pads. The chest is padded with foam pads and then secured to the bed using 3-inch silk tape. An orogastric tube and a urinary catheter are placed. The rectum is irrigated at the beginning of the case with saline and then with Betadine solution. Transverse abdominis plane blocks are used selectively in addition to an aggressive preoperative and postoperative enhanced recovery after surgery (ERAS) protocol.

If the patient has had prior abdominal surgery, initial peritoneal access is achieved, depending on the type(s) of prior abdominal incisions. Diagnostic laparoscopy is performed looking for evidence of carcinomatosis, ascites, or liver metastases. Additional ports are placed. A lower midline incision is made to accommodate the hand-assist device. The incision for the device needs to be 0.5 cm larger than the glove size of the surgeon whose hand will be placed in the device.

In patients who have not had prior surgery, the band access incision is made as the first step of the procedure. Once the wound component of the Gelport (Applied Medical, Rancho Santa Margarita, CA) is placed, a 10-/12-mm camera port is placed under hand-directed control in the infra-or supraumbilical position. Making a fist under the site of trocar placement, the trocar can be safely placed with the trocar tip entering the top of the closed fist. The cap is then placed and uniform pneumoperitoneum to 15 mm Hg achieved. A 30-degree 10-mm scope, 5-mm scope, or flexible tip scopes can be used alternatively. Next, accessory trocars are placed. Three other ports, two 5-mm ports in the right and left lower quadrants and a 5-mm Airseal port (Conmed, Utica, NY) in the right upper quadrant (Fig. 18-1), are used. The Airseal port allows for excellent smoke and plume evacuation with a very steady and stable pneumoperitoneum. If needed, further 5-mm accessory ports can be placed for added retraction, but this is rarely utilized.

FIGURE 18-1 Typical port placement and hand port placement for low anterior resection.

The patient is then placed in steep Trendelenburg position, with the left side elevated/right side down. The surgeon stands between the patient's legs with a monitor at the patient's head or left shoulder for viewing. The assistant stands on the patient's right side and the camera person above the assistant on the right side. A second monitor along the patient's left side can be moved as needed. A medial-to-lateral approach is employed. The left hand in the hand-assisted device elevates the sigmoid/rectosigmoid colon anteriorly, placing the superior hemorrhoidal and inferior mesenteric artery (IMA) pedicle on stretch (Fig. 18-2). A monopolar hook cautery is used to incise the peritoneum from the base of the IMA behind the superior hemorrhoidal to the presacral plane over the sacral promontory. Using two to three fingers of the left hand into the peritoneal incision, it is possible to elevate the superior hemorrhoidal artery. Spreading/blunt dissection with the fingers and sharp dissection with the hook by the assistant exposes the ureter and gonadal vessels, which are reflected posteriorly. A plane is developed behind the IMA pedicle and the ureter is pushed lateral and posterior. A window is created on the cephalad side of the IMA beneath the left colic artery, creating a “T” with the IMA as the vertical component, the superior hemorrhoidal as the inferior limb, and the left colic/IMV inferior mesenteric vein (IMV) as the other limb. Once the anatomy is clearly identified and the ureter is out of the way, the IMA pedicle is divided with an energy-sealing device, LigaSure (Coviden, Minneapolis, MN), (Fig. 18-3). In the rare instance this does not securely control the IMA, an endoloop is easily placed with the control of the hand.

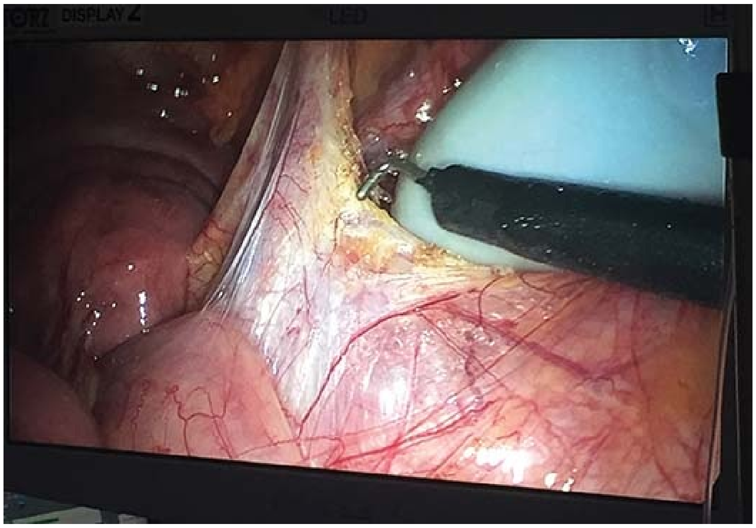


FIGURE 18-2 Elevation of superior hemorrhoidal artery pedicle with hand and hook dissection.

FIGURE 18-3 Inferior mesenteric artery pedicle division.

The IMV is identified at the base of the left colon mesentery, lateral to the fourth portion of the duodenum. Tenting up the mesentery with the left hand, the assistant creates a plane below the IMV at the inferior edge of the pancreas. The IMV is divided with an energy-sealing device. Once the artery and vein pedicles are divided, the left hand elevates the sigmoid and descending colon mesentery, which allows the assistant blunting reflect the retroperitoneal structures posteriorly all the way to the lateral abdominal wall. Using hook cautery, the lateral attachments are taken down along the white line of Toldt from the sigmoid to the splenic flexure, connecting the two dissection planes.

The patient's position is changed to reverse Trendelenburg. Using the falciform ligament as the landmark, the transverse colon is grasped with the left hand and then the assistant grasps the omentum. The avascular plane between the omentum and the transverse colon is incised for several centimeters. Then the deeper layer of omentum is identified and a window is made between the gastroepiploic vessels and the transverse colon, gaining access to the lesser sac. The remaining omentum is released from the colon until the splenic flexure is fully mobilized. Switching back and forth between the descending colon from the left side using the left lower quadrant port for dissection and the transverse colon from the right will allow complete mobilization of the splenic flexure. Retroperitoneal attachments from the left branch of the middle colic and inferior edge of the pancreas are released from the base of splenic flexure mesentery.

The patient is repositioned in steep Trendelenburg position, with the left side slightly elevated to allow the small bowel to be positioned out of the pelvis. Then using the left hand, the rectum is elevated anteriorly, curling the fingers behind the rectum 1–2 cm from the avascular plane; using the left hand as a St Marks retractor (Fig. 18-4). The dissection is performed using monopolar hook cautery and using either a nontraumatic grasper or suction for counter tension. The dissection is carried down typically to the coccyx or Waldeyer's fascia (Fig. 18-5). Next, the rectum is retracted to the right and the lateral dissection is performed toward the anterior pelvic reflection. The rectum is then retracted to the left and the lateral dissection is performed on the right side. Lastly, the rectum is retracted cephalad and the anterior pelvic dissection performed. Using the left hand, the index and middle finger can be splayed like a "peace sign" and used to elevate the seminal vesicles/prostate in a male and the vagina in a female to assist with the anterior dissection. In this case, the assistant will need to retract the rectum cephalad. At any point, the Gelport cap can be removed and dissection can be performed through the Alexis base using narrow lighted retractors. Once the intracorporeal dissection is performed to one's satisfaction, the Gelport cap is removed. The mobilized colon is exteriorized. The IMA pedicle that was ligated is identified and staying just above it the mesocolon is divided to the level of the bare colon wall using advanced bipolar. Depending on whether a colonic J-pouch or straight anastomosis is planned, the colon is divided using an Endo GIA 80-mm stapler (Covidien, Minneapolis, MN) or using a purse string clamp. If a colonic J-pouch is planned, an apical colostomy is made 6–7 cm from the staple line; and using a single firing of a GIA 80-mm stapler, a 6.5-to 7-cm J-pouch is created. Alternatively, if a straight anastomosis is planned, an appropriately sized anvil is placed into the open end of the colon and the purse string is secured.

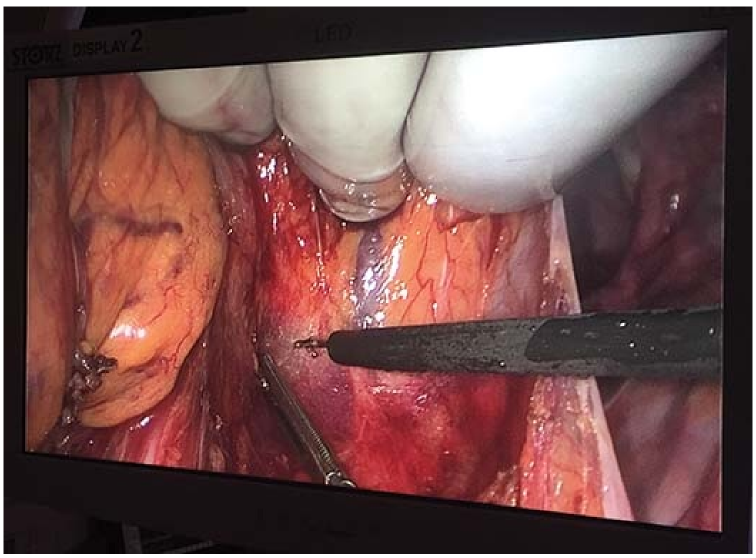


FIGURE 18-4 Dissection in posterior presacral plane with hand retraction.

FIGURE 18-5 Posterior presacral plane with hand suspending rectum anteriorly.

The distal transection site is chosen, typically at the level of the bare rectum at the level of the levators when a total mesorectal excision is performed, but at times higher if a tumor-specific mesorectal excision is performed. A TA 30 green stapler is used to divide the rectum in a single firing under direct vision and the specimen is removed and inspected for the distal margins and quality of the mesorectal excision.

Typically, the anastomosis is created under direct vision through the Alexis base, but intracorporeal anastomosis under pneumoperitoneum can also be performed. Once the anastomosis is completed, a flexible sigmoidoscopy is performed with the anastomosis/pouch submerged under saline and occluded proximally, confirming a circumferentially intact, well-vascularized, non-bleeding, and airtight anastomosis has been achieved. If, for whatever reason, there is a defect or air leak depending on the level of the anastomosis, the incision allows access to the anastomosis, which can be reinforced or repaired.

If a loop ileostomy is performed, the terminal ileum can be identified through the Alexis base and a point is chosen 40 cm proximal to the ileocecal valve. Alternatively, it can be intracorporeally identified after replacing the Gelport cap. The cecum is brought up to the proposed stoma site in the right abdomen to assure it will reach. The ileostomy site is prepared in the usual manner. Once the stoma is pulled up through the abdominal wall, an ileostomy rod is placed and pneumoperitoneum reestablished so that direct visualization can confirm the proper orientation of the stoma. The abdominal cavity is irrigated, the mobilized colon is followed to the pelvis to assure there is no twist, and the cut edge examined to ensure no small bowel has positioned itself under the colon.

examined to ensure no small bowel has positioned itself under the colon. Typically, the ports are removed and through the left lower quadrant port a Jackson Pratt or Blake drain is placed into the pelvis behind the pouch or anastomosis.

The camera port is closed using 0 Vicryl suture on a UR 6 needle and the Pfannenstiel incision closed by closing the anterior rectus fascia using 1.0 PDS suture. The skin at all port sites and incisions are closed with 4.0 monocryl subcuticular sutures. Benzoin, Steri-Strips, and dressings are placed. The ileostomy is then matured in a Brooke manner using a 3.0 chromic suture and a stoma appliance is placed.

POSTOPERATIVE MANAGEMENT

An aggressive ERAS protocol using multimodality pain therapy, rapid diet advancement, aggressive ambulation, and early removal of drains and catheters should be employed.

COMPLICATIONS

A host of minor and major complications can occur following a low anterior resection regardless of the operative approach.

Specific complications relating to the hand-assisted approach are uncommon other than maybe a slightly higher wound infection rate due to a slightly larger incision required for hand-assisted surgery because the average size of extraction incisions are 7.5–8 cm.

Other complications include cardiopulmonary, urinary tract, and septic complications relating to pelvic sepsis and anastomotic leak, which are possible regardless of which minimally invasive approach is utilized.

RESULTS

There are few comparative trials comparing hand-assisted low anterior resection to either open or laparoscopic surgery. However, the benefits of laparoscopic surgery seem to be preserved by hand-assisted surgery while multiple studies would support a shorter operative time using such an approach.

CONCLUSIONS

Hand-assisted low anterior resection is an acceptable alternative to laparoscopy and certainly advantageous over open low anterior resection.

RECOMMENDED REFERENCES AND READINGS

Benlice C, Costedio M, Kessler H, Remzi FH, Gorgun E. Comparison of straight vs hand-assisted laparoscopic colectomy: an assessment from the NSQIP procedure-targeted cohort. *Am J Surg* 2016;212:406–12.

Fleshman J, Branda M, Sargent DJ, *et al.* Effect of laparoscopic-assisted resection vs open resection of stage II or III rectal cancer on pathologic outcomes: The ACOSOG Z6051randomized clinical trial. *JAMA* 2015;314:1346–55.

Lee SW, Sonoda T, Milsom JW. Expediting of laparoscopic rectal dissection using a hand-access device. *Dis Colon Rectum* 2007;50:927–9.

Lee SW, Yoo J, Dujovny N, Sonoda T, Milsom JW. Laparoscopic vs hand-assisted laparoscopic sigmoidectomy for diverticulitis. *Dis Colon Rectum* 2006;49:464–9.

Ljungqvist O, Scott M, Fearon KC. Enhanced recovery after surgery: a review. *JAMA Surg* 2017;152(3):292–8.

Marcello PW, Fleshman JS, Milsom JW, *et al.* Hand-assisted laparoscopic vs laparoscopic colorectal surgery; a multicenter, prospective, randomized trial. *Dis Colon Rectum* 2009;51:818–26.

Pyo DH, Huh JW, Park YA, *et al.* A comparison of hand-assisted laparoscopic surgery and conventional laparoscopic surgery in rectal cancer: a propensity score analysis. *Surg Endosc* 2016;30:2449–56.

Samalavicius NE, Gupta RK, Dulskas A, Kazanavicius D, Petrulis K, Lunevicius R. Clinical outcomes of 103 hand-assisted laparoscopic surgeries for left-sided colon and rectal cancer: single institutional review. *Ann Coloproctol* 2013;29:225–30.

Spanjersberg WR, van Sambeeck JD, Bremers A, Rosman C, van Laarhoven CJ. Systematic review and meta-analysis for laparoscopic versus open colon surgery with or without an ERAS programme. *Surg Endosc* 2015;29:3443–53.

Wolf JS Jr, Moon TD, Nakada SY. Hand-assisted laparoscopic nephrectomy: comparison to standard laparoscopic nephrectomy. *J Urol* 1998;160:22–7.

Zhuang CL, Huang DD, Chen FF, *et al.* Laparoscopic versus open colorectal surgery within enhanced recovery after surgery programs: a systematic review and meta-analysis of randomized controlled trials. *Surg Endosc* 2015;29:2091–100.

Chapter 19

Hybrid Laparoscopic/Open Low Anterior Resection

Amy L. Lightner and Eric J. Dozois

INTRODUCTION

The hybrid low anterior resection (LAR), as originally described, is an operation in which the first part of the procedure (left colon and splenic flexure mobilization) is laparoscopically performed and the second part (pelvic dissection) is accomplished using open methods via a Pfannenstiel or lower midline incision. The hybrid approach to sphincter-saving rectal resections was first introduced a decade ago when limited data were available regarding the oncologic outcomes of a laparoscopic approach to colon and rectal cancer cases. The originators of the hybrid method, convinced of the benefits of laparoscopy, sought means of utilizing laparoscopic techniques to significantly decrease overall incision length and physiologic impact, while permitting an open total mesorectal excision (TME) until data was published regarding the oncologic outcomes with laparoscopy. When the results from the Clinical Outcomes of Surgery Therapy (COST), *C*onventional versus *L*aparoscopic-*A*ssisted *S*urgery *I*n patients with *C*olorectal *C*ancer (CLASSIC), and *CO*lorectal cancer *L*aparoscopic or *O*pen *R*esection (COLOR) trials were published stating that laparoscopic surgery was equivalent to open surgery for colon cancer, several surgeons moved away from the hybrid approach toward a complete laparoscopic technique for both colon and rectal cancer cases.

The hybrid approach, as described in the following text, allows for an open TME while minimizing incision length with a laparoscopic splenic flexure mobilization. In the authors' view, limiting the incision related to flexure mobilization still provides significant benefit to the patient in terms of cosmetic outcome, decreased recovery time, and decreased narcotic use, all of which advocate for the use of this hybrid approach.

INDICATIONS AND CONTRAINDICATIONS

A hybrid LAR can be widely utilized for any rectal cancer patient without a relative or absolute contraindication to laparoscopic surgery. Relative contraindications to a laparoscopic approach include prior abdominal operations, bowel obstruction with dilated loops of bowel, chronic obstructive pulmonary disease, and significant cardiac disease.

PREOPERATIVE PLANNING

Planning before any pelvic operation should include physical examination, tissue diagnosis, local and systemic staging, and review of any prior imaging and operative reports. If imaging is not recent or adequate, it should be repeated during the preoperative evaluation. Patients should have had a computed tomography scan of the chest, abdomen and pelvis for systemic staging, and a magnetic resonance imaging of the rectum for local staging. Pathology slides should be obtained for review and confirmation by a local pathologist if there is any question of an accurate diagnosis. At the time of the outpatient visit, digital rectal examination should be performed on all patients, regardless of dictated location of the cancer on endoscopy or imaging reports. If unable to feel the lesion in its entirety, we perform a flexible sigmoidoscopy in the office to note the location and size of the tumor. If not already performed, completion colonoscopy should be performed to ensure there are no synchronous lesions.

Because the risk of anastomotic leak for low-to-mid rectal cancer approaches 15%, most patients will be diverted, especially in the setting of preoperative radiation. Therefore, patients should have a clear understanding as to the likelihood of a stoma, and meet with an enterostomal therapist for counseling and marking before their operation. In addition, the risk of converting to an open operation requiring a larger midline incision should be discussed.

SURGERY

Order of Operation and Division of Tasks

The laparoscopic portion of the operation is performed first, followed by the open portion to complete the procedure. The steps of the LAR undertaken through the laparoscopic approach include (a) splenic flexure mobilization, (b) proximal vessel ligation, (c) division of the colon and mesentery, and (d) the initial mobilization of the rectum. After completion of these steps, the abdomen is desufflated and a low midline or a Pfannenstiel incision is made and the case is completed using open methods.

LAPAROSCOPIC PORTION

The patient is placed in the modified lithotomy position with both arms tucked to the side and a bladder catheter is placed. Standard anesthesia monitoring, perioperative antibiotics, and subcutaneous heparin are administered. A four-port arrangement is utilized by the authors so that both the surgeon and the first assistant have ports available to them. A 5-or 10-mm camera port is placed just caudad to the umbilicus. In the lower part of the right lower quadrant, a 12-mm port (to allow for intracorporeal stapling) is placed at the site of the diverting ileostomy marking. Two additional 5-mm ports are placed; one is in the suprapubic position in the midline and the other in the left lower quadrant (Fig. 19-1).

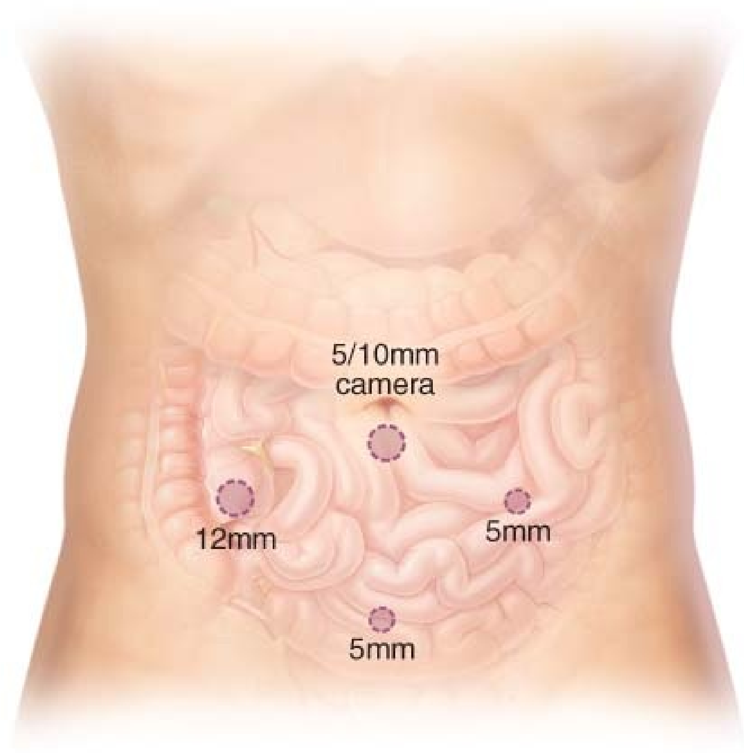


FIGURE 19-1 Port site setup for the laparoscopic portion of the operation.

The splenic flexure is mobilized first because if this portion is not amenable to laparoscopic methods, early conversion can be initiated. There are four basic approaches to flexure takedown: (a) lateral to medial, (b) medial to lateral, starting just caudal to the sacral promontory on the right side of the sigmoid mesentery, (c) medial to lateral, starting at the level of the inferior mesenteric vein (IMV), and (d) starting with the omental “peel” at the level of the distal transverse colon (seldom used). Regardless of the approach that is utilized, the flexure, the descending and distal transverse colon, as well as the mesentery must be fully mobilized (Fig. 19-2).

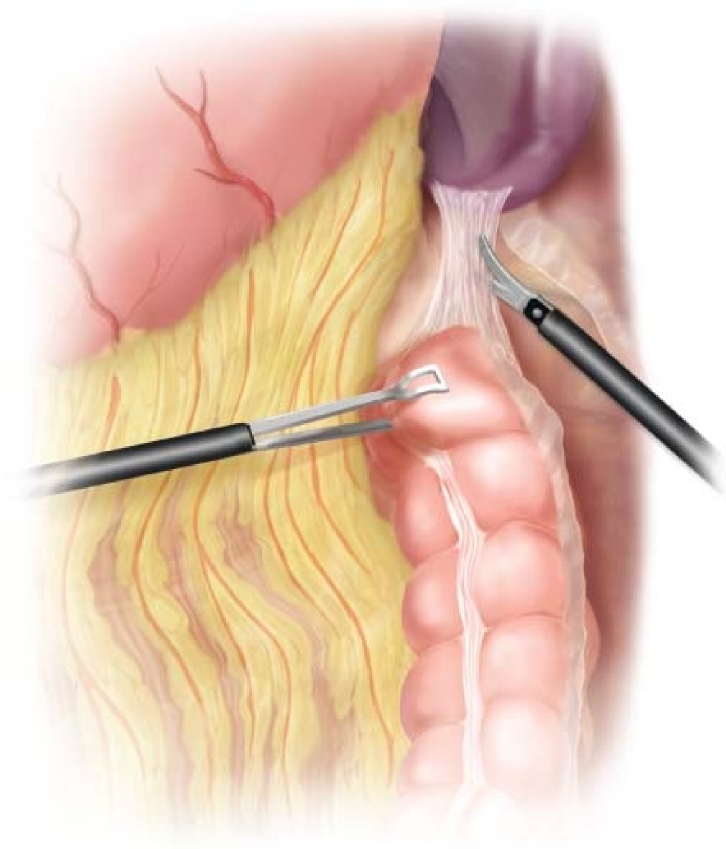


FIGURE 19-2 Mobilization of the splenic flexure.

p. 154

p. 155

Medial to Lateral Starting at the Inferior Mesentery Vein

The patient is placed in the reverse Trendelenburg position with the right side down. The surgeon and cameraperson stand on the patient’s right side, the latter at the level of the patient’s thighs and the former just cephalad. The second assistant stands between the patient’s legs (Fig. 19-3). The area to be exposed is the base of the distal transverse and descending colon mesentery adjacent to the ligament of Treitz. The distal transverse colon is gently grasped by the first assistant via the upper port on the left and retracted upward and cephalad. The proximal descending colon is grasped, also by the first assistant via the lower left port, and retracted up and to the left. This latter move should reveal the location of the left colic vessels that appear as a bowstring. The surgeon then gently moves the small bowel to the right and caudal aspect of the abdomen that should reveal the ligament of Treitz, the proximal jejunum, and the IMV at the base of the descending mesentery. Obtaining this medial and central exposure is the most difficult part of this approach (Fig. 19-4).

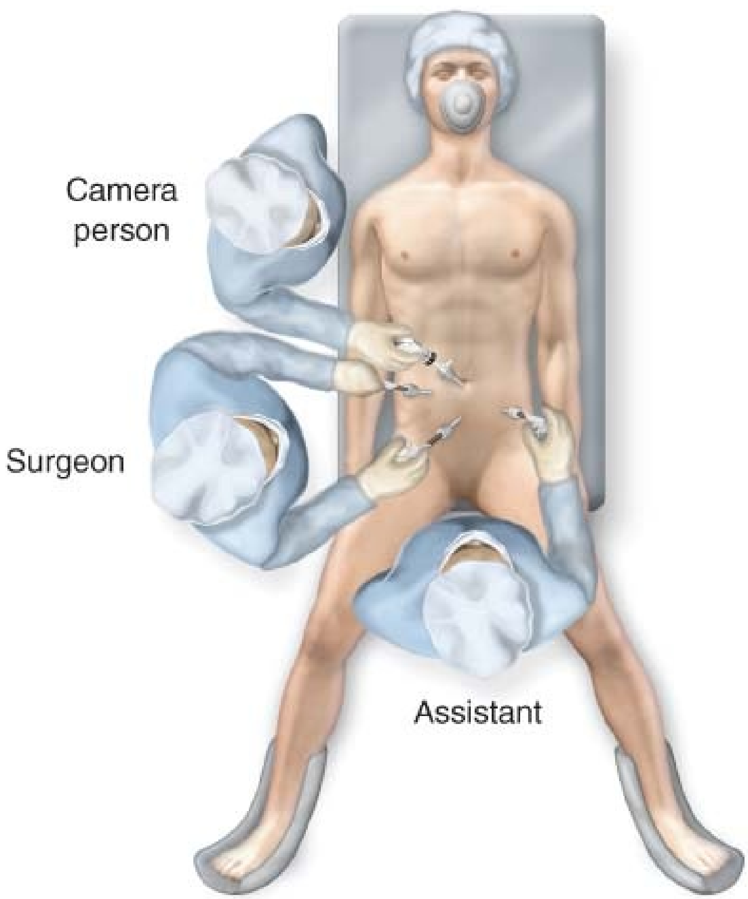


FIGURE 19-3 Positioning of the personnel in the operation room.

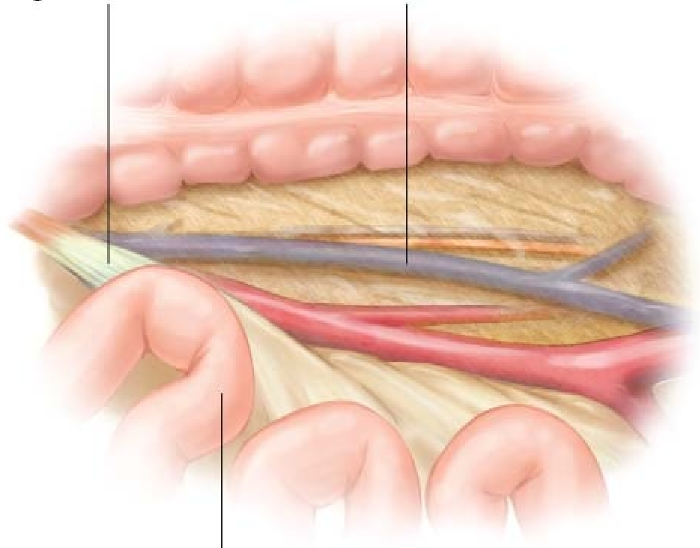


FIGURE 19-4 The ligament of Treitz, the proximal jejunum, and the inferior mesenteric vein at the base of the descending mesentery. Obtaining this medial and central exposure is the most difficult part of this medial-to-lateral approach.

The peritoneum of the mesentery is then scored with a scissors parallel to and a short distance above or below the IMV depending on whether this vein is to be sacrificed or preserved. This opening is enlarged with a bipolar or ultrasonic shears (monopolar devices are avoided when working in this central location) and the plane between the posterior surface of the descending colon mesentery and the anterior aspect of Gerota’s fascia is established. This bloodless plane is usually more superficial than anticipated; if minor bleeding is encountered when doing this dissection, it is likely that one is working dorsal to the anterior layer of Gerota’s fascia. The correct plane, once found, is further developed in the lateral, caudad, and cephalad directions, thus creating a pocket. The lateral limit of dissection is the white line of Toldt, whereas the cephalad limit is the edge of the inferior border of the pancreas. Once the pocket is established, the first assistant’s graspers are placed inside the pocket and used to better expose the retroperitoneal field of dissection. If the IMV is divided at this point, or earlier, then the exposure is improved.

If the inferior mesenteric artery (IMA) is to be transected early, then its location must be established and the vessel exposed by scoring the peritoneum medially and inferiorly toward the pelvis (Fig. 19-5). The retroperitoneal dissection is continued caudally from the already established IMV pocket. The IMA is divided only after it is certain that the left ureter is out of harm’s way. If the IMA is to be divided later in the case, a second mesenteric window is made, caudal to the left colic vessels toward the base of the mesentery. The retroperitoneal avascular dissection plane between the Toldt and Gerota's fascia can then be extended beneath the distal descending colon. The left ureter and gonadal vessels are bluntly dissected away from the underside of the colon mesentery toward the left iliac fossa. After completing the medial-to-lateral mobilization, the descending colon is medially retracted and the remaining lateral attachments are divided sharply. The proximal left colon is released to complete this portion of the procedure. When possible, the left colic vein should be identified before ligating the IMV. The IMV should be ligated cephalad to where the left colic vein drains into the IMV to get maximal mesenteric lengthening.

p. 155

p. 156

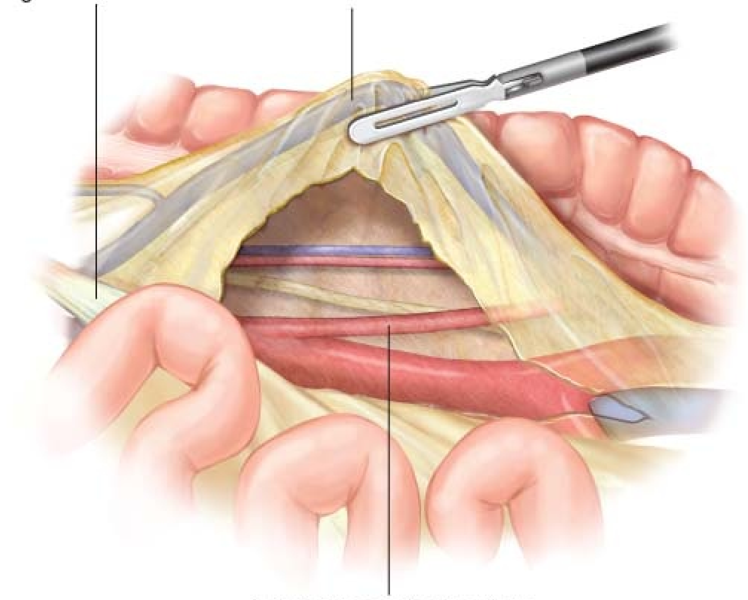


FIGURE 19-5 Visualization of the inferior mesenteric artery.

Medial-to-Lateral Starting at the Sacral Promontory

The surgeon stands on the patient's right side with the camera operator while the first assistant stands on the patient's left. The patient is placed in the Trendelenburg position with the right side down, so as to shift the small bowel out of the lower abdomen. The dissection is initiated at the right base of the rectosigmoid colon at the level of the sacral promontory. The first assistant grasps the sigmoid and rectosigmoid and retracts them up and to the left, which places the rectosigmoid mesentery on stretch and exposes the groove between the inferior mesenteric vascular pedicle and the retroperitoneum. The surgeon then incises the peritoneum immediately beneath the IMA at the level of the sacral promontory and extends this opening into the pelvis for a distance and also cephalad toward the takeoff of the IMA (Fig. 19-6). A plane is developed between the presacral structures and the colon mesentery working from the right toward the left. Care must be taken to identify to preserve the right hypogastric nerve. The left ureter and hypogastric nerve can usually be identified over the iliac artery and dissected away from the mesocolon.This posterior plane dissection is continued cephalad beneath the left colon mesentery toward the origin of the IMA. The peritoneum at the base of the left colic mesentery must be scored to expose the IMA and its branches. The left ureter and nerve in the posterior plane are dissected free of the mesentery, and the IMA is divided. If the IMA is transected at the level of the bifurcation to the left colic and superior rectal artery, the IMV can also be mobilized and divided at this point. Anteroproximal transection of the IMV requires incision of the peritoneum anterior to the aorta to the level of the ligament of Treitz to identify the vein adjacent to the duodenojejunal junction. After detaching these vessels, the medial-to-lateral mobilization is continued cephalad beneath the sigmoid and descending colon mesentery toward the splenic flexure.

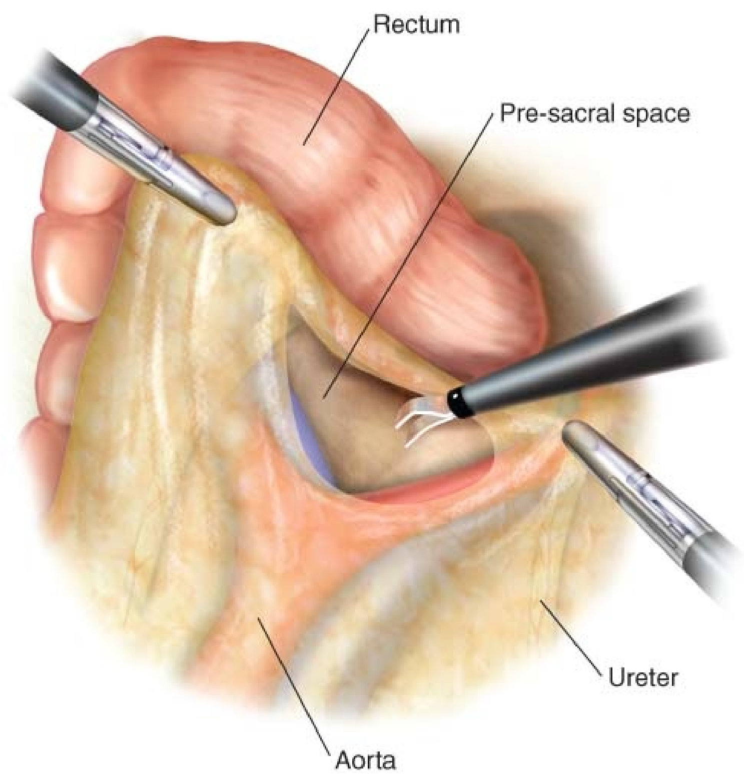


FIGURE 19-6 The rectosigmoid mesentery on stretch and exposes the groove between the inferior

mesenteric vascular pedicle and the retroperitoneum. The surgeon then incises the peritoneum immediately beneath the inferior mesenteric artery (IMA) at the level of the sacral promontory and extends this opening into the pelvis for a distance and also cephalad toward the takeoff of the IMA.

Lateral-to-Medial Approach

The patient is placed in reverse Trendelenburg position with the right side down. The first assistant stands on the patient's right side with the camera operator while the surgeon stands between the legs. The first assistant, using two atraumatic graspers, retracts the distal descending and proximal sigmoid colon medially and upward, which creates tension on the lateral attachments. The surgeon initiates the dissection by dividing the white line of Toldt with a scissors or other device inserted through the lower left port. The dissection begins at the pelvic brim and continues cephalad toward the splenic flexure (Fig. 19-7). As the mobilization progresses, the medial and upward traction provided by the first assistant must be increased so as to maintain traction on the attachments. The correct dissection plane between the anterior Gerota's fascia and the posterior aspect of the mesocolon must be found and developed with minimal to no bleeding. This plane is often not evident at the start; but once established, it is usually easy to maintain throughout to complete the mobilization. At the flexure, it is important to transition from the deeper retroperitoneal plane to a more superficial plane ventral to the pancreas. As one nears the flexure, there is often a tendency to drift lateral and cephalad toward the spleen. The flexure should be retracted caudal and medial and then lifted anterior toward the abdominal wall by the assistant to expose the embryologic avascular plane that often lies well below the spleen.

FIGURE 19-7 Lateral-to-medial dissection of the descending colon. It is important to correctly identify the dissection plane between the anterior Gerota's fascia and the posterior aspect of the mesocolon.

Omental Peel

This step is the same regardless of the order of operation or the chosen method of descending colon mobilization. The goal is to separate the distal transverse colon from the omentum and the stomach. The authors' preference is to "peel" from the colon by dividing the avascular attachments along the antimesenteric surface of the transverse colon. The omentum is reflected up and toward the head while the transverse colon is retracted caudally and dorsally. This dissection is best started just to the left of the mid-transverse colon so as to facilitate entry into the lesser sac and a view of the back wall of the stomach. The surgeon must beware of the possibility of inadvertently "overshooting" the mark and making a window in the transverse colon mesentery, which is both incorrect and dangerous because the marginal artery may be inadvertently divided. Provided that the dorsal wall of the stomach can be seen through the window between the colon and the omentum, the dissection plane is correct. After entering the lesser sac, the remaining attachments between the omentum and the distal transverse colon are divided. The remaining splenic flexure attachments are then divided. The base of the distal transverse mesocolon, just lateral to the site of transection of the IMV and ventral to the inferior edge of the pancreas, is divided to release the final posterior attachment of the splenic flexure. Atypical mesenteric arteries in this area may require hemostatic division. Alternatively, the gastrocolic ligament can be transected outside the gastroepiploic arcade along the great curve of the stomach that detaches the stomach from the still adherent transverse colon and omentum.

Proximal Transection of the Colon and Mesentery

The proximal point of bowel transection should be chosen and the colon and mesentery intracorporeally divided before initiating the open portion of the LAR. Accomplishing this task facilitates the open part of the case. It is important to assess the mobility of the descending and distal transverse colon to determine the proximal most point that will reach into the distal pelvis without tension. The blood supply of this part of the colon should also be assessed to ensure that it is well vascularized. The mesentery is then divided starting at the base just proximal to where the IMA was transected. Great care must be taken at all times to preserve the marginal vessels close to the point of transection. Finally, the colon is divided with an intracorporeal linear stapling device completely detaching the upper and lower bowel and mesenteric segments.

Initial Rectal Mobilization

The peritoneum of the left or right pelvic gutter can be easily scored provided the rectosigmoid and distal sigmoid colon is retracted anteriorly, cephalad, and toward the opposite side. In fact, several of the descending colon mobilization methods described in the preceding text (lateral-to-medial and medial-to-lateral starting at the sacral promontory) include scoring of the iliac fossa peritoneum and partial mobilization of the rectosigmoid mesentery. Monopolar, bipolar, or ultrasonic shears can be used to score the peritoneum and to dissect beneath the rectosigmoid and proximal rectal mesentery. Traction must be maintained on the rectosigmoid to facilitate dissection posteriorly; as this plane is developed, the hypogastric nerves and the ureters need to be identified and preserved. Once started, the most caudal of the first assistant's retractors should be placed in the posterior pocket, opened wide, and then levered so as to lift the overlying mesorectum anteriorly and toward the head. Meanwhile, the first assistant's cephalad retractor is used to retract the mesorectum medially and upward at the level of the sacral promontory, thus providing more traction and improving the surgeon's view of the dissection field. The peritoneum can be scored to the anterior reflection. Once completed, the peritoneal attachments on the opposite side are scored in a similar manner. It is usually a relatively simple matter to join the left and right dissection planes beneath the rectosigmoid mesentery. The

the left and right dissection planes beneath the rectosigmoid mesentery. The anterior peritoneal reflection should be scored, if possible laparoscopically, and the dissection initiated for 1–2 cm.

Before beginning the open portion of the procedure, the proximal bowel should once again be assessed for adequate length to reach the low pelvis. Occasionally, additional mobilization will be needed and it is best laparoscopically performed. In the authors’ experience, retroperitoneal nonvascular attachments that have not been fully transected can limit the downward reach of the proximal bowel. Moreover, if the IMA was transected distal to the takeoff of the left colic artery, the IMA may need to be re-transected near its origin at the aorta to gain additional mesenteric length. For maximal length, the IMV should also be ligated near the inferior border of the pancreas, cephalad to where the left colic vein drains into it.

Open Portion of the Case

As originally described, after completing the closed portion of the operation, the abdomen is desufflated and the laparoscopic ports removed. It is advised that before desufflation, the fascial suture(s) for the 12-mm right lower quadrant port be placed laparoscopically with a laparoscopic suture passer or similar device. Next, either a lower midline or a Pfannenstiel incision is made. If a midline incision is made, it should start just above the pubic symphysis and extend cephalad. If a Pfannenstiel incision is made, it should be placed about two fingerbreadths above the pubic symphysis and be centered on the midline. In both cases, the incision should be between 8 and 10 cm in length. This length will vary depending on the size of the surgeon’s hand, the body habitus of the patient, and the size of the tumor. If need be, the incision can be enlarged.

The use of a wound protector is advised. As mentioned, prior intracorporeal division of the proximal bowel and mesentery facilitates retraction of the proximal colon and small bowel. To start, the proximal end of the bowel specimen is identified and retracted up and out of the wound. All other bowel in the field is then retracted laterally or cephalad after placing moist laparotomy pads. A bladder retractor is then placed and the open rectal mobilization commenced using standard open instruments and retractors (St. Mark’s, wide and narrow Deaver; we have found a lighted, narrow St. Mark’s retractor very useful for this portion) (Fig. 19-8). A total mesenteric excision is then carried out and the rectum divided distally with a transverse linear stapler (Fig. 19-9). If the cancer is located in the proximal rectum or proximal midrectum and the decision has been made not to divide the rectum close to the levator muscles, then the rectal mesentery will also need to be transected in addition to the rectum itself at a level 5 cm below the lowest border of the tumor. The specimen is removed.

The proximal colon is brought into the field and the proximal anvil of the circular end-to-end stapler placed into the colon and secured with a purse string. The completed anastomosis is checked for leaks and a decision made about proximal diversion. If an ileostomy is planned preoperatively, one of the right-sided ports can be placed at the site chosen for the ileostomy. The skin and fascial wounds are enlarged and the bowel exteriorized to create the stoma. The lower abdominal incision is then closed in the usual manner.

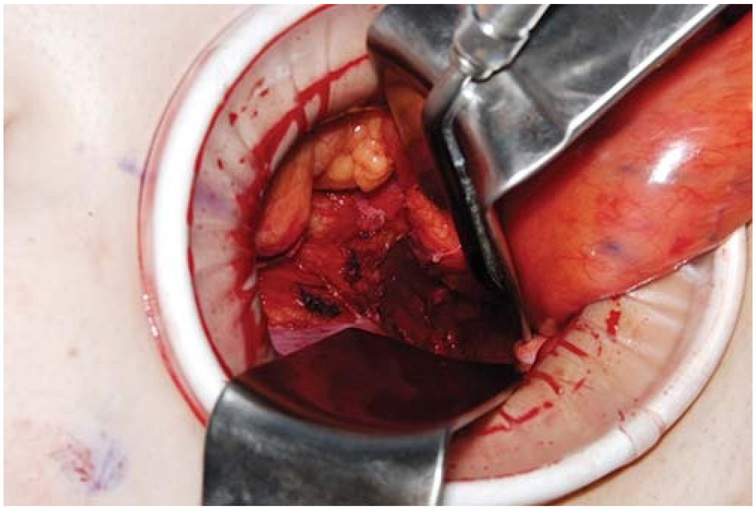


FIGURE 19-8 Retraction and exposure of the rectum after wound protector is placed into the incision.

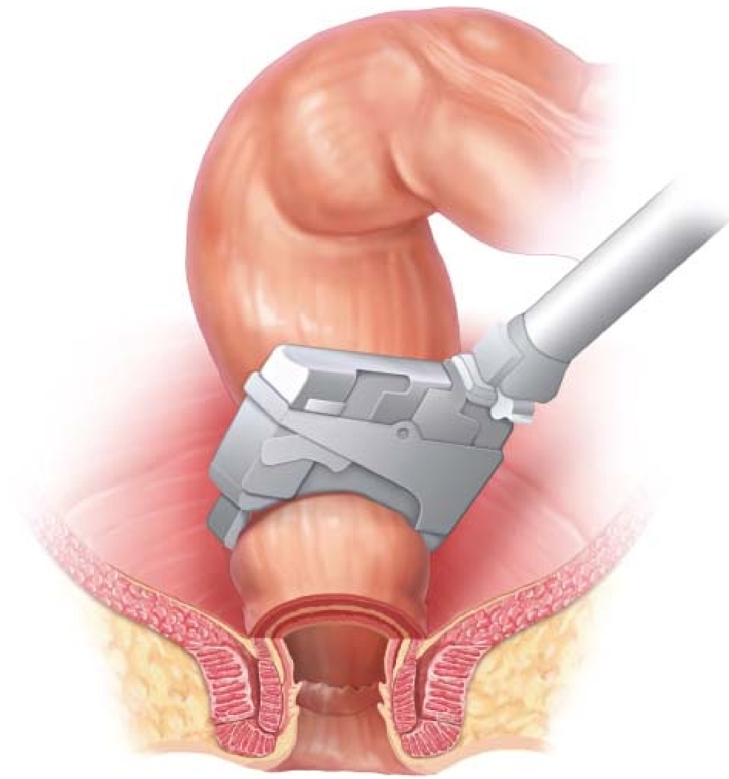


FIGURE 19-9 A 30-mm linear stapler coming across the rectum after the rectum has been dissected.

AUTHORS' CURRENT APPROACH

Except for patients with very large tumors, or the very obese, the case is initiated by placing a camera port periumbilically and two 5-mm working ports on the right side. A thorough exploration is then undertaken. If after laparoscopic evaluation, the patient's anatomy appears to be amenable to a laparoscopic approach, one or two additional 5-mm ports are placed, one in the suprapubic midline and one in the left lower quadrant. If, however, after exploration the attending surgeon judges that by the end of the case an incision of 8 cm or larger is likely to be needed despite the use of laparoscopic methods, then a hand device can be placed in the lower abdomen and the mobilization carried out using hand-assisted laparoscopic methods. If it proves impossible to finish the mobilization via a hand-assist method laparoscopically, then the case is completed through an extended incision. The safest method should always be utilized; the length of the incision is secondary.

INCISION LENGTH

Skin incision length is one of the only objective parameters we have that can be used to assess the abdominal trauma incurred during an operation apart from operative length. It is understood by all that the fascial incision length is longer than the skin incision length. The final skin incision length should be measured at the time the dressing is being applied in the operating room and then recorded on the written and dictated operative reports. Routine measurement and reporting of largest incision length will facilitate meaningful comparison of the series of operations both within and between institutions.

POSTOPERATIVE MANAGEMENT

At our institution, we have adopted an enhanced recovery protocol (ERP) pathway. Several studies have now shown that ERP has proven benefit to the patient, length of hospital stay, and decreased cost without added morbidity or hospital readmission rates. Patients are given intravenous ketorolac and oral oxycodone for pain control on the day of surgery, kept on maintenance fluids (40 ml/hour), and started on an ad lib oral diet. Patients are encouraged to ambulate if the case was performed in the morning. On postoperative day 1, oral oxycodone and an ad lib oral diet is continued, Foley catheters and maintenance fluids are discontinued, patients are encouraged to ambulate at least six times with the assistance of the nursing staff, and stoma therapists visit all patients with stomas. On postoperative day 2, the aforementioned are continued, surgical site dressings are removed, and patients begin showering with Hibiclens solution. If patients have urinary retention, they are taught to self-catheterize in anticipation of discharge.

COMPLICATIONS

The most dreaded complication following a LAR is an anastomotic leak. Other short-term complications include a surgical site superficial infection, deep space infection, postoperative ileus, postoperative obstruction, and dehydration from a high output stoma. An anastomotic leak following LAR has a reported incidence varying from 0% to 36% with a high associated mortality reported between 6% and 22%. Patients more likely to experience an anastomotic leak are male, are diabetic, and have undergone radiation therapy. Patients who experience a leak are more likely to end up with a permanent stoma. Owing to the morbidity and mortality associated with anastomotic leak, most surgeons choose to divert a low rectal anastomosis with a loop ileostomy. A recently published meta-analysis of 4 randomized clinical trials and 21 nonrandomized trials confirmed that a diverting ostomy decreased the clinical anastomotic leak and reoperation rate.

Long-term complications following LAR include anastomotic stricture, small bowel obstruction from adhesions, local recurrence of rectal cancer, and need for a permanent stoma because of anastomotic stricture, fecal incontinence, symptomatic radiation proctitis, or LAR syndrome. In the setting of an anastomotic stricture, direct digital dilatation or Hegar dilators (CooperSurgical, Inc., Trumbull, CT) may be used to dilate an anastomosis in the distal rectum. If unable to be performed, endoscopic balloon dilatation is the most effective method for treating the stricture further proximal in the rectum. It is important to remember that a recurrent malignancy should be excluded before treatment.

RESULTS

Since the first report of laparoscopic colectomy by Jacobs in 1991, laparoscopic surgery has become increasingly utilized in the treatment of colon and rectal cancer. Compared with open surgery, a laparoscopic approach reduces postoperative pain, wound-related complications, and length of hospital stay. However, mastering straight laparoscopy for rectal cancer can be challenging given the poor angles that limit retraction within the confines of the bony pelvis.

Owing to the oncologic importance of performing a complete TME and the uncertainty of survival outcomes with a laparoscopic TME, a hybrid approach is an ideal combination to minimize incision length while maintaining an open proctectomy. This approach is similar to hand-assisted laparoscopic techniques given the small incision made for the open proctectomy.When studying hand-assisted laparoscopy compared to straight laparoscopy, straight laparoscopy appears to have a shorter recovery time. However, the aforementioned benefits with laparoscopy were still seen with the hand-assisted technique.

CONCLUSIONS

A hybrid approach to a LAR allows for an open TME while employing laparoscopic mobilization to minimize incision length and its associated complications. In the current environment, a hybrid approach allowing for an open TME is an optimal technique.

RECOMMENDED REFERENCES AND READINGS

Caulfield H, Hyman NH. Anastomotic leak after low anterior resection: a spectrum of clinical entities. *JAMA Surg* 2013;148(2):177–82.

Fleshman J, Branda M, Sargent DJ, *et al.* Effect of laparoscopic-assisted resection vs open resection of stage II or III rectal cancer on pathologic outcomes: the ACOSOGZ6051 randomized clinical trial. *JAMA* 2015;314(13):1346–55.

Fleshman J, Sargent DJ, Green E, et al; Clinical Outcomes of Surgical Therapy Study Group. Laparoscopic colectomy for cancer is not inferior to open surgery based on 5-year data from the cost study group trial. *Ann Surg* 2007;246(4):655–62; discussion 662–4.

Gustafsson UO, Tiefenthal M, Thorell A, Ljungqvist O, Nygrens J. Laparoscopic-assisted and open high anterior resection within an ERAS protocol. *World J Surg* 2012;36(5):1154–61.

Marcello PW, Fleshman JW, Milsom JW, *et al.* Hand-assisted laparoscopic vs. laparoscopic colorectal surgery: a multicenter, prospective, randomized trial. *Dis Colon Rectum* 2008;51(6):818–26; discussion 826–8.

Stevenson AR, Solomon MJ, Lumley JW, et al; ALaCaRT Investigators. Effect of laparoscopic-assisted resection vsopen resection on pathological outcomes in rectal cancer: the ALaCaRTrandomized clinical trial. *JAMA* 2015;314(13):1356–63.

Vithianathan S, Cooper Z, Betten K, *et al.* Hybrid laparoscopic flexure takedown and open procedure for rectal resection is associated with significantly shorter length of stay than equivalent open resection. *Dis Colon Rectum* 2001;44(7):927–35.

Chapter 20

Intersphincteric Restorative Proctocolectomy for Malignant Disease

Ron G. Landmann

INTRODUCTION

While addressing the issue of rectal cancer treatment, four major objectives are uniformly pursued: (1) cure—including primary local resection with negative margins and subsequent prevention of locoregional (LR) and distant recurrence; (2) decreased morbidity and mortality; (3) preservation of sexual and urinary functions—as manifested by erectile dysfunction, retrograde ejaculation, vaginal dryness, dyspareunia, and difficulty voiding; and (4) maintenance of intestinal continuity/avoidance of a permanent stoma. Currently, despite the advances in chemotherapeutics, biologics, and radiation therapy, surgery is the primary modality to achieve these goals.

Most surgeons with experience in operating on the rectum have at some point dealt with the difficulties associated with a narrow pelvis and its confines and anatomic complexities and intricacies. During the times before modern anesthesia, when an even greater importance was placed on the furtiveness of surgical techniques, most surgeons avoided venturing into the deep and dark den of the rectum. The earliest experience with rectal surgery includes transanal resection of tumors. This approach caused minimal morbidity, but was plagued by a near universal incidence of tumor recurrence. The advent of potent, safe, and efficacious anesthetic techniques has allowed surgeons the opportunity to perform increasingly more complex and delicate rectal operations utilizing a combination of transanal, abdominal, and perineal approaches.

Ernest Miles first published his technique of an abdominoperineal resection (APR) for rectal tumors in 1908. This technique was gradually modified so that by 1924, reports demonstrated a significant and welcome decrease in local recurrence rates from nearly 100% to the range of 30%. Unfortunately, this procedure carried significant morbidity related to a poorly healing perineal wound, autonomic nerve damage resulting in impotence, and a permanent stoma reminding patients of their disease. Still, it became accepted as the standard of care because it provided the best chance of cure. To this day, surgical management of rectal cancer has focused on modifications of Miles' technique in an effort to improve oncologic results and minimize the associated in an effort to improve oncologic results and minimize the associated morbidities.

The APR was also being utilized for the management of perianal Crohn's disease as well as ulcerative colitis and other septic complications. The healing of these perineal wounds was an even greater challenge than those created by surgery for malignancy. The perineal wounds in these patients were initially managed by loose approximation of the skin edges and sump drainage. In 1970, reports were published about successful outcomes after primary suture of the perineal wound with closed suction drainage. Oates described 41 of 53 patients with successful wound healing. A modification of the APR, intersphincteric proctectomy, was first described for benign diseases by Lyttle in 1977. The thought was that sparing the striated external sphincter and pelvic musculature would create a smaller dead space and provide another layer of strong and healthy tissue to aid in wound closure. This expectation was borne out in studies that demonstrated significant improvements in wound healing over the time period of 1 year. In fact, studies showed that when sepsis was initially controlled via drainage or diversion, 1 year after intersphincteric proctectomy, 100% of wounds in patients who did not receive preoperative steroids were observed to have healed.

In 1972, Lee and Dowling reported on a technique that they believed would decrease the morbidity associated with impotence after an APR and named it a Perimuscular Dissection of the Rectum. The thought was that the lateral dissection into the pelvis and superiorly into the region of the prostate resulted in nerve damage that led to impotence. Avoidance of dissection in these areas would thus result in decreased morbidity. Subsequent studies evaluating this technique revealed a dramatic decrease in the incidence of postoperative impotence.

LR recurrence rates were still unacceptably high and it was not until 1979 when Heald advocated for a strict dissection technique that the LR recurrence rates started falling, precipitously. His technique was based on a progressive research providing a better understanding of the embryology of the rectum and perineum combined with the improved understanding of the anatomic pathways of the nerve fibers involved in erection and ejaculation. His technique was optimized to reduce the risk of damage to the cavernosal fibers anterior to the distal rectum along the periprostatic plexus anterior to Denonvilliers' fascia, keep the dissection away from the pelvic side walls and the sympathetic fibers, and by incorporating the mesorectum and associated lymph nodes into the surgical pathology specimen. He named his technique the total mesorectal excision (TME) and subsequently published his findings in 1982. In that paper, he described the precise *sharp* dissection of the avascular plane between the presacral fascia and the fascia propria ("the holy plane") to achieve a resection specimen with an “intact mesorectal envelope.” The goal of achieving a negative circumferential resection margin (CRM) and consequently reduced recurrence were thus first proposed.

The morbidity associated with a permanent stoma after rectal resection has decreased significantly mainly due to the decrease in the percentage of rectal resection requiring an APR. Aided by the advancement in the laparoscopic technique and the stapler technology, the APR has been replaced with restorative surgical procedures such as ultra-low anterior resection (uLAR) with various reconstructive modalities. Furthermore, advances in adjuvant and neoadjuvant therapies have allowed for oncologically acceptable results with sphincter sparing resection even in tumors that involve the internal sphincter.

The distal resection margin (DRM) has been a point of contention and debate among colon and rectal surgeons and surgical oncologists. Many began questioning the previous recommendations and guidelines requiring a 5 cm DRM. The National Surgical Breast and Bowel Project found no significant differences in survival or recurrence when comparing DRMs of less than 2 cm, 2–3 cm, and higher than 3 cm. Moore published a series from Memorial Sloan Kettering Cancer Center demonstrating that intramural tumor extension beyond the gross mucosal edge was uncommon and usually less than 1 cm after the preoperative combined-modality therapy. Later, the same group deemed that a 1 cm margin was acceptable in patients in whom sphincter preservation was required. However, the author still recommends obtaining a frozen section pathological review prior to proceeding with reconstruction. Newer arguments based on the Norwegian Colorectal Cancer Group have now recommended that even more important than a prognostic factor toward decreased LR recurrence, distant metastasis, and overall survival is a negative circumferential margin of greater than 2 mm. However, these data were more strongly prognostic in higher lesions >6 cm above the anal verge.

Current standard practice, based on preoperative staging, either with endorectal ultrasonography or magnetic resonance imaging (MRI), recommends low anterior resection (LAR) or APR for most advanced (i.e., T3 or N+) distal lesions, within 0–5 cm above the dentate line. All the advances in rectal surgery described have been integral to the advent of intersphincteric restorative proctocolectomy (IRP), while continuing to meet the above primary objectives. In this procedure, the internal anal sphincter—a continuation of the rectal wall—is completely or partially excised to obtain the necessary full-thickness DRM. Subsequent coloanal anastomosis to the remaining sphincter complex thereby restores intestinal continuity, with a goal of improved quality of life while preserving oncologic and functional outcomes. With these refinements and improvements in both neoadjuvant chemoradiation therapy and surgical techniques, patients now have another option available for sphincter preservation.

CONSIDERATIONS DURING INTERSPHINCTERIC PROCTECTOMY

INDICATIONS FOR INTERSPHINCTERIC RESECTION

Patient Selection and Preoperative Evaluation

Due to the inherent morbidity associated with a permanent stoma, a restorative proctocolectomy may be offered to all patients with tumors that are amenable to the procedure. Patients generally to be considered for intersphincteric resections (ISRs) are those patients with Stages I–III distal rectal tumors (pretreatment T1–T3, N0–1) within 4 cm of the anal verge that do not have evidence of external sphincter involvement. The decision to perform a restorative procedure should be made in conjunction with the patient after discussing the likely postoperative oncologic and perhaps more importantly, functional outcomes. Whereas involvement of the internal sphincter by an invasive disease should not be viewed as a contraindication to ISR, invasion of the external sphincter or the musculature of the pelvic floor would make the disease incurable via IRP. For the latter, APR is required for appropriate oncological resection and outcomes. A digital rectal examination that shows fixation of the tumor should also be considered a contraindication because it likely means that the tumor has broken through the intersphincteric plane and has fixed the internal sphincter—an embryological derivative and continuation of the rectal wall—to the external sphincter or the pelvic floor musculature. Such a disease would be better managed via APR. A preoperative pelvic MRI or endoanal ultrasound is instrumental in assessing the extent of tumor spread. Indeed, any tumor that has sphincter involvement, prior to the use of neoadjuvant combined-modality therapy, should be excluded from an IRP and offered a standard APR, despite improvement after the therapy. Tumors that respond with downstaging and/or downsizing after neoadjuvant chemoradiation therapy generally make patient candidates for LAR/IRP. A chest X-ray and a CT scan of the abdomen and pelvis should be performed to rule out Stage IV metastatic disease. In the case of low rectal tumors, care should be taken to examine the groins for evidence of inguinal lymphadenopathy. The results of these preoperative evaluations, in conjunction with those following the neoadjuvant therapy, should be used to determine the distal margin of resection and potential for resection with maintenance of intestinal continuity/sphincter preservation.

Body habitus also plays a significant role in operative decision making. Ideally, the patient should not be obese (BMI < 30–32 kg/m^2). Patients who are: male, have a narrow pelvis, or a long anal canal may also make it more difficult to perform an ideal, oncologic resection. Indeed, an IRP is more likely to be performed in patients who are male, have distal tumors, or increased BMI due to difficulty introducing stapling devices (for LAR).

It is also important to determine the patient's preoperative continence. This assessment can be made via history, digital rectal examination, manometry, or a combination of these methods. In patients with good sphincter function on digital rectal examination but recent development of clinical incontinence, the dysfunction may be attributable to the neoplastic process, and it is reasonable to expect that they may benefit from an IRP. Other patients with preoperative incontinence may be better served with a permanent stoma. When possible, these patients may benefit from an intersphincteric non-restorative proctocolectomy due to its healing benefits over APR, especially after undergoing neoadjuvant chemoradiation therapy. Although age per se is not an exclusion criteria, generally older patients have decreased sphincter tone and also less physiological reserve of their remaining musculature after undergoing radiation therapy and internal sphincter resection. A preoperative evaluation with a wound care and ostomy nurse for stoma care teaching and stoma marking is pivotal in these patients and for long-term success of these patients.

CONTRAINDICATIONS TO INTERSPHINCTERIC RESECTION

There are certain exclusion criteria that are generally accepted when evaluating ideal candidates for IRP: pretreatment involvement of the external sphincter by tumor; inadequate distal margin (<1–2 cm); poor preoperative (or anticipated postoperative) sphincter function; patient preference; or an initial, pre-neoadjuvant uT3 lesion with an external sphincter complex involvement. When looking at a nationwide database, factors that were noted to be independent predictors of sphincter preservation included young age, proximal lesions, non-fixed lesions, and institution. Although not specifically addressed, individual training, technique, and outcomes are likely to be attributable to the success of an IRP. One cannot stress enough the importance, as with any procedure, of specialty training and experience mandatory for selecting and then completing these procedures. There is a high learning curve, particularly when approached laparoscopically. Furthermore, a multi-or interdisciplinary approach to evaluation and selection of these patients may help in the postoperative period.

SURGICAL ANATOMY AND CONSIDERATIONS

Autonomic Nerves in Rectal Dissection

During any operation for rectal disease, whether benign or malignant, the surgeon should be acutely aware of the innervations and distribution of the autonomic nerves and their relation to the target resection specimen. Trauma to the autonomic nerves may occur at several points. During high ligation of the inferior mesenteric artery (IMA), close to the aorta, the sympathetic preaortic nerves may be injured. Division of both superior hypogastric plexus (SHP) and hypogastric nerves may also occur during dissection at the level of the sacral promontory or in the presacral space. In such circumstances, sympathetic denervation with intact nervi erigentes results in retrograde ejaculation and bladder dysfunction. The nervi erigentes are located in the posterolateral aspect of the pelvis, and at the point of fusion with the sympathetic nerves are closely related to the middle hemorrhoidal artery. Injury to these nerves completely abolish erectile function. The pelvic plexus may be damaged either by excessive traction on the rectum, particularly laterally, or during division of the lateral stalks when this is performed close to the lateral pelvic wall. Finally, dissection near the seminal vesicles and prostate may damage the periprostatic plexus, leading to a mixed parasympathetic and sympathetic injuries. This can result in erectile impotence as well as a flaccid, neurogenic bladder. Sexual complications after rectal surgery are readily evident in men, but are probably underdiagnosed in women.

Surgical Technique

Various descriptions of intersphincteric restorative proctectomy have been presented in the literature over the past 40 years. This extended resection for rectal malignancies is predicated on the knowledge that rectal tumor infiltration is initially limited by an embryonic plane between the visceral structures and the surrounding somatic skeletal muscles of the pelvic floor (Fig. 20-1). IRP attempts to rid the patient of the disease while the tumor is still confined to this envelop. Throughout the dissection, particular attention is paid to minimize damage to the sympathetic and parasympathetic fibers that are involved in bladder function and sexual potency. Whereas damage to the sympathetic fibers alone leads to a decreased ability to attain orgasm, parasympathetic or combined damage results in impotence in men and vaginal dryness in women, manifesting as dyspareunia.

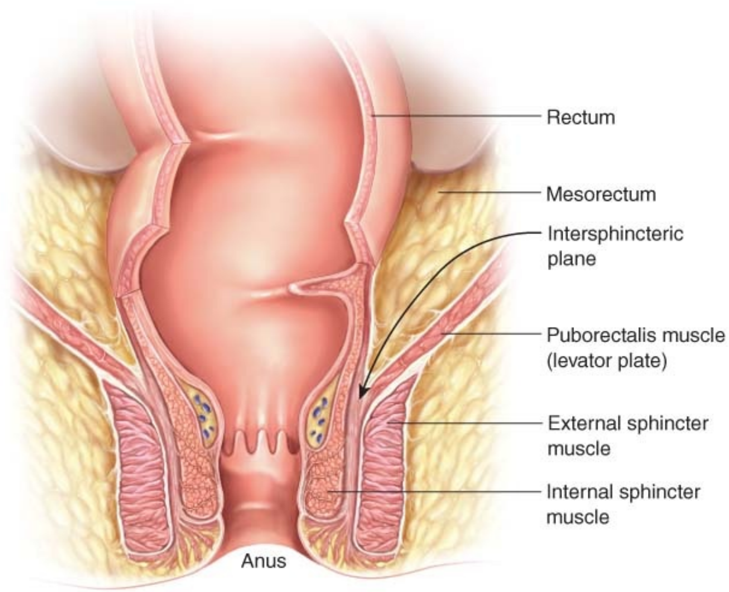


FIGURE 20-1 Schematic representation of the distal anorectal canal. The mesorectum narrows and is completely terminated at the point of meeting the puborectalis muscles and the levator plate. This then proceeds circumferentially in a caudad fashion as the external sphincter muscle, a somatic muscle along the anal canal. Medially, the internal sphincter muscle, a visceral smooth muscle, is observed as a continuation and in apposition to the rectal wall, and is separated by the intersphincteric plane or space from the external sphincter muscle in the embryonic plane by a glistening white peritoneal reflection.

Fecal Diversion

The author's and editors' preference is for fecal diversion of all patients that undergo IRP. There remains some controversy about the role of diversion in rectal surgery due to the morbidity associated with a stoma as well as a second surgery to reverse it. However, we feel that, the increased salvage rate, decreased rate of reoperation, and decreased clinical significance of anastomotic failures in patients with diverted stomas makes the diverting procedure justifiable.

Although there is one randomized prospective trial that shows decreased morbidity in terms of postoperative ileus and small bowel obstructions with a diverting transverse loop colostomy, our preference is to utilize a diverting loop ileostomy. As the splenic flexure is often mobilized to provide adequate length for a coloanal anastomosis during an IRP, maturing a transverse loop colostomy becomes significantly more difficult than a diverting loop ileostomy. The becomes significantly more difficult than a diverting loop ileostomy. The operation to reverse a loop ileostomy is also much easier with decreased postoperative morbidity in terms of wound infection and abdominal wall hernia formation.

p. 166

---

p. 167

The anastomosis is studied 6 weeks later and if the results are satisfactory, the diversion is reversed.

Total Mesorectal Excision

The abdominal phase of the dissection has been described via laparotomy, laparoscopy, and now robotics. It is broadly accepted that the approach to cancers of the rectum should include sharp TME. Others have advocated that tumors, particularly those in the upper part of the rectum, may be resected if adequate margins can be achieved—particularly at least 5 cm of mesorectum distal to and proximal from the rectal tumor. If these mesorectal margins cannot be attained, then complete TME is advocated. Generally, an LAR with a stapled anastomosis can be performed if sufficient distal margins are achieved and a stapler is able to be introduced at or above the level of the levator plate. In the setting of more distal tumors requiring intersphincteric restorative proctectomy, our preference is to perform a complete laparoscopic TME. Based on numerous trials, and also summarized by position statements from the American Society of Colon & Rectal Surgeons and the Society of American Gastrointestinal and Endoscopic Surgeons, laparoscopic techniques for curable colon and rectal cancer have been deemed to be a safe alternative when correct oncological techniques are followed. However, it is critically important to emphasize that a laparoscopic approach is not a simple procedure, and that it requires proper training and experience in advanced minimally invasive surgery. Most of the data presented are based on national data evaluating laparoscopic colon and rectal surgery and extrapolated based on multicenter experience with laparoscopic rectal cancer surgery. Recently, two Western randomized multicentered trials have completed investigating the use of the laparoscopic (and in some cases, robotic) technique for rectal cancer TME. For these trials, the American College of Surgeons Oncology Group Z6051 and the Australasian Laparoscopic Cancer of the Rectum Trial (ALaCaRT) used a surrogate pathological metric to evaluate appropriate surgical resection and attempted to use this composite index as an oncological marker for appropriateness of resection. This surrogate was a summation of completeness of the TME, negative circumferential margin, and negative distal margin. Although there were no differences between the open and laparoscopic approaches in these individual outcomes, the composite index unfortunately did not meet the non-inferiority benchmark criteria, and caution was advised when recommending or performing rectal cancer operations using the minimally invasive laparoscopic performing rectal cancer operations using the minimally invasive laparoscopic approach. There have been numerous editorial reviews and commentary in societies on the outcomes of these trials and currently, in the United States, centers continue to proceed with minimally invasive, and in particular, robotic dissections for rectal cancer. Long-term oncological outcomes from the above trials are still pending.

PREOPERATIVE PLANNING

As with all operations for rectal adenocarcinomas, patients should be appropriately and thoroughly evaluated. A complete and full colonoscopy should be performed and documented to exclude any other synchronous lesions. Flexible sigmoidoscopy after neoadjuvant chemoradiation therapy may be utilized to assess clinical response. Preoperative imaging with computed tomography of the chest, abdomen, and pelvis should be performed to exclude metastatic disease and/or progression during chemoradiation therapy. Dedicated MRI with rectal cancer protocols (with or without endorectal coil or endoluminal gel) should be performed to document local staging, and in particular, assess closeness of the circumferential and distal tumor extent. These latter features may affect the extent of operation performed. A carcinomembryonic antigen level should be drawn preoperatively as a baseline. Baseline assessment of sphincter tone should be performed prior to the operation to assure appropriate resting and squeeze tone. Absent or diminished tone is a contraindication to ISR. Finally, documentation of a multidisciplinary tumor board review of the patient and their disease and subsequent plan is highly suggested.

Preoperatively, all patients are placed on an enhanced recovery protocol. It is the surgeon's preference to have patients complete a complete oral antibiotic and mechanical bowel prep the day prior to the operation. In addition, all patients receive intravenous parenteral prophylactic antibiotics according to Joint Commission Surgical Care Improvement Project guidelines. Patients also receive preoperative oral acetaminophen, celexocib, and gabapentin in the holding area as part of the enhanced recovery protocol.

SURGERY/DESCRIPTION OF TECHNIQUE

The procedure may be broken down conveniently into seven distinct steps: (1) medial-to-lateral mobilization and high intracorporeal vascular division of the IMA and vein; (2) mobilization of the sigmoid colon and left colon; (3) splenic flexure mobilization and inferior mesenteric vein transection; (4) sharp TME with en bloc lymphadenectomy; (5) intersphincteric distal dissection via abdominal approach (and double-stapled anastomosis if possible) or via transperineal transection/intrasphincteric dissection; (6) extracorporeal transperineal creation and anastomosis of a reservoir; and (7) temporary diversion. Following is described the laparoscopic and robotic techniques for an IRP.

Intraoperative Preparation and Positioning

The patient is placed in a modified lithotomy position and both legs are secured in Allen stirrups. Intraoperative evaluation of the rectal tumor is performed via digital rectal examination and rigid proctosigmoidoscopy to determine resectability and the site of the distal resection. The rectum is then irrigated with a cytocidal solution of diluted Betadine. Both the abdomen and the perineum are prepped and draped in a sterile manner. In females, the vagina is also sterilely prepped. Cystoscopy and bilateral ureteral catheter placement may be helpful in the setting of an irradiated pelvis to help visualize the ureters during dissection.

Laparoscopic Port Placement

Peritoneal access is obtained utilizing the open Hasson technique via a 1 cm supraumbilical incision. On obtaining pneumoperitoneum, a 10 mm 30-degree scope is utilized to perform a diagnostic laparoscopy. Particular attention is paid to the liver surface as well as the surface of the peritoneum to evaluate for metastatic disease. A 10–12 mm is placed in the right lower quadrant about 2 cm medial and 2 cm cephalad from the anterior superior iliac spine. An additional 5 mm port is placed in the right upper quadrant about 8 cm cephalad from the previous right lower quadrant port. A final 5 mm port may be placed in the left lower quadrant if needed for later use. This port can help with retraction of the rectum out of the pelvis, defining the anterior dissection plane, and in mobilization of the splenic flexure.

Robotic Port Placement

Currently, the author prefers performing most of the distal rectal dissections with the aide of the robot. The only robots currently on the market are the Intuitive da Vinci Si and Xi platforms (Intuitive Surgical, Inc., Sunnyvale, CA). The robotic system allows for enhanced visualization due to the 3D stereoscopic view and enhanced distal articulation and dissection due to the wristed instrumentation. In addition, in these complex cases, surgeon ergonomics are improved over laparoscopy and certainly more so over conventional open abdominal approaches.

Port placement for both Si and Xi platforms is generally similar. Advantages of the Xi platform include smaller ports, a levitating/articulating boom/arm positioning system, and also port-hopping that allows for the transfer of the camera to various ports, enabling full mobilization of the splenic flexure and also the rectum with single docking. Using the Xi system, a supraumbilical 8-mm camera port is placed about 15 cm cephalad to the pubis. This is performed using an optiview technique. Pneumoperitoneum is attained and similar to conventional open and laparoscopic approaches, diagnostic evaluation to exclude peritoneal or hepatic metastatic disease is performed. When local, non-metastatic disease is confirmed, a stapling port is placed in the right lower quadrant approximately 3 cm medial and superior to the anterior superior iliac spine, and then three additional 8-mm ports are placed as follows: right upper quadrant parallel to the RLQ port; left mid-abdominal port approximately 2–3 cm cephalad to the umbilical port and along the mid-clavicular line; and left lateral port parallel to the umbilicus along the anterior axillary line (Fig. 20-2). With this port placement, single-docking feasible to mobilize the colon from the mid-transverse colon distally to and through the intersphincteric plane around the anorectal canal. The addition of Table Motion software with the Trumpf Medical TruSystem 7,000 surgical bed (both, Trumpf Medizin Systeme GmbH, Saalfeld, Germany), allows for repositioning of the patients while the robotic (Xi) system is docked, enabling splenic flexure mobilization and single docking.

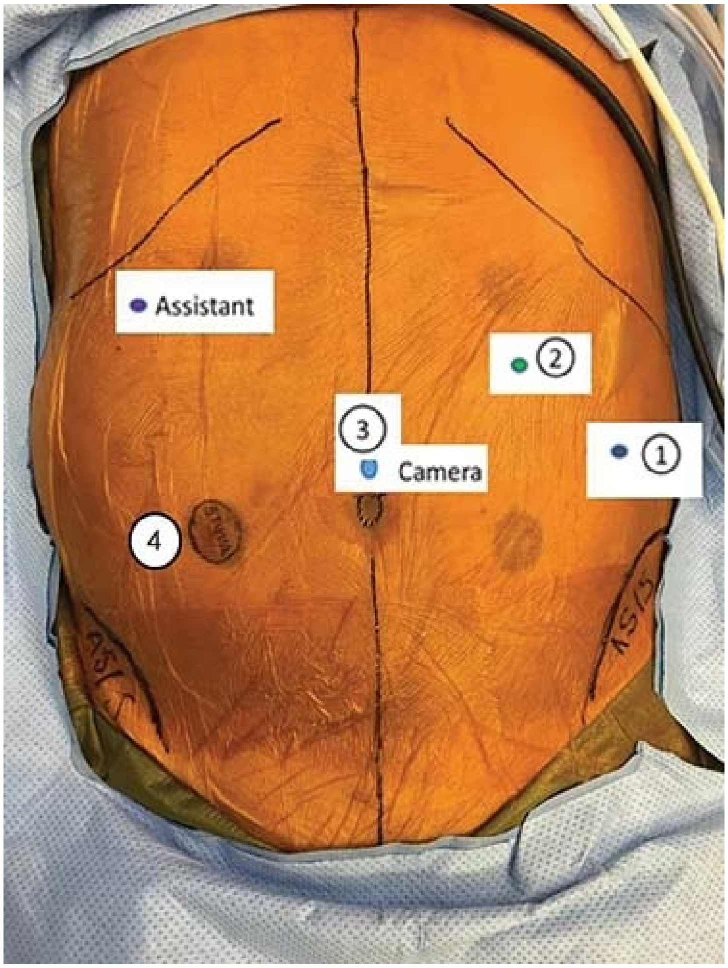


FIGURE 20-2 Robotic low anterior and intersphincteric port placement using the Intuitive daVinci Xi platform. With this setup, the patient bed is initially positioned in 20 degrees Trendelenburg and 10 degrees right inclination for the total mesorectal excision portion of the operation. The robot is docked perpendicularly from the patient's left side. Instrumentation is as follows: 1—bipolar fenestrated grasper for static retraction of the distal sigmoid and anterior retraction of the vagina or prostatic structures; 2—Cadiere grasper for dynamic grasping and manipulation; 3—0 degree 8 mm robotic camera; and 4—monopolar scissors, bipolar vessel sealer, and 45 mm endostapler. When port-hopping for splenic flexure mobilization, the bed is repositioned into reverse Trendelenburg position and the Cadiere grasper moved to the assistant port and monopolar scissors to port 2.

Step 1: Medial-to-Lateral Mobilization and High

Ligation of Inferior Mesenteric Artery

With the patient in slight Trendelenburg position and airplaned to the right, the medial-to-lateral mobilization is initiated. Although some have used energized shears/electrocautery devices, the author contends that an ultrasonic dissector or bipolar vessel sealer may subsequently have a role in later portions of the case for IMA transection and maintenance of hemostasis. The mesentery of the rectosigmoid is tented anteriorly directly overlying the sacral promontory, just to the left of the right common iliac artery. With a gentle application of coagulation current electrocautery in this area, the retroperitoneal presacral space begins to billow as carbon dioxide enters this plane and diffuses and expands the alveolar tissue. Then, dissection of the mesocolon of the rectosigmoid with the IMA is proceeded in the space between the mesentery and the autonomic nerves overlying the aorta. Care is taken to identify the left ureter and to preserve its posterolateral position (Fig. 20-3). Once these vital structures are identified, combinations of medial-to-lateral and lateral-to-medial are continued cephalad to identify the IMA and its origin at the aorta.

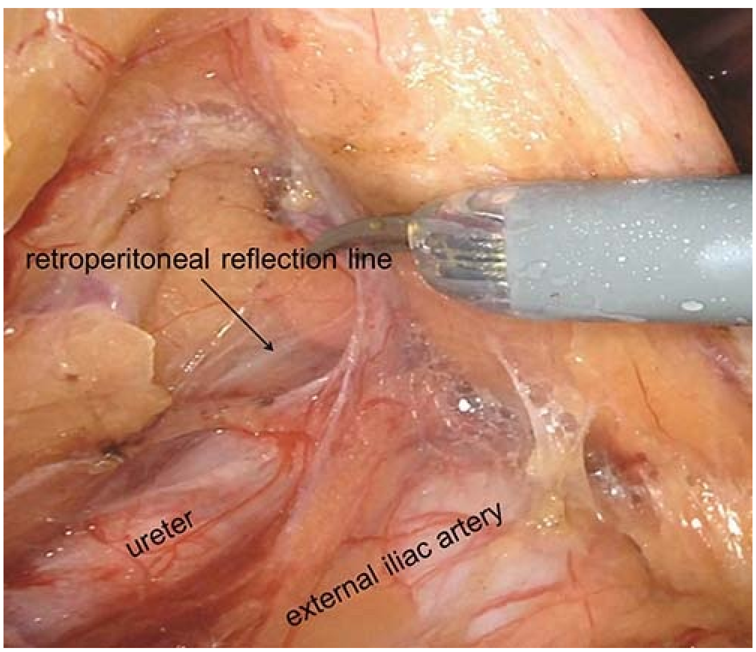


FIGURE 20-3 During medial-to-lateral mobilization, the mesentery of the rectosigmoid is tented anteriorly overlying the aorta and autonomic nerves with visualization of the retroperitoneal structure. The appropriate plane is identified with a positive observation of the retroperitoneal reflection line, the ureter and the left external iliac artery. Prior to this point, during dissection, care should be taken not to disrupt the autonomic nerves overlying the aorta.

A high ligation of the IMA is performed. The relative anatomy of the sympathetic nerves in this region should be kept in mind while performing this segment of the dissection. The SHP and the origin of the hypogastric nerves overlie the aorta, and the sacrum need to be visualized and preserved. They lie behind the IMA as it travels toward the rectum. These sympathetic fibers can sometimes be incorporated in the IMA pedicle if ligation of the IMA is performed too close to its origin from the aorta. Injury to these structures may result in retrograde ejaculation or vaginal dryness.

With the sigmoid colon on stretch and the patient airplaned to the right, mesenteric dissection is continued proximally until the vascular pedicle containing the IMA is identified. A window is created around the IMA. High ligation of the IMA is then performed just distal to its takeoff from the aorta. The author prefers to utilize an energy device (robotic bipolar vessel sealer or laparoscopic advanced energy ultrasonic dissector) for this ligation (Fig. 20-4). Alternatives include a mechanical endostapler of the appropriate staple height.

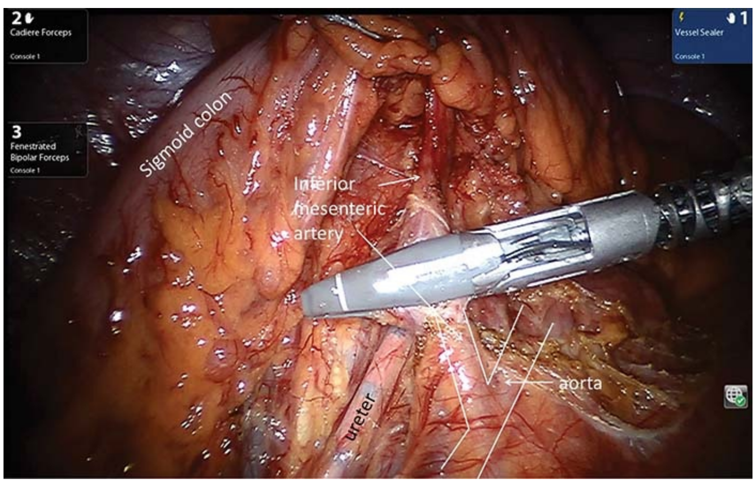


FIGURE 20-4 High ligation of the inferior mesenteric artery (IMA). Note the ureter and pelvic sidewall structures on the left clearly identified and preserved out of harm's way. The takeoff of the IMA off the aorta is seen with high ligation and transection (leaving a 1-cm stump) with the robotic vessel sealer.

Step 2: Left Colon Mobilization

Just proximal to this IMA transection and ligation, the mesocolon is then divided in a perpendicular fashion to the level of the descending-sigmoid colon junction. Prior to transection of the colon and subsequent anastomosis, the colon proximal to the mesocolic division is evaluated for appropriate vascularity. This is to the mesocolic division is evaluated for appropriate vascularity. This is currently performed using an intravenous injection of 4 ml of indocynanine green and endoscopic fluorescence imaging (Novadaq Systems, Ontario, Canada). Continued proximal dissection of the descending colon mesentery from the retroperitoneal structures is performed and facilitated by downward dissection of the white retroperitoneal reflection line. This dissection is continued proximally till above the upper pole of the kidney. In some cases, this mobilization can be continued and the wrong plane entered by dissected inferior/posterior to the pancreas. If this happens, the appropriate plane should be reentered separating the transverse mesocolon and pancreas keeping these structures separate anteriorly and posteriorly, respectively. The inferior mesenteric vein is also then dissected free and divided using another firing of the vascular stapler or ultrasonic dissector or bipolar vessel sealer. These maneuvers allow enough proximal colon length to perform reconstruction with a tension-free anastomosis.

Step 3: Splenic Flexure Mobilization and Inferior Mesenteric Vein Division

The descending colon is mobilized by freeing its remaining lateral abdominal wall attachments along the line of Toldt. These are all that will be left after previous cephalad medial-to-lateral mobilization of the mesentery from the retroperitoneum. This dissection is carried out proximally to the splenic flexure. The patient is then placed in slight reverse Trendelenburg position and starting approximately halfway between the hepatic flexure and the falciform ligament, the gastrocolic omentum and its attachments to the transverse colon are divided. Dissection is carried out distally toward the previous dissection plane. The splenic flexure is thus completely and fully mobilized. Care should be taken to preserve the middle colic artery and vein. The inferior mesenteric vein should be divided at this point if not otherwise done. This should be done in a high fashion immediately caudad to the pancreas. This allows for appropriate tension-free length for the descending colon to reach the anus. The mesenteric dissection may proceed proximally to the level of the ligament of Treitz. In certain cases, with challenging splenic flexures, it may be easiest to enter into the lesser sac by opening up the relatively loose alveolar space immediately superior to the ligament of Treitz within the transverse colon mesentery. Dissection can then proceed anterograde along the distal transverse colon and distally to mobilize the splenic flexure until the prior transection is met from below.

Step 4: Sharp TME with En Bloc Lymphadenectomy

Attention is then turned to the sacral promontory and a sharp TME is performed in the bloodless plane. Laparoscopically, the plane is maximally visualized via lateral manipulation performed with the aid of the left lower quadrant abdominal port site and cephalad-anterior retraction of the rectum performed via the right upper quadrant port site. Robotically, the lateral-most port functions as a static grasper retractor for cephald-anterior retraction of the rectosigmoid and the more medial left-abdominal port functions as the dynamic retractor. Both hypogastric nerves overlying the sacral promontory and proceeding distally along the pelvic sidewalls are identified and preserved (Fig. 20-5). Dissection is carried out initially posteriorly, followed by laterally, and finally anteriorly. Care should be taken to find the correct plane of dissection, described by Heald as the "holy plane of rectal surgery," just outside the fascia propria as the hypogastric nerves pass tangentially to it and medial to the ureter. This is most easily appreciated as a white, loose, alveolar plane. Dissection distally along this plane is easily performed sharply with electrocautery or energy devices.

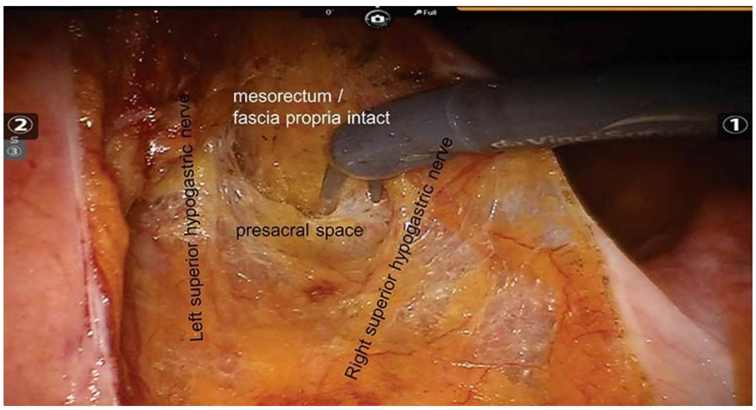


FIGURE 20-5 Initiation of the sharp total mesorectal excision with monopolar scissors. The left and right superior hypogastric nerves are visualized (labeled laterally) immediately adjacent and outside the fascia propria in the presacral space. This plane is maintained and the white loose alveolar tissue is sharply dissected posteriorly and then laterally and finally anteriorly to the level of the levator plate.

The inferior hemorrhoidal plexus (IHP) sends delicate branches to the rectum that travel in the lateral ligaments. The routine use of large clamps to ligate the lateral ligaments in an attempt to avoid hemorrhage from the middle rectal artery is unnecessary because this vessel is found in only 20% of the patients. Utilization of these large clamps may increase the risk of damaging the IHP. We do not routinely include the entirety of Denonvilliers' fascia (believed to be the conglomerate of two layers of the most distal pelvic peritoneum after the space within the layers is obliterated during embryogenesis) in our surgical specimen, unless there is a reason to believe that it would be required to obtain an R0 resection—that is, an anterior lesion.

Care should be taken not to damage the delicate cavernosal fibers while performing the anterolateral separation of the distal rectum from the prostate and the seminal vesicles during both the abdominal and perineal portions of this dissection (Fig. 20-6). The fibers are easy to damage as evidenced by case reports of patients suffering from neurogenic impotence after the injection of sclerosant in too deep of a plane as an attempted therapy for anteriorly located hemorrhoids. These fibers cannot be visualized, making knowledge of their location and pathway particularly crucial. After exiting from their sacral roots, they pass from the pelvis anterolateral to the rectum on their way to pierce the urogenital diaphragm before entering the corpora. Damage can be avoided by performing delicate and avoiding overaggressive rectal dissection at the 2 and 10 o'clock positions, as this is where the cavernosal fibers are at greatest risk. Minimally invasive techniques and laparorobotic visualization aids in this dissection by affording a high-definition and magnified view of the dissection planes with minimal traction artifact. This dissection is carried down to and past the levator plate and into the intersphincteric space. At the completion of the TME, the specimen, with its intact fascia propria encompassing the mesorectum and lymph nodes, has been described as a glistening baby's bottom posteriorly with two lobes.

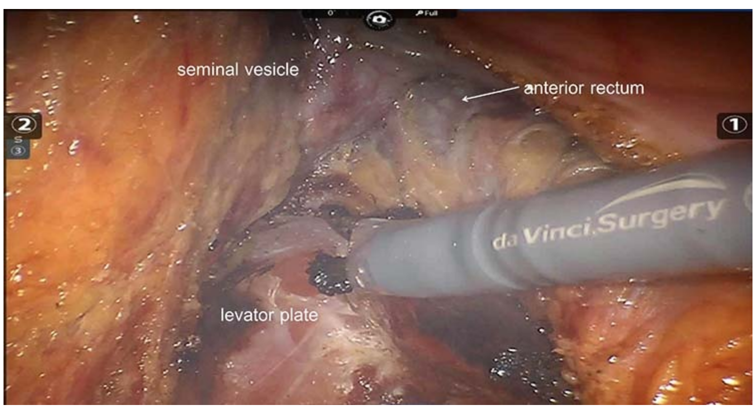


FIGURE 20-6 Left anterolateral distal pelvic dissection. The seminal vesicles and Denonvilliers' fascia overlying the anterior rectum (anterior based tumor) are seen and the levator plate and puborectalis musculature is evident at the interface of the rectum/mesorectum and pelvic floor.

Step 5: Intersphincteric Dissection

Robotic Intersphincteric Dissection (Step 5a)

At this point, if the anastomosis is distal enough that the dissection has proceeded within the intersphincteric plane and distal to the tumor with sufficient margin, two options exist. Traditionally, perineal dissection from below was performed to complete the dissection (see the following).

A second technique, facilitated by robotic systems, allows for avoidance of intersphincteric dissection and handsewn anastomosis from below. With the aid of the robotic system, dissection from the abdominal phase has improved to the point that perineal dissection is significantly less commonly done. When performing the TME dissection from above, the levator plates are encountered. With improved 3D visualization and wristed instrumentation, the surgeon is then able to identify the curvature of the puborectalis circumferentially as it encircles and wraps around the distal anorectal canal. This plane can be visualized with its peritoneal reflection line (a thin white filmy layer). This is appreciated as the embryonic plane between the visceral structures of the internal sphincter musculature and the surrounding somatic skeletal muscles of the pelvic floor and external sphincters. With care, the dissection can proceed distally in this intersphincteric plane circumferentially. Once an appropriate distal margin has been achieved, as verified digitally or endoscopically, the anorectal canal can be divided. The robotic platform for stapling across the distal rectal/anal canal is afforded due to improved articulation and instrumentation. This leaves a very distal/short Hartmann's type anal bud or stump, typically at or just above (and if desired, below), the dentate line (Fig. 20-7). The dentate line may be observed in the proximal colorectal specimen.

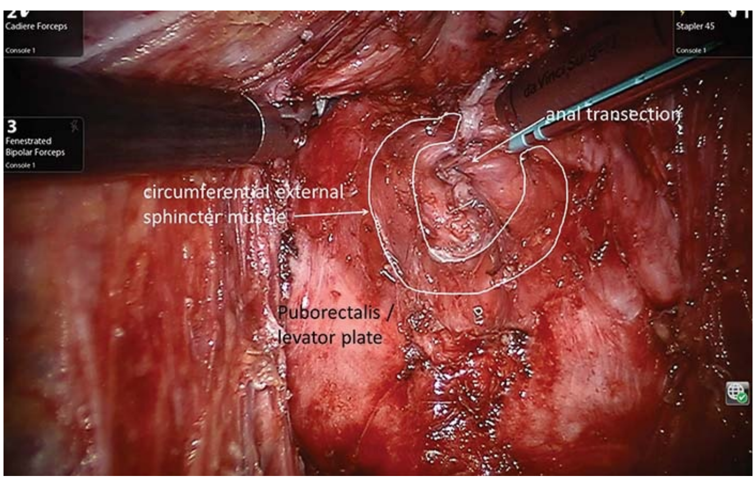


FIGURE 20-7 The bare anorectal canal has been transected with the robotic stapler. The anal transection line and distal anal stump is evident after an anterior–posterior division. The puborectalis and levator plate are seen and then more medially there is a change in orientation of the muscle fibers. The

circular muscle fibers of the external anal sphincter muscles are evident encircling the anal stump. The observer will note that the transection is distal/caudad to the mid and upper external sphincter muscle fibers.

At this point, a stapled anastomosis can then be created—with accordant avoidance and dependence/utilization of a handsewn anastomosis. To proceed at this point, if no perineal portion is required, the site of planned ileostomy is opened up and a wound protector is inserted through the abdominal wall. The stapled end of the distal anorectum and proximal rectum is then extracorporealized. The colon is divided between clamps at the previous mesenteric transection line and where appropriate, proximal vascular supply has been assured. Frozen section pathological review should ascertain and confirm appropriate distal margins. If the margin is inadequate, then the surgeon should proceed with a perineal dissection (Step 5b, below) or convert it to an APR.

p. 172

p. 173

An appropriate colonic conduit is then created (see Step 6 in the following). The notable difference is that the anvil of the end-to-end anastomotic (EEA) stapling device is inserted within the lumen of the proximal colon and brought out on the antimesenteric surface at the proposed site of anastomosis to the anal stump. The colotomy at the prior transection is closed using an endomechanical stapling device. The colonic conduit is placed back within the peritoneal cavity. Under direct visualization, the EEA stapler is carefully and slowly inserted to abut the anal staple line. With anterior retraction of the vagina or prostate, the spike is then slowly advanced through the wall of the anal canal posterior or immediately lateral to the distal transection staple line. The anvil is then mated to the spike and while assuring that there is no twisting or kinking of the colon or its mesentery, and similarly that there is no tension on the proximal colon conduit, the stapler is then closed and fired. In some cases, careful pathological review may yield observation of the dentate line in the distal anastomotic ring after a double-stapled intersphincteric coloanal anastomosis (Fig. 20-8).

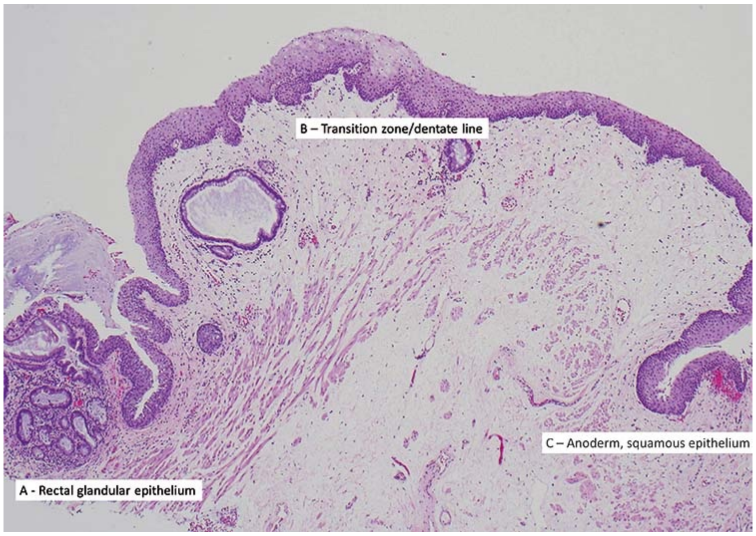


FIGURE 20-8 Distal anastomotic ring after a partial intersphincteric dissection and subsequent double-stapled side-to-end coloanal anastomosis using a circular end-to-end anastomotic stapling device. There is glandular epithelium of the distal rectum on left (A), transitional dentate line in middle (B), and squamous epithelium of the anus on the right (C).

Laparoscopic evaluation and testing of the anastomosis while submerged under sterile saline irrigation and proximal occlusion with flexible endoscopy helps define viability, patency, hemostasis, and absence of an air leak at the anastomosis as well as viability of the proximal colon and anus. Once confirmed, the surgeon may proceed to creation of a diverting loop ileostomy (Step 7).

(Step 5b): Perineal Dissection

Different definitions regarding the types of ISRs abound (Fig. 20-9). There is, however, uniformity in describing the total or complete ISR. The distal resection includes the complete internal anal sphincter complex by dissection at the level of the intersphincteric groove and the anal verge. The subtotal ISR transects the internal sphincter musculature by choosing a dissection line between the dentate and the level of the more distal intersphincteric groove. A partial ISR incorporates a distal line of dissection at or above the dentate. Occasionally, depending on the size/location of the tumor, a non-circumferential/partial internal and even external sphincter resection may be performed. With very limited single quadrant external sphincter resection, quality of life may be acceptable. Please see discussion of functional outcomes below.

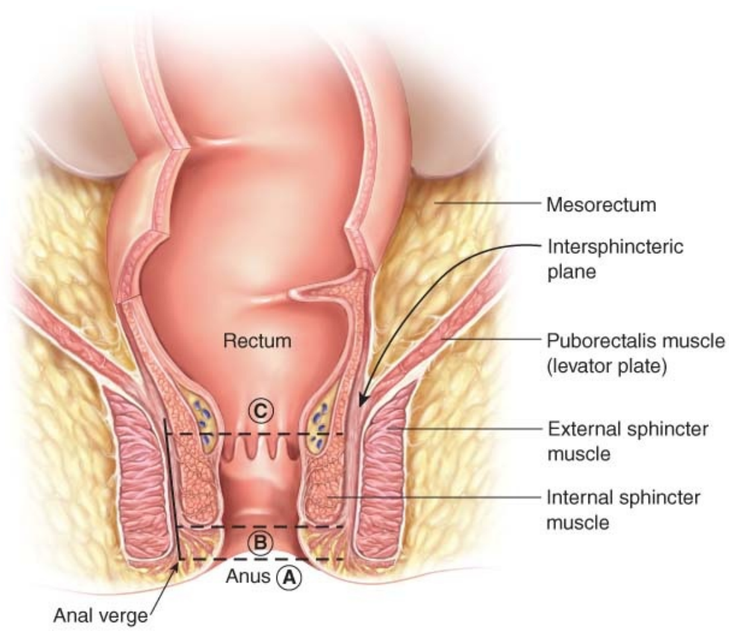


FIGURE 20-9 Classification of intersphincteric resections (ISR). For a total or complete ISR (A), the distal resection includes excision of the complete internal anal sphincter complex by dissection at the level of the intersphincteric groove and the anal verge. The subtotal ISR (B) transects the internal sphincter musculature by choosing a dissection line between the dentate and the level of the more distal intersphincteric groove. A partial ISR (C) incorporates a distal line of dissection at or above the dentate. Occasionally, depending on the size/location of the tumor, a non-circumferential/partial internal and/or even single quadrant limited external sphincter resection may be performed.

At the beginning of the perineal dissection, a decision should be made as to the distal extent of the resection specimen. Although current literature suggests that a negative margin of less than 1 cm does not impair oncologic outcomes, these studies are able to make such claims in patients with locally advanced cancers only. If an attempt to perform a partial ISR is to be made, then the author prefers to start his plane of dissection at least 1 cm distal to the furthest extent of the tumor, if not ideally 2 cm. If this is not possible or if there is preoperative evidence of internal sphincter involvement, a complete/total ISR is advised. In such a situation, the distal plane of the resection should be started at the level of the intersphincteric groove, which may be marked by the white line of Hilton, or even the anal verge.

Once this decision has been made, a self-retaining retractor (Lonestar Retractor, Lonestar Medical Products, Inc., Houston, TX) is utilized for effacement and retraction of the anal canal. Electrocautery is utilized to perform a circumferential mucosal excision at a level at least 1 cm distal to the lesion. This is extended deep past the internal sphincter muscle until the intersphincteric plane is encountered. The anal orifice (or DRM) may be sutured close and the dissection is continued proximally staying in the plane within the smooth internal sphincter and striated external sphincter muscles. We find it helpful to begin the dissection posterior and lateral before dissecting anteriorly as the intersphincteric plane is easier to identify in these locations. During this part of the dissection, care should be taken to avoid compromising Denonvilliers’ fascia because damage to the cavernosal fibers on the other side usually lead to sexual dysfunction. Continued dissection in these planes eventually leads to communication with the abdominal dissection. At this point, therefore, the colon and the rectum are completely free and the specimen is able to be brought out per the anus. Using two bowel clamps to avoid fecal contamination, the colon is divided at an area proximal to the division of the IMA. This mesentery may have already been divided as discussed above (Step 2). The rectal specimen is sent for frozen section analysis to evaluate for appropriate distal and circumferential margins. If the margins are positive, more tissue is excised until negative margins are obtained. In certain cases, the procedure is converted to an APR.

Step 6: Techniques of Coloanal Anastomoses

When the intersphincteric dissection is performed via the perineal approach, a coloanal anastomosis is then performed. Techniques for the various forms of restorative anastomoses are described in the following.

End-to-End Coloanal Anastomosis

Generally, cases requiring IRP necessitate a handsewn anastomosis as using standard EEA stapling devices may not be appropriate. However, stapled techniques for restorative coloanal anastomosis (CAA) after the subtotal intersphincteric proctectomy have been described. In this technique, the remnant internal sphincter is first prepared for anastomosis by eversion and placement of a purse-string suture. An EEA stapler is then utilized to perform the anastomosis. Our preference is to perform a handsewn anastomosis with a single layer of interrupted absorbable sutures. Each suture incorporates full thickness of the wall of the colon, a portion of the internal sphincter (or external sphincter in the case of a complete intersphincteric proctectomy), and the anoderm. A straight end-to-end CAA is generally performed when none of the following reconstructive modalities are feasible. Careful attention to maintain orientation of the bowel and its mesentery is assured.

Transverse Coloplasty Pouch

Another modification of the coloanal anastomosis that results in a volume effect is the Transverse Coloplasty Pouch (TCP). Much like a stricturoplasty or a pyloroplasty, the coloplasty is performed by making a longitudinal incision on the antimesenteric side of the colon and by closing it in a horizontal manner. Our preference is to make a 10–12 cm longitudinal incision starting 4 cm proximal from the most distal stapled end of the colon to be anastomosed to the anus. This incision is then closed in a horizontal manner with a single layer of interrupted 3-0 polydioxanone sutures. Alternatively, this closure can be performed with a running inner layer of absorbable suture and an outer interrupted layer of nonabsorbable imbricating sutures. The stapled end is then introduced into the pelvis. The staple line is removed via electrocautery and a handsewn anastomosis is performed on the anal canal with interrupted sutures via a transanal approach as previously described above for straight EAA.

TCP or straight end-to-end CAA is utilized when the pelvis is restrictively narrowed, there may be insufficient intestinal length, an excessively bulky descending colonic mesentery exists, or depending on the surgeon’s preference.

Colonic J-Pouch Anal Anastomosis (CPA)

The Colonic J-Pouch (CJP) was originally constructed to create a stool reservoir to nullify the increased frequency of bowel movements following a CAA. The author prefers to construct a 5–6 cm J-pouch as recommended by a prospective study evaluating its optimal size. The distal/efferent end of the colon is stapled. The pouch consists of a 10–12 cm segment of colon, with the distal half of this segment brought alongside the proximal half in an antiperistaltic/antimesenteric manner. The colon is held in this configuration with the aid of one or two stay sutures. A colotomy is performed with electrocautery at the side wall of the colon approximately 5–6 cm proximal from the distal efferent stapled end. A gastrointestinal anastomosis stapler is introduced through the colostomy and fired to create a side-to-side anastomosis of the colon resulting in a 5-to 6-cm CJP. The pouch is then introduced into the pelvis and a handsewn anastomosis is performed to the anal canal with interrupted sutures via a transanal approach as previously described in this chapter.

Although not reviewed, in select patients a complete proctocolectomy with intersphincteric dissection may be necessary. In these cases, an ileal pouch anal anastomosis may be utilized as the neorectum and completed in a similar fashion as the CJP. The technique of proctocolectomy and the formation of an ileal reservoir with an ileoanal anastomosis is well described in this textbook. However, the ileal J-pouch should be constructed utilizing a total of 40 cm with a 20-cm pouch length rather than 5–6 cm, as with the CJP.

Side-to-End/Baker-type Coloanal Anastomosis

Baker described the successful use of a colorectal side-to-end anastomosis. More recently, surgeons are utilizing a Baker-type side-to-end coloanal anastomosis following an intersphincteric proctectomy. This method, which has also been referred to as an L-pouch, appears to provide decreased frequency of bowel movements. Furthermore, the L-pouch is less bulky than a CJP, allowing it to reach the anal canal with less difficulty. The technique requires the provision of a colotomy on the antimesenteric surface of the colon, measured 5–6 cm proximal to the stapled end. This colotomy is then anastomosed to the anal canal with interrupted sutures via a transanal approach as discussed hereinbefore.

Step 7: Diverting Loop Ileostomy Creation

The operation is then returned to the abdomen and diagnostic laparoscopy is performed noting the tension-free anastomosis. A drain is guided behind the neorectum in the presacral space and brought out through the left lower quadrant laparoscopic port site. Following this, a loop of terminal ileum approximately 20–25 cm proximal to the ileocecal valve is exteriorized to fashion a loop ileostomy. It is brought out through the abdominal wall at the area previously marked by the stoma nurse. A mesenteric window is created at the apex of the loop and a standard stoma bridge rod is placed within this mesenteric window and sutured into place to prevent the small bowel from reducing back into the peritoneum. The ileostomy is matured only at the termination of the operation to prevent spillage and wound infection.

All laparoscopic port sites are removed under direct visualization. Pneumoperitoneum is released. Fascia and skin incisions are closed and the diverting Brooke loop ileostomy is matured in the standard manner. The diverting stoma is reversed with reestablishment of intestinal continuity performed after completion of postoperative adjuvant therapy. Generally, clinical, endoscopic, and radiologic examination of the anastomosis is performed prior to reversal.

Other Considerations and Novel Approaches to TME Dissection

In rare instances, distal dissection in the TME plane may be challenging. To overcome this, over the past couple of years, a new technique has been devised to help with the distal dissection, called transanal TME (taTME). This procedure perfoms the perineal portion using a modification of a transanal minimally invasive surgery (TAMIS, Applied Medical Systems, CA) port with laparoscopic instrumentation. The reported advantages of this taTME procedure are that the distal margin is assured a priori and supposedly, the TME performed from below is easier. This technique is quite novel and challenging to perform from below is easier. This technique is quite novel and challenging to perform. The planes encountered may be difficult to appreciate and urethral injuries have been reported. A multicenter national US trial is currently being funded with industry support and through the American College of Colon & Rectal Surgeons and the Society of American Gastrointestinal and Endoscopic Surgeons and is due to start in 2017. Feasibility, oncological, and functional outcomes from this trial are eagerly awaited.

It is the author’s preference to perform transabdominal intersphincteric dissections if at all possible. This enables the creation of a stapled, rather than handsewn anastomosis. The former generally leads to improved postoperative function and quality of life, likely as a result of precluded, and thereby decreased sphincter trauma, during the perineal intersphincteric dissection. When able to dissect distally using the robotic technique and staple at the dentate line, a stapled EEA device is then utilized to complete the anastomosis.

The author’s preference is to perform a Baker-type side-to-end anastomosis when a CJP cannot fit or be constructed. When performing handsewn coloanal anastomosis, the Lonestar Retractor is removed. To reduce the risk of tumor implantation and subsequent local recurrence, cytocidal washout is performed. The puncture sites of the Lonestar Retractor are also irrigated as there have been reports of local recurrence at its puncture sites. A rolled-up hemostatic foam is placed within the neorectum.

Irrespective of the method of restoration of intestinal continuity, double-stapled or handsewn, imaging with injection of indocyanine green and endoscopic fluorescence imaging and visualization (Novadaq Systems, Ontario, Canada) may then be performed of the anastomosis to verify appropriate and prompt vascularity of the colonic conduit and anastomosis and distal anal canal.

POSTOPERATIVE MANAGEMENT

All patients undergoing IRP are managed similar to those undergoing standard colorectal procedures—including LAR or APR. All patients are preoperatively counseled on our institution's multimodality enhanced recovery protocol. Patients are started on low-residue diet immediately postoperatively. Narcotic opioid analgesia is minimized with a preference for oral and intravenous nonsteroidal anti-inflammatory drugs (NSAIDs). It is currently not the author's routine to utilize central neuraxial blockade (i.e., intrathecal or spinal epidurals) or transversus abdominis plane blocks, though the latter has been effectively utilized in other centers. The presacral drain placed at the time of operation is also removed once output is serosanguineous and less than 100 ml/day. Once stoma function is appropriate (generally <1,300 ml/day), patients are discharged with follow-up appointments with the ostomy nurse in 2 weeks. Patients are generally advised to wear pads or gauze perianally to capture any mucus or sanguineous discharge in the immediate postoperative period. Most patients are able to be discharged on oral NSAIDs with minimal, if any, narcotic opioids. At approximately 2–6 weeks postoperatively, patients may undergo a water-soluble contrast enema and/or physical examination with flexible sigmoidoscopy to evaluate for patency of the anastomosis and also to exclude an anastomotic leak. If a leak is found, these generally resolve spontaneously during the interval in which patients are on adjuvant chemotherapy. Nevertheless, if a leak is observed, reversal is not performed until a leak is excluded or self-contained and minimal. Management of anastomotic leaks are covered separately in this text.

Outcomes

A meta-analysis of published cases of intersphincteric proctectomy revealed an operative mortality of 1.6%, an anastomotic stricture rate of 5.8%, and an anastomotic leak rate of 10.5%. Neoadjuvant chemoradiation significantly affects the patient's oncological and functional outcomes. Much effort has been made toward finding the effects of the various modifications of this procedure on patient morbidity. The use of laparoscopy, lateral lymphadenectomy, and the various techniques of coloanal anastomosis have been evaluated.

Complications and Anastomotic Problems

IRP suffers from an anastomotic stricture rate of 5.8% and an anastomotic leak rate between 3% and 11%. Rates are seen to rise significantly for more distally situated anastomoses. Morbid sequelae of anastomotic leaks include anastomotic strictures, cancer recurrence, and poor postoperative anorectal function. These anastomotic problems, especially the leaks, lead to significant morbidity in the form of sepsis and delayed or non-closure of stoma. Also, strictures due to septic pelvic complications greatly limit continence after any of the above restorative coloanal anastomoses. Intra-abdominal sepsis also resulted in a decreased ability to achieve arousal. In an attempt to minimize these complications, authors have studied the various manners of gastrointestinal restoration in these patients in an attempt to uncover the method that is most likely to heal without anastomotic problems.

There was some thought that due to a better blood supply in patients undergoing pouch procedures, their anastomosis may heal better with a resultant decrease in the rate of clinically significant anastomotic leaks. This theory seemed to be supported by initial reports indicating that there was a clinically significant lower incidence of anastomotic leaks following colonic pouch anastomosis (2%) compared with those in case of non-pouch CAA (15%).

Studies evaluating the microcirculation at the anastomosis did not reveal the expected results. One group, utilizing laser fluorescence videography, evaluated the microcirculation around anastomosis after rectal resection in dogs. They compared end-to-end, side-to-end, and J-pouch coloanal anastomosis. Bowel perfusion was evaluated using IC-View laser fluorescence videography. Interestingly, it was discovered that straight coloanal anastomoses provides better anastomotic microcirculation after rectal resections than CJP anal anastomoses or side-to-end anastomoses.

Later studies revealed the difference in leak rates between CPA and CAA to be due to a confounding variable. In this study, fecal diversion was performed in only 59% of patients with CAA and in 71% with CPA. A follow-up study by the same group with a protective ileostomy in all patients showed no significant differences. These results have since then been confirmed by other studies. Later, randomized studies looking at leak rates between TCP and CJP and a side-to-end anastomosis also revealed no clinically significant difference.

Reviewing the latest single and multicenter reports, anastomotic leaks and fistulae are noted to be the primary morbidity associated with IRP. Mortality is very low (Table 20-1).

TABLE 20-1 Complications after Intersphincteric Proctectomy

	N	Anastomotic leak	Fistula	Stricture	Abdominal wound infection	Card eve
Weiser, 2009	44	2	2	7	3	1
Han, 2009	40	1			2	
Yamada, 2009	107	5		9	4	

Ito, 2009	96	1			
Chamlou, 2007	90	8	1/8	1	1
Schiessel, 2005	121	6	2	11 (late, cons. Tx)	
Tilney, 2007 and 2008 Meta-analysis	612	49 (10.5)		12 (5.8)	

NR, not reported; PE/DVT, pulmonary embolism/deep vein thrombosis; UGIB, upper gastrointestinal bleeding; UTI, urinary tract infection.

OUTCOMES RESULTS

Quality Indicators and Pathological Comparisons

When evaluating patients undergoing IRP for rectal cancer, certain pathological results have been realized. Patients undergoing IRP generally had a lower-stage (y)pT1-2, greater response to neoadjuvant chemoradiation therapy, increased rate of T downstaging, and lower-grade differentiation than those patients undergoing APR (Table 20-2). Most of these reports also demonstrated an acceptable DRM as well as a generous/acceptable negative CRM with an acceptable stage-for-stage LR recurrence rates. In the most recent data published from Memorial Sloan Kettering Cancer Center, patients undergoing IRP and stapled anastomoses (for higher lesions) had equivalent low LR rates, and were significantly lower than those patients necessitating APR (Table 20-3).

TABLE 20-2 Pathological Results of Intersphincteric Proctectomy

	Stage/(y)pTNM					Response to CMT	
	0	I	II	III	IV	100%/pCR	86–99%
Weiser, 2009	11 (25)	16 (36)	12 (27)	5 (11)		11 (27)*	10 (24)*
Han, 2009		18 (45)	6 (15)	16 (40)			
Yamada, 2009		48 (45)	24 (22)	35 (33)			
Chamlou, 2007	6 (8)	37 (41)	16 (18)	25 (28)	5 (6)		
Schiessel, 2005		49 (41)	33 (28)	37 (31)			

*P < 0.05 when compared with that of abdominoperineal resection.

CMT, combined-modality therapy/neoadjuvant chemoradiation therapy; N-stage; M-stage; pTNM, pathological T-stage; y, after neoadjuvant therapy.

TABLE 20-3 Quality Indicators of Resection

	Median distal	% + CRM ≤ 1 mm

	resection margin	LAR/stapled	LAR/IRP	APR	LA
Weiser, 2009	1 cm (0.1–3.5)	0/41	2/44 (5)	8/63 (13)*	1/4
Schiessel, 2005			3%		
Hohenberger, 2006			4%		
Rullier, 2005			11%		
Portier, 2007					
Koehler, 2000					
Ito, 2009	1.5 (2.2–5.5)		3/96 (3%)		
Chamlou, 2007	1.2 (0.5–35)		4/90 (4.4%)		
Han, 2009			0/40		
Tilney, 2007 Meta-analysis	0.7–2.4				

Most of these reports demonstrated an acceptable DRM as well as a generous/acceptable negative circumferential resection margin (CRM) with acceptable stage-for-stage locoregional (LR) recurrence rates. In the most recent data published from Memorial Sloan Kettering Cancer Center, patients undergoing ISRD and stapled anastomoses (for higher lesions) had equivalent low LR rates, and significantly lower than those patients necessitating abdominoperineal resection (APR).

IRP, intersphincteric restorative proctocolectomy; LAR, low anterior resection.

*$P < 0.05$.

CRM, circumferential resection margin; LR, locoregional recurrence.

Oncologic Outcomes

Some authors have wondered if the poor oncological results from APR compared with LAR are due to an unknown natural history of very low rectal cancers, with potential lymph node metastases outside of the mesorectal envelope. IRP is a potential intermediary that may be able to illuminate that concern as it often deals with the same tumors as an APR residing in the lowest part of the rectum.

In IRP, oncologic outcomes as measured by recurrence-free survival and disease-specific survival do not seem to be different, and are indeed equivalent to those following LAR with stapled anastomosis. Recently, a study on 62 consecutive patients from South Korea undergoing IRP for distal T2 and T3 rectal cancer (without neoadjuvant chemoradiation therapy), reported a 5-year overall survival rate of 94.7–95.8%. Similarly, recurrence-free survival was reported at 86.8–87.5%. In a separate study comparing CAA without resection of the internal sphincter to IRP for rectal cancer, the difference in the 5-year actuarial rate for local recurrence and the overall actuarial survival rate was not found to be clinically significant. As with other forms of rectal resection, the found to be clinically significant. As with other forms of rectal resection, the distant metastasis rate for cases with lymph node metastasis has been observed to be significantly higher than that for cases without lymph node metastasis.

It appears that IRP with negative margins is no worse than LAR, and generally better than APR from the standpoint of oncologic outcomes. Weiser published a series comparing three cohorts of patients undergoing resection for rectal cancer. Patients were stratified by those who were able to undergo LAR with stapled anastomosis, LAR with intersphincteric restorative proctectomy, and handsewn coloanal anastomosis, and those requiring APR. When looking at (y)pT3+ patients, both recurrence-free survival and disease-specific survival were equivalent for both LAR groups and significantly better than the APR group. Five-year recurrence-free survival rates were 85%, 83%, and 47% and 5-year disease-specific survival rates were 97%, 96%,and 59%, respectively, demonstrating a statistically significant difference between the APR group and the two LAR groups. Similar data are obtained from other trials supporting the acceptable oncological outcomes and benefits of IRP. When able to undergo intersphincteric proctectomy, patients had comparable oncological outcomes to patients undergoing LAR with conventional stapled anastomoses, and significantly improved outcomes to those requiring APR (Table 20-4).

TABLE 20-4 Recurrence and Survival

	Median F/U	5-y RFS			
		LAR/stapled (%)	LAR/IRP (%)	APR (%)	LAR/sta
Weiser, 2009	47	85	83	47	9
Ito, 2009 (3-y)	96		87		
Tiret, 2007	56.2		77		
Han, 2009	43		94		
Rullier, 2005					
Shiessel, 2005	94		92.5		
Tilney, 2007 Meta-analysis					

*P < 0.05 when compared with LAR with either stapled or IRP/handsewn coloanal anastomosis.
ARP, abdominoperineal resection; IRP, intersphincteric restorative proctocolectomy; LAR, low anterior resection; RFS, recurrence-free survival; DSS, disease-specific survival; OS, overall survival.

More recently, a Korean trial sought to delineate prognostic factors for oncological outcomes in 163 patients undergoing intersphincteric resections following neoadjuvant chemoradiation therapy. With a median follow-up of 53 months, analysis of the Kaplan–Meier survival curves demonstrated a difference in both 3-year overall disease-free survival (DFS) and locoregional recurrence-free survival (LRFS) for patients with Stage-III disease. Indeed, DFS was reported as 96.2%, 84.8%, 72.9%, and 38% and LRFS was reported as 100%, 92.4%, 91.1%, and 70.9%, for Stages 0–III disease, respectively. Multivariate analysis suggested that ypT (3/4 vs. 0/1/2) and ypN (1/2 vs. 0) stages were associated with differences in DFS. LRFS was similarly associated with the ypN stage, as well as tumor size (≥3.5 vs. > 3.5 cm), and distance from the anal verge (≤2 vs. > 2 cm).

IRP for rectal cancer was initially proposed to obtain an adequate distal margin of resection for ultra-low rectal tumors while avoiding permanent colostomy. Following an initial success with IRP, the envelope was pushed whereby a distal margin of 2 cm was deemed acceptable. The impetus to avoid a permanent ostomy in our society is such that efforts were made to reconnect the bowels in continuity with distal margins of less than 1 cm in patients who had undergone neoadjuvant chemoradiation. It is through the evaluation of the data collected from these procedures that we can confidently state that following the neoadjuvant therapy, IRP with distal margins of less than 1 cm does not appear to compromise the oncologic outcome of an R0 resection.

All patients, whether undergoing standard LAR with stapled coloanal anastomosis, LAR with intersphincteric proctectomy, and handsewn coloanal anastomosis, or APR should be followed for a minimum of 5–8 years based on standard published guidelines to evaluate for recurrence and metastasis.

Functional Outcomes

Following IRP, the functional components of interest include stool incontinence and frequency. It appears reasonable that resecting the internal anal sphincter results in increased incontinence. As expected from our understanding of physiology, ISR resulted in a statistically significant reduction in anal sphincter resting pressure. The squeeze pressures, however, were noted to be at their preoperative levels at the time of their postoperative evaluation. When comparing coloplasty and CJP, Furst was able to demonstrate the absence of any significant difference in resting and squeeze pressure and neorectal volume between both the groups, but observed an increased neorectal sensitivity in the coloplasty group.

The same study that reported on the Korean experience of 62 patients also evaluated functional outcomes of patients undergoing ISR. In this study, patients were evaluated at 1 and 2 years following stoma reversal. Bowel frequency was increased in patients who underwent extended ISR as compared with standard

ISR at 1 year ($P < 0.05$). However, by 2 years, the frequencies decreased in both groups, with no statistically significant difference between those undergoing standard or extended ISR. Any differences in Kirwan classification for continence or Wexner score for fecal incontinence were negated by 2 years. They concluded that extended ISR with quadrant resection of the upper external sphincter (extended ISR) achieved appropriate postoperative continence status and can be used as an alternative to APR without compromising cure or quality of life.

A second survey to evaluate GI function in patients who underwent IRP revealed that the mean Wexner score at 1 year following stoma closure was 10. Because a Wexner score of 16 correlated with patients who experienced major and frequent soiling, this score was utilized as a cutoff for poor anal function. Following an IRP, patients can expect 2–5 bowel movements daily and approximately a 20–60% chance of experiencing urgency. Daytime and nocturnal leakage following IRP is present in 15% and 20% of patients, respectively. Comparison of IRP with sphincter sparing CAA found worsening of continence as measured by the Kirwan and Wexner Scores following an IRP. To compensate, these patients required more utilization of antidiarrheal medications. In a univariate analysis, both the neoadjuvant therapy and the extent of internal sphincter resection were associated with poor anal function, but multivariate analysis revealed that only neoadjuvant therapy is significantly contributory with an odds ratio of more than 10. Overall, outcomes have been generally acceptable with minimal patient dissatisfaction (Tables 20-5 and 20-6).

TABLE 20-5 Factors Associated with Postoperative Continence/Functional Out

	Age	Gender	Tumor location	Diff/Grade	TNM stage	Level of IRP	Pre ra
Yamada, 2009	0.008/0.013*	0.082	0.006*/0.055*	0.778	0.897	0.139	
Tiret, 2007	0.2	0.82			0.63	NS	0.
Ito, 2009	0.5	0.1				0.04/0.8	< 0.

IRP, intersphincteric restorative proctocolectomy; PSWD, pelvic side wall dissection.

TABLE 20-6 One-Year Functional Results after Intersphincteric Proctectomy

	>5 BM/24 h	Nocturnal defecation	Urgency	Pad wearing	Flatus/l discrimi
Chamlou, 2007		24 (29)	16 (19)	38 (46)	21 (25

Chamlou, 2007	3 (4)	24 (29)	16 (19)	38 (46)	21 (2
Ito, 2009	27 (36)	13 (18)	9 (12)	42 (57)	8 (11)
Han, 2009			11 (31)		30 (8
Tilney, 2008 Meta-analysis		20	(19–59%)		

BM, Bowel movements.

An Italian study addressed robotic intersphincteric dissection with handsewn anastomoses. In their limited cohort of 23 patients observed over 4 years, fecal continence was shown to be good in 85.7% based on the Kirwan score, and no patients required colostomy. In the same group, 57.1% showed no Low Anterior Resection Syndrome (LARS) symptoms, 19% with a minor LARS, and 23.8% with a major LARS.

A Japanese study investigated long-term functional outcomes in patients undergoing stapled versus handsewn ISRs for distal rectal cancer following a chemoradiation therapy. They concluded that there were no significant differences in total LARS scores between the two cohorts. ISR was however associated with poorer incontinence scores compared with that in case of double-stapled technique. In a multivariate analysis, only tumor distance from the anal verge and postoperative period were independently associated with a major LARS.

Multiple studies have looked at the functional benefits of pouch procedures versus coloanal anastomosis. When comparing the short-term functional outcomes between CJP and CAA following an ISR, the frequency, urgency, Wexner score and Fecal Incontinence Severity Index were shown to be significantly in the favor of the CJP. Longer-term studies failed to reveal these benefits. It should be observed that a difference in improved functional outcomes even over the short term may be a significant benefit, given the sometimes low life expectancy of these individuals.

A meta-analysis revealed that 61% of patients after CPA and 55% after CAA experienced good functional outcomes in terms of continence (Kirwan I or II). CJP resulted in greater decreased stool frequency than CAA. At a long-term follow-up, studies failed to reveal any difference in maximum pouch volume as neorectal capacity decreased equally in both the groups. This finding has led some authors to propose that the advantage of pouch procedures may not be derived from the increased volume, but rather from decreased motility.

Studies comparing the various types of pouches have observed advantages of the CJP over the side-to-end-anastomosis in the early postoperative period. The TCP was observed to be similar in terms of functional results to CJP. Although no definitive reports have been published, there is a general consensus that a Baker/Side-to-End anastomosis has similar outcomes to those of the CJP and TCP.

Sexual Morbidity

Sexual dysfunction following a rectal resection has been studied by multiple authors. It is more readily observed in males where it manifests as an inability to obtain an erection or as retrograde ejaculation. In females, the manifestation is usually in terms of dyspareunia related to vaginal dryness from decreased parasympathetic stimulation of excretory glands.

When considering sexual function or dysfunction in patients following restorative proctectomy, it is necessary to compare it with the sexual morbidity related to the alternative, an APR. In one survey, findings indicated that following APR, there was no significant change in the patient's sexual activity. The only index of sexual activity that fell postoperatively was related to marital infidelity. An APR with a permanent stoma adds to the sexual morbidity by adding the psychosocial barriers related to the presence of a stoma, the perceived effect of a stoma on the partner, and the fear of leakage from the stoma appliance. This impact is more likely to be perceived by women than by men and by patients than by their partners.

A more recent prospective study looking at the sexual dysfunction of APR compared with restorative procedures in 295 women revealed that women who underwent APR were half as likely to be sexually active 1 year post rectal resection when compared with their counterparts. The frequency of intercourse improved over time the next 4 years. APR was also associated with a sixfold higher likelihood of dyspareunia and a higher frequency of urologic dysfunctions as well.

The lateral pelvic lymphadenectomy described and published by Japanese groups appears to add to the sexual morbidity related to rectal resection by damaging the IHP overlying the pelvic vessels and associated lymph nodes. This manifests as a higher rate of impotence and bladder dysfunction. When conventional rectal dissection is practiced, and lateral pelvic sidewall lymphadenectomy is not undertaken, the rates of impotence reported by the same authors are significantly lower, and bladder dysfunction is uncommon.

Stoma-Free Survival

Weiser published the most recent and largest series documenting the rates of stoma-free survival in patients with distal rectal cancer undergoing LAR. A subgroup analysis comparing patients undergoing LAR with either stapled coloanal anastomosis versus intersphincteric proctectomy with handsewn coloanal anastomosis was performed. With an even distribution between cohorts (41 and 44, respectively), there was no statistically significant difference in the number and percent of patients being stoma-free at the last follow-up (98% and 86%, $P = 0.06$). Failure to restore intestinal continuity (2% and 5%, respectively) was attributed to anastomotic leakage and one death from cardiovascular causes. Stomas were recreated in four patients in the IRP group due to anastomotic leak (1), rectovaginal fistula (2), and stricture. No stomas were created for poor bowel function.

Effect of Neoadjuvant Chemoradiation

Chemoradiation in the adjuvant or neoadjuvant setting has a dramatic effect on the oncological and functional outcomes in relation to intersphincteric proctectomy. It also has a significant effect on other aspects of a patient's life as revealed in a study that found women who underwent radiotherapy in addition to IRP had a fivefold increase in dyspareunia.

A meta-analysis revealed a local recurrence in 51 of 538 patients (9.5%) following an IRP. Early results revealed a significantly higher rate of LR recurrence following ISR without (46.5%) compared with (14.2%) adjuvant chemoradiotherapy. In a group of 39 patients who also underwent long-course neoadjuvant radiotherapy, a follow-up revealed local recurrence only in three patients (8%), all of whom had lymph node positive disease. Other reports of results following neoadjuvant therapy have not been as impressive with Rouanet reporting a local recurrence rate of 13% in a similar cohort whereas another study reported a surprisingly high recurrence rate of 21%. Although there have been some reports of anastomotic fistulas and pelvic hematomas in these patients, no clear pattern of high rates of anastomotic complications is evident from analyzing studies with high proportions of patients receiving a neoadjuvant therapy. Indeed, the most recent study evaluating LR recurrence and disease-specific survival demonstrated favorable rates despite neoadjuvant chemoradiation therapy and have been described hereinbefore.

Studies of GI function in patients following a neoadjuvant therapy note a decrease in resting and squeeze pressures as well as maximum tolerable volume following IRP. Multivariate analysis revealed only maximum tolerable volume to be correlating with the Wexner/Fecal Incontinence Scores. This change was decreased with a pouch anastomosis. Interestingly, neorectal sensitivity was increased with coloplasty.

When examining factors thought to have contributed to poor bowel function, preoperative radiation therapy was most consistently observed to be the sole prognostic factor. Age, gender, and type of reconstruction technique were not significant (Table 20-7).

TABLE 20-7 One-Year Wexner Fecal Incontinence Score and Kirwan Class Meas

		Kirwan classification			
	Wexner score	I—Perfect	II—Incontinence to flatus	III—Occ. minor soiling	IV—F s
Ito, 2009	10	18 (25)	8 (11)	27 (37)	
Han, 2009		15 (43)	10 (29)	6 (17)	

CONCLUSIONS

IRP, be it subtotal or total, appears to be a viable alternative to abdominal perineal resection in terms of oncologic outcomes while maximizing the quality of life in carefully selected cohorts of patients with malignant disease. Indeed, in properly selected and motivated patients able to undergo IRP, excellent and equivalent recurrence-free survival and disease-specific survival similar to those undergoing LAR with stapled anastomosis have been reported. These oncological outcomes are significantly improved compared with those requiring APR. While avoiding a stoma and maintaining intestinal continuity with sphincter preservation is a principle concern, patients should be counseled as to the expected functional outcome and the real risk of incontinence following an IRP. This is particularly the case if neoadjuvant therapy is utilized for malignant disease. The use of chemoradiation therapy can offer benefits in terms of oncologic result with decreased LR recurrence, improvements in resectability, and sphincter preservation. However, this may come at the cost of worse, yet acceptable, functional outcomes. In these patients, even the best reported results allow for 25% of patients with occasional and major incontinence, though rarely progress to requiring permanent stomas. New techniques and instrumentation, particularly computer-aided minimally invasive surgery—or robotic surgery, have facilitated more distal dissection in the intersphincteric space and may allow for increased numbers of double-stapled anastomoses with improved functional outcomes.

RECOMMENDED REFERENCES AND READINGS

Baker JW. Low end to side rectosigmoidal anastomosis; description of technic. *Arch Surg* 1950;61(1):143–57.

Beppu N, Kimura H, Matsubara N, Tomita N, Yanagi H, Yamanaka N. Long-term functional outcomes of total mesorectal excision following chemoradiotherapy for lower rectal cancer: stapled anastomosis versus intersphincteric resection. *Dig Surg* 2016;33(1):33–42.

Bernstein TE, Endreseth BH, Romundstad P, Wibe A. Circumferential resection margin as a prognostic factor in rectal cancer. *Br J Surg* 2009;96(11):1348–57.

Bernstein WC, Bernstein EF. Sexual dysfunction following radical surgery for cancer of the rectum. *Dis Colon Rectum* 1966;9(5):328–32.

Berry AR, de Campos R, Lee EC. Perineal and pelvic morbidity following perimuscular excision of the rectum for inflammatory bowel disease. *Br J Surg* 1986;73(8):675–7.

Bittorf B, Stadelmaier U, Gohl J, Hohenberger W, Matzel KE. Functional outcome after intersphincteric resection of the rectum with coloanal anastomosis in low rectal cancer. *Eur J Surg Oncol* 2004;30(3):260–5.

Braun J, Treutner KH, Winkeltau G, Heidenreich U, Lerch MM, Schumpelick V. Results of intersphincteric resection of the rectum with direct coloanal anastomosis for rectal carcinoma. *Am J Surg*. 1992;163(4):407–12.

Brennan TV, Lipshutz GS, Gibbs VC, Norton JA. Total mesenteric excision in the treatment of rectal carcinoma: methods and outcomes. *Surg Oncol* 2002;10(4):171–6.

Bretagnol F, Rullier E, Laurent C, Zerbib F, Gontier R, Saric J. Comparison of functional results and quality of life between intersphincteric resection and conventional coloanal anastomosis for low rectal cancer. *Dis Colon Rectum* 2004;47(6):832–8.

Bullock N. Impotence after sclerotherapy of haemorrhoids: case reports. *BMJ* 1997;314(7078):419.

Chamlou R, Parc Y, Simon T, *et al.* Long-term results of intersphincteric resection for low rectal cancer. *Ann Surg* 2007;246(6):916–21; discussion 21–2.

Chung CC, Ha JP, Tsang WW, Li MK. Laparoscopic-assisted total mesorectal excision and colonic J pouch reconstruction in the treatment of rectal cancer. *Surg Endosc* 2001;15(10):1098–101.

Cornish JA, Tilney HS, Heriot AG, Lavery IC, Fazio VW, Tekkis PP. A meta-analysis of quality of life for abdominoperineal excision of rectum versus anterior resection for rectal cancer. *Ann Surg Oncol* 2007;14(7):2056–68.

Dlin BM, Perlman A, Ringold E. Psychosexual response to ileostomy and colostomy. *Am J Psychiatry* 1969;126(3):374–81.

Favuzza J, Brady K, Delaney CP. Transversus abdominis plane blocks and enhanced recovery pathways: making the 23-h hospital stay a realistic goal after laparoscopic colorectal surgery. *Surg Endosc*

2013;27(7):2481–6.
Fazio VW, Mantyh CR, Hull TL. Colonic “coloplasty”: novel technique to enhance low colorectal or coloanal anastomosis. *Dis Colon Rectum* 2000;43(10):1448–50.
Fleshman J, Branda M, Sargent DJ, *et al.* Effect of laparoscopic-assisted resection vs open resection of stage II or III rectal cancer on pathologic outcomes: the ACOSOG Z6051 randomized clinical trial. *JAMA* 2015;314(13):1346–55.
Furst A, Burghofer K, Hutzel L, Jauch KW. Neorectal reservoir is not the functional principle of the colonic J-pouch: the volume of a short colonic J-pouch does not differ from a straight coloanal anastomosis. *Dis Colon Rectum* 2002;45(5):660–7.
Furst A, Suttner S, Agha A, Beham A, Jauch KW. Colonic J-pouch vs. coloplasty following resection of distal rectal cancer: early results of a prospective, randomized, pilot study. *Dis Colon Rectum* 2003;46(9):1161–6.
Guillem JG, Chessin DB, Shia J, *et al.* A prospective pathologic analysis using whole-mount sections of rectal cancer following preoperative combined modality therapy: implications for sphincter preservation. *Ann Surg* 2007;245(1):88–93.
Hallbook O, Pahlman L, Krog M, Wexner SD, Sjodahl R. Randomized comparison of straight and colonic J pouch anastomosis after low anterior resection. *Ann Surg* 1996;224(1):58–65.
Han JG, Wei GH, Gao ZG, Zheng Y, Wang ZJ. Intersphincteric resection with direct coloanal anastomosis for ultralow rectal cancer: the experience of People’s Republic of China. *Dis Colon Rectum* 2009;52(5):950–7.
Heald RJ. The ‘Holy Plane’ of rectal surgery. *J R Soc Med* 1988;81(9):503–8.
Heald RJ, Husband EM, Ryall RD. The mesorectum in rectal cancer surgery—the clue to pelvic recurrence? *Br J Surg* 1982;69(10):613–6.
Heald RJ, Ryall RD. Recurrence and survival after total mesorectal excision for rectal cancer. *Lancet* 1986;1(8496):1479–82.
Heriot AG, Tekkis PP, Constantinides V, *et al.* Meta-analysis of colonic reservoirs versus straight coloanal anastomosis after anterior resection. *Br J Surg* 2006;93(1):19–32.
Hida J, Yasutomi M, Fujimoto K, *et al.* Functional outcome after low anterior resection with low anastomosis for rectal cancer using the colonic J-pouch. Prospective randomized study for determination of optimum pouch size. *Dis Colon Rectum* 1996;39(9):986–91.
Hill GL, Rafique M. Extrafascial excision of the rectum for rectal cancer. *Br J Surg* 1998;85(6):809–12.
Hohenberger W, Merkel S, Matzel K, Bittorf B, Papadopoulos T, Gohl J. The influence of abdomino-peranal (intersphincteric) resection of lower third rectal carcinoma on the rates of sphincter preservation and locoregional recurrence. *Colorectal Dis* 2006;8(1):23–33.
Hojo K, Sawada T, Moriya Y. An analysis of survival and voiding, sexual function after wide iliopelvic lymphadenectomy in patients with carcinoma of the rectum, compared with conventional lymphadenectomy. *Dis Colon Rectum* 1989;32(2):128–33.
Huber FT, Herter B, Siewert JR. Colonic pouch vs. side-to-end anastomosis in low anterior resection. *Dis Colon Rectum* 1999;42(7):896–902.
Ito M, Saito N, Sugito M, Kobayashi A, Nishizawa Y, Tsunoda Y. Analysis of clinical factors associated with anal function after intersphincteric resection for very low rectal cancer. *Dis Colon Rectum* 2009;52(1):64–70.
Jones OM, Smeulders N, Wiseman O, Miller R. Lateral ligaments of the rectum: an anatomical study. *Br J Surg* 1999;86(4):487–9.
Jorge JM, Wexner SD. Etiology and management of fecal incontinence. *Dis Colon Rectum* 1993;36(1):77–

97.
Karanjia ND, Corder AP, Bearn P, Heald RJ. Leakage from stapled low anastomosis after total mesorectal excision for carcinoma of the rectum. *Br J Surg* 1994;81(8):1224–6.
Kasperk R, Schumpelick V. Sphincter preserving techniques: from anterior resection to coloanal anastomosis. *Langenbecks Arch Surg* 1998;383(6):397–401.
Keating JP. Sexual function after rectal excision. *ANZ J Surg* 2004;74(4):248–59.
Keller DS, Ermlich BO, Delaney CP. Demonstrating the benefits of transversus abdominis plane blocks on patient outcomes in laparoscopic colorectal surgery: review of 200 consecutive cases. *J Am Coll Surg* 2014;219(6):1143–8.
Kim HS, Ko S, Oh NG. Long-term results of extended intersphincteric resection for very low rectal cancer: a retrospective study. *BMC Surg* 2016;16:21.
Kirwan WO, Turnbull RB Jr, Fazio VW, Weakley FL. Pullthrough operation with delayed anastomosis for rectal cancer. *Br J Surg* 1978;65(10):695–8.
Kohler A, Athanasiadis S, Ommer A, Psarakis E. Long-term results of low anterior resection with intersphincteric anastomosis in carcinoma of the lower one-third of the rectum: analysis of 31 patients. *Dis Colon Rectum* 2000;43(6):843–50.
Law WL, Chu KW, Choi HK. Randomized clinical trial comparing loop ileostomy and loop transverse colostomy for faecal diversion following total mesorectal excision. *Br J Surg* 2002;89(6):704–8.
Lee EC, Dowling BL. Perimuscular excision of the rectum for Crohn’s disease and ulcerative colitis. A conservation technique. *Br J Surg* 1972;59(1):29–32.
Lee SY, Jo JS, Kim HJ, Kim CH, Kim YJ, Kim HR. Prognostic factors for low rectal cancer patients undergoing intersphincteric resection after neoadjuvant chemoradiation. *J Surg Oncol* 2015;111(8):1054–8.
Leicester RJ, Ritchie JK, Wadsworth J, Thomson JP, Hawley PR. Sexual function and perineal wound healing after intersphincteric excision of the rectum for inflammatory bowel disease. *Dis Colon Rectum* 1984;27(4):244–8.
Lindsey I, George BD, Kettlewell MG, Mortensen NJ. Impotence after mesorectal and close rectal dissection for inflammatory bowel disease. *Dis Colon Rectum* 2001;44(6):831–5.
Long DM Jr, Bernstein WC. Sexual dysfunction as a complication of abdominoperineal resection of the rectum in the male: an anatomic and physiologic study. *Dis Colon Rectum* 1959;2:540–8.
Luca F, Valvo M, Guerra-Cogorno M, *et al.* Functional results of robotic total intersphincteric resection with hand-sewn coloanal anastomosis. *Eur J Surg Oncol* 2016;42(6):841–7.
Lyttle JA, Parks AG. Intersphincteric excision of the rectum. *Br J Surg* 1977;64(6):413–6.

Maas CP, Moriya Y, Steup WH, Kiebert GM, Kranenbarg WM, van de Velde CJ. Radical and nerve-preserving surgery for rectal cancer in The Netherlands: a prospective study on morbidity and functional outcome. *Br J Surg* 1998;85(1):92–7.
Machado M, Nygren J, Goldman S, Ljungqvist O. Functional and physiologic assessment of the colonic reservoir or side-to-end anastomosis after low anterior resection for rectal cancer: a two-year follow-up. *Dis Colon Rectum* 2005;48(1):29–36.
McLemore EC, Harnsberger CR, Broderick RC, *et al.* Transanal total mesorectal excision (taTME) for

rectal cancer: a training pathway. *Surg Endosc* 2016;30(9):4130–5.
Miles WE. A method of performing abdominoperineal excision of carcinoma of the rectum and the terminal portion of the pelvic colon. *Lancet* 1908;2:1812.
Mohiuddin M, Regine WF, Marks GJ, Marks JW. High-dose preoperative radiation and the challenge of sphincter-preservation surgery for cancer of the distal 2 cm of the rectum. *Int J Radiat Oncol Biol Phys* 1998;40(3):569–74.
Moore HG, Riedel E, Minsky BD, *et al.* Adequacy of 1-cm distal margin after restorative rectal cancer resection with sharp mesorectal excision and preoperative combined-modality therapy. *Ann Surg Oncol* 2003;10(1):80–5.
Oates GD, Williams JA. Primary closure of the perineal wound in excision of the rectum. *Proc R Soc Med* 1970;63(Suppl):128.
Park JG, Lee MR, Lim SB, *et al.* Colonic J-pouch anal anastomosis after ultralow anterior resection with upper sphincter excision for low-lying rectal cancer. *World J Gastroenterol* 2005;11(17):2570–3.
Portier G, Ghouti L, Kirzin S, Guimbaud R, Rives M, Lazorthes F. Oncological outcome of ultralow coloanal anastomosis with and without intersphincteric resection for low rectal adenocarcinoma. *Br J Surg* 2007;94(3):341–5.
Rouanet P, Saint-Aubert B, Lemanski C, *et al.* Restorative and nonrestorative surgery for low rectal cancer after high-dose radiation: long-term oncologic and functional results. *Dis Colon Rectum* 2002;45(3):305–13; discussion 13–5.
Rullier E, Laurent C, Bretagnol F, Rullier A, Vendrely V, Zerbib F. Sphincter-saving resection for all rectal carcinomas: the end of the 2-cm distal rule. *Ann Surg* 2005;241(3):465–9.
Rullier E, Laurent C, Garrelon JL, Michel P, Saric J, Parneix M. Risk factors for anastomotic leakage after resection of rectal cancer. *Br J Surg* 1998;85(3):355–8.
Rullier E, Le Toux N, Laurent C, Garrelon JL, Parneix M, Saric J. Loop ileostomy versus loop colostomy for defunctioning low anastomoses during rectal cancer surgery. *World J Surg* 2001;25(3):274–7; discussion 7–8.
Schiessel R, Novi G, Holzer B, *et al.* Technique and long-term results of intersphincteric resection for low rectal cancer. *Dis Colon Rectum* 2005;48(10):1858–65; discussion 65–7.
Stevenson AR, Solomon MJ, Lumley JW, *et al.* Effect of laparoscopic-assisted resection vs open resection on pathological outcomes in rectal cancer: the ALaCaRT randomized clinical trial. *JAMA* 2015;314(13):1356–63.
Tekkis PP, Cornish JA, Remzi FH, *et al.* Measuring sexual and urinary outcomes in women after rectal cancer excision. *Dis Colon Rectum* 2009;52(1):46–54.
Tekkis PP, Heriot AG, Smith J, Thompson MR, Finan P, Stamatakis JD. Comparison of circumferential margin involvement between restorative and nonrestorative resections for rectal cancer. *Colorectal Dis* 2005;7(4):369–74.
Temple LK, Romanus D, Niland J, *et al.* Factors associated with sphincter-preserving surgery for rectal cancer at national comprehensive cancer network centers. *Ann Surg* 2009;250(2):260–7.
Teramoto T, Watanabe M, Kitajima M. Per anum intersphincteric rectal dissection with direct coloanal anastomosis for lower rectal cancer: the ultimate sphincter-preserving operation. *Dis Colon Rectum* 1997;40(10 Suppl):S43–7.
Tilney HS, Tekkis PP. Extending the horizons of restorative rectal surgery: intersphincteric resection for low rectal cancer. *Colorectal Dis* 2008;10(1):3–15; discussion 15–6.
Tiret E, Poupardin B, McNamara D, Dehni N, Parc R. Ultralow anterior resection with intersphincteric dissection—what is the limit of safe sphincter preservation? *Colorectal Dis* 2003;5(5):454–7.

Tranchart H, Benoist S, Penna C, Julie C, Rougier P, Nordlinger B. Cutaneous perianal recurrence on the site of Lone Star Retractor after J-pouch coloanal anastomosis for rectal cancer: report of two cases. *Dis Colon Rectum* 2008;51(12):1850–2.

Ueno M, Oya M, Azekura K, Yamaguchi T, Muto T. Incidence and prognostic significance of lateral lymph node metastasis in patients with advanced low rectal cancer. *Br J Surg* 2005;92(6):756–63.

Ulrich AB, Seiler C, Rahbari N, Weitz J, Buchler MW. Diverting stoma after low anterior resection: more arguments in favor. *Dis Colon Rectum* 2009;52(3):412–8.

Ulrich AB, Seiler CM, Z'Graggen K, Loffler T, Weitz J, Buchler MW. Early results from a randomized clinical trial of colon J pouch versus transverse coloplasty pouch after low anterior resection for rectal cancer. *Br J Surg* 2008;95(10):1257–63.

Wagman R, Minsky BD, Cohen AM, Guillem JG, Paty PP. Sphincter preservation in rectal cancer with preoperative radiation therapy and coloanal anastomosis: long term follow-up. *Int J Radiat Oncol Biol Phys* 1998;42(1):51–7.

Weiser MR, Milsom JW. Laparoscopic total mesorectal excision with autonomic nerve preservation. *Semin Surg Oncol* 2000;19(4):396–403.

Weiser MR, Quah HM, Shia J, *et al.* Sphincter preservation in low rectal cancer is facilitated by preoperative chemoradiation and intersphincteric dissection. *Ann Surg* 2009;249(2):236–42.

Willis S, Holzl F, Krones CJ, Tittel A, Schumpelick V. Evaluation of anastomotic microcirculation after low anterior rectal resection: an experimental study with different reconstruction forms in dogs. *Tech Coloproctol* 2006;10(3):222–6.

Willis S, Kasperk R, Braun J, Schumpelick V. Comparison of colonic J-pouch reconstruction and straight coloanal anastomosis after intersphincteric rectal resection. *Langenbecks Arch Surg* 2001;386(3):193–9.

Yamada K, Ogata S, Saiki Y, Fukunaga M, Tsuji Y, Takano M. Long-term results of intersphincteric resection for low rectal cancer. *Dis Colon Rectum* 2009;52(6):1065–71.

Yoo JH, Hasegawa H, Ishii Y, Nishibori H, Watanabe M, Kitajima M. Long-term outcome of per anum intersphincteric rectal dissection with direct coloanal anastomosis for lower rectal cancer. *Colorectal Dis* 2005;7(5):434–40.

Young-Fadok TM, Fanelli RD, Price RR, Earle DB. Laparoscopic resection of curable colon and rectal cancer: an evidence-based review. *Surg Endosc* 2007;21(7):1063–8.

Zeitels JR, Fiddian-Green RG, Dent TL. Intersphincteric proctectomy. *Surgery* 1984;96(4):617–23.

Z'Graggen K, Maurer CA, Mettler D, Stoupis C, Wildi S, Buchler MW. A novel colon pouch and its comparison with a straight coloanal and colon J-pouch—anal anastomosis: preliminary results in pigs. *Surgery* 1999;125(1):105–12.

Chapter 21

Transanal Total Mesorectal Excision

Chaya Shwaartz and Patricia Sylla

INTRODUCTION

In 1982, Heald *et al.* first described the concept of total mesorectal excision (TME) and established this technique as the gold standard for the surgical treatment of middle and lower rectal cancer. Sharp en bloc resection of the rectum and mesorectum, including high ligation of the inferior mesenteric artery (IMA), was shown to significantly reduce rates of positive circumferential resection margins (CRMs), leading to lower risk of local recurrence and higher cancer-specific survival.

Minimally invasive surgery has been shown to achieve results similar to those of open surgery with respect to oncologic resection of rectal cancer. Multiple randomized controlled trials (RCTs) have shown that laparoscopic TME is associated with similar perioperative morbidity compared to open surgery, with less blood loss, rapid intestinal recovery, shorter hospital stay, and no compromise of oncologic outcomes. Despite the failure of the recent American College of Surgeons Oncology Group Z6051 and Australasian Laparoscopic Cancer of the Rectum RCTs to demonstrate non-inferiority of laparoscopic TME relative to open TME, long-term results from several RCTs continue to support the use of laparoscopic surgery for rectal cancer and show no difference regarding oncologic outcomes. Nevertheless, relatively high conversion rates to open surgery continue to be reported, even when performed in high-volume expert centers. Robotic TME has been touted as associated with a shorter length of hospital stay, and better recovery outcomes when compared to open surgery in patients with low and mid-rectal cancer.

Laparoscopic and robotic surgeries have improved the approach to the pelvis when performing TME, and have been validated from an oncologic standpoint. However, achieving a complete TME with sphincter preservation and negative distal and radial margins for low rectal tumors, while preserving autonomic nerves and avoiding conversion, can be extremely challenging, even in the hands of experienced colorectal surgeons. The anatomic configuration of the distal rectum in tight apposition to the prostate, sacrum, pelvic plexus, and puborectalis, especially the narrow male pelvis, complicates the maneuvering required to complete sharp mesorectal dissection and transect the rectum well below the rectal tumor under direct visualization.

By providing direct and in-line intraluminal and transrectal access to the low rectum and mesorectum, a transanal natural orifice transluminal endoscopic surgery (NOTES) approach, first described in human cadavers in 2007, was proposed as a novel minimally invasive approach to overcome the anatomic limitation of a transabdominal approach to the low pelvis. Transanal proctectomy with total mesorectal excision (or transanal TME) with laparoscopic assistance, whereby TME is undertaken from a "bottoms-up" approach under direct visualization provided through transanal endoscopic multiport platforms, was first described in a clinical case in 2009 and has since become increasingly adopted worldwide as an attractive alternative to standard and minimally invasive TME. Benefits of using a transanal approach to complete the distal-most dissection of the mesorectum had been well described for rectal tumors located less than 5 cm from the anal verge, out of reach from a transabdominal approach, and when sphincter preservation was attempted.

The transanal-transabdominal technique with intersphincteric resection (ISR) has evolved from the necessity of resecting part or all of the internal anal sphincter muscle in continuity with the distal rectum and mesorectum, to achieve negative distal margins for low rectal tumors. Likewise, transanal endoscopic access not only permits early identification and transection of the distal rectal margin with or without ISR but also allows taTME to be carried out entirely through a transanal endoscopic platform. With improved videoscopic visualization and exposure achieved with CO_2 insufflation, nerve-sparing and complete dissection of the mesorectal fascia is greatly facilitated.

Other benefits provided by taTME include that distal rectal transection is performed transanally, under direct vision, and does not require laparoscopic staplers. Another advantage is that transanal specimen extraction, when feasible, avoids the need for specimen extraction sites and reduces wound-related complications. In addition, taTME procedures performed with a two-team approach, with both abdominal and transanal teams working simultaneously, may reduce operating time and intraoperative complications including conversion to open surgery.

Overall, despite the demonstrated benefits in postoperative recovery provided by the use of multi-and single-port laparoscopy and robotics for rectal cancer resection, adoption and conversion rates have plateaued, which reflects the technical difficulties and the lengthy learning curve required for performing TME using these minimally invasive techniques. Since our first report of taTME performed for a mid-rectal cancer using a transanal endoscopic operation (TEO) rigid platform (Karl Storz, Tubingen, Germany) and an early case series reported the feasibility of this approach for rectal cancer, taTME adoption has been facilitated by increased access to disposable transanal minimally invasive facilitated by increased access to disposable transanal minimally invasive surgery (TAMIS) platforms and supported by preliminary small and mid-sized series, confirming the procedural and preliminary oncologic safety of taTME. Thus far, the reported factors driving taTME adoption have been the high success with taTME completion for low rectal tumors, with sphincter preservation and exceedingly low conversion rates. In addition, oncologic results have demonstrated high rates of complete and near-complete TME grade achieved. We believe that in the hands of experienced operators, taTME is becoming the preferred approach for mid-and low rectal tumors, particularly in obese male patients because of the superior exposure provided, for procedures that would otherwise be technically difficult to approach from the abdomen.

The aim of this chapter is to provide a comprehensive review on taTME for rectal cancer, describe the procedure in detail, and summarize the preliminary outcomes of this procedure based on published results from the largest taTME series.

TRANSANAL TOTAL MESORECTAL EXCISION: TRAINING AND STANDARDIZATION OF PROCEDURES

There is clear consensus that taTME should be performed by experienced, skilled, and well-trained surgeons who can outgrow the learning curve in the most efficient way. A recent consensus of an expert group of surgeons from an international taTME conference states that training is necessary before surgeons undertake this procedure. Furthermore, it strongly recommends that surgeons undertake a taTME training course that includes didactic lectures, mentored cadaveric dissection, live surgery, and unedited video before clinical application. Ideally, this approach should be undertaken by high-volume rectal cancer surgeons with expertise not only in laparoscopic or robotic TME but also in transanal endoscopic microsurgery (TEM; Richard Wolf, Knittlingen, Germany), TEO, or TAMIS, and familiar with ISR techniques for very low rectal tumors. Institutions contemplating initiating the taTME program should demonstrate multidisciplinary expertise in the management of rectal cancer with tumor board review of all rectal cancers. Even for surgeons with all prerequisite skills for taTME, in-depth procedural training is mandatory before clinical practice. In addition, proctorship for the first few clinical cases is strongly recommended, given the lack of familiarity with anatomically correct perineal dissection planes from a perineal endoscopic approach. These recommendations stem from the fact that taTME procedures call upon mastery of several essential technical competencies, namely, laparoscopic suturing through a single-incision platform, transanal endoscopic dissection, and, most importantly, familiarity with the perineal anatomy and in-depth understanding of the relationship between the rectum, anal sphincters, prostate, and urethra.

The porcine model has been extensively investigated as a training model for transanal colorectal NOTES. However, because of the bony narrow porcine pelvis that does not allow dissection to the bottom of the pelvic floor, and given the lack of a true mesorectum, it was largely abandoned as a model for taTME training. Fresh human cadavers, on the other hand, are an optimal model for taTME training. In the largest cadaver series of transanal NOTES colorectal resections performed in 32 fresh male and female cadavers, our group demonstrated that although feasible in a few cadavers with favorable anatomy, pure transanal and combined transanal and transgastric NOTES colorectal resections were limited by the lack of specialized instrumentation, and that laparoscopic assistance was necessary to complete transanal NOTES procedures safely. With regard to the procedural learning curve anticipated for these procedures, in this large cadaver study of transanal NOTES colorectal resections, a significant decrease in the operative time and increase in the length of rectosigmoid colon mobilized was achieved after performance of the first five cases. Although no formalized learning curve analysis has yet been performed for taTME, several mid-and large-sized institutional series have demonstrated a significant decrease in operative time with experience. In 2013, Lacy *et al.* reported their first 20 cases of taTME with a mean operating room (OR) time of 234 minutes. In 2015, the same group reported their experience with 140 taTME cases with a mean OR time of 166 minutes. Although this decrease in OR time may reflect the increased use of a synchronous two-team approach, it may also reflect the impact of the learning curve for surgical teams that have become experienced with taTME.

In 2014, Buscaglia *et al.* presented an alternative to cadaver and animal training. They introduced transanal NOTES sigmoidectomy training using an endoscopy simulation model. Four participants (two colorectal surgeons and two gastroenterologists) performed simulated NOTES sigmoidectomy with a baseline test, mentored training sessions, and a non-mentored simulated final test to the final testing. They showed a 42% reduction in operative time from the baseline performance. This preliminary data suggest that simulator use before performing the procedure in animal or cadaver models may improve the training process.

In a recent video manuscript, Mclemore *et al.* proposed a rigorous training pathway for taTME. This included team training in a fresh cadaver the day before the first clinical case with the same operative team consisting of surgeons, nurses, and operative staff. In addition, the case was proctored by an experienced taTME surgeon. The authors reiterated the key elements for successful development of a taTME program, including expertise in minimally invasive and sphincter-preserving TME, TES, and ISR for very low rectal invasive neoplasms. Experience with this first case reaffirmed the importance of procedural team training in cadavers.

One of the challenges of taTME has been the lack of standardization of the technique. Published reports and video presentations continuously demonstrate variations in operative setup and sequence, dissection and anastomotic techniques, and instrumentation that may or may not impact outcomes. Ongoing efforts are under way to define standard steps of taTME dissection using video-based assessments, to standardize procedures in preparation for randomized controlled comparison of taTME to other TME approaches.

Overall, prerequisite expertise in rectal cancer resections and appropriate procedural training in taTME will profoundly impact intraoperative and postoperative outcomes, especially the quality of the mesorectal dissection achieved and hence short-and long-term oncologic outcomes. Formal taTME cadaver training courses incorporate video-based didactics and hands-on training cadaver training courses incorporate video-based didactics and hands-on training by experienced proctors. In the United States, the first American Society of Colon and Rectal Surgery (ASCRS)-sponsored taTME hands-on cadaver course and symposium was organized in May 2016.

The international (Low Rectal Cancer National Development Program) LOREC taTME registry contains 720 taTME cases performed for benign and malignant indications. The (American Society of Colon and Rectal Surgeons Optimizing the Surgical Treatment of Rectal Cancer) ASCRS OSTRiCh taTME registry used by US surgeons is identical to the LOREC registry. While awaiting the results of large prospective phase II taTME studies or RCT comparing taTME to open and or minimally invasive TME, it is hoped that these registries will accurately reflect current trends with adoption and outcomes of taTME, including operative techniques, indications, and procedural, postoperative, oncologic, and functional results. Large-scale data collected for these registries may also help standardize the technique.

INDICATIONS/CONTRAINDICATIONS

Indications for Transanal Total Mesorectal Excision

There are no strict indications for using taTME rather than open, laparoscopic, or robotic TME at this time. However, on the basis of the unanimous reports of enhanced visualization of and unobstructed in-line access to rectal and mesorectal dissection planes provided by the transanal approach, taTME is particularly well suited for a subset of rectal tumors and for patients with rectal cancer. Performing rectal resection in a morbidly obese male patient with a narrow pelvis can be very challenging even for an experienced surgeon, especially when oncologic resection is the goal. As reflected by the fact that the large majority of taTME cases published to date have been performed for tumors located 5 cm or less from the anal verge, the patients who would benefit the most from this approach are males with a narrow and deep pelvis, particularly males with significant visceral obesity, an enlarged prostate, with tumors located ≤5 cm from the anal verge. These are the same tumor and patient characteristics that predict a more challenging dissection and a high risk of conversion when utilizing a minimally invasive transabdominal approach. However, as with any other oncologic resection, careful patient selection is essential to optimize outcomes including selection of resectable tumors with predicted negative circumferential radial margins based on preoperative magnetic resonance imaging (MRI) staging.

taTME is ideally suited for very low rectal tumors when the goals of resection include sphincter preservation along with a complete mesorectum and negative margins. Tumors located within 1–2 cm of the dentate line require partial or complete ISR. taTME procedures in this subset of tumors are more technically challenging and require familiarity with intersphincteric anatomy and dissection techniques. It is strongly recommended that, early in the operator’s learning curve, ISR be performed using a traditional open transanal approach to identify mesorectum and other anatomic landmarks. Completion of taTME can then be performed through the transanal endoscopic platform. The steep learning curve associated with these more complex cases can be overcome by first mastering the taTME technique for low and mid-rectal tumors, and/or when combined with completion proctectomy for benign indications.

Contraindications to Transanal Total Mesorectal Excision

Excision

Tumor Stage

At this time, there are no absolute contraindications for this procedure. However, taTME is relatively contraindicated in patients with persistent clinical T4 disease despite treatment with neoadjuvant therapy. taTME can be combined with en bloc vaginectomy, prostatectomy, anterior or posterior exenteration with transabdominal assistance, and any other procedure required to achieve an R0 resection; but in those circumstances sphincter preservation may not be reasonable. Likewise, taTME is relatively contraindicated in patients with persistent predicted positive CRM or involvement of the levator ani or external anal sphincter based on restaging pelvic MRI following neoadjuvant therapy. In the latter case, standard open or minimally invasive abdominoperineal resection (APR) or extralevator abdominoperineal excision should be performed to achieve an R0 resection. Patients with an already compromised sphincter function may be able to have taTME anatomically, but the functional outcome will be unacceptable.

Anatomic Factors and Reoperation

taTME has been relatively contraindicated in the reoperative pelvis and in patients with prior pelvic radiation, because of anticipated difficulties with dissection of correct anatomic planes with increased risk of injury to the rectum, vagina, prostate, ureters, or urethra. The presence of an enlarged prostate and prostate cancer (after prior treatment with radioactive seeds) is considered a relative contraindication to taTME because of potential urethral injury. The transanal approach may facilitate redo colorectal and coloanal anastomoses and salvage proctectomy following anastomotic recurrence. Borstlap *et al.* reported their experience with taTME in redo colorectal anastomoses: 14 cases of anastomotic reconstruction and three cases of completion proctectomy. Overall, they reported a 14% anastomotic leak rate and 24% incidence of pelvic abscess requiring reintervention.

Rectal Tumor Location

There is a strong consensus that there is minimal benefit in using taTME for tumor-specific total mesorectal excision. Stapled anastomosis is not usually technically difficult. Completing a stapled colorectal anastomosis following taTME, 5 cm from the anal verge, requires multiple additional steps that render this procedure technically challenging. Purse string closure of the open rectal stump must be performed through the transanal platform. The anvil in the proximal colon must be guided laparoscopically toward the center of the rectal purse string. Finally, the distal rectal purse string must be tied around the proximal anvil.

PREOPERATIVE ASSESSMENT AND PLANNING

Preoperative Staging

Preoperative evaluation includes multidisciplinary tumor board review of each rectal cancer case, with consensus on the best therapeutic strategy, including the need for neoadjuvant treatment and most appropriate surgical approach based on tumor staging, predicted CRM status, and relationship of the tumor to the anal sphincters and anorectal ring. Patients who are eligible for low anterior resection (LAR) with TME are extensively counseled about the need for a temporary fecal diversion, and the expected outcomes with taTME versus other TME approaches, particularly with regard to intraoperative and postoperative risks, expected length of hospital stay and overall recovery, short-and long-term oncologic outcomes, and anticipated defecatory dysfunction. This is particularly important in patients with low rectal tumors who are candidates for TME with ISR and hand-sewn coloanal anastomosis, and who are highly motivated to avoid APR.

Preoperative Preparation

Full oral mechanical and antibiotic bowel preparation is recommended for taTME, with enemas in the evening before surgery. A poorly prepped rectum must be avoided because it will compromise tumor identification and accurate endoscopic placement of the occluding purse string suture. Preoperative deep venous thrombosis and antibiotic prophylaxis is provided as per routine protocols. Strategies for pain control include transversus abdominis plane block, epidural catheter, and/or standard patient-controlled anesthesia. A bladder catheter is inserted and patients are positioned in lithotomy position using stirrups, with arms tucked to the side, and both the abdomen and the perineum prepped and draped.

SURGERY

Operating Room and Team Setup

Although it is strongly recommended that taTME procedures be performed as a two-team approach, with both abdominal and transanal teams working simultaneously, at least during the transanal endoscopic portion, many surgeons perform this procedure as a single-team approach and perform both abdominal and transanal dissection sequentially. The abdominal and transanal teams should be provided with a video feed of the other team's operative field so that surgical steps can easily be synchronized. ORs with ample space should be utilized so that there is sufficient space to accommodate tables and equipment for both teams, including the robot in case the abdominal team plans on docking the robot for the abdominal dissection.

When taTME is performed using rigid transanal platforms, a single transanal operator is usually seated in between the patient's legs, because the videoscope is anchored to the platform which is in turn anchored to the OR table. However, when performed using TAMIS platforms, a dedicated camera operator is needed, in addition to the transanal surgeon, for the entire duration of transanal procedure.

Equipment

Combined CO_2 insufflation and smoke evacuation provides a steady-state pressure without collapse of the operative field. The TEM platform is equipped with an integrated automatic pressure-controlled CO_2 insufflation system. AirSeal System (SurgiQuest, Inc, Milford, CT) has become the most commonly used insufflation and filtering system during taTME procedures, and can easily be combined with TAMIS platforms. The system provides a continuous flow circuit that evacuates CO_2 and smoke and quickly recirculates filtered and high-pressure CO_2, thereby maintaining a stable pneumorectum at all times.

The use of bipolar energy during transanal dissection should be minimized. Nerve injury from excessive heat from dissecting instruments should be avoided. Transanal dissection should be primarily performed using monopolar energy.

The list of recommended equipment for taTME takes into account the use of either the TEO rigid platform or the GelPOINT Path TAMIS platform (Applied Medical, Rancho Santa Margarita, CA).

SURGICAL PROCEDURE

One-Versus Two-Team Approach

When possible, a two-team approach should be used, where the abdominal and transanal teams work simultaneously during the entire duration of the transanal dissection to shorten the operative time. The improved visualization of deep pelvic structures by combining the view from the abdominal and transanal vantage points may increase the accuracy of the dissection. Table 21-1 includes a list of recommended equipment for taTME.

TABLE 21-1 Suggested Abdominal and Transanal Equipment List for taTME

ABDOMINAL EQUIPMENT
Standard laparoscopic bowel resection tray
Four to five 5-mm trocars and one 12-mm trocar
Monopolar cautery
Bipolar device
Pelvic drain
Stoma appliance
Small wound protector
TRANSANAL EQUIPMENT USING TEO PLATFORM
Headlight
Standard anorectal tray
Lone Star retractor with spikes
Monopolar cautery
Standard insufflation system
Standard high-flow insufflator unit (UHI-4, Olympus Medical Systems, Tokyo, Japan)
Plastic anoscope (graduated plastic anoscope that is part of the Medtronic (Minneapolis, MN) PPH stapler set)
TEO set (proctoscope, camera, and angled-tip instruments)
Flexible tip hook dissector (Medtronic, Mansfield, MA)

Flexible tip hook dissector (Medtronic, Mansfield, MA)	
EEA staplers (28 or 31 mm)	
3-0 Vicryl and 2-0 Prolene sutures	
Indocyanine green fluorescence imaging	
Angled-tip laparoscopic instruments	
TRANSANAL EQUIPMENT USING TAMIS PLATFORM	
Headlight	
Standard anorectal tray	
Lone Star retractor with spikes	
Monopolar cautery	
Insufflation and smoke evacuation system (AirSeal System ConMed Utica, NY)	
Plastic anoscope (preference is the graduated plastic anoscope that is part of the Medtronic PPH stapler set)	
TAMIS platform (GelPOINT Applied Medical, Ranch Santa Margarita, CA Path or SILS Medronic, Minneapolis, MN)	
Bariatric length 5-mm 30-degree scope with an angled light cord for TAMIS	
Circular staplers (28 or 31 mm)	
3-0 Vicryl and 2-0 Prolene sutures	
Indocyanine green fluorescence imaging	
Angled-tip laparoscopic instruments	

EEA, end-to-end anastomosis; TAMIS, transanal minimally invasive surgery; taTME, transanal total mesorectal excision; TEO, transanal endoscopic surgery.

The two-team approach usually starts with the abdominal portion, with placement of laparoscopic trocars per standard for laparoscopic LAR (Fig. 21-1). The abdominal team proceeds with high ligation of the IMA and inferior mesentery vein, followed by sharp mobilization of the sigmoid and rectosigmoid mesentery. Transanal dissection is then initiated while the abdominal team continues mobilizing the left colon and performs a complete splenic flexure takedown. Care must be taken to reduce the total CO_2 insufflation pressures and avoid CO_2 retention and embolism. Typically, abdominal pressures are reduced from 15 down to 10 mm Hg, whereas transanal pressures are maintained at 10–12 mm Hg. Leg position in stirrups and the degree of Trendelenburg must be adjusted to optimize exposure for the transanal team and avoid obstructing the abdominal team from maneuvering.

p. 191

p. 192

FIGURE 21-1 Trocar position for the laparoscopic portion of transanal total mesorectal excision (TME) with diverting loop ileostomy. Excellent cosmetic results are achieved when transanal specimen extraction is possible.

p. 192

p. 193

As transanal dissection proceeds cephalad and approaches the level of the peritoneal reflection anteriorly, the abdominal team should have completed left colonic mobilization and started mobilizing the upper portion of the rectum and mesorectum. The abdominal team usually provides the most assistance with the posterior aspect of the TME, namely, mobilization of the posterior mesorectum, which is usually challenging to complete transanally. The steep angle of the sacral promontory usually precludes proximal dissection of the mesorectum by the transanal team, and the abdominal team should preferentially dissect the mesorectum posteriorly toward the pelvic floor. On the other hand, anterior mesorectal mobilization should be preferentially performed entirely transanally, which is where taTME has a unique advantage over any other surgical approach. Anterior mobilization ends with peritoneal entry. Incision of the cul-de-sac is performed by the transanal team under vision by the abdominal team, and followed by the combined transanal and abdominal dissection to complete the TME. The rendezvous approach to complete the TME is a major advantage of taTME. It combines complementary views with angles of retraction and dissection from the abdominal and transanal perspective.

The colon must be delivered transanally for colorectal or coloanal anastomosis. This is facilitated by the abdominal team.

A one-team approach is widely used with excellent outcomes, and is particularly attractive for surgeons who prefer completing the abdominal dissection robotically. A two-team approach is not always practical. The transanal team employs abdominal assistance during critical times; at the time of transanal peritoneal entry, during the rendezvous portion of the case, when completing rectal and mesorectal mobilization, during specimen extraction, and especially during delivery of the colonic conduit transanally. This allows visual confirmation of the lack of tension and ischemia before colorectal or colonanal anastomosis.

Although some centers will initiate taTME procedures with the transanal dissection portion first, especially when attempting pure NOTES taTME, there is consensus among experts that whether a one-team or two-team approach is used, abdominal access should be established first, before transanal dissection. This is based on standard oncologic principles established by Heald et al., which apply to open and minimally invasive TME and include high ligation of the inferior mesenteric vessels before mesorectal dissection and rectal tumor manipulation.

The extent of pelvic dissection depends on the surgeon's preference; but as a general rule, it is usually carried out until more distal rectal and mesorectal dissection becomes difficult because of poor exposure. Most one-team operators maintain laparoscopic or robotic TME until the peritoneal reflection is reached anteriorly and extend the posterior mesorectal dissection until it becomes obstructed or complicated by limited exposure. At that point, the one-team operator will desufflate the abdomen and will initiate taTME. Upon transanal completion of the TME, assistance may be provided by an abdominal operator for the rendezvous dissection, specimen extraction, and completion of the anastomosis. Alternatively, the same team will return to the abdominal approach to complete any additional steps, including loop ileostomy creation, pelvic drain placement, and abdominal wound closure.

Transanal Total Mesorectal Excision with Low Anterior Resection

The patient is positioned in high lithotomy position. Whether a one-team or two-team approach is utilized, the steps of transanal dissection are dependent on the exact location of the rectal cancer relative to the dentate line and anorectal ring, because it will affect whether or not ISR is needed. Following confirmation of the exact location of the tumor by digital rectal examination, anoscopy, and/or proctoscopy, a decision is made with respect to the exact level of distal rectal transection needed to ensure a negative distal margin.

The most important first step of the transanal dissection is the occlusion of the rectum with a purse string suture below the tumor. For tumors that are >2 cm above the dentate line, or ≥1 cm above the anorectal ring, that is, when ISR is not needed, the purse string suture is placed to occlude the rectum 0.5–1 cm below the tumor. If the tumor is located <5 cm from the anal verge, the purse string can be placed directly after exposure is achieved with a Lone Star retractor and anoscope. This is followed by insertion of the transanal platform. It is our preference to use a disposable graduated plastic anoscope, part of a stapled hemorrhoidectomy kit (Fig. 21-2). If the tumor is located ≥5 cm from the anal verge, the transanal platform is inserted first, followed by endoscopic placement of the purse string suture to occlude the rectum. Our preference is to use a 2-0 Vicryl purse string, but a suture of 2-0 Prolene may be used (Fig. 21-3). The purse string suture must be airtight to avoid distension of the proximal colon with CO_2, and spillage of fecal material or tumor cells into the operative field. If upon CO_2 insufflation to 10–15 mm Hg through the rectum, the purse string is leaking, it must be redone or reinforced.

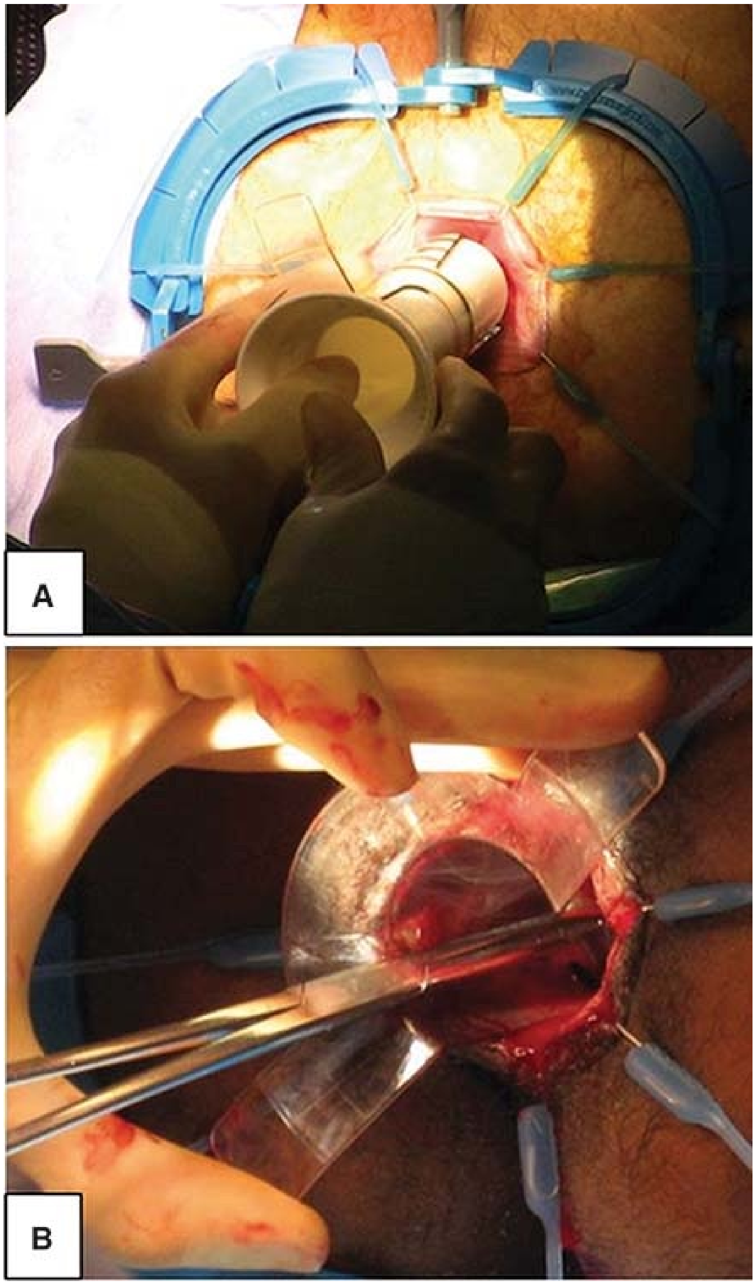


FIGURE 21-2 A Lone Star retractor (Cooper Surgical, Trumbull, CT) and plastic anoscopy (A) are used to facilitate transanal placement of a pursestring suture to occlude the rectum below low-lying rectal tumors (B).

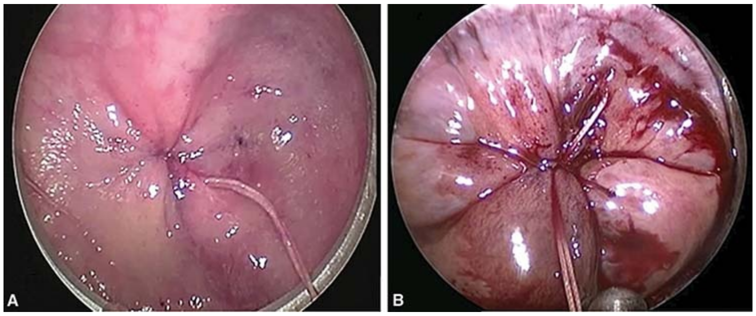


FIGURE 21-3 Purse string occlusion of the rectum for a rectal tumor located >5 cm above the anorectal ring (A). Purse string occlusion of the rectum for a rectal tumor located <5 cm below the anorectal ring (B), close to the dentate line.

p. 193

p. 194

Following purse string occlusion of the rectum, the rectal mucosa is incised with monopolar cautery, followed by full-thickness circumferential incision of the rectal wall (Fig. 21-4). Full-thickness rectal and mesorectal mobilization is carried out using monopolar cautery, with efforts to limit the use of bipolar energy to control troublesome bleeding. Posterior mesorectal dissection must be carried out along the avascular plane between the posterior mesorectum and presacral fascia (Fig. 21-5), and is usually the easiest to achieve because of the easily identifiable anatomic landmarks. The presacral fascia, the shiny mesorectal fascia and the angel hair plane in between, guides the dissection. Care must be taken to avoid dissection too close to the sacrum and injury to the presacral plexus. We suggest starting the taTME dissection posteriorly and then following the TME plane laterally and anteriorly. Anteriorly, dissection is carried out between the rectovaginal fascia or rectoprostatic fascia (Fig. 21-6). Laterally, care must be taken to avoid dissection of the pelvic sidewall during mesorectal mobilization, to preserve the nervi erigente. During the anterolateral dissection of the rectum and mesorectum, care must be taken to avoid injury to the neurovascular bundles bilaterally. It also serves as a landmark for the location of the prostate, if difficulties are encountered during anterior mobilization and identification of the posterior aspect of the prostate. It is important to emphasize that dissection should be carried out circumferentially and in a sequential pattern, and every effort is made to avoid uneven dissection to circumvent plane distortion, which can disorient and lead the operator astray. Of note, one of the key advantages of the transanal approach is the effect of the pneumorectum, which dissects avascular tissue planes around the rectum. Ultimately, anterior dissection is carried out cephalad until the peritoneal reflection is reached as described earlier. Peritoneal entry is usually performed transanally and under laparoscopic visualization from above (Fig. 21-7). Posteriorly, depending on the angulation of the sacral promontory, transanal dissection can usually be extended toward S1–S2 levels. The remainder of the posterior and lateral dissection is completed using a combined abdominal and transanal approach (Fig. 21-8). An en bloc transanal prostatectomy with urethral anastomosis is feasible as first described by Wexner and Sands at Cleveland Clinic Florida.

p. 194

p. 195

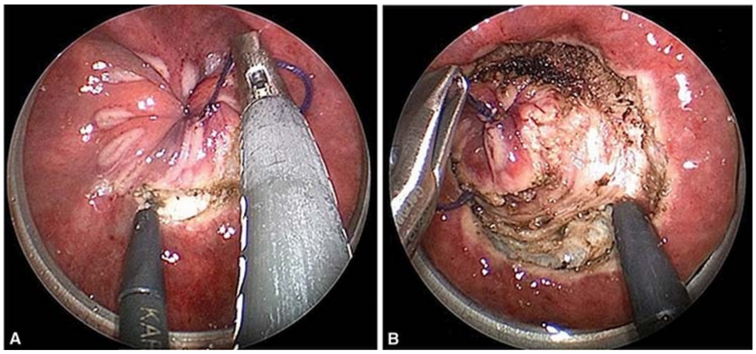


FIGURE 21-4 The rectum is insufflated with CO_2 and the rectal mucosa is scored circumferentially with monopolar cautery (A) followed by full-thickness incision through the rectal wall (B).

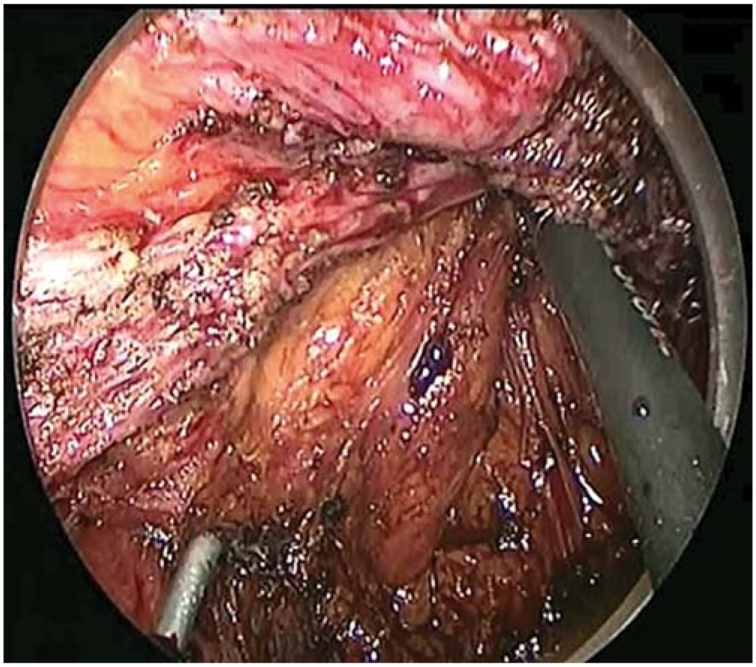


FIGURE 21-5 Posterior mobilization of the rectum and mesorectum is carried out sharply through the transanal endoscopic platform.

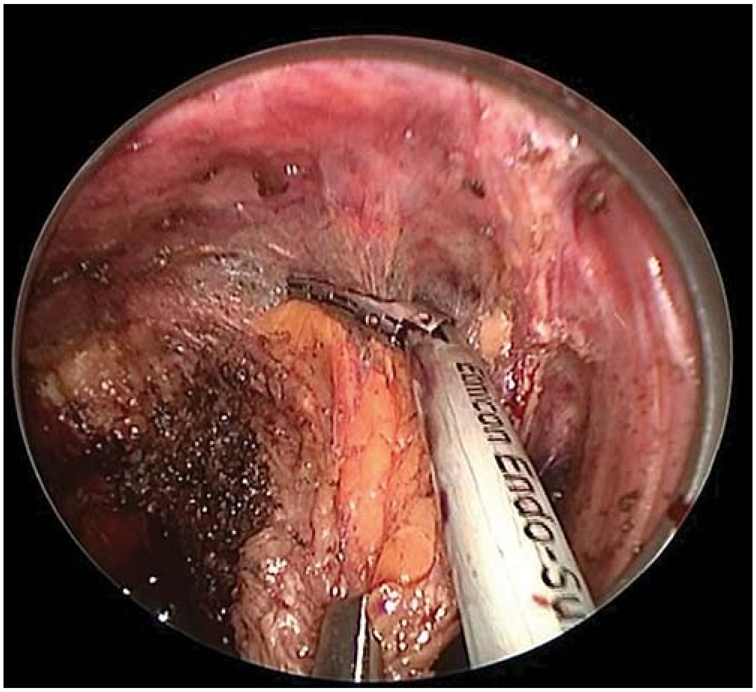


FIGURE 21-6 Anterior and lateral mobilization of the rectum and mesorectum is carried out sharply through the transanal endoscopic platform. Anteriorly, the plane between the anterior rectum and the posterior vagina or prostate is dissected under excellent visualization.

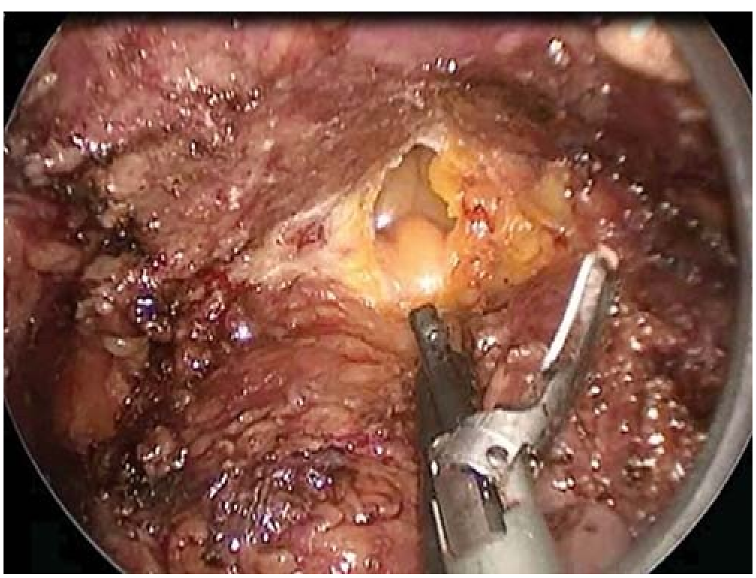


FIGURE 21-7 Transanal anterior rectal and mesorectal dissection proceeds until the peritoneal reflection is reached anteriorly and divided

transanally.

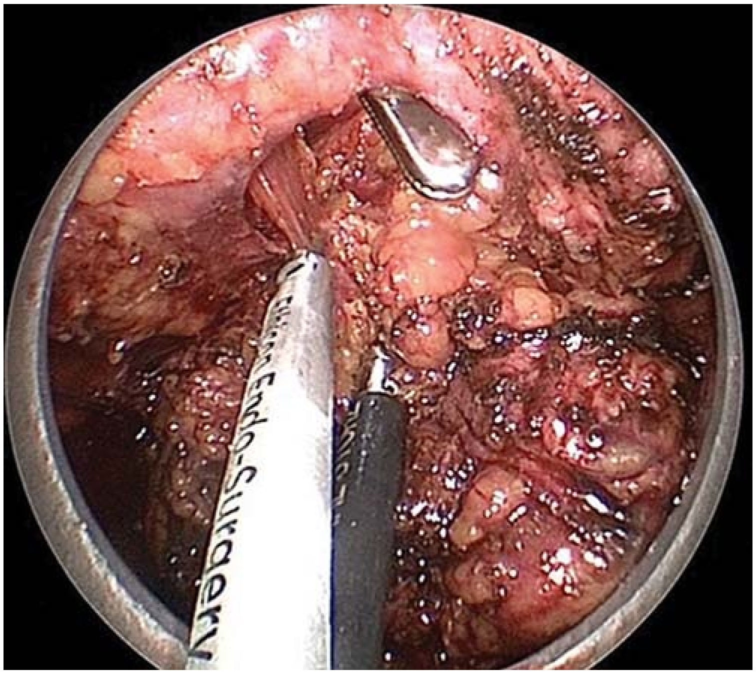


FIGURE 21-8 Rectal and mesorectal mobilization is completed using a rendezvous technique with combined abdominal and transanal dissection to divide all remainder attachments.

Specimen Extraction

Following complete mobilization of the TME specimen, the colon is either exteriorized transanally or through an abdominal incision (Fig. 21-9). An abdominal extraction incision can usually be avoided in the majority of the patients except when the specimen is deemed too bulky to permit transanal extraction without tearing, or when excessive tension on the marginal artery blood supply threatens perfusion of the coloanal anastomosis. Common extraction sites include a low Pfannenstiel incision, a lower vertical midline incision, or the planned loop ileostomy site in the right lower quadrant. Fluorescence imaging with Indocyanine green (ICG) is performed before proximal colon transection, which is particularly useful following transanal pull-through, to confirm the viability of the colonic conduit before completing the anastomosis. Following transection of the specimen, stapled colorectal anastomosis is carried out when feasible. The TME specimen is sent fresh to pathology, photographed, and processed according to standard TME protocols (Fig. 21-10).

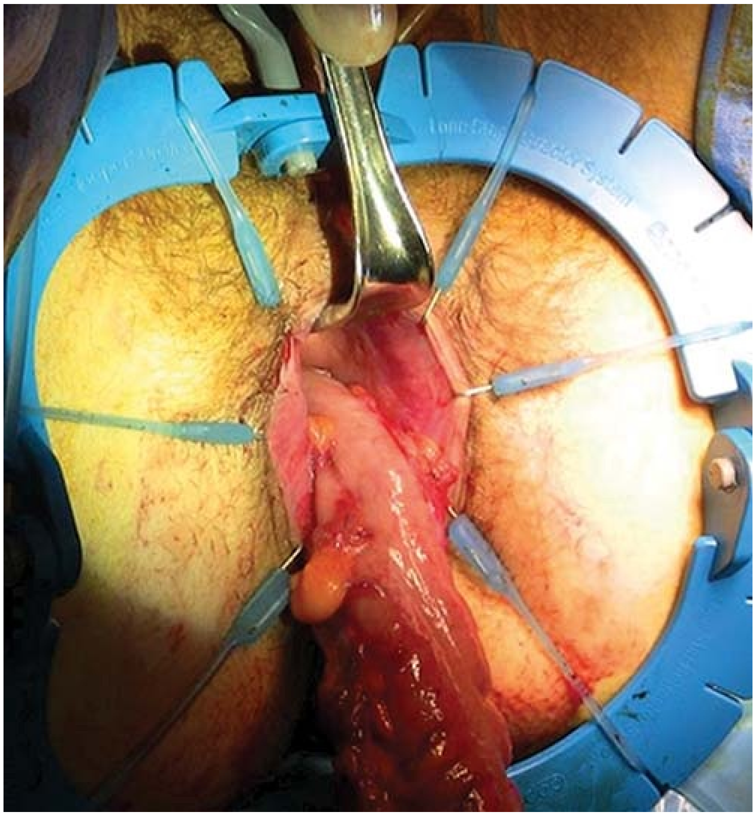


FIGURE 21-9 When feasible, the total mesorectal excision (TME) specimen is extracted transanally followed by hand-sewn or stapled colorectal or coloanal anastomosis.

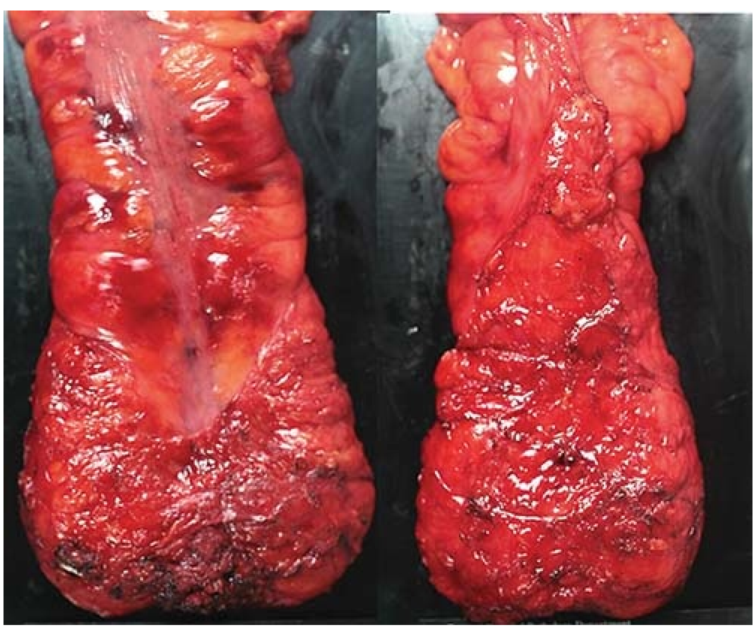


FIGURE 21-10 Total mesorectal excision (TME) specimen photographed anteriorly and posteriorly following transanal total mesorectal excision (taTME).

Stapled Colorectal Anastomosis

Several anastomotic techniques are possible when hand-sewn coloanal anastomosis is not absolutely required, that is, when rectal transection was initiated well above the dentate line. A double purse string stapled anastomosis technique is used, with end-to-end, side-to-end, coloanal J-pouch, or transverse coloplasty, depending on the surgeon’s preference. A full-thickness purse string suture must first be placed on the distal open rectal stump through the transanal platform, and it is crucial that this purse string be intact and complete to ensure a complete anastomosis. If the rectal stump is relatively high, purse string placement must be endoscopically performed. A red rubber catheter placed on the anvil located in the proximal colon can be then pulled through the distal rectal purse string, which is then tied around it and used to guide the circular stapler into correct position and under visualization and guidance by the abdominal team.

After firing the stapler, the anastomosis should be inspected and reinforced with sutures as needed, and a leak test can be performed as per the surgeon’s preference. Endoscopic fluorescence imaging of the anastomosis with indocyanine green (ICG) ICG is performed to more objectively assess anastomotic perfusion.

Transanal Total Mesorectal Excision with Low Anterior Resection and Intersphincteric Resection

For tumors located <2 cm from the dentate line or <1 cm from the top of the anorectal ring, ISR, either partial or complete, is performed first to achieve negative distal resection margins. ISR is performed first through a Lone Star retractor using monopolar cautery. Full-thickness, circumferential incision of the rectal wall to enter the intersphincteric plane is then extended cephalad until the puborectalis and bottom of the mesorectum are identified posteriorly, and the rectovaginal or retroprostatic plane is visualized anteriorly. The anorectal stump is then closed with a purse string suture and the transanal platform is inserted followed by CO_2 insufflation of the distal rectal stump. Further dissection is needed posteriorly, including division of the anococcygeal raphe to access the retromesenteric plane. Following identification of the inferior aspect of the mesorectum posteriorly, and the rectovaginal or rectoprostatic plane anteriorly, taTME can proceed as described. Following specimen extraction, hand-sewn coloanal anastomosis is performed using end-to-end, side-to-end, coloanal J-pouch, or transverse coloplasty with a protective ileostomy.

Transanal Total Mesorectal Excision with Abdominoperineal Resection

For rectal tumors necessitating APR, taTME can facilitate the perineal dissection, particularly in the obese male patient. Procedures are performed in lithotomy position and abdominal access is achieved followed by laparoscopic, robotic, or open ligation of the inferior mesenteric vessels, mobilization of the left colon and rectosigmoid, and proximal TME dissection. Abdominal dissection is performed either before taTME (one-team approach) or concurrently with taTME (two-team approach, Fig. 21-11). If performed as a one-team approach, the colon can be transected and the colostomy prepared for maturation before moving to the perineal dissection.

FIGURE 21-11 Two-team operative setup during transanal total mesorectal excision (taTME). Both abdominal and transanal teams are working simultaneously during critical portions of the

operation.

Perineal dissection is initiated in a standard manner with suture closure of the anus followed by extrasphincteric proctectomy using monopolar cautery, a Lone Star retractor, and a standard perineal tray. Transanal dissection is superiorly extended until the perineal body has been divided and the rectoprostatic or rectovaginal plane is identified. Posteriorly, dissection is carried out until the puborectalis is visualized. The transanal platform is then inserted with CO_2 insufflation, and further rectal dissection is carried out endoscopically as described previously. Of note, surgeons will often complain of critical CO_2 leakage around the transanal platform because of the large size of the perineal wound. When using a rigid TEM and TEO 4-cm-wide platform, leakage can usually be resolved by placing sutures to occlude the perineal skin around the platform. When using TAMIS, a strategy described is the use of a wider single-incision platform, like the Gelport Laparoscopic System (Applied Medical). Following the proctectomy, the specimen is exteriorized transanally followed by perineal wound closure in layers.

POSTOPERATIVE MANAGEMENT AND FOLLOW-UP

Patients undergoing taTME are managed using the same enhanced recovery protocols as with any other minimally invasive TME procedure. Removal of the Foley catheter is usually delayed until the second or third postoperative day in patients with risk factors for urinary retention; males with an enlarged prostate and benign prostatic hyperplasia, and patients who have undergone deep perineal dissection and very low LAR. Additional parenteral antibiotics are given as indicated, and patients are discharged home according to standard protocols once adequate pain control, oral fluid intake, stoma function, and teaching have been achieved.

Postoperative oncologic surveillance after taTME follows standard National Comprehensive Cancer Network guidelines for rectal cancer. Coloanal or colorectal anastomoses are evaluated using standard gastrografin enema and endoscopic assessment to rule out anastomotic complications. Ileostomy closure is performed approximately 3 months postoperatively, or deferred until completion of adjuvant treatment if indicated.

COMPLICATIONS

The first clinical case of a NOTES transanal resection using TME and laparoscopic assistance in 2009 was performed in a female patient with a cT2N2 rectal cancer located 8 cm from the anal verge and treated with neoadjuvant chemoradiation. The procedure was completed in 270 minutes with no complications, with 23 negative nodes, negative distal and radial margins, and a complete mesorectum. This first case was performed under institutional board review approval, as were the first few case series on this approach. These early reports demonstrated the feasibility and procedural safety of hybrid taTME with good short-term oncologic and functional outcomes.

Overall, a total of 13 taTME series with a sample size greater than 15 patients (range 16–140) have been published. The conversion rate was 3% and intraoperative complication occurred in 21 patients (3.1%) including significant intraoperative bleeding in 8 patients, three perforations, four urethral injuries, one prostatic injury, one ureteral injury, one vaginal wall injury, one air embolism, and one injury to the iliac vessels. Intraoperative complications tend to occur relatively early in the learning curve. The use of a hybrid procedure (laparoscopic assisted) may potentially lower the risks of intraoperative complications.

The overall mortality rate was less than 1%. There was one 30-day postoperative mortality in a 71-year-old male with myocardial infarction 3 days after surgery and a second mortality 8 weeks postoperatively from a pulmonary embolism. The rate of postoperative morbidity was 30% across these series and complications include anastomotic leak, ileus, intra-abdominal abscess/collection, urinary disorders (urinary retention and urinary dysfunction not otherwise specified), dehydration, and acute renal failure due to high ileostomy output, small bowel obstruction, wound infection, hemorrhage, postoperative fever, transfusion, sepsis, anastomotic bleeding, urinary tract infection, pelvic hematoma, pneumonia, bowel ischemia, cerebrovascular accident, ischemia of the proximal limb of colon, small bowel laceration.

Some studies reported delayed postoperative complications (more than 30 days following surgery), which included anastomotic stricture, delayed pelvic sepsis, high ileostomy output, and sexual dysfunction.

Urethral injury is a rare complication when performing laparoscopic and open TME even during a challenging APR or a recurrent case. The estimated incidence is 1.5–2%. Thus far, four cases of urethral injuries during taTME have been reported in three series. Fifty percent of reported urethral injuries occurred in the Rouanet study, which was not entirely surprising given the selection of high-risk patients, including males with very low, bulky, and mostly anterior tumors. The authors pointed out that the two urethral injuries occurred early in their learning curve and during dissection of bulky anterior tumors, one of them with concomitant prostatic carcinoma. On the basis of this report and personal communications with surgeons who have faced this complication, the risk of urethral injury seems to be highest early during surgeon's learning curve, during difficult anterior dissection, and in patients with bulky anterior rectal tumors or enlarged prostate. Although Penna *et al.* reported a 0.7% rate of urethral injuries among the first 720 cases of taTME voluntarily entered in the LOREC international taTME registry, based on personal communications with other surgeons who have faced this complication, it is suspected that this injury may be grossly underreported. Risk factors for these injuries include very low rectal tumors in males when partial or complete ISR is needed, bulky and anterior tumors, a large and bulky prostate, previous radiation, and prior prostatectomy. Furthermore, on the basis of published experience and reports from other surgeons about complications with this injury, it appears that the injury is more likely to occur early along the adopter's learning curve, when the operator is insufficiently trained in and familiar with the bottoms-up and deep perineal anatomy. These reports again emphasize the critical importance of adequate procedural training in taTME, proctoring during the operator's early experience, and participation in a taTME registry.

With regard to perioperative morbidity associated with taTME, the published rates are comparable to historical rates following open and laparoscopic TME. Long-term functional disturbances such as defecatory, urinary, and sexual dysfunction are largely unknown and need to be investigated in larger long-term trials.

RESULTS

Since the first case report of hybrid taTME, it is estimated that over 4,000 cases have been performed worldwide, for both benign and malignant indications. On the basis of the published literature, over 700 cases have been reported on the basis of case reports, small to mid-sized case series, and a handful of multicenter series. The long-awaited LOREC international taTME registry results will soon be published and will summarize collected data from 720 cases between July 2014 and December 2016. Although results from large multicenter phase II prospective studies and RCTs are still awaited, review of the cumulative results from the largest taTME series demonstrates favorable outcomes with respect to procedural safety and preliminary oncologic and functional outcomes in carefully selected patients (Tables 21-2 to 21-4).

TABLE 21-2 Largest Published taTME Series: Patient and Tumor Characteristic

Series	Year of publication	N	Age (y)	Age range	Gender M:F	E
Rouanet et al.	2013	30	65	43–82	30:0	
Chouillard et al.	2014	16	57.7	34–81	6:10	
Tuech et al.	2015	56	65	39–83	41:15	
Buchs et al.	2016	20	59.3	32–87	14:6	
Veltcamp Helbach et al.	2016	80	66.5	42–86	48:32	
Lacy et al.	2015	140	65.5	NR	89:51	
Muratore et al.	2015	26	65.8	38–84	16:10	
de'Angelis et al. (compared to laparoscopic TME)	2015	32	64.9	NR	21:11	
Perdawood et al. (compared to laparoscopic TME)	2016	25	70	54–76	19:6	
Kang et al.	2016	20	58.6	36–84	12:8	
	2016			39–88		

Serra-Aracil et al.		32	68		24:8
Burke et al.	2016	50	56.5	50–65	30:20
Chen et al. (compared to laparoscopic TME)	2016	50	57.3	29–80	38:12

AV, anal verge; BMI, body mass index; CRT, chemoradiotherapy; DL, dentate line; F, female; M, male; NR, not reported; taTME, transanal total mesorectal excision; TME, total mesorectal excision.

TABLE 21-3 Largest Published taTME Series: Operative Details and Pathology

Series	Year of publication	N	Abdominal approach	Transanal platform	T re
Rouanet et al.	2013	30	LA	TEO	30 LAR
Chouillard et al.	2014	16	LA 6, pure 10	SILS port	14 LAR 1 APR, procto
Tuech et al.	2015	56	LA (41), SILS (8), open (4), RA (1)	EndorecTrochar (42), SILS Port (11), GelPOINT Path (3)	LAR 52
Buchs et al.	2016	20	18 LA, 1 RA, 1 pure	Gloveport4, GelPOINT Path 16	LAR 16 ELAPE compl procte
Veltcamp Helbach et al.	2016	80	LA, SILS	SILS Port, GelPOINT Path	LAR 65

Lacy et al.	2015	140	LA	GelPOINT	LAR 13 procto w IPAA
Muratore et al.	2015	26	LA	SILS Port	25 LAR
De'Angelis et al. (compared to laparoscopic TME)	2015	32	LA, SILS	GelPOINT	LAR 32
Perdawood et al. (compared to laparoscopic TME)	2016	25	LA	GelPOINT	LAR 18
Kang et al.	2016	20	11 pure, 9 LA	SILS port	LAR 20
Serra-Aracil et al.	2016	32	LA	TEO	32 LAR
Burke et al.	2016	50	Open (4), LA (14), HA (19), RA (10)	GelPOINT Path	APR 6 LAR 43 1 proc (2%)
Chen et al. (compared to laparoscopic TME)	2016	50	LA, SILS	GelPOINT Path	LAR 50

APR, abdominoperineal resection; ELAPE, extra levator abdominoperineal excision; HA, hand assisted; IPAA, ileal pouch-anal anastomosis; LA, laparoscopic assisted; LAR, low anterior resection; NR, not reported; RA, robotic assisted; SILS, single-incision laparoscopic surgery; TAMIS, transanal minimally invasive surgery; TEM, transanal endoscopic microsurgery; TEO, transanal endoscopic operation.

TABLE 21-4 Largest Published taTME Series: Complications and Outcomes

Series	Year of publication	N	Length of stay (d)	Intraoperative complications (n)	Mor rat
Rouanet et al.	2013	30	14 (9–25)	Two urethral injuries (due to anterior bulky tumor and concurrent prostatic tumor), one air embolism	3
Chouillard et al.	2014	16	10.4 (4–29)	0	1
Tuech et al.	2015	56	10 (6–21)	0	2
Buchs et al.	2016	20	7 (3–36)	Bleeding (1)	3
Veltcamp Helbach et al.	2015	80	8 (3–41)	Bleeding (2), perforation (3)	3

Lacy et al.	2015	140	7.8 (3–39)	None	3
Muratore et al.	2015	26	7 (3–25)	NR	2
De’Angelis et al. (compared to laparoscopic TME)	2015	32	7.8	0	2
Perdawood et al. (compared to laparoscopic TME)	2015	25	5 (2–43)	Two bleeding	5
Kang et al.	2015	20	NR	One massive bleeding, one prostate and urethra injury	2
Serra-Aracil et al.	2016	32	8 (4–20)	0	3

Burke et al.	2016	50	4.5 (4.0–8.0)	one urethral injury, one ureteral injury, one injury to iliac vessels	3
Chen et al. (compared to laparoscopic TME)	2016	50	7.4 (5–18)	Two presacral bleeding, one vaginal wall injury	2

FU, follow-up; mets, metastasis; MI, myocardial infarction; NR, not reported; SBO, small bowel obstruction; SSI, surgical site infection; UTI, urinary tract infection; TME, total mesorectal excision; taTME, transanal total mesorectal excision.

Multiple clinical series have been published since this first case presenting variations in patient selection, surgical technique, complications, and outcomes. The largest series to date was published by Lacy *et al.* in 2015 and included 140 patients with rectal cancer.

All taTME case series or comparative studies published to date that included more than 15 patients with rectal cancer were reviewed. A total of 13 series including a total of 577 patients were analyzed. The average patient age was 63 years (range 29–88) and included 388 males and 189 females with an average body mass index (BMI) of 25.9 (range 16–46) kg/m^2.

p. 206

p. 207

Preoperative Staging

The majority of the reported patients had middle and low rectal cancer. The mean distance from the anal verge was 5.4 cm. Among studies reporting on histopathologic tumor staging, tumors consisted in T0 (12%), T1 (7), T3 (47%), T4 (4%); N0 (65%), N1 (24%), and N2 (11%)—62% of the patients received chemoradiotherapy, 9% received radiotherapy, 1.5% received chemotherapy, and 27.5% received no neoadjuvant treatment.

Operative Characteristics

With regard to the operative details, the majority of patients (94%) underwent

With regard to the operative details, the majority of patients (94%) underwent taTME with LAR, whereas the rest of the patients underwent taTME with APR (6%). Approximately 4% of the patients underwent pure taTME; and of the patients who underwent a hybrid procedure, less than 1% had robotic surgery, and the majority of the patients had laparoscopic surgery. The mean operative time was 247 minutes (range 166–315 minutes) and the mean length of postoperative hospital stay ranged from 4.5 to 14 days.

Oncologic Outcomes

The mean number of lymph nodes harvested ranged from 10 to 23.2. On the basis of studies reporting on TME specimen grading, the mesorectal excision was described as complete in 90% of the cases, near complete in 9%, and incomplete in 1%. The CRM was negative, with a distance between resection margin and tumor of more than 1 mm in 96% of the cases and was positive in 4%. Distal resection margin was negative in 99.5% of cases, and positive in 0.5% of the cases.

The mean follow-up period was ranging from 5 to 32.6 months. Ten studies reported local recurrence in 14 cases, and 39 cases with distal recurrence. The time for recurrence ranged from 3 to 24 months. In the studies reporting follow-up after surgery, 14 patients had locoregional recurrence, and 32 patients had distal recurrence. Furthermore, 11 patients died of tumor progression at the time of follow-up.

Functional Outcomes

With regard to the functional outcomes, the data is more limited and needs to be addressed in future studies. Only six studies reported the functional status of the patients following surgery. The range of Wexner score in the reported series was 4.5 to 11. One study by Burke *et al.* reported that most of the patients had mild fecal incontinence defined as less than one accident per day, and one patient reported more severe incontinence with a Wexner score of 16.

Transanal Total Mesorectal Excision Versus Laparoscopic Surgery

To date, there is still no matched prospective study comparing taTME to laparoscopic surgery. In 2015, Fernandez-Hevia *et al.* compared a prospective cohort of 37 patients who underwent taTME with a retrospective cohort of 37 patients who underwent laparoscopic surgery for middle and low rectal cancer. There was no difference with respect to number of lymph nodes resected, CRM, or TME specimen quality between the groups. Distal resection margin was significantly shorter in patients undergoing laparoscopic surgery compared with transanal surgery. Velthuis *et al.* retrospectively compared a total of 25 patients who underwent taTME with 25 patients who underwent laparoscopic surgery.

The authors found no difference in terms of length of specimen, CRM, or distal margin. However, the macroscopic quality of the specimen was complete in 94% of the patients who underwent transanal surgery compared to only 72% of the specimens in the patients who underwent laparoscopic surgery. Similar results were reported in several other recent studies. In the largest series to date by Lacy et al., the authors reported their experience with 140 taTME cases for rectal cancer. The authors reported a lower conversion rate (0% vs. 20%) and shorter mean operative time (154 vs. 179 minutes) when performing taTME compared to laparoscopic TME. The postoperative outcomes including ileus, anastomotic leak, pelvic fluid collection, and urinary retention were similar in the taTME cases compared to those in the laparoscopic cases (4.1% vs. 1.3%, 8.6% vs. 7.3%, 4.1% vs. 1.3%, and 1.8% vs. 2.7%, respectively). The *CO*lorectal cancer *L*aparoscopic or *O*pen *R*esection III trial is an international, multicenter, randomized trial that is currently in planning. This trial will compare laparoscopic and taTME with a CRM as the primary endpoint and completeness of mesorectum, residual mesocolon, morbidity and mortality, local recurrence, disease-free and overall survival, percentage of sphincter-saving procedures, functional outcomes, and quality of life as secondary outcomes.

Pure Natural Orifice Transluminal Endoscopic Surgery Transanal Total Mesorectal Excision

In 2013, Leroy *et al.* described pure taTME in a 56-year-old female with a T2 mid-rectal polysoid benign mass. The authors used the TEO platform for the transanal dissection. The sigmoid colon was mobilized by a posterior retroperitoneal approach. The procedure was completed with no intraoperative complications and no diverting ileostomy, in 190 minutes. The specimen included 16 lymph nodes. Another group that described pure taTME was Zhang *et al.* The case was performed on a 48-old-female with a BMI of 20 kg/m^2 who had a rectal mass located 8 cm from the anal verge with T3N1M0 on pathology. The specimen had 12 lymph nodes and a negative CRM. There were no intraoperative complications and the patient did well postoperatively. The largest series on pure NOTES taTME to date was published by Kang *et al.* who reported 15 cases (out of 20 TME cases). The authors used the SILS platform (Medtronic, Mansfield, MA) with a mean operating time of 180.6 minutes, a mean of 12 lymph nodes in the specimen, and no positive CRM. Out of the 15 cases, 4 were converted to laparoscopic assistance for the prostatic and urethral injury with massive bleeding, unsatisfactory exposure with mild hemorrhage, and resistance to deliver the specimen because of bulky mesorectum. All patients who underwent conversion were males.

Chouillard *et al.* also reported their experience with pure taTME procedure in 10 patients. They used GelPOINT Path or SILS Port, had a mean operative time of 272.5 minutes, negative CRM in all patients, and no conversions. However, these promising results are restricted to a small number of carefully selected patients, and this approach needs to be evaluated in larger studies. At this time, the consensus among experts is that until significant improvement in instrumentations and platforms occur, taTME should be performed with transabdominal assistance for safety purposes, that is, to maximize exposure to critical structures and minimize the risk of organ injury.

CONCLUSIONS

taTME is feasible and safe when performed in carefully selected patients by appropriately trained surgeons. This approach should only be adopted by experienced colorectal surgeons with expertise in minimally invasive TME as well as transanal endoscopic surgery and are familiar with ISR techniques. Adequate didactic and procedural training in human cadavers is essential, and proctoring of the initial cases is highly recommended to shorten the learning curve. Among well-trained operators and in carefully selected patients, the preliminary results of taTME demonstrate excellent oncologic outcomes, particularly with respect to the quality of the mesorectum and margin clearance. This approach is particularly attractive in cases of mid-and low rectal cancer, where it eliminates the need for distal rectal stapling and crossing staple lines, and dramatically improves exposure of the distal rectum, mesorectum, and adjacent pelvic structures.

RECOMMENDED REFERENCES AND READINGS

Andersson A, Bergdahl L. Urologic complications following abdominoperineal resection of the rectum. *Arch Surg* 1976;111:969–71.

Bertrand MM, Colombo PE, Alsaid B, Prudhomme M, Rouanet P. Transanal endoscopic proctectomy and nerve injury risk: bottom to top surgical anatomy, key points. *Dis Colon Rectum* 2014;57:1145–8.

Bislenghi G, Wolthuis AM, de Buck van Overstraeten A, D'Hoore A. AirSeal system insufflator to maintain a stable pneumorectum during TAMIS. *Tech Coloproctol* 2015;19:43–45.

Bonjer HJ, Deijen CL, Haglind E; COLOR II Study Group. A randomized trial of laparoscopic versus open surgery for rectal cancer. *N Engl J Med* 2015;372:1324–32.

Borstlap WA, Harran N, Tanis PJ, Bemelman WA. Feasibility of the TAMIS technique for redo pelvic surgery. *Surg Endosc* 2016;30:5364–71.

Breukink SO, van der Zaag-Loonen HJ, Bouma EM, *et al.* Prospective evaluation of quality of life and sexual functioning after laparoscopic total mesorectal excision. *Dis Colon Rectum* 2007;50:147–55.

Buchs NC, Nicholson GA, Yeung T, *et al.* Transanal rectal resection: an initial experience of 20 cases. *Colorectal Dis* 2016;18:45–50.

Burke JP, Martin-Perez B, Khan A, *et al.* Transanal total mesorectal excision for rectal cancer: early outcomes in 50 consecutive patients. *Colorectal Dis* 2016;18:570–7.

Buscaglia JM, Karas J, Palladino N, *et al.* Simulated transanal NOTES sigmoidectomy training improves the responsiveness of surgical endoscopists. *Gastrointest Endosc* 2014;80:126–32.

Chen CC, Lai YL, Jiang JK, *et al.* Transanal total mesorectal excision versus laparoscopic surgery for rectal cancer receiving neoadjuvant chemoradiation: a matched case-control study. *Ann Surg Oncol* 2016;23:1169–76.

Chouillard E, Chahine E, Khoury G, *et al.* NOTES total mesorectal excision (TME) for patients with rectal neoplasia: a preliminary experience. *Surg Endosc* 2014;28:3150–7.

Chouillard E, Regnier A, Vitte RL, *et al.* Transanal NOTES total mesorectal excision (TME) in patients with rectal cancer: is anatomy better preserved? *Tech Coloproctol* 2016;20:537–44.

---

de Lacy AM, Rattner DW, Adelsdorfer C, *et al.* Transanal natural orifice transluminal endoscopic surgery (NOTES) rectal resection: "down-to-up" total mesorectal excision (TME)—short-term outcomes in the first 20 cases. *Surg Endosc* 2013;27:3165–72.

de'Angelis N, Portigliotti L, Azoulay D, Brunetti F. Transanal total mesorectal excision for rectal cancer: a single center experience and systematic review of the literature. *Langenbecks Arch Surg* 2015;400:945–59.

Deijen CL, Velthuis S, Tsai A, *et al.* COLOR III: a multicentre randomised clinical trial comparing transanal TME versus laparoscopic TME for mid and low rectal cancer. *Surg Endosc* 2016;30:3210–5.

Dumont F, Goere D, Honore C, Elias D. Transanal endoscopic total mesorectal excision combined with

single-port laparoscopy. *Dis Colon Rectum* 2012;55:996–1001.
Fengler J. Near-infrared fluorescence laparoscopy—technical description of PINPOINT(R) a novel and commercially available system. *Colorectal Dis* 2015;17 Suppl 3:3–6.
Fernandez-Hevia M, Delgado S, Castells A, *et al.* Transanal total mesorectal excision in rectal cancer: short-term outcomes in comparison with laparoscopic surgery. *Ann Surg* 2015;261:221–7.
Green BL, Marshall HC, Collinson F, *et al.* Long-term follow-up of the Medical Research Council CLASICC trial of conventional versus laparoscopically assisted resection in colorectal cancer. *Br J Surg* 2013;100:75–82.
Grone J, Koch D, Kreis ME. Impact of intraoperative microperfusion assessment with Pinpoint Perfusion Imaging on surgical management of laparoscopic low rectal and anorectal anastomoses. *Colorectal Dis* 2015;17 Suppl 3:22–28.
Harrysson IJ, Cook J, Sirimanna P, Feldman LS, Darzi A, Aggarwal R. Systematic review of learning curves for minimally invasive abdominal surgery: a review of the methodology of data collection, depiction of outcomes, and statistical analysis. *Ann Surg* 2014;260:37–45.
Heald RJ, Ryall RD. Recurrence and survival after total mesorectal excision for rectal cancer. *Lancet*. 1986;1(8496):1479–82.
Jeong SY, Park JW, Nam BH, *et al.* Open versus laparoscopic surgery for mid-rectal or low-rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): survival outcomes of an open-label, non-inferiority, randomised controlled trial. *Lancet Oncol* 2014;15:767–74.
Kang J, Yoon KJ, Min BS, *et al.* The impact of robotic surgery for mid and low rectal cancer: a case-matched analysis of a 3-arm comparison–open, laparoscopic, and robotic surgery. *Ann Surg* 2013;257:95–101.
Kang L, Chen WH, Luo SL, *et al.* Transanal total mesorectal excision for rectal cancer: a preliminary report. *Surg Endosc* 2016;30:2552–62.
Kang SB, Park JW, Jeong SY, *et al.* Open versus laparoscopic surgery for mid or low rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): short-term outcomes of an open-label randomised controlled trial. *Lancet Oncol* 2010;11:637–45.
Lacy AM, Tasende MM, Delgado S, *et al.* Transanal total mesorectal excision for rectal cancer: outcomes after 140 patients. *J Am Coll Surg* 2015;221:415–23.
Leroy J, Barry BD, Melani A, Mutter D, Marescaux J. No-scar transanal total mesorectal excision: the last step to pure NOTES for colorectal surgery. *JAMA Surg* 2013;148:226–30; discussion 31.
Luanne Force MD, Yuksel Atinel MD, Dana Sands MD, Nicholas Muruve MD, Steven Wexner MD. Transanal total mesorectal excision with en bloc prostatectomy for rectal cancer (Video). Presented at the Annual Meeting of the American College of Surgeons, October 22–26, 2017, San Diego, CA.
Lujan J, Valero G, Hernandez Q,Sanchez A, Frutos MD, Parrilla P. Randomized clinical trial comparing laparoscopic and open surgery in patients with rectal cancer. *Br J Surg* 2009;96:982–9.
Marks J, Nassif G, Schoonyoung H, *et al.* Sphincter-sparing surgery for adenocarcinoma of the distal 3 cm of the true rectum: results after neoadjuvant therapy and minimally invasive radical surgery or local excision. *Surg Endosc* 2013;27:4469–77.
Marks JH, Frenkel JL, D'Andrea AP, Greenleaf CE. Maximizing rectal cancer results: TEM and TATA techniques to expand sphincter preservation. *Surg Oncol Clin N Am* 2011;20:501–20, viii–ix.
Marks JH, Salem JF. From TATA to NOTES, how taTME fits into the evolutionary surgical tree. *Tech Coloproctol* 2016;20:513–5.
McLemore EC, Harnsberger CR, Broderick RC, *et al.* Transanal total mesorectal excision (taTME) for rectal cancer: a training pathway. *Surg Endosc* 2016;30:4130–5.

Morris MS, Graham LA, Chu DI,Cannon JA, Hawn MT. Oral antibiotic bowel preparation significantly reduces surgical site infection rates and readmission rates in elective colorectal surgery. *Ann Surg* 2015;261:1034–40.

Motson RW, Whiteford MH, Hompes R, Albert M, Miles WF; Expert Group. Current status of transanal total mesorectal excision (TaTME) following the Second International Consensus Conference. *Colorectal Dis* 2016;18:13–18.

Muratore A, Mellano A, Marsanic P, De Simone M. Transanal total mesorectal excision (taTME) for cancer located in the lower rectum: short-and mid-term results. *Eur J Surg Oncol* 2015;41:478–83.

Ng KH, Ng DC, Cheung HY, *et al.* Laparoscopic resection for rectal cancers: lessons learned from 579 cases. *Ann Surg* 2009;249:82–6.

Ng SS, Leung KL, Lee JF, Yiu RY, Li JC, Hon SS. Long-term morbidity and oncologic outcomes of laparoscopic-assisted anterior resection for upper rectal cancer: ten-year results of a prospective, randomized trial. *Dis Colon Rectum* 2009;52:558–66.

Niraj G, Kelkar A, Hart E, Kaushik V, Fleet D, Jameson J. Four quadrant transversus abdominis plane block and continuous transversus abdominis plane analgesia: a 3-year prospective audit in 124 patients. *J Clin Anesth* 2015;27:579–84.

Penna M, Hompes R, Arnold S, *et al.* Transanal total mesorectal excision: international registry results of the first 720 cases. *Ann Surg*. 2017;266(1):111–7.

Perdawood SK, Al Khefagie GA. Transanal vs laparoscopic total mesorectal excision for rectal cancer: initial experience from Denmark. *Colorectal Dis* 2016;18:51–58.

Rouanet P, Mourregot A, Azar CC, *et al.* Transanal endoscopic proctectomy: an innovative procedure for difficult resection of rectal tumors in men with narrow pelvis. *Dis Colon Rectum* 2013;56:408–15.

Rullier E, Goffre B, Bonnel C, Zerbib F, Caudry M, Saric J. Preoperative radiochemotherapy and sphincter-saving resection for T3 carcinomas of the lower third of the rectum. *Ann Surg* 2001;234:633–40.

Rullier E, Laurent C, Bretagnol F,Rullier A, Vendrely V, Zerbib F. Sphincter-saving resection for all rectal carcinomas: the end of the 2-cm distal rule. *Ann Surg* 2005;241:465–9.

Rullier E, Sa Cunha A, Couderc P, Rullier A, Gontier R, Saric J. Laparoscopic intersphincteric resection with coloplasty and coloanal anastomosis for mid and low rectal cancer. *Br J Surg* 2003;90:445–51.

Rullier E, Zerbib F, Laurent C, *et al.* Intersphincteric resection with excision of internal anal sphincter for conservative treatment of very low rectal cancer. *Dis Colon Rectum* 1999;42:1168–75.

Serra-Aracil X, Mora-Lopez L, Casalots A, Pericay C, Guerrero R, Navarro-Soto S. Hybrid NOTES: TEO for transanal total mesorectal excision: intracorporeal resection and anastomosis. *Surg Endosc* 2016;30:346–54.

Simillis C, Hompes R, Penna M, Rasheed S, Tekkis PP. A systematic review of transanal total mesorectal excision: is this the future of rectal cancer surgery? *Colorectal Dis* 2016;18:19–36.

Smith SR, Draganic B, Pockney P, *et al.* Transversus abdominis plane blockade in laparoscopic colorectal surgery: a double-blind randomized clinical trial. *Int J Colorectal Dis* 2015;30:1237–45.

Stevenson AR, Solomon MJ, Lumley JW, *et al.* Effect of laparoscopic-assisted resection vs open resection on pathological outcomes in rectal cancer: the ALaCaRT randomized clinical trial. *JAMA* 2015;314:1356–63.

Sylla P, Rattner DW, Delgado S, Lacy AM. NOTES transanal rectal cancer resection using transanal endoscopic microsurgery and laparoscopic assistance. *Surg Endosc* 2010;24:1205–10.

Sylla P, Sohn DK, Cizginer S, *et al.* Survival study of natural orifice translumenal endoscopic surgery for rectosigmoid resection using transanal endoscopic microsurgery with or without transgastric endoscopic assistance in a swine model. *Surg Endosc* 2010;24:2022–30.

Sylla P, Willingham FF, Sohn DK, Gee D, Brugge WR, Rattner DW. NOTES rectosigmoid resection using transanal endoscopic microsurgery (TEM) with transgastric endoscopic assistance: a pilot study in swine. *J Gastrointest Surg* 2008;12:1717–23.

Sylla P. Current experience and future directions of completely NOTES colorectal resection. *World J Gastrointest Surg* 2010;2:193–8.

Tuech JJ, Bridoux V, Kianifard B, *et al.* Natural orifice total mesorectal excision using transanal port and laparoscopic assistance. *Eur J Surg Oncol* 2011;37:334–5.

Tuech JJ, Karoui M, Lelong B, *et al.* A step toward NOTES total mesorectal excision for rectal cancer: endoscopic transanal proctectomy. *Ann Surg* 2015;261:228–33.

van der Pas MH, Haglind E, Cuesta MA, *et al.* Laparoscopic versus open surgery for rectal cancer (COLOR II): short-term outcomes of a randomised, phase 3 trial. *Lancet Oncol* 2013;14:210–8.

Veltcamp Helbach M, Deijen CL, Velthuis S, *et al.* Transanal total mesorectal excision for rectal carcinoma: short-term outcomes and experience after 80 cases. *Surg Endosc* 2016;30:464–70.

Velthuis S, Nieuwenhuis DH, Ruijter TE,Cuesta MA, Bonjer HJ, Sietses C. Transanal versus traditional laparoscopic total mesorectal excision for rectal carcinoma. *Surg Endosc* 2014;28:3494–9.

Whiteford MH, Denk PM, Swanstrom LL. Feasibility of radical sigmoid colectomy performed as natural orifice translumenal endoscopic surgery (NOTES) using transanal endoscopic microsurgery. *Surg Endosc* 2007;21:1870–4.

Xiong B, Ma L, Huang W, Zhao Q, Cheng Y, Liu J. Robotic versus laparoscopic total mesorectal excision for rectal cancer: a meta-analysis of eight studies. *J Gastrointest Surg* 2015;19:516–26.

Zhang H, Zhang YS, Jin XW, Li MZ, Fan JS, Yang ZH. Transanal single-port laparoscopic total mesorectal excision in the treatment of rectal cancer. *Tech Coloproctol* 2013;17:117–23.

Zorron R, Phillips HN, Coelho D, Flach L, Lemos FB, Vassallo RC. Perirectal NOTES access: “down-to-up” total mesorectal excision for rectal cancer. *Surg Innov* 2012;19:11–19.

PART IV

TOTAL COLECTOMY WITH ILEORECTAL ANASTOMOSIS

Chapter 22

Open Total Abdominal Colectomy with Ileorectal Anastomosis

W. Forrest Johnston and Charles M. Friel

INDICATIONS/CONTRAINDICATIONS

Total abdominal colectomy involves resection of the entire colon that is in the abdominal cavity with preservation of the rectum, thus making it distinct from total proctocolectomy which by definition includes rectal resection (Fig. 22-1). Strictly speaking, a total abdominal colectomy should be to the top of the rectum. However, in practice there are many circumstances in which a portion of the sigmoid colon is preserved. Under these circumstances, the procedure is better described as a subtotal colectomy. For the purposes of this discussion, a subtotal and a total colectomy are considered synonymous. It is up to surgeon discretion and experience to decide the best approach given the clinical circumstances. Furthermore, this operation is frequently performed in the emergent setting. Under these circumstances, it may be prudent to perform this procedure in stages by creating either an end or a loop ileostomy and restoring intestinal continuity at a later date. Whether to perform an ileostomy or do a primary anastomosis with or without proximal diversion will be dictated by the clinical scenario and requires sound surgical judgment.

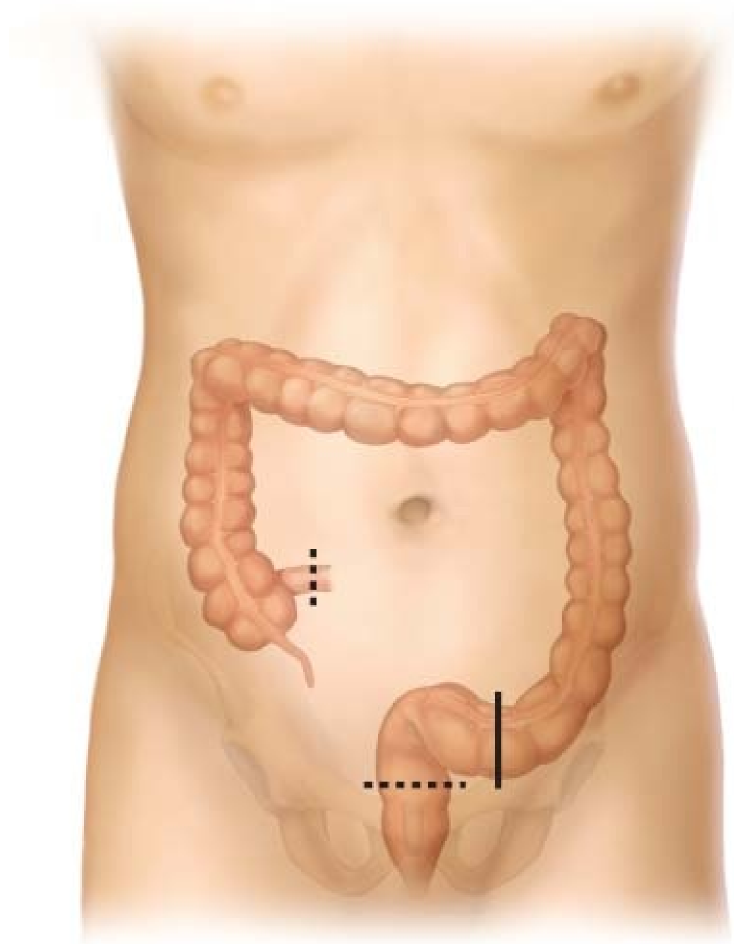


FIGURE 22-1 Extent of bowel resection with total abdominal colectomy. Distal resection is the top of the rectum (dotted line). Subtotal colectomy would involve resection of the sigmoid colon (solid line).

p. 211

p. 212

Conditions that can be treated with total abdominal colectomy with ileorectal anastomosis include the following:

Indications

Familial adenomatous polyposis (FAP) and *MYH*-associated polyposis (MAP) with rectal sparing: If there is rectal involvement, the treatment of choice is total proctocolectomy with or without ileal pouch-anal anastomosis (IPAA).

Lynch syndrome, previously known as hereditary non-polyposis colorectal cancer.

Synchronous or metachronous colon cancers: particularly if the tumors involve both the right side and left side of the colon, necessitating a high ligation of multiple arteries supplying the colon. Under these circumstances, an ileorectal anastomosis may be the best option. Frequent rectal surveillance will then be necessary.

Crohn’s colitis with rectal sparing. If the rectum is scarred and non-distensible or if there is significant anorectal disease, it is best to perform a proctocolectomy with a permanent ileostomy.

Ulcerative colitis with relative rectal sparing.

Indeterminate colitis with relative rectal sparing: This option may avoid the construction of an ileal pouch in a patient who may have Crohn’s disease.

Isolated colonic inertia/chronic constipation with normal pelvic floor function.

Pseudomembranous colitis: Usually done in stages with an emergency total colectomy with end ileostomy with subsequent ileorectal anastomosis once the patient fully recovers.

Left-sided obstructing colon cancer with proximal colonic dilation.

Massive lower gastrointestinal (GI) bleeding.

Benefits of Leaving the Rectum

Less risk of injury to pelvic nerves, which should decrease risk of sexual and bladder dysfunction

Limits risk of urinary retention and infertility

Improved bowel function compared with an IPAA (less frequent bowel movements with less nocturnal seepage and incontinence)

Technically easier than IPAA with less complications

Often a one-stage procedure

Contraindications for a Primary Anastomosis

Patient instability.

Pelvic sepsis.

Malnutrition: We routinely check albumin as a marker of nutrition preoperatively as well as discuss weight loss in the past 3 months. Because recent significant weight loss increases the risk of anastomotic failure, patients with weight loss of >15 lb in the past 3 months are often treated with resection and ostomy creation. An anastomosis can then be done once the medical conditions have been treated.

Severe inflammation of the rectum.

Fulminant colitis.

Rectal dysplasia or numerous polyps: In these scenarios, a proctectomy should also be undertaken.

Patient intolerance for moderate diarrhea, preexisting anorectal incontinence: In these situations, an ileostomy is a better option.

PREOPERATIVE PLANNING

Preoperative planning is twofold: (1) to make sure that total abdominal colectomy is needed and is the best option for the patient's condition and (2) to make sure that the patient can tolerate major abdominal surgery. Planning is based on the indications and contraindications as noted. Preoperative counseling is crucial so that patients understand the implications of this surgery. Patients need to understand that removal of the entire colon will impact their GI function. Ideally, postoperative function is adequate with about 4–5 loose bowel movements per day with acceptable continence. However, functional outcomes can be highly variable and some patients may experience more frequent bowel activity and even incontinence. Assessment of the overall functional status of the patient with a focus on anal incontinence is essential. Elderly or frail patients with poor anal continence before surgery are likely to have debilitating diarrhea and may be better served with a permanent ileostomy. Having these conversations preoperatively will help set patient expectations and will clarify the best option for each patient.

FAP and MAP are uncommon genetic polyposis disorders that if left untreated will progress to colorectal cancer. In patients with FAP or MAP, careful endoscopic evaluation must be performed to determine the degree of rectal involvement. If there are <20 polyps in the rectum, it may be possible to endoscopically resect all lesions to preserve the rectum. Postoperatively, the rectum will need frequent surveillance with flexible sigmoidoscopy every 3–12 months, depending on the number of rectal polyps detected on future examinations. Total abdominal colectomy is particularly applicable to patients with attenuated FAP and MAP, when there are usually <100 polyps (instead of thousands) and the polyps are often proximal to the rectum. Upper endoscopy is also needed to evaluate for gastric and duodenal lesions. A positive family history of desmoid tumors should prompt a computed tomography (CT) scan of the abdomen and pelvis to evaluate for possible intra-abdominal desmoids that would affect the surgical approach to colectomy.

Lynch syndrome accounts for 2–4% of all colon cancers. Although there is up to a 70% lifetime risk of colon cancer, prophylactic total abdominal colectomy is not currently the standard of care. Once diagnosed with Lynch syndrome, colonoscopy every 1–2 years is recommended. When a colon malignancy is detected, a total abdominal colectomy should be considered given the increased risk of metachronous disease. The recommendation of a total colectomy or segmental resection is a complicated decision that involves balancing the risk of future cancer with diminished GI function. The choice of procedure requires future cancer with diminished GI function. The choice of procedure requires extensive patient discussion. A total abdominal colectomy should be encouraged in younger patients given the increased risk of malignancy over time. However, older patients may opt for a segmental resection to preserve GI function with a focus on quality of life. There is also a 30–45% risk of endometrial cancer and 6–14% risk of ovarian cancer, so that prophylactic total abdominal hysterectomy and bilateral salpingo-oophorectomy may be often done at the time of colectomy in women who have completed childbearing. Historically, the diagnosis of Lynch syndrome has been determined on clinical grounds using family and personal history. Molecular testing has become more available, and current National Comprehensive Cancer Network guidelines advocate universal molecular testing of all newly diagnosed colon cancer. Immunohistochemistry for mismatch repair genes or polymerase chain reaction testing for microsatellite instability can identify patients at high risk for Lynch syndrome, which may prompt genetic testing and discussions about optimal surgical management when appropriate. Ideally, this testing can be performed on preoperative tumor biopsies before any surgical intervention. If Lynch syndrome is diagnosed after surgical resection, colonoscopy is needed every 1–2 years for surveillance of the remainder of the colon given the risk of metachronous tumors.

Patients with inflammatory bowel disease need colonoscopy, endoscopy, small bowel imaging (capsule or enterography), and pathology to determine the extent of disease. Total abdominal colectomy with ileorectal anastomosis is best for patients with minimal small bowel, rectal, and perianal disease and who have excellent anorectal continence. In addition, consideration of their medical management is required because many of the patients utilize long-term steroids and/or anti-tumor necrosis factor (TNF) agents. We typically wait 6 weeks after the last dose of anti-TNF medication and work closely with gastroenterology specialists regarding newer medications. If a patient is unable to wean from steroids, was given recent anti-TNF agents, or has malnutrition, consideration should be given to performing an end ileostomy rather than an anastomosis with the plan to restore intestinal continuity once the patient’s medical condition improves. This operation is best for patients with known Crohn’s disease or indeterminate colitis with rectal sparing and who would prefer to avoid a permanent stoma. Because ulcerative colitis always involves the rectum, it is unusual to preserve the rectum once there are indications for surgery. However, if surgery is necessary and the disease in the rectum is quiescent, an ileorectal anastomosis can be an option. Special circumstances may include female patients who are concerned about the risk of infertility associated with a pelvic dissection and obese patients when construction of an ileal J-pouch may not be feasible. Given the risk of dysplasia subsequently developing in the rectum, frequent surveillance is mandatory for these patients. An ileorectal anastomosis can be converted to an ileal J-pouch or a permanent ileostomy if the clinical parameters were to change.

Severe constipation is defined as infrequent (≤3) bowel movements per week associated with straining (>25% bowel movements with straining or patient sensation of hard stool). If dietary modification and medical management cannot sensation of hard stool). If dietary modification and medical management cannot bring relief, mechanical causes should be excluded with colonoscopy or barium enema. After excluding a mechanical cause, colonic transit study (Sitz markers) and defecography can be useful to find the rare patient with slow colonic transit and a normal functioning rectum. Under these conditions, a total abdominal colectomy with an ileorectal anastomosis can be performed. This procedure will usually successfully increase the frequency of bowel movements. However, only about 50% of patients will have relief of their associated abdominal pain. Furthermore, because some patients will experience difficulty with diarrhea and incontinence, preoperative counseling is critical.

On rare occasions, a total abdominal colectomy may be necessary for massive lower GI bleeding. The most common causes of massive lower GI bleeding are diverticulosis or arteriovenous malformation. The majority of lower GI bleeding will spontaneously cease. Patients who continue to bleed should have attempts at radiographic localization with CT angiography, tagged red blood cell scans, or arteriography. If the bleeding is localized, endovascular embolization can often control it. The threshold for total abdominal colectomy has historically been >6 packed red blood cell transfusions. However, provocative angiography with instillation of dilute tissue plasminogen activator or heparin is an additional consideration before colectomy and can frequently unmask the source of bleeding to allow targeted treatment. Once adequately localized, a segmental resection can be done for those patients who either continue to bleed or rebleed. Rarely, patients will continue to bleed and despite several attempts cannot be adequately localized. In patients who are either hemodynamically unstable or have ongoing transfusion requirements, a total abdominal colectomy is a reasonable operative solution. Before surgery, an upper GI source should be excluded with either upper endoscopy or, possibly, a well-placed nasogastric tube with gastric lavage. Because significant lower GI bleeding can be due to hemorrhoids, a detailed anorectal examination must be performed. If possible, small bowel imaging should also be done before surgery. However, if emergent surgery is necessary, the surgeon should carefully examine the small bowel for any evidence that the small bowel may be the source. If nothing is found in the small bowel, the bleeding is likely from the colon, necessitating a “blind” total colectomy. For high-risk patients with hemodynamic instability, an ileostomy should be created with a plan for an ileorectal anastomosis at a later date. For lower risk patients, a primary anastomosis may be reasonable.

Finally, patients presenting with a malignant large bowel obstruction may be candidates for a total colectomy and ileorectal anastomosis. This operation is particularly appealing for tumors near the splenic flexure. Under these circumstances, the tumor and the distended colon can be removed and a primary anastomosis performed. The procedure can be a subtotal colectomy with an ileosigmoid anastomosis or total colectomy with ileorectal anastomosis. Regardless of which option is selected, in the absence of left colonic malignancy, preservation of the inferior mesenteric and superior rectal vessels may be desirable to try to optimize distal anastomotic vascularity.

SURGERY

The three phases of surgery include colonic mobilization, ligation of the mesentery and division of the bowel, and anastomosis.

Positioning

The patient is placed in the lithotomy position with the arms abducted. Placing the arm boards as high as possible and tucking the sheets under the mattress are useful when the self-retaining retractor is placed later in the case. The legs should rest comfortably in well-padded stirrups to prevent peripheral nerve injury. A urinary catheter is placed and an orogastric tube is inserted.

Technique

The abdomen is entered through a midline laparotomy. Thorough inspection of the peritoneum, liver, omentum, stomach, and small bowel is performed to evaluate for other pathology or metastatic disease. Typically, a self-retaining retractor that can be adjusted throughout the case is used, depending on which portion of the colon is being dissected; a large wound protector may also be employed.

The patient is put in Trendelenburg position to assist with moving the entire small bowel out of the pelvis. The terminal ileum (TI) is identified along with the cecum and appendix. The right colon is mobilized from a lateral-to-medial approach by incising the lateral peritoneal attachments of the cecum. Medial and cranial tension on the right colon during dissection will highlight the correct plane to lift the terminal ileal mesentery. With medial tension on the right colon, the lateral attachments of the ascending colon are divided. Because incising along the white line of Toldt may potentially lead to inadvertent mobilization of the kidney, the peritoneum can instead be divided 1–2 mm medial to the white line of Toldt to try to encourage dissection anterior to Gerota's fascia. Once the peritoneum is incised, the ascending colon can be mobilized off of Gerota's fascia in a bloodless plane up to the level of the hepatic flexure; the majority of this dissection can be done bluntly. The TI must be fully mobilized off the retroperitoneum to ensure adequate mobilization of the TI and a tension-free anastomosis. At this time, the gonadal vessels and ureter can be identified and reflected posteriorly. Near the hepatic flexure, the second and third portions of the duodenum are visualized. The anterior surface of the duodenum is kept posteriorly while the filmy attachments of the overlying mesocolon are divided (Fig. 22-2).

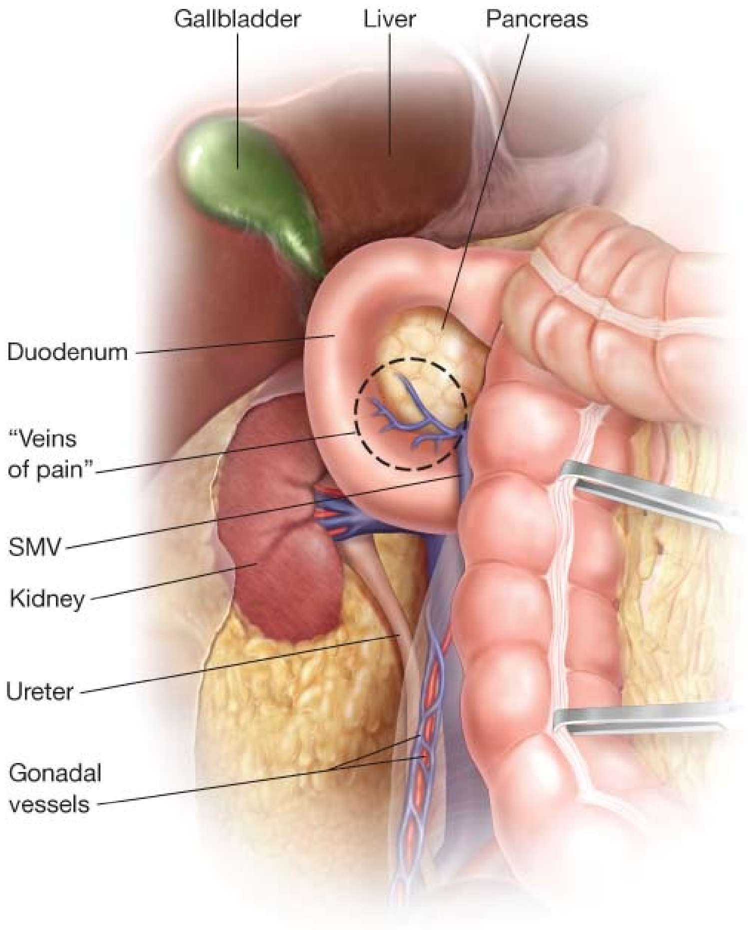


FIGURE 22-2 Mobilization of the right colon and hepatic reflection in a bloodless plane that leaves the kidney, ureters, gonadal vessels, and duodenum in the retroperitoneum. Care must be taken around the superior mesenteric vein (SMV) branches, also known as the "veins of pain" (circled).

To fully mobilize the hepatic flexure, the patient is placed in reverse Trendelenburg position. The self-retaining retractor is used for lateral and superior retraction. If the hepatic flexure is low, the dissection plane can be continued superiorly from the ascending colon dissection. In the case of a high hepatic flexure or prior cholecystectomy with resultant adhesions, it is often useful to incise the gastrocolic omentum to gain entry to the lesser sac and approach the hepatic flexure from both sides. In either situation, the second portion of the duodenum will be seen and should be swept posteriorly to stay with the retroperitoneum.

As the transition between the second and third portion of the duodenum is seen, care must be taken to avoid blunt dissection and excessive traction.

The omentum and the transverse colon mesentery are often adherent to each other on the right side of midline. Careful dissection with gentle traction will avoid injury to the delicate branches of the middle colic vein as it comes off of the superior mesenteric vein. Unlike the left and right colon, moderate tension on the transverse colon near the hepatic flexure may injure these delicate tributaries, causing bleeding that can be profuse and challenging to control because the veins often retract into tissue near the head of the pancreas. The branches of the middle colic vein are therefore often nicknamed “the veins of pain” (Fig. 22-2).

The hepatic flexure contains vessels within the gastrocolic “ligament” that often require ligation either with ties or with a bipolar tissue-sealing device. The planes are then connected to the prior dissection from the ascending colon. At this point, the right colon is fully mobilized and is solely attached by mesentery. Mesenteric windows are made on either side of the ileocolic pedicle. If present, the right colic artery is divided. High ligation is performed with clamps and 0 silk ties or an appropriate energy device if lymphadenectomy is needed. Otherwise, the ascending colon mesentery can be divided with the bipolar device close to the colon to avoid possible injury to retroperitoneal structures and to preserve the ileal branches of the ileocolic vessels in case an ileal pouch is subsequently created. The TI is divided as close to the ileocecal valve as possible, while ensuring that it has good blood supply.

With the cecum and hepatic flexure fully mobilized, the omentum is next approached and is preserved or removed. Although the omentum can be useful for infectious isolation, it can also be a source of postoperative adhesions. If preserved, the omentum is separated off of the transverse colon in the avascular plane adjacent to the transverse colon. If removed, the omentum is divided distal to the gastroepiploic vessels. This avascular plane will require either an energy device or serial clamps and ties to maintain hemostasis. Entry into the lesser sac can be confirmed by visualization of the posterior wall of the stomach. Attachments to the transverse colon from the omentum, duodenum, and pancreas are divided before division of the transverse colon mesentery.

Following the plane created by mesenteric ligation of the ileocolic vessels, the middle colic vessels are ligated next. Because the middle colic artery sits on top of the superior mesenteric artery, care is taken to avoid injury to the underlying superior mesenteric artery. The middle colic artery is frequently very short and branches early to the right and left (Fig. 22-3). If lymphadenectomy is needed, the middle colic artery is dissected and divided between ties near the inferior border of the pancreas. Otherwise, the left and right branches of the middle colic artery can be divided with an energy device closer to the edge of the colon. The division of the transverse colon mesentery is continued as far as possible toward the splenic flexure.

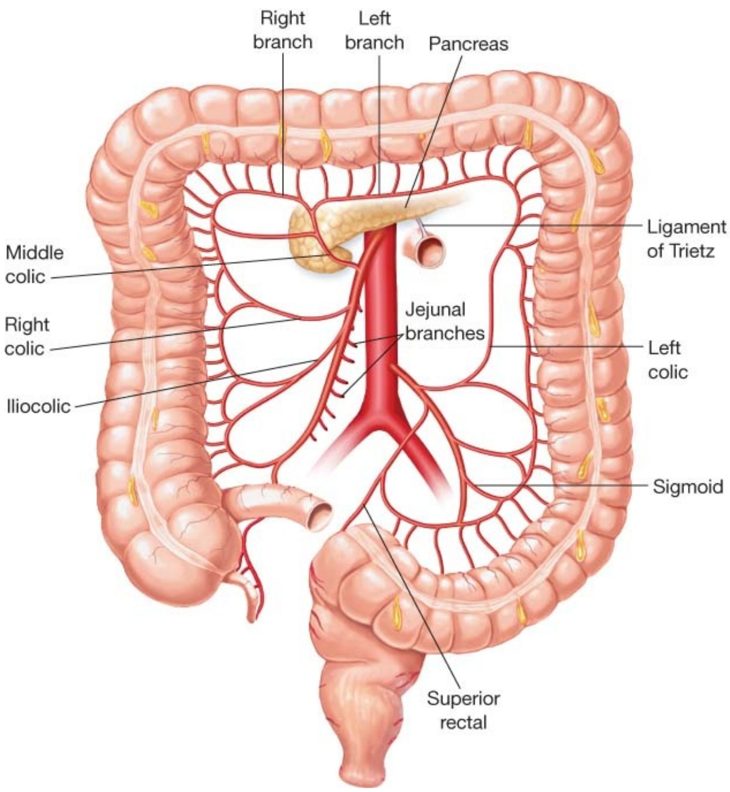


FIGURE 22-3 Arterial blood supply to the colon.

Because there are often moderate-sized omental veins near the splenic flexure, excessive tension on the flexure is avoided. Once dissection up to the splenic flexure becomes challenging, attention is turned toward the descending and sigmoid colon. The patient is taken out of reverse Trendelenburg and rolled to the right. The self-retaining retractor is repositioned. The sigmoid colon is mobilized from a lateral-to-medial manner, similar to the right colon. The peritoneum is divided 1–2 mm medial to the white line of Toldt to ensure dissection anterior to the kidney. The left kidney is left down in the retroperitoneum. For novice surgeons, dissection may inadvertently be too lateral, effectively mobilizing the left kidney from the retroperitoneum. Identifying the subtle but correct plane over the kidney should facilitate a bloodless dissection. The gonadal vessels and ureter are identified and a plane is created anterior to these structures (Fig. 22-4). Blunt dissection can be carried medially over the left kidney to the inferior mesenteric vein (IMV). With the transverse colon and left colon medially retracted, the posterior attachment of the splenic flexure is divided with a bipolar device and electrocautery. The splenic flexure attachments are divided as close to the transverse colon as possible (2–3 mm) to avoid inadvertent dissection into the retroperitoneum. This precaution should allow the surgeon to avoid injury to the tail of the pancreas.

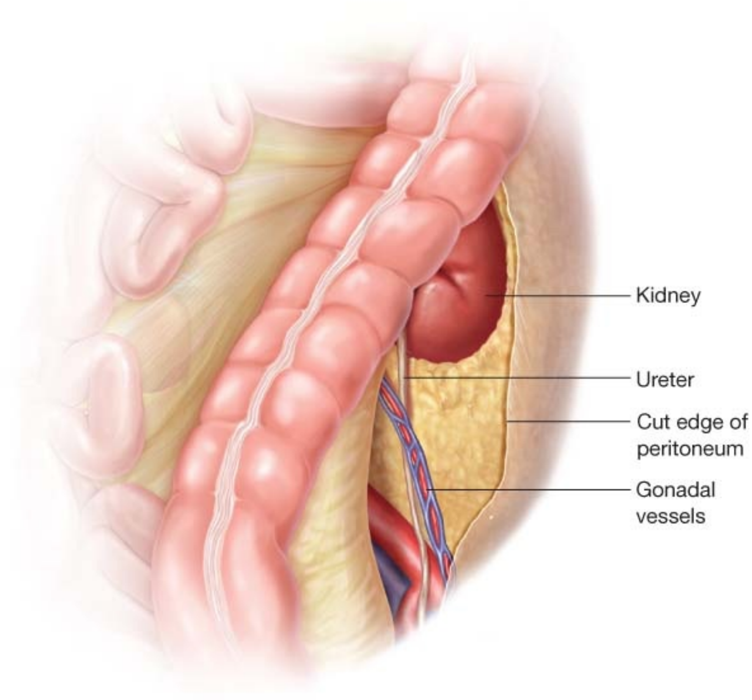


FIGURE 22-4 Medial mobilization of the sigmoid colon in a bloodless plane that leaves the gonadal vessels, ureter, and kidney down in the retroperitoneum.

p. 216

---

p. 217

The sigmoid colon is medially retracted to facilitate identification of the inferior mesenteric artery (IMA). The IMV will run just to the left of the IMA. If lymphadenectomy is needed in the sigmoid colon, the IMA is divided near the origin of the IMA off of the aorta. If proximal ligation is needed, care must be taken to avoid injury to the sympathetic nerves that run along the aorta. The IMA branches into the left colic artery, the sigmoid arteries, and the superior rectal artery. In benign disease, a more distal division of the branches of the IMA will allow sparing of the superior rectal artery.

If an ileorectal anastomosis is planned, dissection should continue to the top of the rectum, possibly with division of the superior rectal artery. The top of the rectum is identified by (1) broadening of the taenia coli, (2) top of the sacral promontory, or (3) the loss of epiploic fat. In addition, flexible endoscopy may be performed to verify the rectosigmoid junction. At this point, the surgeon needs to decide how "low" to go. Removal of more colon and rectum will lead to worse GI function. Leaving some residual sigmoid colon may improve function and facilitate an easier anastomosis, but may be a less well vascularized anastomosis. This decision requires good surgical judgment. If the surgeon can adequately address the fundamental disease process while preserving some additional sigmoid colon and the superior rectal artery, this approach may be prudent. However, care must be taken to ensure that the intended anastomosis will not be to a muscular hypertrophied, diverticular, or sigmoid colon. Regardless of the level of distal colon transection, the distal closure is performed with a stapler.

Anastomosis

The anastomosis can be constructed in several different ways. In cases where there is a long rectal stump or if some residual colon has been left, a side-to-side functional end-to-end anastomosis can be done. The TI is brought into the pelvis and aligned alongside the rectum in an anti-peristaltic configuration, taking care to make sure the small bowel mesentery is not twisted. The corners of each the transverse staple lines are excised and a linear cutting stapler is used to create a common channel (Fig. 22-5). A stapler is then used to close the common enterotomy. The editors' preference are for an anastomotic end-to-end anastomosis. Moreover, one may avoid double-stapling by using a purse string on the rectal side of the anastomosis. Therefore, if an end-to-end anastomosis cannot be done, a side-to-end technique can be employed (Fig. 22-6). The transverse staple line is excised off the TI and a circular stapler anvil is placed into the lumen of the small bowel. A small enterotomy is made several centimeters upstream on the antimesenteric border of the small bowel. The shaft of the anvil can then be passed through the enterotomy and the anvil turned 90 degrees to effectively efface on the antimesenteric border of the small bowel. The distal end of the small bowel is then closed with another stapler firing. Ideally, the enterotomy is only the diameter of the shaft of the anvil. If the enterotomy is too large, a polypropylene purse string suture can be placed to ensure that the bowel is snug around the anvil shaft. The circular stapler is then introduced and opposed to the top of the rectum. The trocar is deployed either through or just anterior or just posterior to the linear rectal closure staple line. Care is taken to avoid entrapment of the bladder, vagina, or small bowel in the anastomosis. Once the stapler is fired, the circular stapler is removed. Two circumferential tissue "donuts" are inspected to ensure that the anastomosis is intact. Flexible sigmoidoscopy is routinely performed to inspect the anastomosis and look for hemostasis. The pelvis is filled with saline and the more proximal bowel is occluded to perform an air leak test. If any bubbles are seen, the origin of the bubbles is identified and directly repaired with 3-0 polyglactin (Vicryl) suture. Alternatively, the anastomosis may be completely redone. Consideration may be given to proximal diversion. A repeat air leak test is then performed to ensure that no further leaking is seen. Clearly, there are a host of other anastomotic techniques that are acceptable options. In our hands, however, these are our most common approaches.

p. 217

p. 218

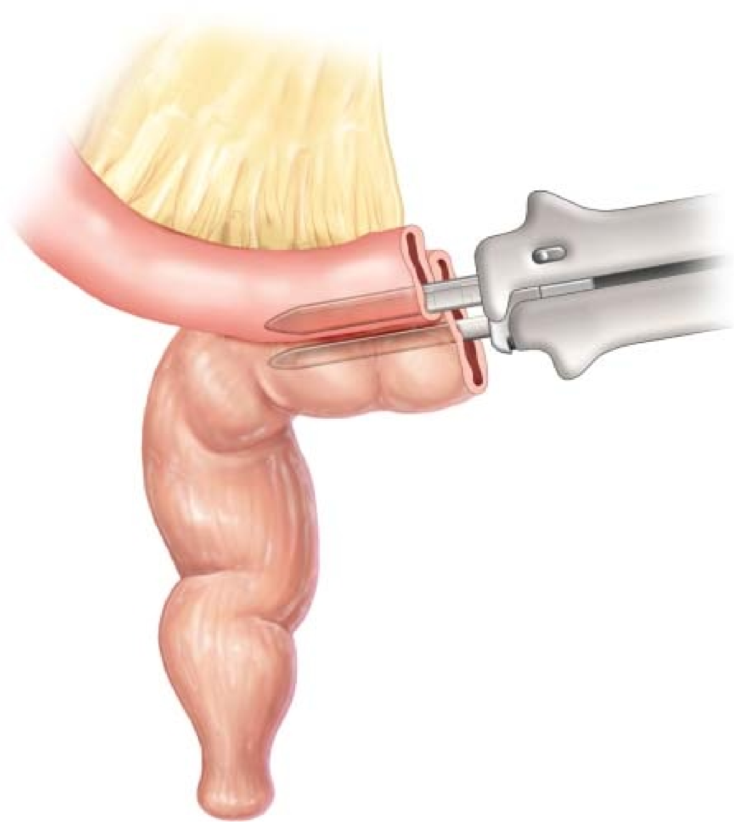


FIGURE 22-5 Side-to-side functional end-to-end ileocolic anastomosis.

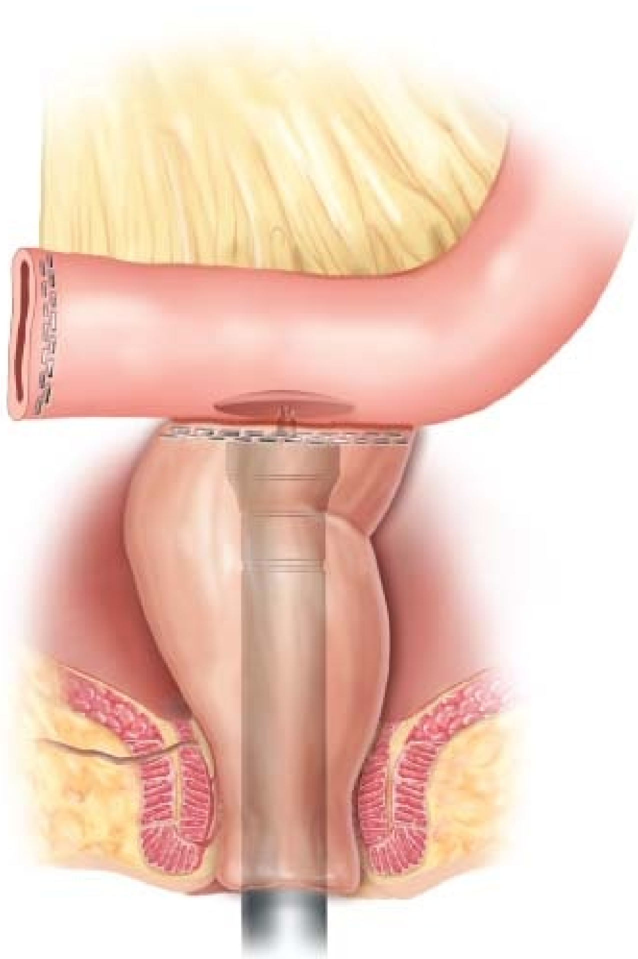


FIGURE 22-6 Side-to-end ileorectal anastomosis. EEA, end-to-end anastomosis.

p. 218

p. 219

Any available omentum can be delivered to cover the bowel, after which the laparotomy incision is closed. We use a clean closure tray with new drapes, gowns, and gloves in an effort to decrease superficial wound infections. The fascia is closed with running #1 looped polydioxanone suture. The skin can be closed with staples or subcuticular stitches.

POSTOPERATIVE MANAGEMENT

We currently use an enhanced recovery pathway for all elective colon and rectal procedures. By restricting intraoperative fluids using a goal-directed algorithm and minimizing intravenous (IV) narcotic pain medication, we have demonstrated a faster return to bowel function and shorter length of hospital stay. Nasogastric tubes are not routinely used. Patients are given a clear liquid diet following surgery and then advanced to a soft diet by the evening of postoperative day 1. IV fluids are infused at a low rate (40 ml/hour).We use multimodality strategies for pain management including a narcotic-only spinal anesthetic on the day of surgery, nonsteroidal medications, and gabapentin. Pain is managed with scheduled IV and PO acetaminophen with oxycodone only available for breakthrough pain. Ambulation is required the evening following surgery. Urinary catheters are left in place overnight and removed on postoperative day 1. Home medications are started on postoperative day 1. Discharge from the hospital is expected on postoperative days 3–4 using this protocol.

COMPLICATIONS

The most common complication following total abdominal colectomy is diarrhea and increased frequency because of a lack of absorption. Because the rectum and pelvic muscles remain intact, incontinence is uncommon in the absence of anal sphincter compromise. Diarrhea is managed with stool bulking agents (fiber) as well as loperamide tablets. Anti-diarrheal medications are not started until the postoperative ileus is resolved. Patients are counseled regarding expectations for approximately 4–5 loose bowel movements per day. Bowel movements may initially be more frequent, but slowly improve during the following weeks after surgery as the bowel adapts. Diarrhea may result in dehydration, and patients are counseled to monitor their urine output.

The dreaded complication is anastomotic leak, frequently heralded by persistent postoperative tachycardia. Other indications may be increasing abdominal pain, postoperative fever, increasing abdominal distension, or change in hemodynamics. If the patient remains tachycardic 3–5 days after surgery or is not progressing as expected, a CT scan is performed to evaluate. Anastomotic leaks are treated on the basis of the degree of leakage:

Small contained leak—bowel rest, image-guided drainage, antibiotics

Free extravasation of contrast—taken back to the operating room for abdominal exploration and washout

- If small defect in ileorectal anastomosis → primary repair/revision and diverting loop ileostomy
- If large defect with necrosis or ischemia of the anastomosis → takedown of anastomosis with end ileostomy and Hartmann rectal pouch

Other complications include intra-abdominal or pelvic abscess formation that can most frequently be treated by image-guided percutaneous drainage and antibiotics. In women, rectovaginal fistulae may arise from either incorporation of the back wall of the vagina in the circular stapler or from erosion into the vagina of a pelvic abscess, but this should be an unusual complication.

Omental attachments to the spleen can be avulsed when applying downward traction on the splenic flexure, causing a capsular tear of the spleen. Usually, local measures can be used to control the bleeding. Rarely, however, splenectomy may be necessary for ongoing bleeding.

Following total abdominal colectomy, patients are at risk of developing small bowel obstruction from adhesions. The risk of small bowel obstruction is up to 30% 10 years following colectomy. The most common site of obstruction is the pelvis. Placement of adhesion barriers at the time of colectomy is one mitigation strategy.

RESULTS

Function following total abdominal colectomy with ileorectal anastomosis depends on the patient's baseline continence, comorbid conditions, operative indication, and age. A good result is 4–5 semisolid bowel movements per day with no incontinence. Patients can frequently adjust to this pattern without interference in their quality of life. Functional results may vary with different indications for the procedure and depending on how much sigmoid colon remains.

CONCLUSIONS

Total or subtotal abdominal colectomy with primary anastomosis is a useful operation in selected patients, which can be performed with excellent functional results and low morbidity.

RECOMMENDED REFERENCES AND READINGS

Barrow E, Hill J, Evans DG. Cancer risk in lynch syndrome. *Fam Cancer* 2013;12:229–40.

Bulow S, Bulow C, Vasen H, Jarvinen H, Bjork J, Christensen IJ. Colectomy and ileorectal anastomosis is still an option for selected patients with familial adenomatous polyposis. *DisColon Rectum* 2008;51:1318–23.

Giardiello FM, Allen JI, Axilbund JE, *et al.* Guidelines on genetic evaluation and management of Lynch syndrome: a consensus statement by the US Multi-Society Task Force on Colorectal Cancer. *Dis Colon Rectum* 2014;57:1025–48.

Hennekinne-Mucci S, Tuech JJ, Brehant O, *et al.* Emergency subtotal/total colectomy in the management of obstructed left colon carcinoma. *Int J Colorectal Dis* 2006;21:538–4.

Maeda T, Cannom RR, Beart RW Jr, Etzioni DA. Decision model of segmental compared with total abdominal colectomy for colon cancer in hereditary nonpolyposis colorectal cancer. *JClinOncol* 2010;28:1175–80.

McCoy JA, Beck DE. Surgical management of colonic inertia. *Clin Colon Rectal Surg* 2012;25:20–23.

Nakamura T, Pikarsky AJ, Potenti FM, *et al.* Are complications of subtotal colectomy with ileorectal anastomosis related to the original disease? *Am JSurg* 2001;67:417–20.

National Comprehensive Cancer Network. Clinical practice guidelines in oncology. Colon cancer, version 2.2016. https://www.nccn.org/professionals/physician_gls/pdf/colon.pdf. Accessed May 30, 2016.

O'Riordan JM, O'Connor BI, Huang H, *et al.* Long-term outcome of colectomy and ileorectal anastomosis for Crohn's colitis. *Dis Colon Rectum* 2011;54:1347–54.

Pastore RL, Wolff BG, Hodge D. Total abdominal colectomy and ileorectal anastomosis for inflammatory bowel disease. *Dis Colon Rectum* 1997;40:1455–64.

Rajaratnam SG, Eglinton TW, Hider P, Fearnhead NS. Impact of ileal pouch-anal anastomosis on female fertility: meta-analysis and systematic review. *Int J Colorectal Dis* 2011;26:1365–74.

Raphaeli T, Menon R. Current treatment of lower gastrointestinal hemorrhage. *Clin Colon Rectal Surg* 2012;25:219–27.

Thiele RH, Rea KM, Turrentine FE, *et al.* Standardization of care: impact of an enhanced recovery protocol on length of stay, complications, and direct costs after colorectal surgery. *J AmCollSurg* 2015;220:430–43.

You YN, Chua HK, Nelson H, Hassan I, Barnes SA, Harrington J. Segmental vs. extended colectomy: measurable differences in morbidity, function, and quality of life. *Dis Colon Rectum* 2008;51:1036–43.

Chapter 23

Laparoscopic Total Colectomy with Ileorectal Anastomosis

Bashar Safar

INDICATIONS/CONTRAINDICATIONS

Total colectomy may be indicated to treat diseases that either diffusely affect the colon but spare the rectum or in conditions affecting multiple segments of the colon making it necessary to remove the entire colon. Reestablishing gastrointestinal continuity is desirable in many of these conditions; however, the indication for surgery must be taken into consideration along with the patient's overall condition and current ability to maintain fecal control.

Indications for the operation (Table 23-1) can be separated into infectious, inflammatory, malignant, and functional.

TABLE 23-1 Indications for Laparoscopic Total Abdominal Colectomy and Ileorectal Anastomosis

- Recurrent C. diff
- IBD
  - Crohn's
  - Ulcerative colitis
- FAP
- Synchronous colorectal cancers
- Colonic inertia
- Recurrent GI bleeds

C. diff, Clostridium difficile; IBD, inflammatory bowel disease; FAP, familial adenomatous polyposis; GI, gastrointestinal.

Infectious

Clostridium difficile Colitis

This common infection presents in a variety of ways. In its severe form, the patient might have sepsis and require urgent surgical intervention; however, it may present as a recurrent infection in the outpatient setting. In any case, total colectomy is the operation of choice. An ileorectal anastomosis should never be performed in the unstable patient, however, this operation might be required in those with recurrent *Clostridium difficile* infections who have failed fecal transplant.

Inflammatory

Crohn's Colitis

Colitis can be the presenting and predominant feature in up to 30% of patients with Crohn's disease. This operation may be indicated in patients with multiple colonic strictures secondary to Crohn's disease or in patients with diffuse colonic inflammation and rectal/anal sparing.

Ulcerative Colitis

Surgery is performed in patients with ulcerative colitis for a number of indications: failure of medical therapy, severe toxic colitis, and concerns for malignancy. In most instances, an ileoanal pouch is the procedure of choice. However, in a select group of patients with rectal sparing, a total colectomy with ileorectal anastomosis might be offered. This procedure is rarely undertaken today, although it may be offered selectively to young individuals anxious to avoid sexual dysfunction or reduction in fertility.

Malignant

Polyposis/Lynch Syndrome

Classic familial polyposis affects the entire colon and rectum, with thousands of polyps occurring in the patient by their third decade. In attenuated forms, the rectum is spared making it possible to perform ileorectal anastomosis. Patients known to have Lynch syndrome should be offered a total colectomy with ileorectal anastomosis even if presenting with only right-sided cancer. The risk of metachronous cancer developing in the remainder of the colon is up to 20% and any remaining colon after partial colectomy will require intense surveillance or should be removed.

Synchronous Colorectal Cancer

Up to 2% of patients presenting with a primary colon cancer may have a synchronous lesion. Patients presenting with a tumor in the sigmoid colon and another in the right colon should undergo a total colectomy with ileorectal anastomosis.

Completely Obstructing Sigmoid Colon Cancer with Extreme Dilation of the Proximal Colon

Complete obstruction at the sigmoid colon due to a tumor or diverticular stricture will result in a severely dilated colon with areas of pressure-induced ischemia that cannot be used for an anastomosis. These patients are not candidates for the laparoscopic approach because the colon is too distended to handle laparoscopically.

Functional

Colonic Inertia

Patients presenting with severe constipation should be assessed for colon inertia. Colonic inertia, also known as slow transit constipation, is a motility disorder that affects the colon and results in significant discomfort for the patient. Sitz marker study confirms the diagnosis. Extracolonic etiologies should be excluded and medical therapy (polyethylene glycol [PEG] compounds, fiber, stimulant laxatives) should be exhausted before surgery.

Lower Gastrointestinal Bleed

Patients with pan diverticulosis and recurrent gastrointestinal bleeding, which cannot be localized before surgery, might require a total colectomy with ileorectal anastomosis.

CONTRAINDICATIONS

Contraindications may include those similar to any laparoscopic procedure such as multiple prior laparotomies with severe adhesions. The operation with an anastomosis is contraindicated in patients with severe malnutrition, sepsis, and disease processes involving the rectum. In the case of patients with sepsis, such as toxic *C. diff* colitis, the mortality from the disease process is high, let alone with emergency surgery. An anastomosis should not be entertained in these circumstances. Significant rectal involvement, be it polyps in patients with familial adenomatous polyposis or inflammation in patients with ulcerative colitis, precludes the patient as a candidate for this procedure. Patients with inadequate anal function and baseline incontinence should not be considered for this procedure. Similarly, patients with limited mobility, unable to tolerate urgency and frequency of stool, should avoid an ileorectal anastomosis because of the multiple bowel movements a day that are expected from the procedure. A patient with a high-grade large bowel obstruction that results in inability to handle the colon and risks intraoperative perforation may be better served by a decompressing and diverting loop colostomy or a “blow hole” transverse colostomy to release pressure and allow preparation, imaging, and endoscopy.

PREOPERATIVE PLANNING

Before performing a total colectomy with ileorectal anastomosis, the surgeon must ensure that the rectum is normal. Office-based rigid proctoscopy or flexible proctoscopy should be performed to ensure rectal sparing. Careful questioning of the patient regarding continence is necessary because the consistency of stool is likely to be liquid initially and soft at best in the long term. Patients with baseline incontinence should be counseled against having this procedure. Careful assessment of the patient's sphincter should be performed in the office, making sure to note the function of the anal sphincter. If there is any doubt, preoperative manometry should be obtained to establish a baseline of resting and squeeze pressure.

A combination of oral mechanical cathartic bowel preparation and oral antibiotics has recently been shown to reduce surgical site infections in patients undergoing colorectal surgery and should be given the day before surgery.

Procedure Details

Prophylactic antibiotics and preoperative heparin should be given 30–60 minutes before making an incision. Intravenous access should be obtained and checked after tucking the arms. Both arms should be tucked to allow the surgeon and the assistant to change sides as needed. The patient should be placed on a non-sliding mat that is also designed to minimize pressure on bony prominence. The abdomen is shaved with an electric clipper. An orogastric tube should be placed after induction of anesthesia and removed at the end of the procedure. Chlorhexidine is used to widely prep the abdomen in case additional intra-abdominal access ports and/or an incision are needed.

Positioning

The patient is placed in the supine position for induction and then in the modified lithotomy position. Care must be taken to pad the knees and all pressure points to try to avoid nerve injury. Accordingly, both arms are tucked and again padded. A tape is placed across the chest to help prevent the patient from sliding when placed in steep Trendelenburg and tilted left or right. The legs should be in line with the torso to allow the laparoscopic ports to have full mobility. The editors also employ a beanbag to help prevent sliding.

Technique

Entry to the abdomen can be gained in an open Hasson manner or through a Veress needle and optical view port. The editors prefer the Hasson technique. Ports around the abdomen can be either 5 mm or 10/12 in size. Use of a 5-mm scope, which provides a good quality image, is the preferred method because 5-mm ports do not need to be closed at the fascia level at the end of the procedure. The only port that needs to be larger is the right lower quadrant one to accommodate for the laparoscopic stapler to divide the rectum. The extraction site should be decided before deciding on ports. A Pfannenstiel incision provides better cosmetic and lower hernia rates postoperatively and can be placed as the suprapubic port if needed. Assuming entry to the abdomen was gained in the supraumbilical position with a Hasson port, four other ports are generally needed: a 10/12 in the right lower quadrant as discussed and 5-mm ports in the right upper, left upper, and left lower quadrants.

The Right Colon

The dissection is commenced on the right side of the abdomen. The ileocecal valve is elevated exposing the ileocolic pedicle. The pedicle is isolated immediately below the duodenum. A window is created around the pedicle. The duodenum should be clearly seen and dropped down before dividing the pedicle. Once a clear window is created, the vessels can be divided with a vascular-sealing device. The window is then enlarged and further dissected to separate the mesocolon from the retroperitoneum. The operating surgeon must always be aware that there is a tendency to dissect deep into the retroperitoneum and aim higher when separating the two planes. Once the gallbladder fossa is reached medially and the medial-to-lateral plane is dissected as far as possible inferiorly, attention should be turned to mobilizing the small bowel from the iliac fossa to the duodenum. The patient is placed in steep Trendelenburg and the entire small bowel is reflected in the upper abdomen. The peritoneum should be scored all the way to the second portion of the duodenum. The area around the duodenum should have been dissected when the medial plane was being developed. Blunt separation can be performed to separate the mesentery of the small bowel and the right colon from the retroperitoneum. The lateral attachments are then taken down heading toward the hepatic flexure. Of note, 5-mm nontraumatic graspers are used to handle the bowel throughout the case and grasping of the bowel wall should be avoided to avoid serosal tears. The entire C loop of the second portion and the third portion of the duodenum should be clearly visible at this time. After the patient is placed in reverse Trendelenburg, the right colon is carefully retracted toward the feet to expose the hepatic flexure. Frequently, the medially created dissection plane can be identified and the remaining peritoneum at the hepatic flexure divided with vessel sealers, to bring down the hepatic flexure completely. Once again, care must be taken to handle the tissue gently at this location because damage to some of the tributaries to the portal vein can result in significant bleeding, which can be very difficult to control.

Dividing the Transverse Mesocolon

This portion of a total colectomy is the most challenging; it is difficult to visualize planes, and the mobility of the transverse colon makes retraction difficult. The dissection can either continue from the right or a new plane from the left can be created. The omentum is either removed with the specimen or kept in situ. Some surgeons believe that leaving the omentum attached to the stomach after removing the colon might result in twisting of the omentum, resulting in infraction and development of adhesive bands. If the omentum is to be left attached to the stomach, the dissection should continue close to the colon from the right heading toward the splenic flexure. The lesser sac is obliterated on the right side of the abdomen and, to clearly enter the open space, dissection needs to start to the left of midline. If the omentum is to be removed with the specimen, the lesser sac should be entered along the greater curve outside of the gastroepiploic arcade, close to the spleen. Once the lesser sac is entered, the surgeon must backtrack and connect that plane to the previously identified plane on the right. Now the transverse mesocolon is ready to be divided. Dividing the mesentery can be undertaken by finding the window created at the beginning of the procedure to divide the ileocolic vessel and following the colonic mesentery to the patient’s left. Care must be taken to ensure that the small bowel mesentery is separated from the colonic mesentery because this represents a potential area of confusion, resulting in the superior mesenteric artery being lifted into the dissection plane.

Alternatively, once the lesser sac is entered, the dissection is commenced on the left side of the abdomen. The inferior mesenteric vein is identified and divided lateral to the fourth portion of the duodenum. This maneuver allows the mesocolon to be divided above the pancreas while entering the lesser sac. The mesocolon can then be divided left to right to connect to the previously created plane. Once the lesser sac is entered as described, the plane is extended to the left all the way toward the spleen. The splenic flexure should be released from the left upper quadrant completely, making sure to clearly identify the inferior edge of the pancreas and avoid any injury to the pancreatic parenchyma.

The Left Colon

The distal transection point of the left colon should be decided. Dividing the inferior mesorectal artery (IMA) high at its origin allows the surgeon to enter into the correct planes early and avoid injury to any critical structures such as the ureter. The medial aspect of the left colon is elevated exposing the origin of the IMA. Medial-to-lateral dissection similar to the one performed on the right side should be performed. The left ureter should be viewed before dividing the vessel; preoperative ureteral stent placement can assist in this goal. Once the ureter is identified on the left, the IMA can be safely divided with a vessel-sealing device. The lateral attachments of the sigmoid colon and descending colon are divided and blunt dissection can be performed to separate the colon are divided and blunt dissection can be performed to separate the mesentery from the retroperitoneum. Finally, the mesentery of the colon is divided toward the transection point at the top of the rectum at the sacral promontory where the tinea coalesces. The rectum is then divided utilizing a single firing of an endoscopic linear cutting stapler with one cartridge to avoid multiple crossing staple lines. It is preferable to use green-load to minimize tissue ischemia.

The Anastomosis

Once the entire colon attachments and mesentery have been divided, the specimen is ready to be extracted. A locking instrument is placed at the colonic staple line for identification. The periumbilical incision is enlarged to 4 cm, or as large as needed, to allow the specimen to be removed. After a wound protector is placed, the specimen is removed. The small bowel mesentery is divided with vessel sealer and the bowel prepared for anastomosis. The ileorectal anastomosis can be performed in a number of ways; however, for a laparoscopic approach, an end-to-end or an end-to-side are the options. In both cases, the anvil of the circular stapler should be secured in the proximal bowel. The bowel and stapler anvil is reintroduced into the abdomen and the abdomen is insufflated. This should either be performed by occluding the wound protector or reclosing the extraction site until it is small enough to allow the Hasson port without leakage. The mesentery of the small bowel should be inspected and there should be a straight line going up to the duodenum. Once the circular stapler is deployed, the donuts are inspected for integrity and an endoscopic air leak test is performed. A drain is optional in the pelvis and can be extracted through the left lower quadrant port site. The ports are then removed and the incisions are closed at the skin level other than the extraction site and the right lower quadrant port site, which require fascial level closure also.

POSTOPERATIVE MANAGEMENT

Enhanced recovery pathways are established in most hospitals and should be followed. These should be protocol based and only slight deviations are expected. In the case of laparoscopic ileorectal anastomoses, a prolonged ileus can occur and early feeding might not be wise in this patient population. Minimizing narcotics and early ambulation is encouraged. Chemical thromboembolism prophylaxis should be utilized. Judicious use of intravenous fluids is preferred. Early signs of anastomotic leakage should be recognized, prompting further evaluation.

COMPLICATIONS

Complications are divided into intraoperative, immediately postoperative, and delayed. The colon spans the entire abdomen in its location. Complications of the procedure are related to mobilizing the various portions of the colon. On the right side, the duodenum and ureter are at risk. If the mobilization is commenced on the right, injury to the superior mesenteric artery is possible if the mesentery of the colon and small bowel are not carefully separated. On the left side, the ureter and the spleen are at risk. Bleeding encountered when dividing the transverse mesocolon is difficult to control. The inferior mesenteric vein must be sealed away from the pancreas over an adequate distance to ensure hemostasis.

Early Postoperative

With the advent of enhanced recovery after surgery pathways in colorectal surgery, we have witnessed a reduction in postoperative ileus and postoperative hospital stay. An exception to this is a prolonged ileus following this procedure. It is not unusual after a laparoscopic total colectomy with ileorectal anastomosis for a patient to spend a week in the hospital without having any other complications. The treating physician should be aware of this and might consider starting parenteral nutrition in these patients. Anastomotic leakage is the most feared complication from this procedure. Ileorectal anastomoses leak is more frequently seen than right colon and left colon anastomoses. The leak rate can be as high as 5%. Consequences from a leaked anastomosis can range from postoperative abscess requiring only interventional radiology drainage to complete dehiscence requiring laparotomy, takedown, and end ileostomy. Sepsis can be life threatening.

Delayed

Diarrhea and severe dehydration is a concern in older patients. Therefore, close follow-up for several weeks should be arranged upon discharge. Delayed abscesses and fistulae, and anastomotic stricture can occur, usually in patients with Crohn’s disease.

RESULTS

Postoperative outcomes from laparoscopic total colectomy with ileorectal anastomosis are consistent with other laparoscopic colon surgeries with the following notable differences. The anastomosis is associated with higher risk of leak and the patients are more likely to develop postoperative ileus, making the hospital stay longer. A recent study comparing the technique to the open technique revealed that average hospital stay was 9 days and postoperative ileus was found in 24% of patients. Moreover, the operation took significantly more time than did laparotomy and the anastomotic leak rate was 5%.

Long-term result depends on the diagnosis. The average number of bowel movements to be expected is 5–6. This may be significantly more in patients with inflammatory bowel disease and significantly less in patients with colonic inertia (see Table 23-2).

TABLE 23-2 Functional Outcomes Following Total Colectomy and Ileorectal Anastomosis in Familial Adenomatous Polyposis

Daytime stool frequency	4–6
Nighttime frequency	1–2
Soiling	10–50%
Incontinence	6–30%

CONCLUSIONS

Laparoscopic total colectomy with ileorectal anastomosis is a safe and feasible operation. The surgeon is encouraged to track own results as well as those of the institution at which he or she practices. Soiling and incontinence are likely to worsen with age; and in most of these cases if the rectum becomes diseased, an end ileostomy might have to be considered.

RECOMMENDED REFERENCES AND READINGS

O'Riordan JM, O'Connor BI, Huang H, *et al*. Long term outcome of colectomy and ileorectal anastomosis for Crohn's colitis. *Dis Colon Rectum* 2011;54:1347–54.

Onder A, Benlice C, Church J, Kessler H, Gorgun E. Short term outcomes of laparoscopic versus open total colectomy with ileorectal anastomosis: a case matched analysis from a nationwide database. *Tech Coloproctol* 2016;20:767–73.

Pikarsky AJ, Singh JJ, Weiss EG, Nogueras JJ, Wexner SD. Long term follow up of patients undergoing colectomy for colonic inertia. *Dis Colon Rectum* 2001;44:179–83.

van Duijvendijk P, Slors JF, Taat CW, Oosterveld P, Vasen HF. Functional outcome after colectomy and ileorectal anastomosis compared with proctocolectomy and ileal pouch anal anastomosis in familial adenomatous polyposis. *Ann Surg* 1999;230:648–54.

Chapter 24

Hand-Assisted Laparoscopic Total Abdominal Colectomy

David A. Margolin

INDICATIONS/CONTRAINDICATIONS

Laparoscopic total abdominal colectomy is one of the more challenging laparoscopic colon procedures (LAP), because the surgeon must work in all four quadrants of the abdomen. The use of hand-assisted laparoscopic (HAL) techniques has been shown not only to facilitate the technical aspects of the procedure by restoring some tactile sensation but also to decrease the operative time. In essence, it makes laparoscopic procedures “more like open surgery.” The indications for the procedure are the same whether performed as open, laparoscopic, or hand assisted. However, it is up to the surgeon to determine whether the patient is a candidate for minimally invasive surgery. The surgeon needs to take into account the patient’s overall comorbidities as well as surgical history. Although multiple previous abdominal operations are not an absolute contraindication for LAP or HAL, the individual surgeon’s level of comfort and experience with the planned procedure plays a large role.

PREOPERATIVE PLANNING

Preoperative Preparation

Standard mechanical bowel preparation with a polyethylene glycol solution and the addition of oral metronidazole and erythromycin is the author's preference, because it is easier to handle an empty colon and the addition of oral antibiotics has been shown to decrease the incidence of surgical site infections. The patients are maintained on clear liquids up to 2 hours before surgery. We ensure that standard intravenous (IV) broad-spectrum antibiotics are given within 1 hour of skin incision. Because the patients will be in a modified lithotomy position for several hours, venous thromboembolic prophylaxis is mandatory. The author utilizes both subcutaneous heparin and sequential compression device (SCD) stockings, commencing immediately before surgery and continued after surgery. In an attempt to minimize narcotics use, patients receive IV ibuprofen and acetaminophen within 1 hour of surgery. All patients have an informed consent that includes the potential for conversion to an open procedure.

SURGERY

Patient Positioning and Preparation

The patient is placed on a self-securing pad with a chest strap to prevent slippage. After induction of general anesthesia, an orogastric tube and indwelling urinary bladder catheter are placed. The patient is placed in a modified lithotomy position using Yellowfin Stirrups (Allen Medical, Batesville, IN) with the thighs even with the hips and all potential pressure points appropriately padded. Care is taken to ensure that there is no pressure on the peroneal nerves and that the patient's knees are in line with contralateral shoulder. Both arms are tucked in the adducted position to facilitate securing the patients for the extremes of positioning used during laparoscopy. Rectal irrigation is performed and the skin is prepped with a 2% chlorhexidine-based solution and draped in a standard manner. Before draping, the table is rotated in all directions to ensure that the patient is secure.

Instrument/Monitor Positioning

Two monitors are utilized during the procedure. One is on the patient's right side at the level of the shoulder. The other monitor is placed on the patient's left side at the level of the hip. At the author's institution, the monitors are mounted on booms from the ceiling allowing easy repositioning for optimal visualization. In the author's institution, the insufflation tubing, suction tubing, cautery power cord, laparoscopy camera wiring, and a laparoscope light cord are brought off the patient's left side at the foot of the table. The author routinely uses a 10-mm laparoscope with a 30-degree lens. However, with the increased availability of high-definition cameras and monitors, a 5-mm laparoscope may be an acceptable alternative.

Port Selection and Placement

Before placing any ports, the outline of the hand-assist device is marked on the patient's abdomen. The author uses the Applied Medical GelPort (Applied Medical, Ranch Santa Margarita, CA). By tracing the outline of the device we ensure that all of our ports are outside the outline to function throughout the procedure. The author places the inferior edge of the device 2–3 cm from the pubic symphysis in the midline. Once this marking is done, a modified Hasson technique is employed to enter the abdomen above the umbilicus and obtain pneumoperitoneum. A vertical skin incision is made with a scalpel followed by dissection down to the linea alba. A Kocher clamp is used to elevate the fascia in the midline at the level of the umbilical stump and the linea alba is then incised. S-shaped retractors are helpful in exposing the midline. Entry into the peritoneal cavity is accomplished sharply. Once entry into the peritoneal cavity is obtained, a 10-mm blunt-tip balloon trocar is placed and inflated. A total of four additional ports are used. We use two 5-mm ports in the left and right upper quadrants and a 5-mm port in the left lower quadrant. A 12-mm port is employed in the right lower quadrant to allow placement of an endoscopic stapler if necessary; the hand port is placed later in the procedure (Fig. 24-1).

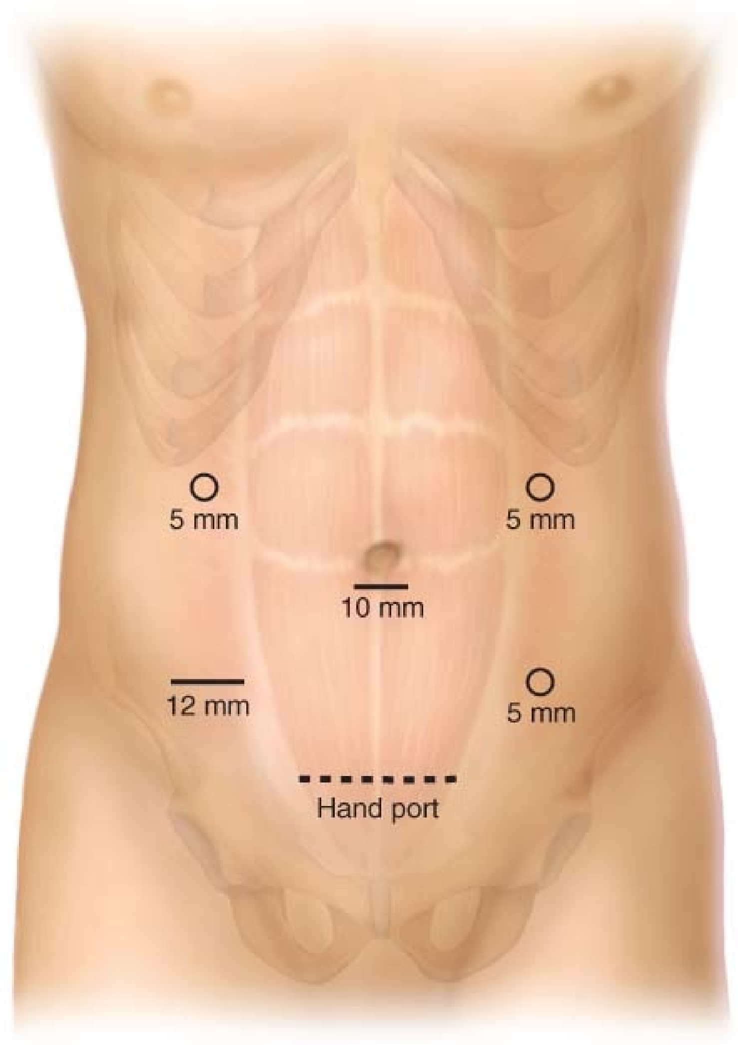


FIGURE 24-1 Laparoscopic port sites and hand port placement.

Mobilization and Transection

After establishing pneumoperitoneum and placing the necessary ports, the abdominal cavity is laparoscopically explored. To help with postoperative pain, we a place a transversus abdominis plane (TAP) block with bupivacaine. The TAP block is performed at the anterior axillary line midway between the costal margin and the iliac crest. A 20-gauge needle is passed through the skin and continued until two distinct “pops” are felt, signifying passage through the oblique layers and into the TAP. Here, boluses of bupivacaine are placed at 2-cm intervals. The entire process is visualized laparoscopically.

The patient is then placed in slight reverse Trendelenburg position and is rotated to the patient’s right. We initially begin the operation with both splenic flexure and right colon mobilization before placement of the hand port. Unlike other authors, we find that placing the hand port before mobilizing these steps actually slows down the operation. With the patient rotated to the right, the small bowel is swept to the right and inferior. This exposes the ligament of Treitz. Looking laterally the inferior mesenteric vein (IMV) is clearly visible. The vein is carefully elevated and dissection is carried out laterally, posterior to the IMV and anterior to Gerota’s fascia to the abdominal sidewall posterior to the colon. Once the plane is developed, the IMV is divided using a vessel-sealing device such as the Ethicon EnSeal (Ethicon Endosurgery, Cincinnati, OH), although the choice of the alternate energy source is left to the surgeons’ discretion. The dissection is carried out superiorly to the inferior border of the pancreas and inferiorly to the inferior mesenteric artery (IMA).

At this point, the table is rotated to the left and the patient is placed in Trendelenburg. The terminal ileum is elevated and the avascular plane at the root of the small-bowel mesentery is incised. Using careful blunt dissection the duodenum comes into view. The dissection is carried out up to the third portion of the duodenum. Care is taken at this point to sweep the duodenum medially. Sweeping away from the duodenum can lead to serosal tears. At this point, the terminal ileum is released and allowed to fall inferiorly. The avascular plane anterior to the duodenum through the colon mesentery is clearly visible. This plane is opened by careful blunt dissection aiming at the gallbladder fossa. Once this window is opened, dissection is carried out inferiorly from medial to lateral. The first vessel encountered is the ileocolic artery. The artery is grasped and elevated, and the avascular plane on either side is dissected free to allow clear visualization of the duodenum. The vessel is then ligated and divided using a vessel-sealing device. The colon is then retracted medially and the lateral attachments of the right colon are laparoscopically mobilized, being careful to stay in the lateral avascular plane.

Once both the splenic flexure and right colon are mobilized, the hand port is placed. As previously mentioned, we find that placing the hand port before mobilizing the right colon and splenic flexure is more of a hindrance. A 7-cm mobilizing the right colon and splenic flexure is more of a hindrance. A 7-cm vertical incision is made 2–3 cm superior to the pubic synthesis and dissection is continued to the fascia. The fascia is opened for 7 cm, the port is placed, and pneumoperitoneum is reestablished. Standing on the patient's left side, the patient is rotated to neutral with a slight amount of reverse Trendelenburg. The left hand is placed through the port to apply downward traction distal transverse colon. Using the right hand an alternate energy source device is placed through one of the left-sided trocars and omentum is taken off the transverse colon. Once the omentum is removed, the transverse colon is grasped and elevated anteriorly; and from underneath the transverse mesocolon and the middle colic artery are mobilized and divided from the patient's left to right meeting the dissection plane from the initial right colon mobilization. The assistant who is on the patient's left side plays a key role in the portion of the procedure to provide counter-traction through one of the left-sided ports.

An alternate approach is occasionally used, to make the hand port incision, as described earlier, at the beginning of the case. Using handheld retractors we then mobilize the cecum and ascending and sigmoid colon up toward their respective flexures. Once difficulty is encountered with the mobilization, pneumoperitoneum is established and the trocars are placed under direct vision in the previously mentioned locations. This limited open dissection may significantly decrease operative time, especially in thinner patients.

The patient is now placed in Trendelenburg. Using the left hand the sigmoid colon is grasped and elevated to the abdominal wall. This allows visualization of the IMA pedicle. Using the right hand with an alternative energy source, the avascular plane inferior to the IMA is opened and the left ureter is identified. The IMA is then isolated and ligated. Superior and lateral dissection is undertaken from a medial-to-lateral direction behind the colon and anterior to the left ureter up to the level of the previous dissection.

Creation of the Anastomosis

Once the colon is completely mobilized, the top of the hand port is removed and the colon at the sacral promontory is divided using an open 45-mm stapler. The remainder of the colon is delivered through the hand port, the distal terminal ileum is divided, and the specimen is removed from the field. Then, using a Furness clamp, a purse string is made in the distal terminal ileum and the anvil and a 29-mm circular stapler is secured in the terminal ileum. A Fansler retractor is used to gently dilate the anal sphincters and allow easy transanal passage of the stapler. Once the stapler is passed into the anal canal, the Fansler retractor is removed and the stapler is manipulated through the rectum to the staple line. The trocar is deployed. Care is taken to ensure that the trocar does not go through the staple line but 1–2 mm anterior or posterior to the rectal staple line. After a tension-free anastomosis is created, the pelvis is filled with water, and colonoscopic visualization is performed to check for an air leak and bleeding from the anastomosis. Because of the proximal nature of the anastomosis, a small leak can be repaired under direct vision through the hand port.

small leak can be repaired under direct vision through the hand port. Alternatively, the anastomosis can easily be redone through the hand port.

Closure of Port Sites

After verification of hemostasis and a sponge and instrument count, the ports are removed. The 5-and 10-mm port sites are irrigated and the skin is closed with a subcuticular monofilament absorbable suture (Vicryl-Ethicon, Somerville, NJ) such as 4-0 poliglecaprone (Monocryl) suture. The fascia at the umbilical port site is closed with a single 0 (Vicryl) and the hand port site is closed with a monofilament absorbable suture polydioxanone; the skin is closed similar to the other port sites.

POSTOPERATIVE MANAGEMENT

Postoperatively, patients are given clear liquids the night of surgery and then a low-residue diet the next day. Care is taken to manage patient expectations with regard to eating. Although food is available, it is up to the individual to eat what he or she feels comfortable with. The bladder catheter is removed the first postoperative morning. Patients are encouraged to use incentive spirometry and ambulate at least three times a day. We continue the use of SCD and thromboembolic device hose while hospitalized. Narcotics should be administered through the continued use of IV ibuprofen and acetaminophen for the first 24 hours postoperatively followed by oral pain medication. Patients are discharged when they meet the following requirements: have their pain controlled with oral analgesics, tolerate a diet, and pass flatus.

COMPLICATIONS

HAL retains most of the potential complications associated with both the open and the laparoscopic procedures including hemorrhage, adjacent organ injury, and anastomotic dehiscence. Although still present, the risk of incisional hernia and postoperative surgical site infection may be significantly decreased compared to that in the open procedure. One complication that is more common and fortunately preventable in HAL than in open surgery is a 360-degree twist of the anastomosis. This potentially devastating complication occurs because of the decreased field of view with the laparoscope. To prevent this problem, it is imperative that the surgeon uses good techniques and follows the cut small-bowel mesentery proximally to verify that there are no twists and that it lies in a straight line on top of the retroperitoneum.

RESULTS

Hand-assisted total abdominal colectomy has been shown to be an efficacious modality in lieu of open or laparoscopic surgery. Many authors have touted it as a potential hybrid procedure that maintains the advantages of laparoscopy. Nakajima in a review of 23 patients, 12 HAL and 11 LAP, found no difference in conversion rate, blood loss, or perioperative complications between the two groups, and a significantly shorter operative time in the HAL group. Boushey, in reviewing 130 nonrandomized cases, again showed no difference in anything but conversion rate and a trend toward shorter operative time in the HAL group. Marcello et al., in a randomized prospective multicenter trial comparing HAL to laparoscopy for left-sided and total colostomies, demonstrated a significant decrease in operative time with no loss of the benefits of laparoscopic surgery. Subset analysis for the patients undergoing total abdominal colectomies showed a decrease in time from 285 ± 105 to 199 ± 35 minutes. Although a small sample size, 14 in the HAL and in the 15 laparoscopy group in this randomized trial, there was no difference in time to flatus, diet, or length of hospital stay. Recent National Surgical Quality Improvement Program analysis of over 8,700 patients showed that HAL demonstrated reduced overall complications, wound complications, anastomotic leak, length of hospital stay, and readmission without increased operative time. For segmental resection, HAL demonstrated reduced overall complications, wound complications, respiratory complications, postoperative ileus, anastomotic leak, transfusion, length of hospital stay, and readmissions (all $P < 0.05$). There is some concern that the long-term benefits of LAP will be lost with HAL, especially the incidence of postoperative hernias and bowel obstruction. Sonoda in reviewing 536 patients over a 5-year period, 266 HAL and 270 LAP, found no difference in either incisional hernias or in the incidence of bowel obstruction with a median follow-up of 27 months. However, Cobb in 2012 reviewed 405 patients undergoing HAL procedures and found the overall incidence of incisional hernia was 10.6%. As expected, the hernia rate correlated with body mass index. They also found that for patients who were followed up for more than 12 months in 188 (46%) of patients, the rate of incisional hernia was 17%.

CONCLUSION

Some of the technical challenges of laparoscopic total abdominal colectomy may be overcome by the HAL approach. Most of the benefits of laparoscopy appear to be maintained while operative times may be shortened. The tactile sensation afforded by use of the hand may be beneficial to many surgeons.

RECOMMENDED REFERENCES AND READINGS

Aalbers AG, Biere SS, van Berge Henegouwen MI, Bemelman WA. Hand-assisted or laparoscopic-assisted approach in colorectal surgery: a systematic review and meta-analysis. *Surg Endosc* 2008;22:1769–80.

Agha A, Moser C, Iesalnieks I, Piso P, Schlitt HJ. Combination of hand-assisted and laparoscopic proctocolectomy (HALP): technical aspects, learning curve and early postoperative results. *Surg Endosc* 2008;22(6):1547–52.

Benlice C, Costedio M, Kessler H, Remzi FH, Gorgun E. Comparison of straight vs hand-assisted laparoscopic colectomy: an assessment from the NSQIP procedure-targeted cohort. *Am J Surg* 2016;212(3):406–12.

Boushey RP, Marcello PW, Martel G, Rusin LC, Roberts PL, Schoetz DJ Jr. Laparoscopic total colectomy: an evolutionary experience. *Dis Colon Rectum* 2007;50:1512–9.

Cima RR, Pattana-arun J, Larson DW, Dozois EJ, Wolff BG, Pemberton JH. Experience with 969 minimal access colectomies: the role of hand-assisted laparoscopy in expanding minimally invasive surgery for complex colectomies. *J Am Coll Surg* 2008;206(5):946–50; discussion 950–2.

Cobb WS, Carbonell AM, Snipes GM, *et al.* Incisional hernia risk after hand-assisted laparoscopic surgery. *Am Surg* 2012;78(8):864–9.

Ding J, Xia Y, Liao GQ, *et al.* Hand-assisted laparoscopic surgery versus open surgery for colorectal disease: a systematic review and meta-analysis. *Am J Surg* 2014;207(1):109–19.

Hassan I, You YN, Cima RR, *et al.* Hand-assisted versus laparoscopic-assisted colorectal surgery: practice patterns and clinical outcomes in a minimally-invasive colorectal practice. *Surg Endosc* 2008;22(3):739–43.

Hsiao KC, Jao SW, Wu CC, Lee TY, Lai HJ, Kang JC. Hand-assisted laparoscopic total colectomy for slow transit constipation. *Int J Colorectal Dis* 2008;23(4):419–24.

Leraas HJ, Ong CT, Sun Z, *et al.* Hand-assisted laparoscopic colectomy improves perioperative outcomes without increasing operative time compared to the open approach: a national analysis of 8791 patients. *J Gastrointest Surg* 2017;21(4):684–91.

Marcello PW, Fleshman JW, Milsom JW, *et al.* Hand-assisted laparoscopic vs. laparoscopic colorectal surgery: a multicenter, prospective, randomized trial. *Dis Colon Rectum* 2008;51:818–26; discussion 826–8.

Martel G, Boushey RP, Marcello PW. Hand-assisted laparoscopic colorectal surgery: an evidence-based review. *Minerva Chir* 2008;63:373–83.

Nakajima K, Lee SW, Cocilovo C, Foglia C, Sonoda T, Milsom JW. Laparoscopic total colectomy: hand-assisted vs. standard technique. *Surg Endosc* 2004;18:582–6.

Ozturk E, Kiran PR, Remzi F, Geisler D, Fazio V. Hand-assisted laparoscopic surgery may be a useful tool for surgeons early in the learning curve performing total abdominal colectomy. *Colorectal Dis* 2010;12(3):199–205.

Pendlimari R, Holubar SD, Dozois EJ, Larson DW, Pemberton JH, Cima RR. Technical proficiency in hand-assisted laparoscopic colon and rectal surgery: determining how many cases are required to achieve mastery. *Arch Surg* 2012;147(4):317–22.

Polle SW, Dunker MS, Slors JF, *et al.* Body image, cosmesis, quality of life, and functional outcome of hand-assisted laparoscopic versus open restorative proctocolectomy: long-term results of a randomized trial. *Surg Endosc* 2007;21(8):1301–7.
Rivadeneira DE, Marcello PW, Roberts PL, *et al.* Benefits of hand-assisted laparoscopic restorative proctocolectomy: a comparative study. *Dis Colon Rectum* 2004;47:1371–6.
Roslani AC, Koh DC, Tsang CB, Wong KS, Cheong WK, Wong HB. Hand-assisted laparoscopic colectomy versus standard laparoscopic colectomy: a cost analysis. *Colorectal Dis* 2009;11(5):496–501.
Sonoda T, Pandey S, Trencheva K, Lee S, Milsom J. Long-term complications of hand-assisted versus laparoscopic colectomy. *J Am Coll Surg* 2009;208:62–6.

Chapter 25

Robotic

Venkatesh Munikrishanan and Manish Chand

The use of robotic platforms for colorectal resectional surgery has significantly increased in the past decade. As surgeons have become more familiar with and proficient at robotic surgery, a greater number and variety of procedures have been added to the repertoire. Historically, robotic colorectal surgery has focused on the pelvis, where some surgeons have found laparoscopy to be challenging. The pelvis can prove to be difficult for some laparoscopic surgeons because the limited space combined with the close proximity to important structures can impose problems with rigid "straight" laparoscopic instruments. The theoretical technical advantages of "wristed" instruments and 3D binocular vision have been most commonly used for rectal cancer surgery, but we describe the robotic approach to total colectomy (TC) with ileorectal anastomosis.

INDICATIONS AND CONTRAINDICATIONS

Indications

In general terms, the indications and contraindications for robotic TC are the same as those for laparoscopy. These attributes are determined by both clinical and technical factors related to the disease and patient, respectively. While the disease-related factors have not changed over many years, the evolution of laparoscopy has meant that the number and variety of indications from a technical standpoint have increased. Consequently, the contraindications that may have been historically considered "absolute" are now "relative" contraindications. This divide is often a function of individual surgeons and unit expertise rather than strict parameters.

Table 25-1 shows the common indications for TC, which can be broadly divided into malignant and benign conditions. However, as surgeon experience increases, one may also consider emergent indications.

TABLE 25-1 Indications for Robotic Total Colectomy

Indication	Benign/malignant	Elective/acute

Synchronous colonic tumor	Malignancy	Elective
Synchronous tumor and dysplasia	Malignancy	Elective
Familial adenomatous polyposis; hereditary non-polyposis colorectal cancer	Malignancy	Elective
Colitis (inflammatory bowel disease; rarely other causes, e.g., diverticulitis, ischemic)	Benign	Elective/emergent
Functional disorder (colonic inertia)	Benign	Elective

An important consideration, regardless of indication, must be the anticipated functional consequences. The traditional measures include normal resting sphincter tone, absence of perianal disease, and sufficient rectal capacity and compliance. If these conditions are not met, the patient is at high risk of developing significant quality of life deterioration. The objective measure of anorectal physiology testing may be necessary for some patients.

Malignant Conditions

The technical approach to resection of malignant disease often differs from that for benign disease in TC as one considers the oncologic aspects of the procedure. However, synchronous tumors and dysplasia are potential problems.

As with laparoscopy, the malignant conditions are often less challenging because the anatomy is less distorted than it might be in the presence of inflammation. There is commonly more non-diseased bowel that can be manipulated with greater confidence, and often there are fewer adhesions. This combination of factors can affect the procedure and often cannot be fully assessed until first inspection of the abdominopelvic cavity following induction of pneumoperitoneum.

Familial adenomatous polyposis and hereditary non-polyposis colorectal cancer provide indications for prophylactic colectomy, but one must consider surveillance strategies if required. The discussion of risk of colorectal cancer (CRC) and alternative surveillance strategies must be had in detail, often in conjunction with a clinical geneticist. These patients require significant counseling and support before undertaking the surgery. Functional consequences and fecundity must be discussed in detail because these may well be young patients.

Benign Conditions

The indications for TC in benign disease are commonly colitis with rectal sparing, but may occasionally be ischemic with colitis or pancolonic diverticulitis.

Patients with significant colonic inertia may request or be offered a TC as a last resort. These patients have often had a long relationship with the clinical team and failed a variety of treatments before reaching the point of surgery. Because there is no immediate urgency for surgery, appropriate counseling in a multidisciplinary setting in conjunction with a gastroenterologist, psychologist, stoma nurses, and other allied health professionals is necessary to achieve patient satisfaction. The technique differs from the conditions mentioned and there is usually no concern with pathologic anatomy, but it can often be colonic redundancy with which the surgeon must contend. The redundant bowel can lead to challenges in manipulating and positioning.

The level of distal transection and subsequent restoration of gastrointestinal continuity is based on individual cases and should be discussed with the patient before the procedure. The distal transection will be commonly influenced by the distal extent of disease, future surveillance strategy, and risk of recurrence of the disease and desire to restore continuity. The distal margin should be to the rectum in patients in whom the surgical indication is diverticulitis.

There are currently little data supporting the use of a robotic platform in the emergent setting. Again, many of the same general arguments for the use of minimally invasive surgery apply. However, there may be additional concerns surrounding costs, setup time, and access, which have largely been addressed by laparoscopy in this setting. Additional indications in this setting are colonic hemorrhage, inflammatory bowel disease, pseudomembranous colitis, and ischemic colitis.

Contraindications

Table 25-2 shows the common contraindications. The majority of these factors are deemed "relative" contraindications, and often it is the experience of the surgeon following detailed patient consultation that makes the final decision. The evolution of these relative contraindications mimics that of laparoscopy. As surgeons become more experienced, they are able to consider an increasing number of such cases for robotic TC. The contraindications can be broadly divided into patient comorbidities that may restrict patient positioning and pneumoperitoneum and patient technical factors causing restricted access and vision.

TABLE 25-2 Contraindications for Robotic Total Colectomy

Patient variable	Description/rationale	Level of contraindication

Severe intra-abdominal adhesions	Inability to visualize the abdominopelvic compartment	Relative
Acute colitis	Friable bowel	
Acute bowel obstruction	Lack of space within the abdominopelvic compartment	Relative
Morbid obesity	Inability to create space within compartment; cardiorespiratory compromise restricts ability to maintain pneumoperitoneum	Dependent on BMI
Massive ascites	Fluid-filled cavity	Absolute
ASA grade	Inability to maintain pneumoperitoneum	Dependent on grade
Coagulation disorder	Risk of bleeding	Dependent on severity

ASA, American Society of Anesthesiologists; BMI, body mass index.

The most important considerations in Table 25-2 are the anesthetic and perioperative factors. Robotic TC involves considerable investment from the theatre team, surgeon, and institution. A patient not suitable for a prolonged surgical procedure with a pneumoperitoneum is an inappropriate candidate for robotics. There must be a detailed discussion with the anesthesia and intensive care teams in this regard, not only about the surgery but also about the postoperative care setting.

From a technical standpoint, the key to successful surgery is the ability to access and visualize the entire abdomen–pelvic cavity. Adhesions, ascites, and bowel distension can restrict access and vision, and the severity of these will dictate whether the procedure is possible. The surgeon will be best placed to determine whether with appropriate adhesiolysis and manipulation/positioning of the bowel the procedure can be safely undertaken on the basis of prior experience.

Obesity can affect the procedure from an anesthesia and technical perspective. If the size of the patient impairs cardiorespiratory function during pneumoperitoneum, it may not be possible to complete the procedure. This problem is usually apparent early in the procedure, particularly when patient positioning is performed in reverse Trendelenburg. An increase in intra-abdominal fat can impair vision, make positioning of the bowel challenging and reduce access to the pelvic cavity where space is at a premium reduce access to the pelvic cavity where space is at a premium.

PREOPERATIVE PLANNING

Multidisciplinary Team Meeting

The first aspect of preoperative planning starts with a discussion of the clinical case within the forum of a multidisciplinary team (MDT) dedicated to the management of patients undergoing robotic surgery. Many units now have such an MDT that regularly convenes to discuss robotic surgery cases. This setting allows all members of the clinical team to ensure they are satisfied that robotic surgery is suitable and appropriate for the patient. Once a collective decision is made, patients are invited to a preoperative anesthesia assessment and counseling session. Here, patients are assessed by the anesthesia team with regard to fitness for surgery, with necessary clearances from other specialists if there are concerns over comorbidity. The patient is also counseled by the specialist colorectal nurse, who runs through the sequence of events pertaining to arrival at the hospital, the procedure, postoperative care, and follow-up. If patients have further questions, they are addressed by the operating team. Patients are counseled for a possible stoma and the site is appropriately marked.

Patient Preparation

Patients undergo full mechanical and cathartic bowel preparation the day before surgery. The editors also employ preoperative oral antibiotics. There is now accumulating evidence for the importance of mechanical bowel preparation in combination with intravenous antibiotics at induction to reduce the risk of surgical site infection and reduce the risk of anastomotic leaks. Patients are admitted to hospital the day before surgery and are given carbohydrate loading in the form of an oral solution. Many units now have a policy of admitting patients on the day of surgery, particularly in socialized healthcare systems where "bed-days" are at a premium. In addition, patients are given segmental compression stockings and preoperative subcutaneous thromboprophylaxis.

SURGERY

Patient positioning for the surgery depends on how the procedure is approached (right or left colon first), because once the robot is docked the table cannot move (the latest generation da Vinci Xi does have a Table Motion option, which allows the table to be moved during surgery). In our experience, we start with the right side of the colon where the patient is placed supine, slight Trendelenburg tilt, rotated to the left with both arms tucked by the side. All pressure points are carefully protected with suitable gel padding and a beanbag. Patients have a urinary catheter and nasogastric tube placed. The robotic cart is docked from the right side. Typically, the 12-mm camera port is placed at the umbilicus, the 8-mm port for arm 1 is placed 10 cm lateral to the umbilical port in the left upper quadrant (P1), and the port for arm 2 for fine retraction and dissection is placed in the suprapubic region (P2). The port for arm 3 is placed in the right iliac fossa (P3), and this arm is used to retract the cecum/colon. A 5-mm port is placed in the left lower quadrant to assist (Fig. 25-1). In the Xi platform, the ports are placed in a straight line from left upper quadrant to suprapubic region.

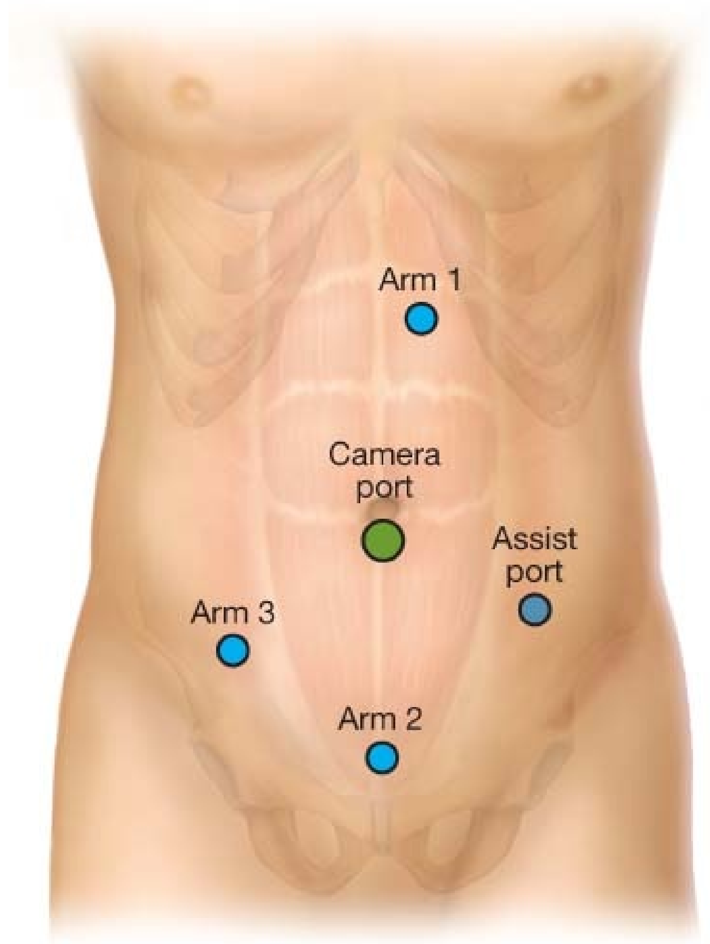


FIGURE 25-1 Port placements for right colon mobilization (Si).

p. 235

p. 236

For the left colon mobilization, there is a repositioning with the robot patient cart being placed from the left at an almost 50-degree angle to the patient. The camera port is placed at the umbilicus, the port for arm 1 is right lower quadrant (P1), again making sure the ports are placed 10 cm away from each other to avoid collision of instruments. The port for arm 2 is placed 10 cm left lateral to the umbilical port (P2). The port for arm 3 is placed in the subcostal region, which helps with retraction of the left colon and splenic flexure (Fig. 25-2). A 12-mm assist port is placed close to the right anterior superior iliac spine for usage with stapling instruments. Again, in the Xi system, diagonal or transverse port placement facilitates multiquadrant surgery (Fig. 25-3).

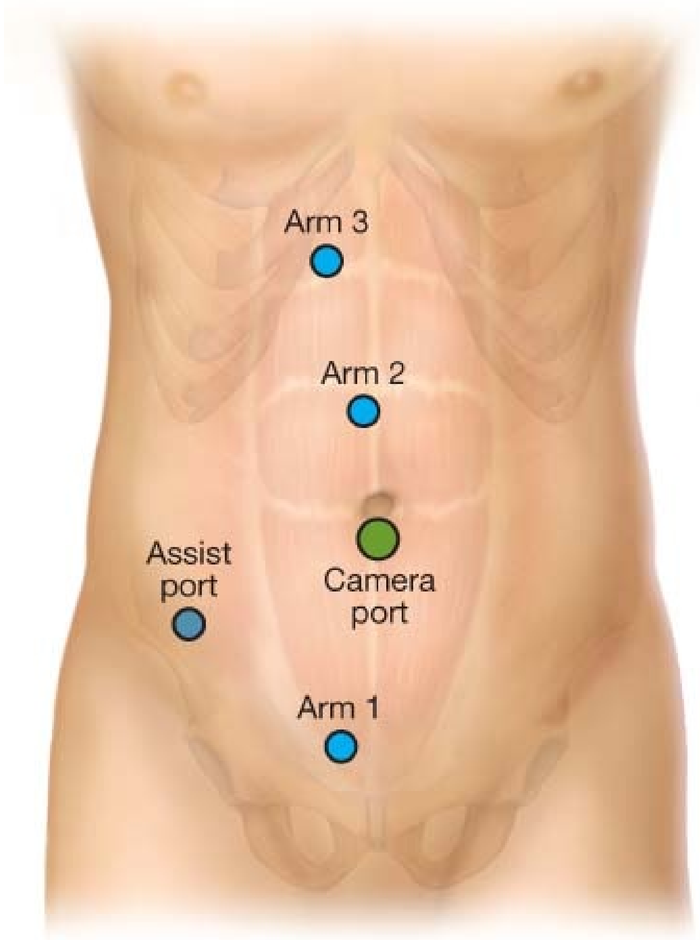


FIGURE 25-2 Port placement for left colon mobilisation (Si).

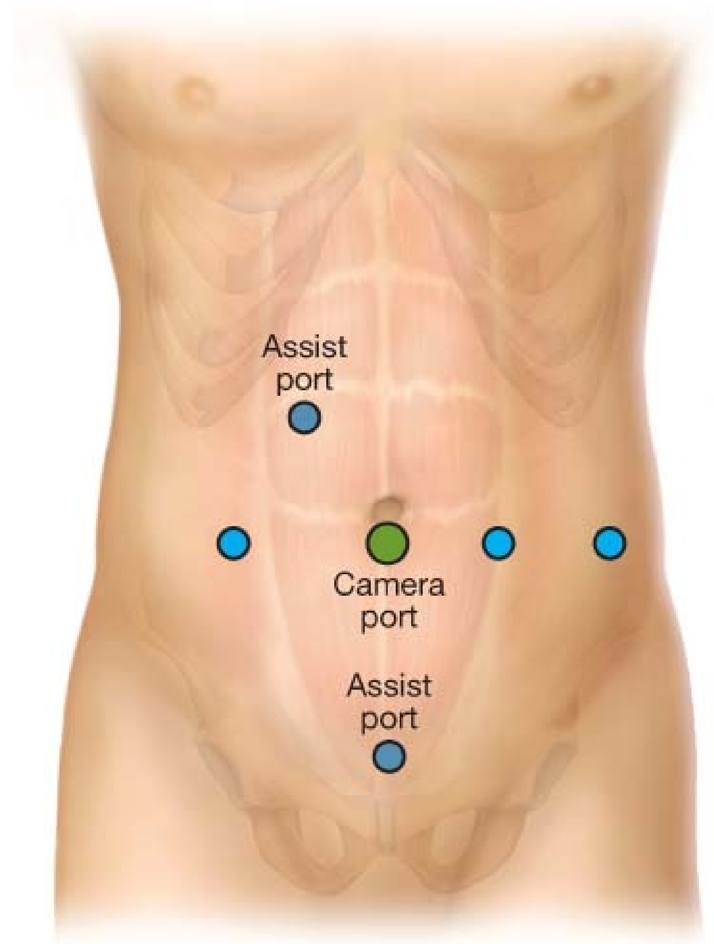


FIGURE 25-3 Port placement for total colectomy (Xi) and the light blue circles Arm 1, Arm 2, Arm 3 left to right of picture.

Technique

Right Colon/Hepatic Flexure

The right colon resection is undertaken in a medial-to-lateral approach. The procedure begins with identification of the ileocolic vessels by placing traction on the cecum and appendix with arm 3. The arm 2 has bipolar fenestrated graspers and “tents up” the ileocolic vessels, allowing arm 1 with the monopolar scissors to incise the peritoneum envelope over the tented mesentery. An avascular window is made to help skeletonize the ileocolic vessels division with two proximal and one distal clip (Hem-o-Lok, Weck, Teleflex, Ireland) before vessel transection. The articulated instruments are extremely useful in these maneuvers to display the vessels and provide appropriate traction while limiting injury to nearby structures, in particular the duodenum. The dissection is carried medial to lateral, with arm 2 elevating the mesentery or the “curtain” with gentle but purposeful blunt dissection in an anteroposterior direction. The duodenum will be visible close to the pedicle and should be confidently identified and preserved before carefully continuing the dissection. The transverse colon can be seen through the thin layer of the remaining mesentery. A swab can be placed on top of the duodenum to facilitate identification when the direction of dissection is changed. The lateral dissection is carried out with a combination of blunt “up”’ and “down” movements until Toldt’s fascia can be identified. The terminal ileum and cecum is next mobilized off its pelvic brim attachments with sharp dissection. The cecum is retracted with arm 3 toward the left upper quadrant. The dissection is continued to mobilize the cecum and right colon from the right abdominal wall up to the hepatic flexure. At this point, the previously placed swab comes into view. Now arm 3 is used to medially rotate the cecum and colon to facilitate the mobilization of the hepatic flexure from its attachments with monopolar scissors. The greater omentum is lifted up with arm 3, and arm 2 is used to apply traction on the colon. The arm 1 with monopolar scissors is used to free the omentum of the colon. Bleeding that occurs during dissection can usually be effectively controlled with a combination of bipolar fenestrated graspers in arm 2 and the monopolar scissor tip in arm 1. The omentum is completely dissected from the proximal transverse colon. Similar avascular windows are made in the mesentery to skeletonize the right colic and middle colic vessels with the Gold Hem-o-lok clips being applied once more in a similar manner of two on the proximal side in the patient and one on the distal aspect.

The dissection of splenic flexure and left and sigmoid colon is again approached in a medial-to-lateral technique. The sigmoid colon/mesentery is held at the apex with arm 3 so that the inferior mesenteric vessels become taut. The peritoneum over the medial side of the sigmoid mesentery is held up with arm 2 and the monopolar scissors in arm 1 scores the peritoneum in an arc below the level of vessels starting from the root of the vessels up to the pelvic brim. This maneuver lets the CO_2 into the retroperitoneal space and helps identify the right plane of dissection. The root of the inferior mesenteric artery is clearly identified and the vessel skeletonized. The vessel is transected in between clips. This maneuver starts the medial-to-lateral dissection behind the sigmoid mesentery. Careful up and down blunt movements will help preserve the nerve bundles, the left ureter, and left gonadal vessels. Identifying and preserving the left ureter is a key step in the dissection. The distal dissection is carried up to the upper rectum at the point of entry into the posterior “Holy Plane” used for total mesorectal excision. Proximal and lateral dissection is carried to the inferior mesenteric vein at the inferior edge of the pancreas where it is ligated with arm 3 holding up the left colon mesentery and arms 1 and 2 carrying out the dissection.

A swab may be left behind the sigmoid mesentery, which will help identify the correct plane later.

The sigmoid colon is medially retracted with arm 3 and its attachments to the left pelvic brim and sidewall are freed with monopolar scissors in arm 1. The sigmoid colon and the left colon are freed from the left abdominal wall. The dissection is carried proximally up to the splenic flexure. The omentum is lifted up with the arm 3 grasper. The left colon and splenic flexure is retracted toward the right iliac fossa with the arm 2 grasper and all peritoneal attachments are freed with the arm 1 monopolar scissors. Any bleeding is usually minimal and can generally be effectively controlled by a combination of bipolar grasper in arm 3 and monopolar cautery in arm 1. Further traction on the splenic flexure toward the pelvis helps dissect the omentum from the distal transverse colon. Avascular windows are made in the left colon mesentery to facilitate ligation of left and middle colic vessels. The entire colon should be free of its embryologic attachments at this point.

Robotic staplers are used to transect the colon at the upper rectum after re-identification of nerves and ureters. A small transverse incision is made in the right iliac fossa and a small wound protector is used to exteriorize the specimen. The entire colon is delivered through the wound. The ileum is transected at the appropriate point. The appropriate sized circular end-to-end staplers are chosen. The anvil is placed in the transected ileum and closed with a purse string stitch using 2.0 prolene. The ileorectal anastomosis is performed with the preference being an end-to-side anastomosis at 5 cm. An “air-leak” test is undertaken using rigid or flexible sigmoidoscopy. A stoma is created at the discretion of the surgeon.

The Surgical Robot Systems

The Intuitive Surgical da Vinci System and TransEnterix Senhance are the only currently available robotic systems in Europe. In the United States it is only the da Vinci system, which is FDA approved. The most widely used system is the Si model. The difference between the Si and the Xi model is shown in Table 25-3.

TABLE 25-3 da Vinci Robotic Surgical Platforms

System	Si	Xi
Four arms	One camera, three instruments	Multifunctional
Port placement	Fixed, may need new ports	Universal port placement

	and redocking for multiquadrant surgery	facilitating multiquadrant surgery
Camera drapes	Required for camera and instruments	Only for instruments
Endoscopes	12 mm with 0/30 degrees	8.5 mm with 0/30 degrees
Firefly (fluorescence)	Optional upgrade	Enabled
Vessel sealer/energy sources	Optional	ERBE monopolar, bipolar, vessel sealer enabled
Staplers	No	Enabled
Simulator	Optional	Optional
Second console	Optional	Optional
Image recording	No	Enabled

POSTOPERATIVE MANAGEMENT

In our experience, the patient is best managed for the first 24 hours in the high-dependency unit, although in most cases this level of observation is not necessary in the minimally invasive approach. Early mobilization is encouraged and accelerated recovery is one of the main benefits of this approach. Oral intake begins with “clear fluids” of up to 30 ml for the first few hours and then gradual increase toward light diet as tolerated. Appropriate chest physiotherapy is given with mobilization after 24 hours. The epidural catheter is removed with addition of suitable oral analgesia—patient-controlled analgesia (PCA) systems are not encouraged as a routine. The editors prefer a PCA to an epidural catheter. The urinary catheter is removed as soon as patients are well mobilized. The oral intake is increased to regular soft solid diet as tolerated. The patients are given appropriate stoma training before discharge. The patients are discharged when they are mobile, on regular diet, and are stoma trained.

COMPLICATIONS

The complications related to robotic colectomy are very similar to those of laparoscopic procedures and the morbidity associated with TC has been suggested to be as high as 26%. As with any minimally invasive procedure, care should be taken with port access, all energy devices, retraction, and counter traction to ensure there is no obvious or occult collateral injury. In particular, care should be taken when using the robotic third arm for retracting vital structures because these arms are strong, rigid, heavy, and do not provide tactile feedback when the surgeon is using the other two arms. Ideally, all the arms/instrument tips should be in view to avoid such issues. The vital structures that are at risk during any approach to a TC remain a concern (spleen, ureter, pancreas, duodenum), but the advantages of vision and access means that morbidity is actually reduced—this is a hallmark of most series in robotic colorectal surgery.

It is important to have the arms appropriately padded and use shoulder supports to minimize injury due to positioning. If the procedure is prolonged, there are theoretic risks of traction or pressure injuries as well as retinal damage. Thorough planning and an experienced theatre and anesthesia team will minimize this risk.

As with any ileorectal anastomosis, there is a risk of anastomotic leak. Depending on the level of the anastomosis and other patient factors, one may choose to perform a defunctioning ileostomy. Indocyanine green imaging may improve safety and decrease incidence of anastomotic leak.

The most common longer term complication is due to adhesions and resultant bowel obstruction. However, minimally invasive surgery reduces this potential complication.

RESULTS

There are limited data comparing the use of robotics with laparoscopy for TC, and current studies have shown no oncologic benefit for robotic colectomy. Further, there has also been the question of cost-per-case as well as loss of productivity within the operating room. Zarak and colleagues conducted a review and meta-analysis of postoperative outcomes following robotic and laparoscopic approaches for colonic surgery. Nine studies were included in the analysis totaling 1,058 patients (688 laparoscopic; 370 robotic). Although the non-pooled data analysis showed no significant alliances between the two approaches, faster return to gut function was seen after robotic surgery. Such reports have not provided the clinical outcome evidence with sufficient confidence to overcome the concerns of costs. The studies included were a combination of randomized controlled trials (RCTs) and comparative studies and not exclusively RCTs. Dolejs and colleagues interrogated the American College of Surgeons National Surgical Quality Improvement Project Colectomy-Targeted Dataset. Almost 19,000 colectomies were included for analysis, of which less than 700 were performed robotically. There were no significant differences in mortality, morbidity, ileus, and leak rates. There were fewer conversions for robotic right colectomies (OR 0.58, 95% CI 0.34–0.96) and lower length of hospital stay by 1 day overall. This was offset by a longer median operating time of 45 minutes. An earlier study using the same dataset looked specifically at 30-day outcomes for colectomy. For all procedures, there were no significant difference in major morbidity, conversions, leak rate, and reoperation; but there was increased operating time (233 vs. 180 minutes) and a decreased length of hospital stay (5.04 vs. 6.06 days) in favor of robotic surgery.

The learning curve for more demanding procedures has not been well established. The learning curve played a significant role in the evolution of laparoscopy and with greater experience shifted the balance of indications and contraindications. Studies of robotic surgery learning curve for colorectal procedures are limited; and for more complicated surgery such as TC, this is almost nonexistent. The learning curve from laparoscopy to robotics is not directly comparable to open surgery to laparoscopy. Bokhari and colleagues suggested that the learning curve was on the order of 15–25 cases, which would be shorter than that for laparoscopy. A multiphasic learning curve for robotic rectal surgery has been suggested. In a study of 197 patients, the “initial learning curve” (approximately 35 cases) was described, whereby surgeons encounter an introduction to the technique before a second phase in which more challenging cases are undertaken (up to 100 cases). The final phase is consolidation of skill. Odermatt *et al.* used cumulative sum charts (CUSUM analysis) to investigate the learning curve of experienced laparoscopic surgeons adopting robotic surgery. Using outcome measures of operative time, lymph node harvest, and major complications, the formal learning curve was considered to be around the 15-case mark.

Perhaps the most important consideration during the adoption of complex robotic surgery is the vision and view for the surgeon. Contrary to the evolution from open surgery to laparoscopic, whereby the steps of a procedure were unfamiliar to even experienced surgeons with no prior laparoscopic training, the transition from laparoscopy to robotics does not suffer from this challenge. Robotic surgery may be seen as an extension of laparoscopy, whereby the steps and view are the same and the major difference is that of the instrumentation. This opinion means that the surgeons do not have to relearn the steps of the procedure but merely familiarize themselves with the platform and setup.

CONCLUSION

TC can be performed for a number of indications including benign and malignant disease as well as for risk reduction in high-risk individuals with a known genetic susceptibility to CRC. The use of robotic platforms in colorectal surgery is increasing; and with greater experience, surgeons are embarking on more complex procedures such as TC. The technique can be modified depending on the indication for TC. The preoperative preparation, patient setup, and postoperative care remain similar to that for laparoscopic approaches. The use of a diverting or permanent stoma and the level and method of reconstruction is again dependent on the indication. Robotic TC may be a method used more frequently in this scenario.

RECOMMENDED REFERENCES AND READINGS

Bokhari MB, Patel CB, Ramos-Valadez DI, Ragupathi M, Haas EM. Learning curve for robotic-assisted laparoscopic colorectal surgery. *Surg Endosc* 2011;25:855–60.

Chand M, Heald RJ. Laparoscopic rectal cancer surgery. *Br J Surg* 2011;98:166–7.

Davis BR, Yoo AC, Moore M, Gunnarsson C. Robotic-assisted versus laparoscopic colectomy: cost and clinical outcomes. *JSLS* 2014;18:211–24.

Dolejs SC, Waters JA, Ceppa EP, Zarzaur BL. Laparoscopic versus robotic colectomy: a national surgical quality improvement project analysis. *Surg Endosc* 2017;31(6):2387–96.

Hanna GB, Miskovic D, Ni M, Wyles SM, Tekkis P. Learning curve and case selection in laparoscopic colorectal surgery: a systematic review and international multicentre analysis of 4852 cases. *Dis Colon Rectum* 2012;55:1300–10.

Jafari MD, Wexner SD, Martz JE, *et al.* Perfusion assessment in laparoscopic left-sided/anterior resection (PILLAR II): a multi-institutional study. *J Am Coll Surg* 2015;220:82–92.

Kiran RP, Murray AC, Chiuzan C, Estrada D, Forde K. Combined preoperative mechanical bowel preparation with oral antibiotics significantly reduces surgical site infection, anastomotic leak, and ileus after colorectal surgery. *Ann Surg* 2015;262:416–25.

Miller PE, Dao H, Paluvoi N, *et al.* Comparison of 30-day postoperative outcomes after laparoscopic vs robotic colectomy. *J Am Coll Surg* 2016;223:369–73.

Odermatt M, Ahmed J, Panteleimonitis S, Khan J, Parvaiz A. Prior experience in laparoscopic rectal surgery can minimise the learning curve for robotic rectal resections: a cumulative sum analysis. *Surg Endosc* 2017. doi:10.1007/s00464-017-5453-9.

Park JS, Choi GS, Park SY, Kim HJ, Ryuk JP. Randomized clinical trial of robot-assisted versus standard laparoscopic right colectomy. *Br J Surg* 2012;9:1219–26.

Sng KK, Hara M, Shin JW, Yoo BE, Yang KS, Kim SH. The multiphasic learning curve for robot-assisted rectal surgery. *Surg Endosc* 2013;27:3297–307.

Tyler JA, Fox JP, Desai MM, Perry WB, Glasgow SC. Outcomes and costs associated with robotic colectomy in the minimally invasive era. *Dis Colon Rectum* 2013;56:458–66.

Yang Y, Wang F, Zhang P, *et al.* Robot-assisted versus conventional laparoscopic surgery for colorectal disease, focusing on rectal cancer: a meta-analysis. *Ann Surg Oncol* 2012;19:3727–36.

Zarak A, Castillo A, Kichler K, de la Cruz L, Tamariz L, Kaza S. Robotic versus laparoscopic surgery for colonic disease: a meta-analysis of postoperative variables. *Surg Endosc* 2015;29:1341–7.

PART V

OPEN TOTAL PROCTOCOLECTOMY WITH ILEOSTOMY

Chapter 26

Open

Matthew Z. Wilson and David B. Stewart Sr

INDICATIONS/CONTRAINDICATIONS

Total proctocolectomy with end ileostomy (TPCI) is an extensive surgery that involves the removal of the entire large intestine (colon, rectum, and anus). Owing to the radical and irreversible nature of this procedure with a resultant life-long ileostomy, the indications for TPCI are limited and only used in instances that leave no feasible alternative when considering both disease-and patient-related factors.

Crohn's Colitis with or Without Involvement of the Anoperineum

Since there is no medical or surgical cure for Crohn's disease (CD), surgery in this setting is only indicated for disease-related complications that cannot be addressed by medical or endoscopic therapies. Given the chronic and recurrent nature of CD, and considering the high incidence of clinical recurrence rates following partial colectomies in Crohn's of the large intestine, decisions regarding sparing the large intestine as well as decisions regarding constructing an anastomosis must be tailored to the patient. This chain of thought needs to take into account the particular disease complication requiring surgery (inflammation and related manifestations vs. dysplasia/cancer), the patient's overall health status, the patient's anticipated postoperative fecal continence, and the risk associated with the potential need for additional major surgery in the setting of future CD recurrences.

In general, TPCI for CD is reserved for the following scenarios. Patients with pan-proctocolitis who are either medically refractory to appropriate therapy or prove to be non compliant with treatment regimens are considered for this surgery. Such patients would have no feasible alternative surgery which would both remove their diseased intestine while providing them with an anastomosis with acceptable continence. As a subcategory of this group are patients who might otherwise have been offered an ileorectal anastomosis but who because of age, continence, and/or health-related reasons are felt to be better served with an end ileostomy. In this scenario, a TPCI removes the rectum that might otherwise have been stapled and left in discontinuity, which depending on the patient's age would pose a risk for the subsequent development of rectal cancer. Patients who have undergone a prior partial colectomy for CD, but who now have a clinical recurrence should be considered for a completion proctocolectomy with an end ileostomy, depending on the involvement of their rectum, their length of remaining colon, and their current continence and frequency of bowel movements. Although the management options for low-grade dysplasia have been recently revisited in an effort to avoid radical surgery, patients with high-grade dysplasia or histologically proven adenocarcinoma of the large intestine in the setting of CD should undergo TPCI. Dysplasia and cancer are often multifocal in these patients, and since surveillance for colorectal cancer is more difficult in patients with inflammatory bowel disease (IBD), a TPCI will remove all of the at-risk tissue for cancer in the large intestine.

p. 241

---

p. 242

CD can concomitantly affect the perineum in the setting of Crohn's proctocolitis, and the severity of perineal involvement should be taken into account in surgical planning. Although complex enough to warrant its own chapter, as a general principle of management, active perineal sepsis is a contraindication to a TPCI because of the need to operate in the infected field of the perineum. In this scenario, a total abdominal colectomy with an end ileostomy and a stapled rectal stump should be selected, allowing for resolution of perineal sepsis, with a subsequent completion proctectomy when the patient's perineum poses a less challenging surgical field. This approach has the benefit of taking into account the additional operative time and blood loss associated with the need for soft tissue coverage of a perineum with this extent of disease, which often requires a rotational or pedicled myocutaneous flap.

Ulcerative Colitis in a Patient for Whom a Restorative Procedure Is Contraindicated or Not Desired

Unlike CD, ulcerative colitis (UC) has a putative surgical cure that involves the removal of the colon and rectum. For younger, healthier patients, a restorative procedure with an ileal pouch-anal anastomosis (IPAA) provides an option that, when properly performed, removes the symptoms of UC but without the requirement of a permanent stoma. Since an IPAA results in stools of a more frequent and more diarrheal character, the decision to construct an IPAA must take into account the patient's preoperative continence, making it a less appropriate surgical option for older patients, for patients with limited mobility who cannot, when needed, proceed quickly to a bathroom facility, or for patients with preoperative incontinence. In addition, many surgeons divert patients undergoing an IPAA, which then requires a second surgery to close the diverting stoma; this should be taken into account for older and other higher risk patients. The indications for a TPCI in UC include medically refractory disease as well as the diagnosis of dysplasia or adenocarcinoma, when the considerations listed earlier are also present. Some patients may request surgery for UC because of dissatisfaction with the cost, the side effects, and the time commitment associated with medical therapy.

Synchronous Malignancies of the Large Intestine, with at Least One Malignancy Involving the Rectum

Although all patients with synchronous colorectal cancers do not require a TPCI, when one of these malignancies involves the rectum, the decision to spare the anus must be carefully weighed against the risks of metachronous cancers and poor postoperative continence. Patients with synchronous colorectal cancers have a significant risk for metachronous polyps (often advanced adenomas) and cancers, which may require future surgery of a greater difficulty given the postoperative state of the abdomen. Further, because some rectal cancers require chemoradiotherapy, this has implications for both postoperative continence as well as the risk of future surgeries if the large intestine is spared. These considerations carry even greater force for older patients, or patients with greater surgical risk, who would be better served with one major surgery and not two.

Familial Adenomatous Polyposis in a Patient for Whom a Restorative Procedure Is Contraindicated or Not Desired

Attenuated forms of familial adenomatous polyposis (FAP) spare the rectum to a degree that a total colectomy with an ileorectal anastomosis is a surgical option. In FAP that presents with carpeting of the entire colon and rectum with polyps, removal of the entire large intestine is required to diagnose and to prevent adenocarcinoma of the large intestine. The decision to perform a TPCI as opposed to a restorative procedure shares similar decision making in many respects to the scenario described for UC.

Contraindications and Final Comments

A TPCI is a lengthy procedure with two fields of operation (abdominal and perineal). It is not an appropriate surgery in an emergent setting, where a total colectomy with an end ileostomy and a stapled rectal stump should instead be selected. In an emergent setting, or in an elective setting with perineal sepsis, a total colectomy allows for resolution of these mitigating factors, with an elective completion proctectomy at a more opportune time. The added operative time and blood loss associated with resection of the anorectum is neither needed nor warranted in an emergent surgery. In addition, because a perineal surgical site is associated with a high incidence of infectious and wound-healing complications, it should be avoided in patients with moderate or severe protein–calorie malnutrition.

PREOPERATIVE PLANNING

Preoperative evaluation of the patient begins with a colonoscopy to confirm the diagnosis and the need for a proctocolectomy. Patients with a malignancy should have a preoperative carcinoembryonic antigen level obtained, as well as clinical staging with either a dual contrast-enhanced computed tomography (CT) scan of the chest, abdomen, and pelvis, or with magnetic resonance (MR) imaging if iodinated contrast is contraindicated. For CD, owing to its multifocal distribution, CT or MR imaging is critical to identify every site of the affected gut, especially within the small intestine. For patients with CD and UC, every effort should be made to discontinue or limit steroid use. The use of immunomodulators can be associated with decreased blood counts, including neutropenia, and the use of biologic agents can increase the risk of postoperative infections; these medications should be discontinued, and, if possible, a suitable time should be provided to allow the effects of these medications to resolve before surgery. The timing of surgery should balance the desire to limit or discontinue immunosuppression while not leaving the now untreated patient at risk for a flare of IBD.

In addition to obtaining preoperative laboratory tests such as a complete blood count, electrolytes, and renal and liver function tests, for IBD patients with chronic symptoms, albumin and, possibly, prealbumin levels should be measured to identify patients with protein–calorie malnutrition. A perineal dissection should be avoided in moderately or severely malnourished patients.

Although the benefits and risks of a mechanical bowel preparation have been debated by surgeons, the authors prefer its use for TPCI to avoid contamination of the pelvis or perineum during a difficult dissection where a proctotomy might be committed.

Because a TPCI will result in a permanent stoma, the proper siting of the ileostomy is extremely important, especially in obese patients or in those who have prior surgical scarring of the abdomen. Before surgery, a patient should undergo stoma-site marking by a stoma therapist. If possible, patients who have given consent for a TPCI should also undergo preoperative counseling and education regarding life with a stoma and proper stoma care. A group setting with other ileostomates is often helpful for prospective patients to avoid feeling isolated or unique in their need for an ileostomy, as well as providing the opportunity for patients to hear encouraging reports from those who have already had this surgery performed.

SURGERY

Venous Thromboembolic Prophylaxis

IBD, cancer, and lengthy operations are associated with a high risk for a perioperative venous thromboembolic event. At minimum, the use of chemoprophylaxis beginning on the day of the procedure (and before the induction of general anesthesia) should be part of routine patient care. Initiation of lower extremity pneumatic compression is required before the patient is anesthetized. It is the authors' practice to also provide a dose of chemoprophylaxis at noon the day before surgery, and to prescribe 2 weeks (benign disease) or 4 weeks (cancer) of outpatient chemoprophylaxis following discharge for benign or malignant disease, respectively.

Antibiotic Prophylaxis

The use and the timing of prophylactic antibiotics should be in accordance with Surgical Care Improvement Project guidelines for selection and timing of these agents.

Positioning and Placement of Support Devices

The patient is placed in modified lithotomy positioning to allow for access to the peritoneal cavity and to the perineum. Care must be exercised to avoid hyperextension, excessive external rotation, or abduction of the hip and knee, and to adequately cushion potential pressure points to avoid skin breakdown or nerve injury, particularly with respect to the femoral and peroneal nerves. The patient's upper extremities are placed on padded arm boards oriented perpendicular to the torso, to allow for the maximum space for the surgeon and the assistant to stand; a bladder catheter should be placed.

Consideration of Ureteral Stenting

Although ureteral stents are not proven to prevent ureteral injuries, they may help identify such injuries during the course of surgery, preventing a delay in the diagnosis of this complication and allowing for that issue to be addressed during the index procedure. Ureteral stents should considered for cases where it is anticipated that identification of one or both ureters may be difficult, such as in the setting of obesity, reoperative pelvic surgery, prior radiotherapy to the abdomen and pelvis, or significant suspected disease-related complications involving intra-abdominal sepsis where scarring may obscure anatomic planes.

Performance of Abdominal Portion of the Procedure

A TPCI begins with the abdominal portion of the procedure. A midline incision is created, usually extending from the pubic symphysis to ensure that exposure of the pelvis is adequate. This incision will virtually always need to extend cephalad to the umbilicus except in the thinnest of subjects. Since most ileostomies will be sited on the right abdomen, therefore it is good practice to incise around the umbilicus to the left to avoid interfering with a right-sided stoma and its appliance.

The abdomen is then explored for evidence of the need to revise the preoperative diagnosis or plan. The authors prefer to begin with mobilization of the right colon, proceeding in a proximal-to-distal direction until the surgery is completed.

In this scenario, the patient is placed in Trendelenburg and left lateral decubitus positioning. Although there are multiple and equally effective approaches to mobilizing the right colon, the authors prefer a posterior mobilization (Fig. 26-1). The ileocolic junction is retracted away from the retroperitoneum, exposing the confluence between the ascending mesocolon and the retroperitoneum in the region of the right pelvic inlet. This will also bring into view the right ureter, the external iliac vessels, and the duodenum in all but the most obese subjects. This confluence is then scored with cautery; and with adequate countertraction applied through elevating the ascending mesocolon, either cautery or blunt tissue separation is used to separate the right colon mesentery from the retroperitoneum as far cephalad as the transverse colon, as far laterally as the right abdominal wall, and as far medially as the duodenum. This process will allow for isolation of the right ureter and the duodenum before resection of the right mesocolon, while providing a quick and bloodless dissection if properly performed.

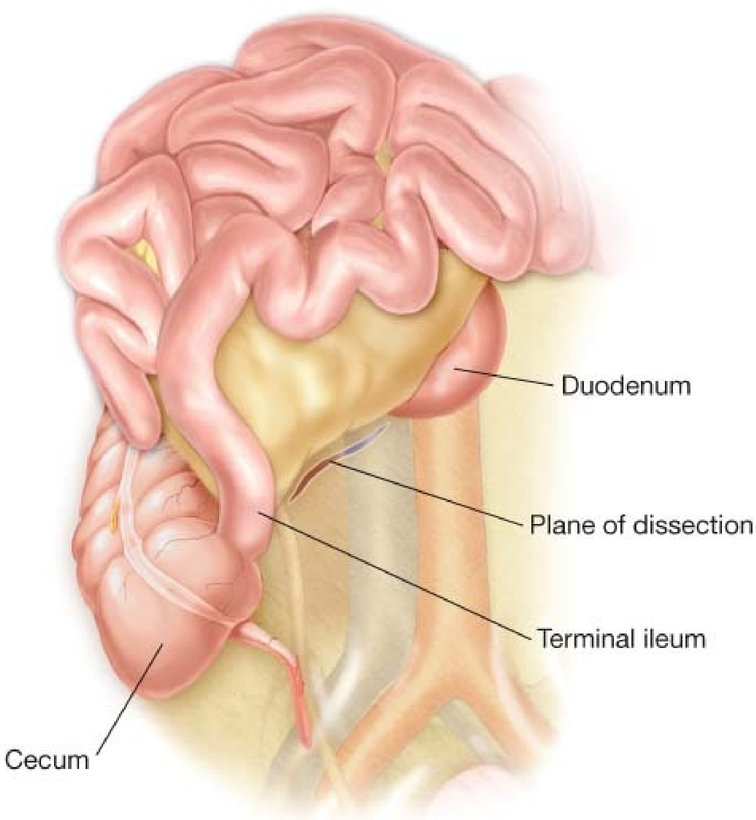


FIGURE 26-1 Posterior mobilization of ascending colon. The ileocolic junction is retracted away from the retroperitoneum, and the confluence between the mesocolon and retroperitoneum is scored. Often, the right ureter and the duodenum are also in view from this perspective, aiding the surgeon in avoiding an injury to these organs.

Although not mandatory, the authors prefer the use of an advanced bipolar energy device for much of the dissection, and especially for sealing major vessels. Lateral attachments extending from the cecum to the hepatic flexure are transected at this juncture. The ascending colon is then retracted laterally, exposing the ileocolic artery and avascular mesenteric windows cephalad and caudal to this vessel. The duodenum will also be visible at this juncture, being associated with the cephalad avascular window and adjacent to the ileocolic artery (Fig. 26-2). Both of these mesenteric windows are then opened for ligation of the ileocolic artery. This vessel is ligated at a level depending on the indication for surgery; away from the superior mesenteric artery (SMA) for benign disease, closer to the SMA for cancer for cancer involving the right colon.

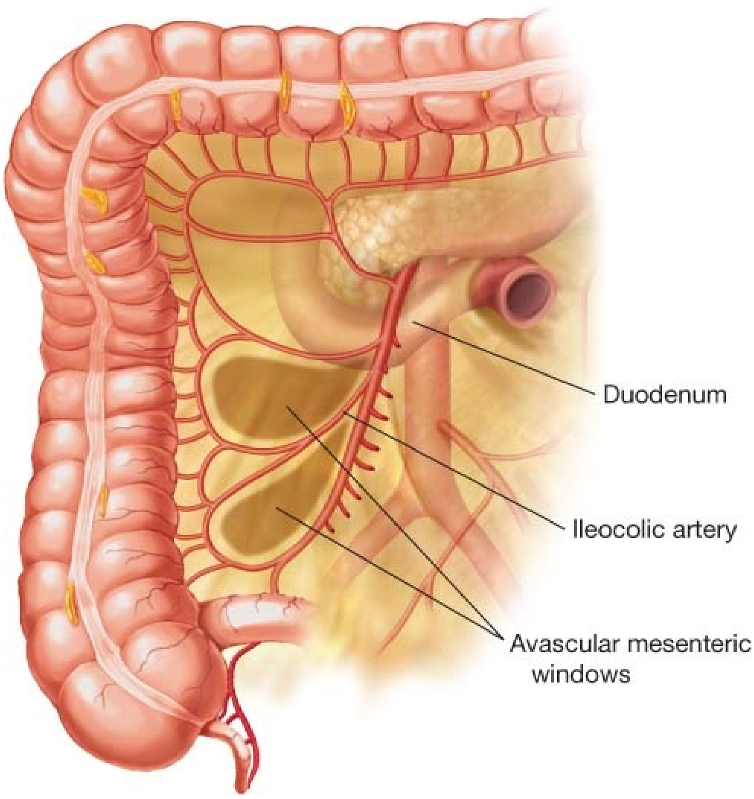


FIGURE 26-2 Exposure of the ileocolic artery. The mobilized ascending mesocolon, now separated from the right-sided retroperitoneum, is retracted laterally, exposing the ileocolic artery and two avascular mesenteric windows immediately cephalad and caudal to this structure.

p. 244

---

p. 245

The energy device is then used to transect the terminal ileal mesentery extending from the ligated ileocolic artery to a point 5–7 cm proximal to the ileocolic junction. A linear cutting stapler is then used to transect the ileum.

The remaining ascending colon mesentery is transected with the bipolar energy device extending in a straight line of dissection from the ligated ileocolic artery toward the transverse colon.

At this juncture, the proximal transverse mesocolon is fully mobilized, including the hepatic flexure. With the duodenum in view, the transverse mesocolon is transected with the energy device; a right branch of the middle colic vessels may be present, and, if so, this represents the major vessel to be ligated during this step. Transection of the transverse mesocolon can be continued distally, ligating the main branch of the middle colic vessels and progressing toward the splenic flexure. Mobilization of the splenic flexure is often best accomplished by deferring it for a later time.

At this juncture, the authors place the patient in right lateral decubitus positioning and the sigmoid colon is retracted medially. The white line of Toldt is scored with monopolar cautery, and the sigmoid mesocolon is elevated away from the retroperitoneum as far medially as the midline peritoneal cavity using a tissue distraction technique similar to that mentioned for the ascending colon. A blunt tissue dissection, if performed in the correct plane, can allow for identification of the left ureter without the use of electrical energy, further avoiding a ureteral injury. With the sigmoid colon then retracted toward the anterior abdominal wall within the midline peritoneal cavity, avascular mesenteric windows immediately cephalad and caudal to the inferior mesenteric artery (IMA) are mechanically developed (Fig. 26-3). The IMA is then transected at its bifurcation for benign disease and proximal to its bifurcation in the setting of cancer. The left ureter should be reidentified after ligation of the IMA to ensure the absence of an injury. The surgeon will return to the rectosigmoid colon and rectum at a later point in the surgery.

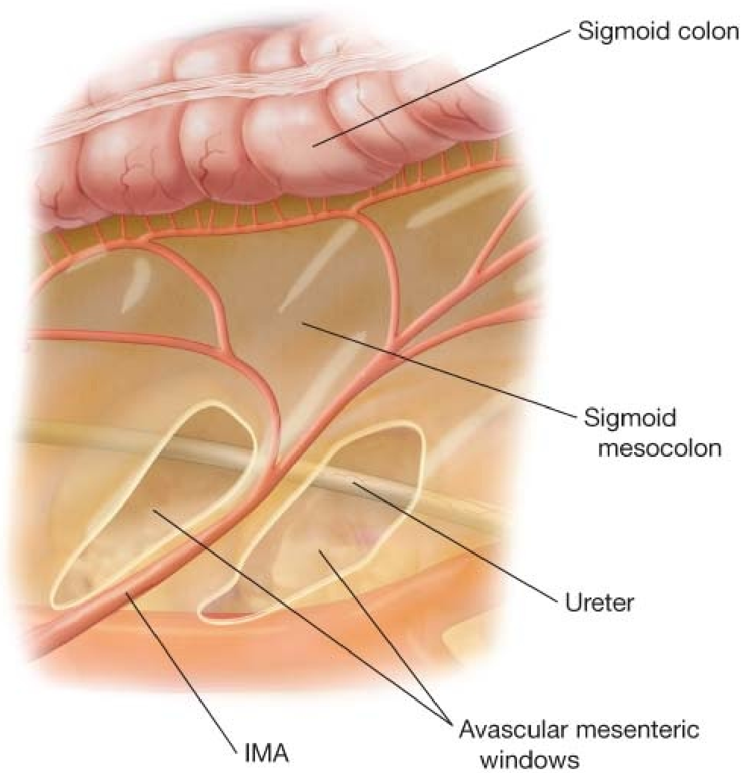


FIGURE 26-3 Isolation of the inferior mesenteric artery (IMA). The sigmoid colon is retracted anteriorly, exposing the IMA. Avascular mesenteric windows are developed on either side of the IMA, and the left ureter is reidentified from a medial perspective.

The descending colon is mobilized in a manner similar to that described for

The descending colon is mobilized in a manner similar to that described for the sigmoid colon. The white line of Toldt is scored with cautery, and a tissue distraction technique is used to elevate the remaining left colon to the midline peritoneal cavity. A clear separation of colon mesentery from the retroperitoneum allows for added safety against an injury to the left ureter and the left kidney. The energy device is then used to transect the base of the descending mesocolon, typically occupying a more proximal line of mesenteric dissection either to improve nodal yield in the setting of cancer or to remove thickened and diseased mesentery in the setting of IBD. This process includes a ligation of the inferior mesenteric vein near its origin adjacent to the duodenum.

p. 245

---

p. 246

The splenic flexure is mobilized with the patient in reverse Trendelenburg position. The gastrocolic ligament is opened, outside the gastroepiploic arcade to open the lesser sac, the pancreas, the inferior splenic pole, and the transverse mesocolon. A medial-to-lateral mobilization of the distal transverse mesocolon is preferred by the authors, which involves retracting the transverse colon in an anterior and caudal direction while using the vessel sealer to mechanically develop avascular mesenteric windows between the main branch and left branch of the middle colic vessels. The distal transverse mesocolon is then transected toward the splenic flexure parallel to the tail of the pancreas. The exposure afforded by this approach prevents dissection too far cephalad toward the splenic hilum or the pancreas. The line of mesocolic dissection should be adjacent to the retroperitoneum in the setting of a transverse colon cancer, in an effort to maximize nodal yield. In IBD, the mesentery can be less distally dissected. The division of the middle colic vessel completes the transverse colectomy.

The rectosigmoid colon is then retracted toward the midline peritoneal cavity and toward the anterior abdominal wall. With the left ureter in view, the remaining rectosigmoid mesentery is freed from the retroperitoneum, extending to the pelvic inlet. At the sacral promontory, a proximal ligation of the superior rectal artery is performed, allowing for entrance into the presacral space.

A total mesorectal excision is then performed, circumferentially mobilizing the rectum to the level of the *levator ani* musculature (Fig. 26-4). This process involves hemostatic dissection through Denonvilliers’ fascia, with care taken to separate the extraperitoneal rectum from the bladder, while occupying a safe plane of dissection that avoids injury to the seminal vesicles or vagina. Whether the indication is for cancer or not, a sharp dissection will often result in less bleeding. For benign disease, some surgeons prefer dissecting through the mesorectum, in an effort to avoid injury to the pelvic nerves. This dissection is frequently associated with greater blood loss.

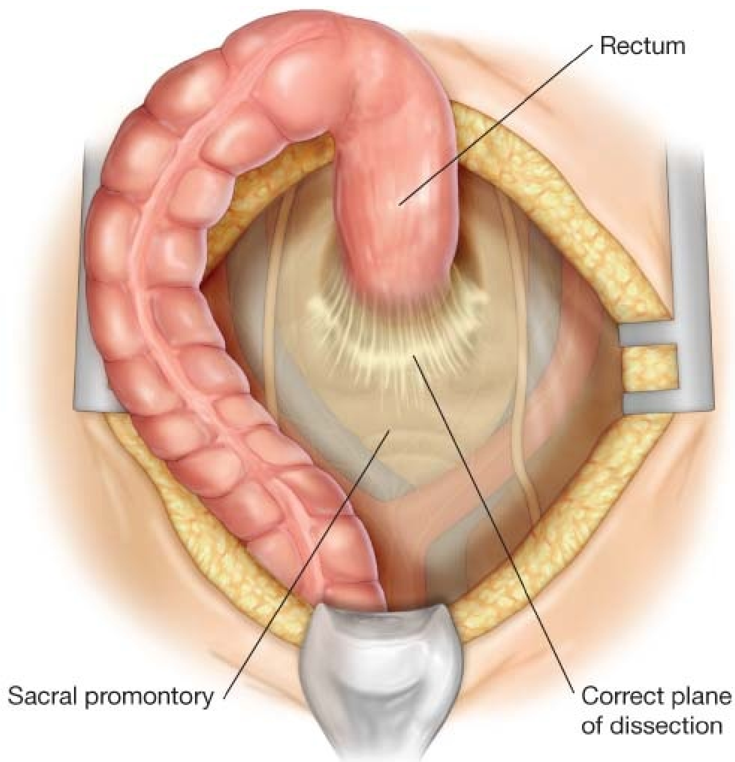


FIGURE 26-4 Total mesorectal excision. With the rectum retracted anteriorly, the proper plan of posterior dissection is exposed, occupying a bloodless plan of dissection between the mesorectum and the investing fascia of the sacrum.

Performance of the Perineal Portion of the Procedure

At this point in the procedure, the perineal dissection is begun. A monofilament suture is used to encircle and occlude the anal orifice. Cautery is then used to create a circumanal incision that extends from a point anterior to the coccyx, extending bilaterally to the ischiorectal fossae and then terminating anteriorly near the posterior aspect of the perineal body. An extrasphincteric mobilization of the anus is performed for cancers involving the rectum or anus. An intersphincteric plane of dissection is sufficient for IBD, and this latter scenario has the advantage of providing an additional volume of soft tissue for closure of the perineal surgical site. This dissection is extended to the level of the *levator ani*. Cautery is then used to enter the distal pelvis by incising the pelvic floor muscles between the sacrococcygeum and the anorectum; this entry into the pelvis can be extended posterolaterally in both directions. Cautery is then used to complete the perineal dissection in a posterior-to-anterior direction. The releasing of the anorectum from the region of the prostate and prostatic urethra is often the most difficult aspect of the perineal dissection. The greatest exposure of these urologic structures is possible when all other portions of the anorectal mobilization have been completed. The specimen can then be passed off of the surgical field.

The perineal surgical site is re-approximated in layers using absorbable sutures, beginning at the level of the *levator ani* and extending to the subdermal tissue. The skin is re-approximated either with interrupted subdermal absorbable sutures or with interrupted nylon sutures.

A 19-French Blake drain (Ethicon) is placed in the pelvis. Using cautery, a circular skin incision is created, centered on the patient's stoma-site marking. A cylinder of skin and subcutaneous tissue is resected to the level of the rectus fascia, at which point cautery is used to create a longitudinal fasciotomy. The rectus muscles are spread and spared, exposing the posterior rectus fascia. The posterior sheath is opened the same length as the anterior sheath. The terminal ileum is externalized through an aperture large enough to accommodate two of the surgeon's digits. To avoid contamination, the midline incision is closed before maturation of the ileostomy.

An end ileostomy is matured as a spigot. The terminal ileal staple line is excised. Multiple absorbable 2-0 sutures are placed around the antimesenteric surface in 3-point "pulley suture" method; cut edge, seromuscular, dermal. Along the mesenteric aspect of the bowel, bipartite bites sewing the full thickness of the bowel wall to subdermal tissue are placed. Everting the ileostomy 3-cm to 5-cm above the abdominal wall skin will help maintain a seal between the mucosa and the opening of the face plate to avoid stoma appliance leakages.

POSTOPERATIVE CARE

Patients receive clear liquids on the day of surgery, with the goal of advancing these patients to a low-residue diet during the next 48–72 hours. They are initially provided with a patient-controlled analgesia, although a transition to oral analgesics (both narcotic and nonnarcotic agents) is attempted during the first 72 hours after surgery. Bladder catheters are left indwelling for the first 72 hours because of the high likelihood of urinary retention. Stoma therapists provide patient education. Care management teams arrange outpatient visiting nurses for outpatient stoma care.

COMPLICATIONS

Several intraoperative complications deserve specific mention. These problems may be potentially avoided by careful attention to a few specific surgical steps.

The ureter and gonadal vessels may be injured while mobilizing the right or left colon, although these injuries are more commonly committed on the left side. The gonadal vessels cross the ureter anteriorly. Thus, remaining anterior to the gonadal vessels will help in avoiding injury to either of these retroperitoneal structures.

The gastrocolic omentum is sometimes shortened and adherent to the gall bladder in obese individuals, among those who have undergone prior surgery, and in those with prior episodes of cholecystitis. In such instances, the gall bladder, stomach, the porta hepatis, and the right gastroepiploic artery are at risk for injury.

A more cephalad ("high-riding") splenic flexure may be a challenge to mobilize. Because these flexures may require greater than typical retraction for adequate exposure, the risk of a splenic capsular injury is greater in this scenario. A medial-to-lateral mobilization of the splenic flexure as described helps open the lesser sac, exposing the transverse mesocolon and the spleen while allowing the splenocolic ligament, if present, to be divided. This allows for strong retraction of the transverse colon without this force being transmitted to the spleen.

Failure to distinguish mesorectal fat from retroperitoneal fat involving the lateral pelvic walls tends to lead the surgeon into a line of dissection which is too lateral. The internal iliac vein is at particular risk for injury in this scenario, and may lead to significant bleeding that may be difficult to control.

The presacral venous plexus is very rarely injured at the level of the sacral promontory because the proper plane of dissection is very well defined at this point. However, the presacral plexus is at risk for injury at other points during the procedure.

During posterior dissection, the surgeon must remember that the rectum follows an anteroinferior course. Failure to recognize this could result in the surgeon dissecting into a plane too posterior to the rectum, risking an injury to presacral veins.

If the rectum is retracted too forcefully away from the distal pelvis during distal dissection, branches of the middle rectal artery adjacent to the lateral pelvic stalks are at risk for avulsion, resulting in bleeding. This problem can be avoided by incising Waldeyer's peritoneal reflection to release the rectum from the sacrum 3–4 level.

During entry into the distal pelvis via the perineal surgical site, there is a tendency to occupy a plane of dissection more posterior than necessary, which can place presacral vessels at risk. A hand or laparotomy pad placed posterior to the rectum can help avoid this error.

Presacral bleeding can be significant and difficult to stop, because these vessels retract into sacral foramina where cautery or simple suture ligation is inadequate for hemostasis. Repeated attempts at cauterization should be avoided because this method only exacerbates the injury to the vessel. The application of manual pressure, or firm packing with laparotomy pads, can provide an initial step toward slowing the bleeding. If needed, additional measures include the placement of deep suture ligation usually with pledgets (either as ready-to-use suture pledgets or with a small patch of rectus muscle) and tacking devices.

Sexual and urologic dysfunction resulting from autonomic nerve injuries involving the lumbar and pelvic plexuses is quite common, although their incidence is often underreported because of embarrassment on the part of patients. Nerve injury is prevented by avoiding over vigorous retraction of the rectosigmoid colon and rectum, limiting proximal ligation of the IMA and superior rectal artery when possible, meticulous pelvic dissection in the proper plane between mesorectum and the pelvic sidewalls and avoidance of anterior structures such as the seminal vesicles.

RESULTS

Before the advent of pouch surgery, a larger number of patients underwent TPCI. On the basis of published series from that era, subjects undergoing TPCI have predictable and durable outcomes. In patients with IBD-associated colitis, the relief provided by surgery frequently offsets the lifestyle adjustment imposed by an ileostomy.

CONCLUSIONS

An open TPCI is a major surgical undertaking which, thankfully, has a limited number of indications.

RECOMMENDED REFERENCES AND READINGS

Kalady MF, You YN. Molecular basis of colorectal cancer and overview of inherited colorectal cancer syndromes. In: Steele SR, Hull T, Read T, et al, eds. *The ASCRS Textbook of Colon and Rectal Surgery*. Vol. 2. 3rd ed. New York, NY: Springer; 2016:390–1.

Krane MK, Lange EO, Fichera A. Ulcerative colitis: surgical management. In: Steele SR, Hull T, Read T, et al, eds. *The ASCRS Textbook of Colon and Rectal Surgery*. Vol.2. 3rd ed. New York, NY: Springer; 2016:881–4.

McMurrick PJ, Dozois RR. Chronic ulcerative colitis: surgical options. In: Fazio VW, Church JM, Delaney CP, et al, eds. *Current Therapy in Colon and Rectal Surgery*. 2nd ed. Philadelphia, PA: Mosby; 2005:211–7.

Muldoon R, Herline AJ. Crohn's disease: surgical management. In: Steele SR, Hull T, Read T, et al, eds. *The ASCRS Textbook of Colon and Rectal Surgery*. Vol. 2. 3rd ed. New York, NY: Springer; 2016:845–55.

Chapter 27

Restorative Proctocolectomy—Hand Assisted

Peter W. Marcello

INDICATIONS/CONTRAINDICATIONS

Restorative proctocolectomy is the procedure of choice for patients with ulcerative colitis, requiring surgical intervention, who wish to have a restorative procedure. The procedure is also indicated in patients with familial adenomatous polyposis with extensive rectal polyp formation. Unless otherwise contraindicated, a laparoscopic approach is preferred. Whether the procedure is performed by multiport laparoscopy or hand-assisted surgery is based on the surgeon’s experience. A hand-assisted approach compared to a laparoscopic approach has been associated with a reduction in operative time and conversions, and therefore is the author’s preferred approach. There are rare contraindications, such as the following:

- Extensive adhesion formation from prior surgery
- Inability to tolerate pneumoperitoneum

PREOPERATIVE PLANNING

There are no specific preoperative planning needs for a hand-assisted approach compared to either laparoscopically or conventional open surgery. Appropriate preoperative antibiotics, heparin administration, and marking of a site for temporary fecal diversion, should be planned.

SURGERY

Positioning

The patient is placed in a modified lithotomy position on a spilt-leg electric table.

The arms are at the sides surrounded by a beanbag.

Three-inch silk tape is wrapped around the patient and beanbag to the table.

Technique

The operation begins with partial creation of the ileostomy (Fig. 27-1).

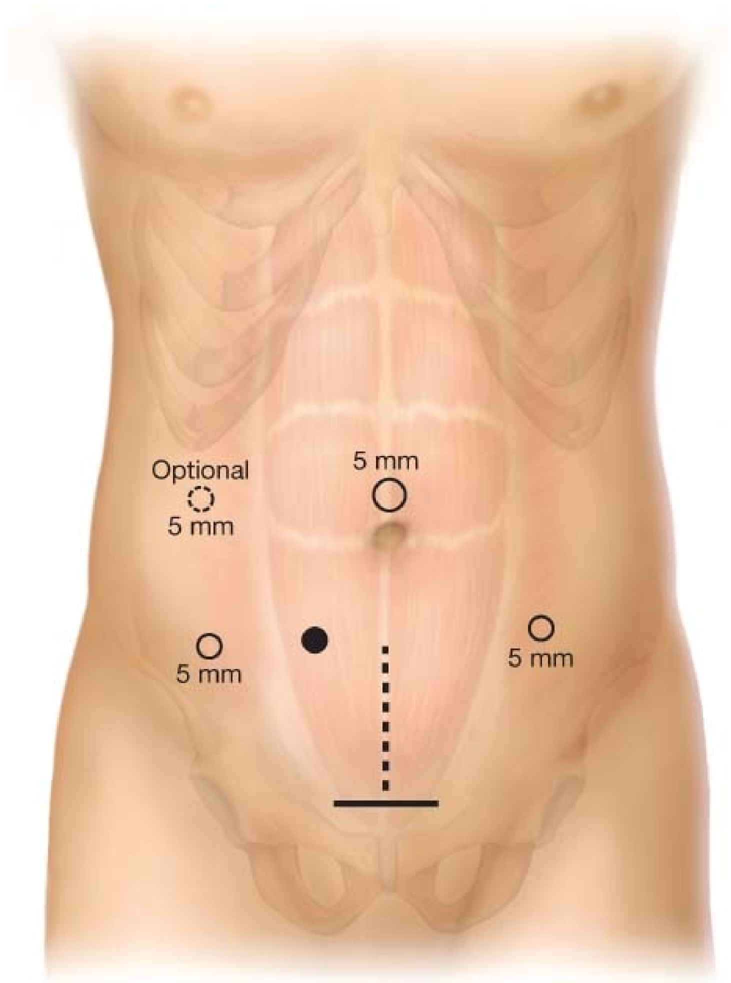


FIGURE 27-1 Trocar and incision placement.

A core of skin and subcutaneous tissue is removed.

The anterior rectus sheath is vertically incised.

This step is done to prevent the development of an obstruction of the loop ileostomy by the anterior rectus sheath following closure of the fascia in the Pfannenstiel incision. When a Pfannenstiel incision is created, the anterior rectus sheath is dissected from the rectus muscle and will fold upward. If the ileostomy is made after the Pfannenstiel incision is created, it can act as a "shutter valve" when the fascia is closed, and may cause an obstruction at the ileostomy. This obviously is only done in cases where a temporary loop ileostomy is planned.

An 8-cm Pfannenstiel incision is made two fingerbreadths above the pubic symphysis.

The anterior rectus sheath is incised transversely and superior and inferior flaps are created over the rectus muscles.

The peritoneum is vertically opened between the rectus muscles.

The sleeve is placed for the hand device.

Five-mm trocars are positioned in the left lateral, umbilical, and right lateral positions. The right lateral trocar is placed lateral to, and above the ileostomy siting. Trocars are placed with the hand inside the abdomen to protect the intestine from injury (Fig. 27-1).

Right Colectomy—Medial Approach

The surgeon stands to the patient's left with the left hand through the hand port and the right hand with a laparoscopic instrument (Fig. 27-2). The assistant stands cephalad to the surgeon, holding the camera. The patient is in slight Trendelenburg position with the right side up.

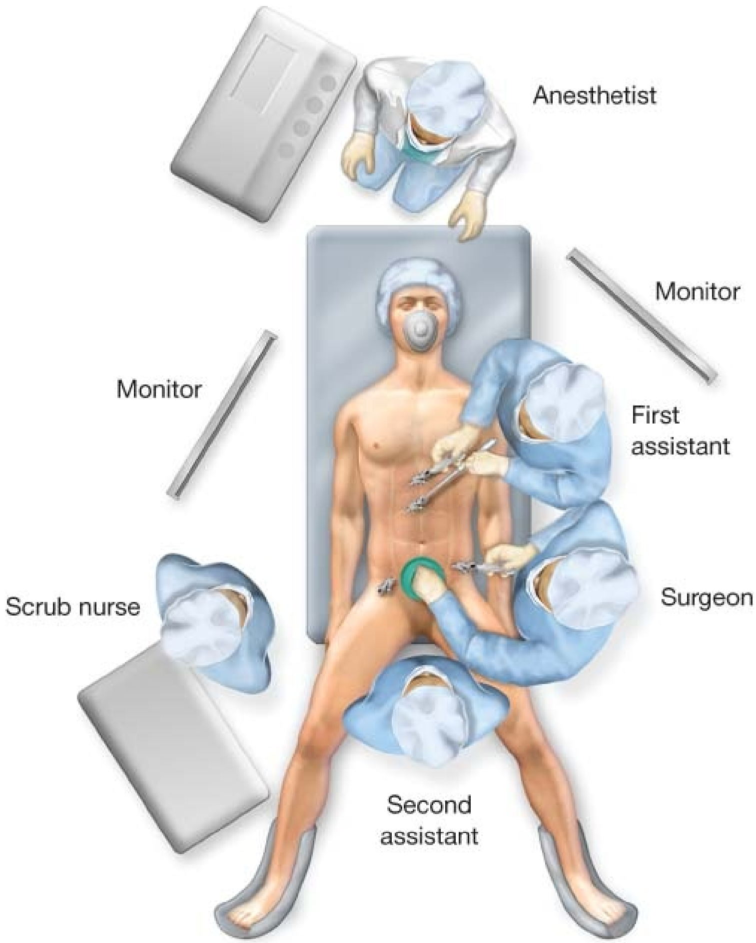


FIGURE 27-2 Surgeon and assistant positioning.

An exploration is undertaken; the colon is examined to determine the extent and severity of disease and the small bowel is examined to exclude Crohn's disease.

The cecum and terminal ileum are elevated and laterally retracted with the hand.

A medial-to-lateral dissection of the right and transverse mesocolon is performed. An incision is made under the ileocolic pedicle and the duodenum is swept downward (Fig. 27-3). The ileocolic pedicle is then isolated. The fingers are quite useful for isolating the pedicles. The ileocolic vessels are then divided and ligated using a bipolar vessel-sealing device (Fig. 27-4). The 5-mm bipolar sealing device is the preferred method of vessel ligation and division. Multiple applications of the device are used before the pedicle is divided. Although somewhat controversial, the author's preference is to divide the ileocolic vessels.

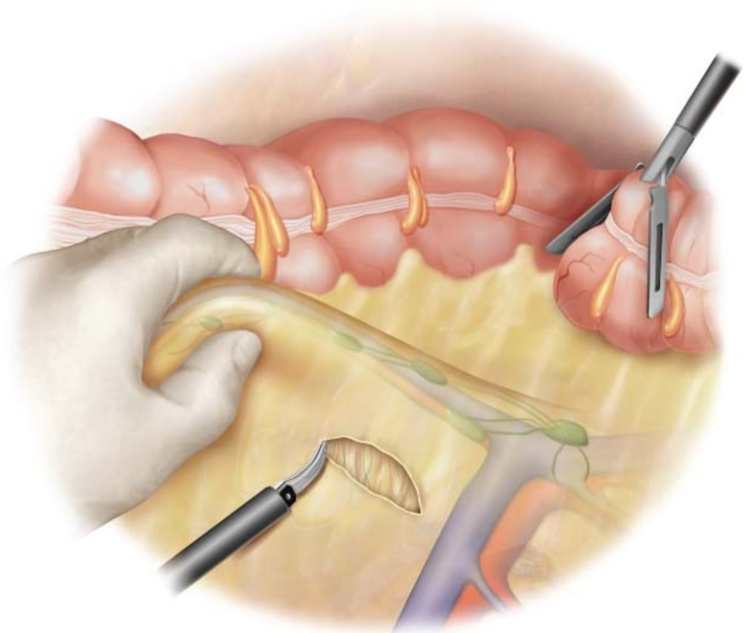


FIGURE 27-3 Isolation of ileocolic pedicle.

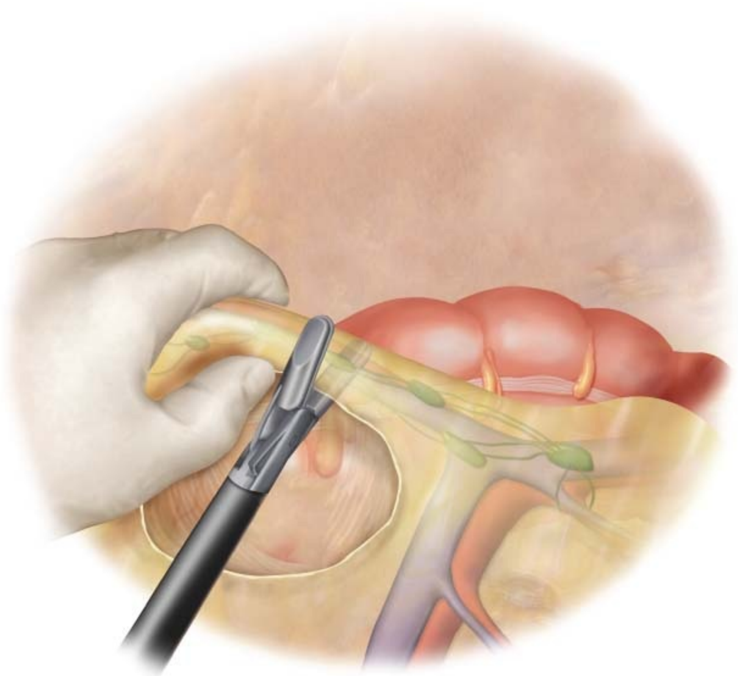


FIGURE 27-4 Ligation of ileocolic pedicle with bipolar energy.

The right-sided colon is mobilized from medial to lateral (Fig. 27-5). The colon mesentery is freed from the retroperitoneum and duodenum. A hand is used to create traction while the scissors are used to perform the dissection.

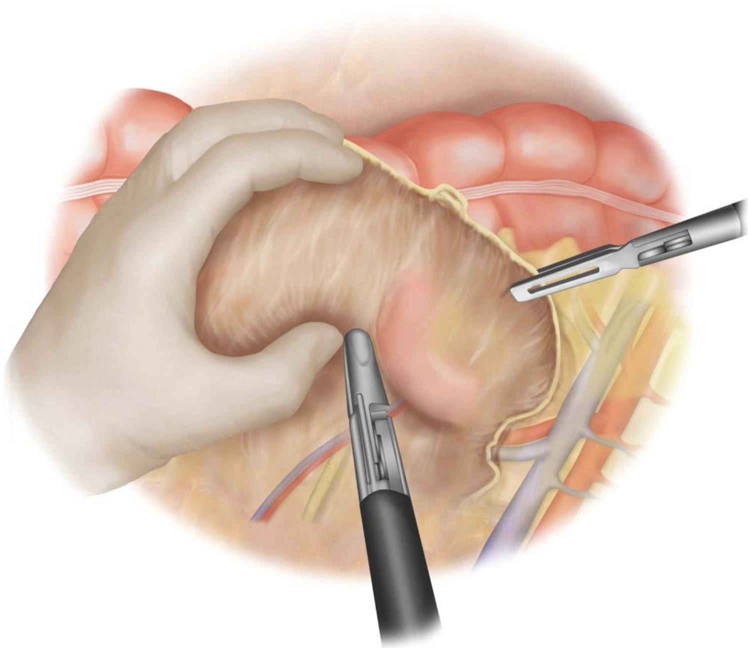


FIGURE 27-5 Medial to lateral mobilization over duodenum and Gerota's fascia.

If present, the right colic vessels are isolated and divided.

Transverse Colectomy—Medial Approach

Attention is then shifted to the transverse mesocolon. The assistant moves from the patient's left side to stand between the legs. The assistant's left hand elevates the transverse mesocolon with a laparoscopic instrument through the right lateral trocar. The assistant's right hand controls the camera through the umbilical port. The surgeon remains to the patient's left side, with the left hand through the hand device and the right hand with a laparoscopic instrument. The assistant elevates the transverse mesocolon with a grasper in the left hand through the right-sided trocar, while the surgeon isolates each of the individual middle colic vessels. The dissection generally begins to the left of the midline in the transverse mesocolon (Fig. 27-6). This plane often has fewer adhesions into the lesser sac. The lesser sac is entered and the distal transverse mesocolon sharply divided.

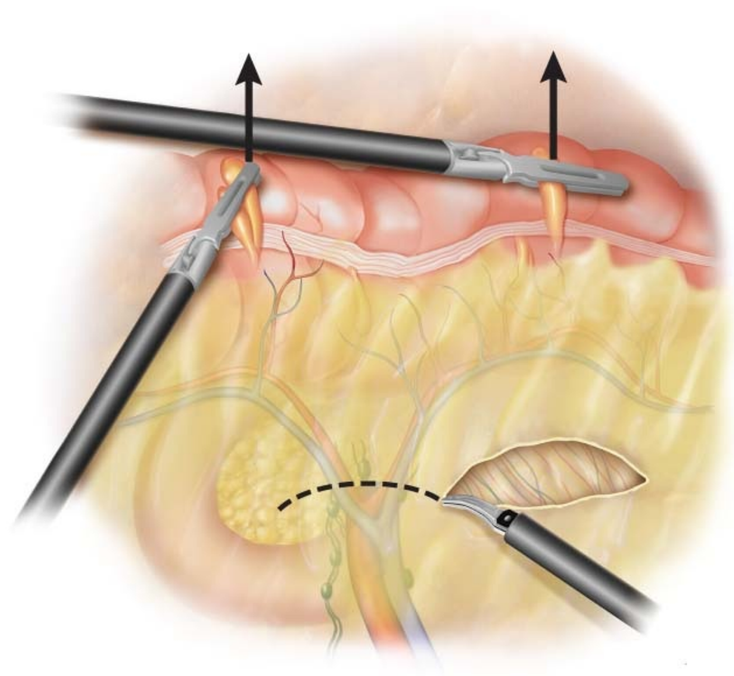


FIGURE 27-6 Isolation of the middle colic vessels.

p. 254

p. 255

Working back toward the patient's right side, the main trunk middle colic vessel is isolated and divided (Figs. 27-7 and 27-8). The middle colic vessels may sometimes be ligated together or individually. Excessive tension on the vessels should be avoided when using a bipolar vessel-sealing device. The entire proximal and mid-transverse mesocolon has now been fully divided.

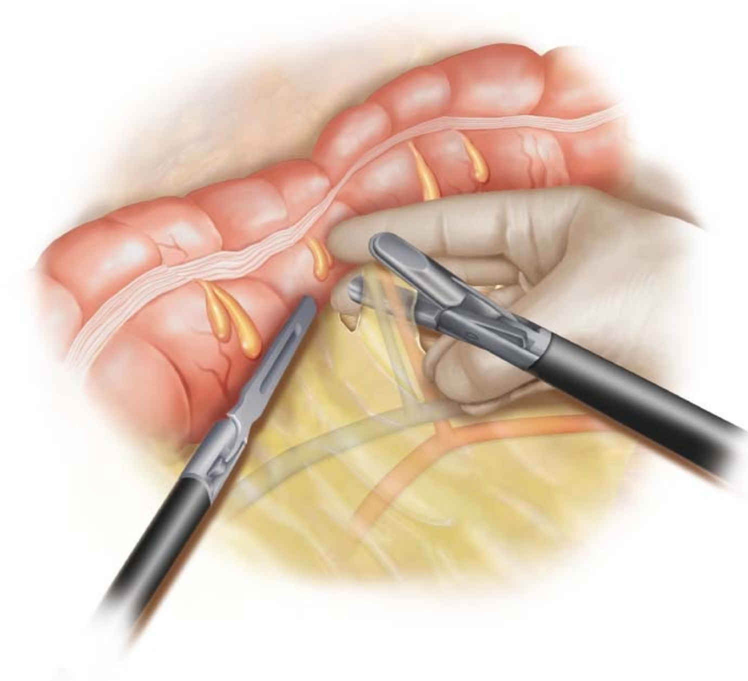


FIGURE 27-7 Ligation of middle colic pedicle.

p. 255

p. 256

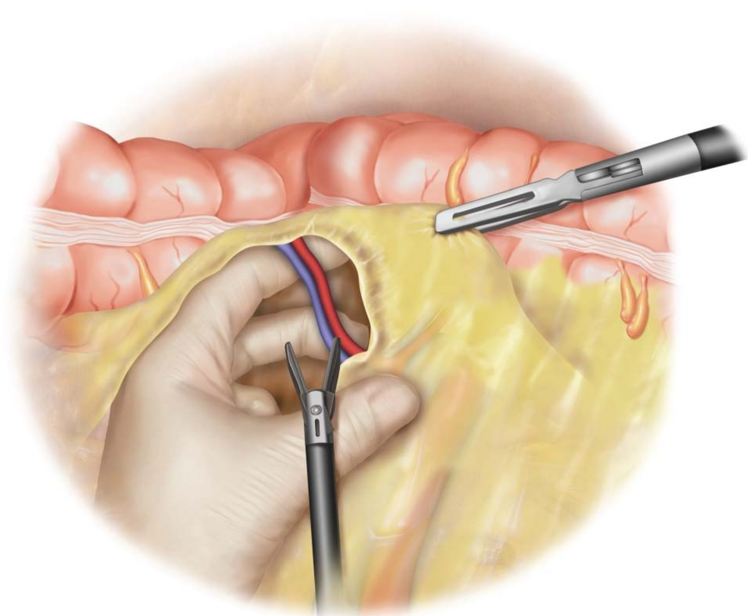


FIGURE 27-8 Isolation of the right branch of the middle colic vessels.

Right and Transverse Colectomy—Lateral Approach

The terminal ileum and right colon are laterally mobilized. This portion begins by a laparoscopic technique.

Scissors are placed directly through the hand device and a grasper through the left lateral trocar. The cecum and terminal ileum are mobilized.

The hand is then used to help mobilize the terminal ileal mesentery up to and then over the duodenum as a critical lengthening maneuver when performing ileoanal pouch construction.

The remaining lateral attachments are divided, with the assistant using the hook cautery through the right lateral trocar, and the surgeon remaining in the same position with the left hand in and the right hand with a laparoscopic grasper.

The bipolar vessel sealer may also be used to help separate the omentum, and control any minor bleeding (Figs. 27-9 and 27-10). After the right and transverse colon have been mobilized and devascularized, they are placed back into anatomic position before turning to the left colectomy.

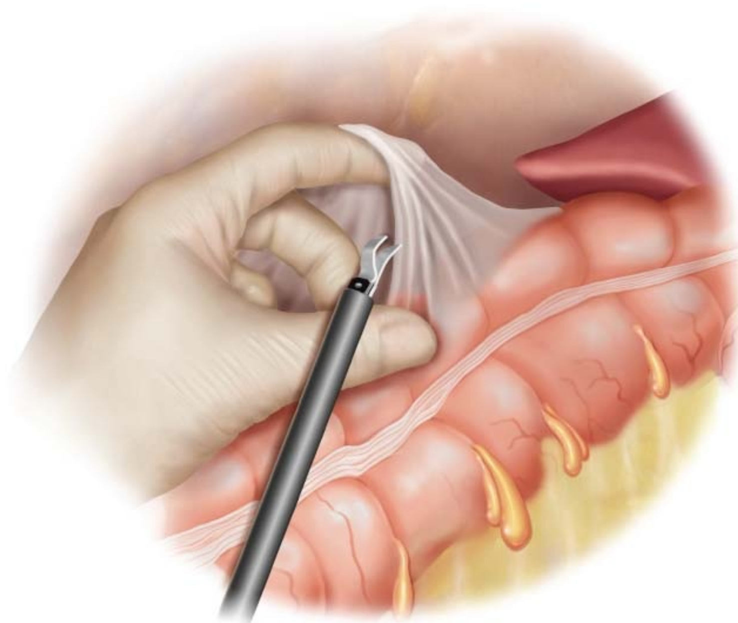


FIGURE 27-9 Lateral mobilization of right colon.

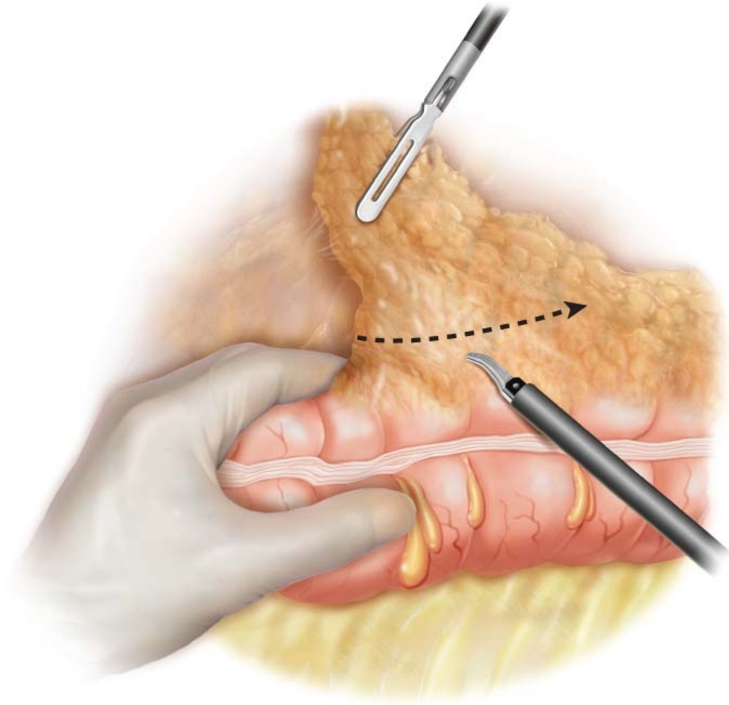


FIGURE 27-10 Separation of the omentum.

Left Colectomy

The surgeon then stands to the patient's right side, with the right hand through the hand device and the left hand with an instrument through the right lateral trocar site. The assistant stands cephalad to the surgeon, holding the camera (Fig. 27-11). The patient is in a mild Trendelenburg and left-side up position. The small bowel is packed out of the pelvis to the right upper quadrant with a sponge.

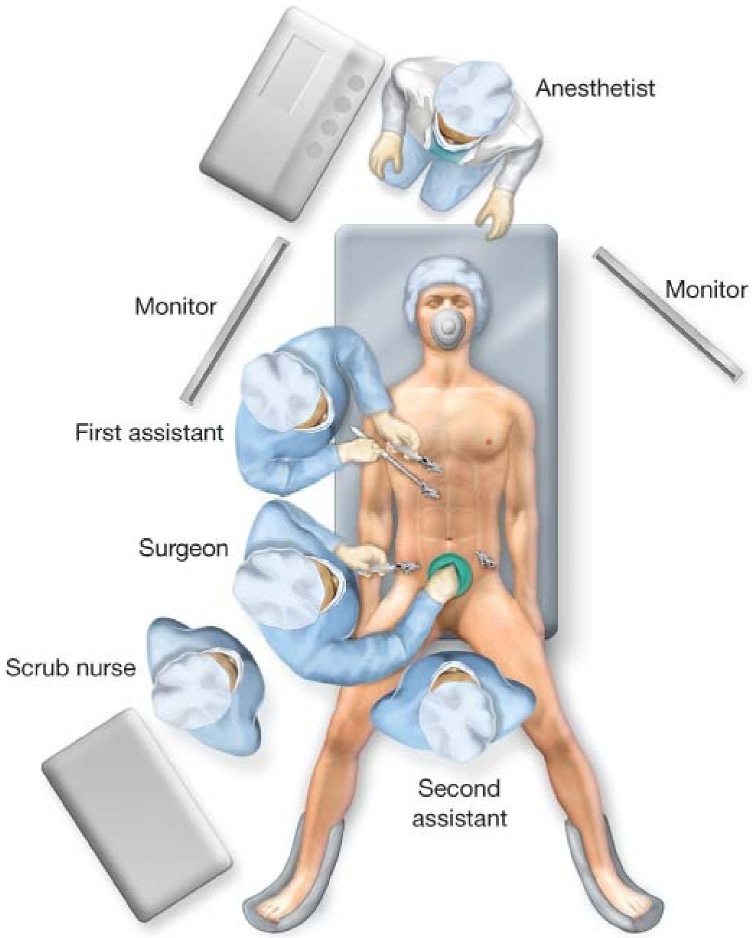


FIGURE 27-11 Surgeon and assistant positioning.

If the indication for surgical resection includes cancer of the left colon or rectum, then a dissection that includes the inferior mesenteric artery (IMA) pedicle will follow. There is the potential risk of injury to the hypogastric nerves when performing a high pedicle ligation.

The right hand elevates the IMA pedicle and an incision is made along the right peritoneal fold of the rectosigmoid mesentery extending into the pelvis (Fig. 27-12). The plane beneath the inferior mesenteric pedicle is developed heading to the left side. Care is taken to sweep down the sympathetic nerve fibers of the hypogastric nerves (Fig. 27-13). A plane is developed over the left ureter and left ovarian vessels and the IMA pedicle is isolated and divided below the takeoff of the left colic vessels (Fig. 27-14).

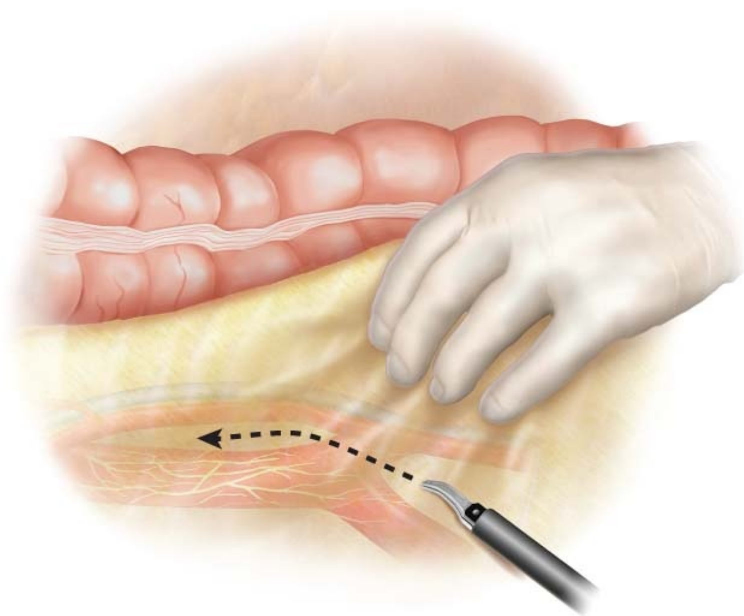


FIGURE 27-12 Planned incision for IMA pedicle isolation.

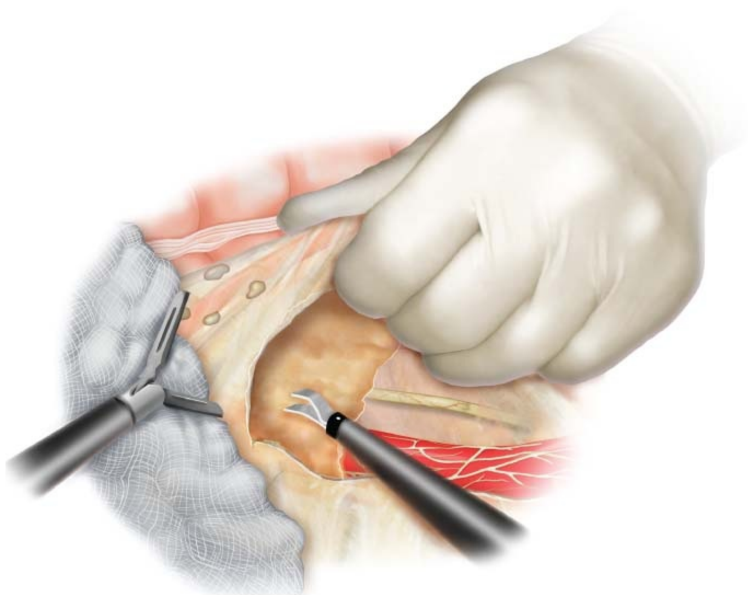


FIGURE 27-13 Isolation of IMA pedicle over left ureter and hypogastric nerves.

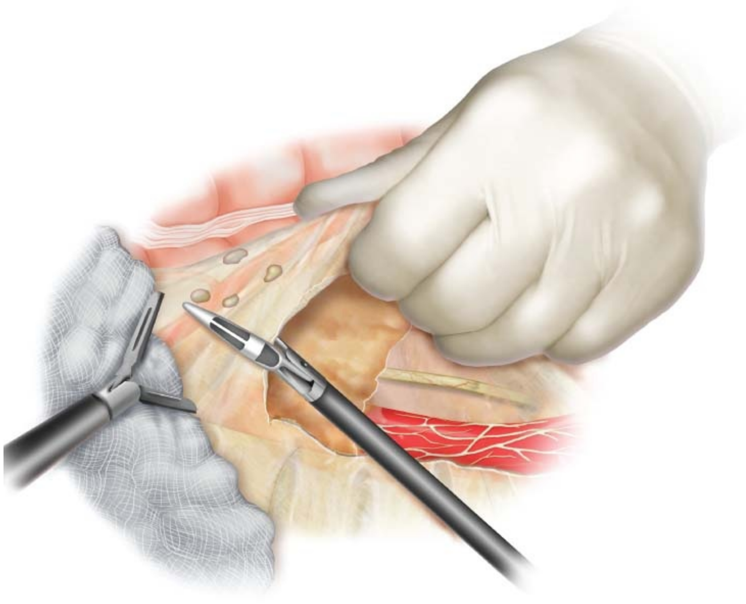


FIGURE 27-14 Ligation of IMA pedicle below the left colic vessels.

p. 257

p. 258

If the indication for resection does not include the risk of carcinoma, then the preference is to preserve the IMA and superior hemorrhoidal pedicles into the pelvis to reduce the risk of injury to the hypogastric nerves.

p. 258

p. 259

The right hand elevates the mesentery lateral to the inferior mesenteric vein (IMV) in the “bare area” of the left colon between the left colic vessels and the first sigmoidal branches (Fig. 27-15A).

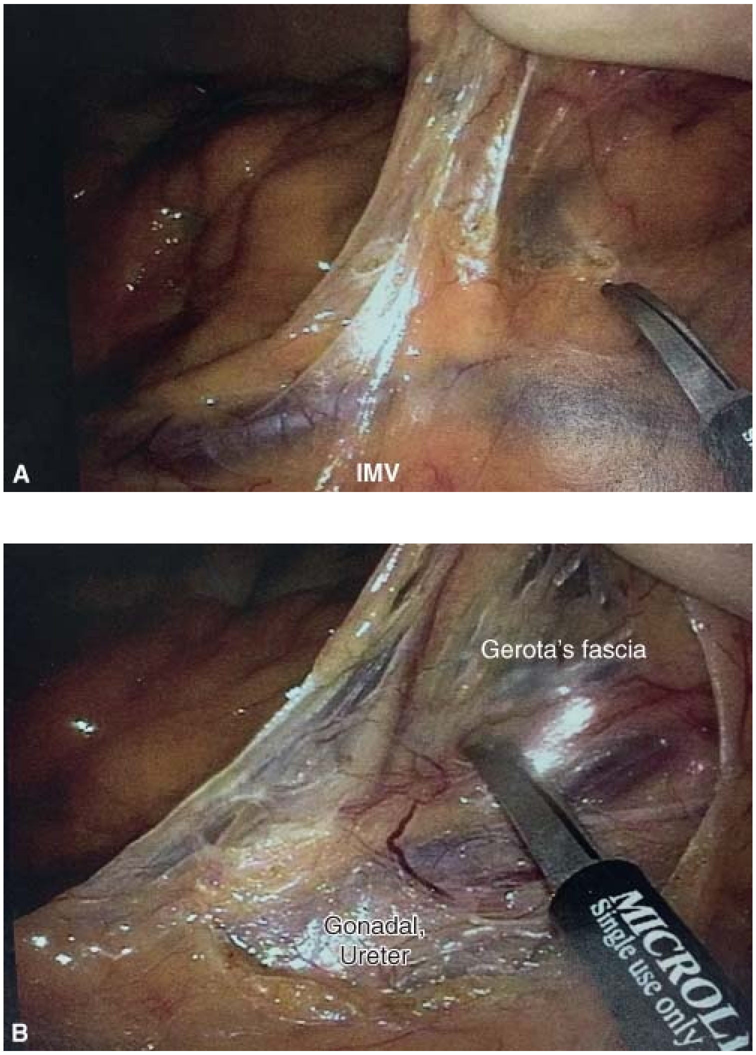


FIGURE 27-15 A. Planned incision lateral to IMV in cases of benign disease. B. dissection over Gerota's fascia.

The mesentery is incised just lateral to the IMV and a dissection begins between the left colon mesentery and Gerota's fascia. The gonadal vessels will be below the Gerota's fascia and the dissection continues out to the lateral sidewall (Fig. 27-15B). The ureter is typically under the IMA pedicle and will not be seen. The sigmoid branches are then identified, isolated, and divided with a bipolar vessel sealer.

The left-sided colon is then mobilized from medial to lateral in the inferior plane overlying Gerota’s fascia (Fig. 27-16). This dissection will continue to the left pelvic sidewall, into the upper retrorectal space, and superiorly, we will come up and under the mesentery toward the splenic flexure.

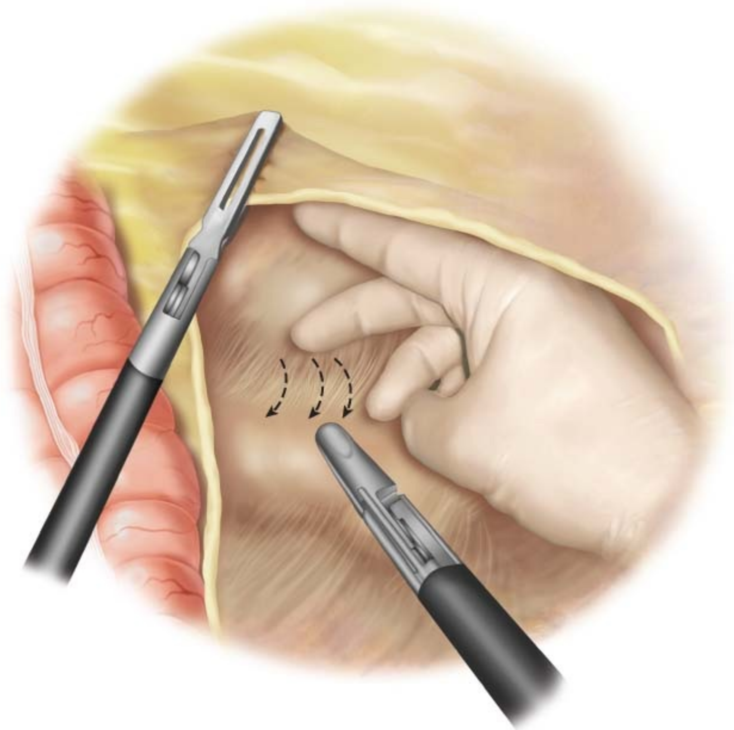


FIGURE 27-16 Medial to lateral mobilization of the left colon mesentery.

The left colon mesentery is medially divided and the left colic vessels are isolated and divided. The medial dissection continues out to the lateral sidewall, where the line of Toldt can be divided.

After the lateral attachments are divided, the white line of Toldt is divided through the left lateral trocar (Fig. 27-17).

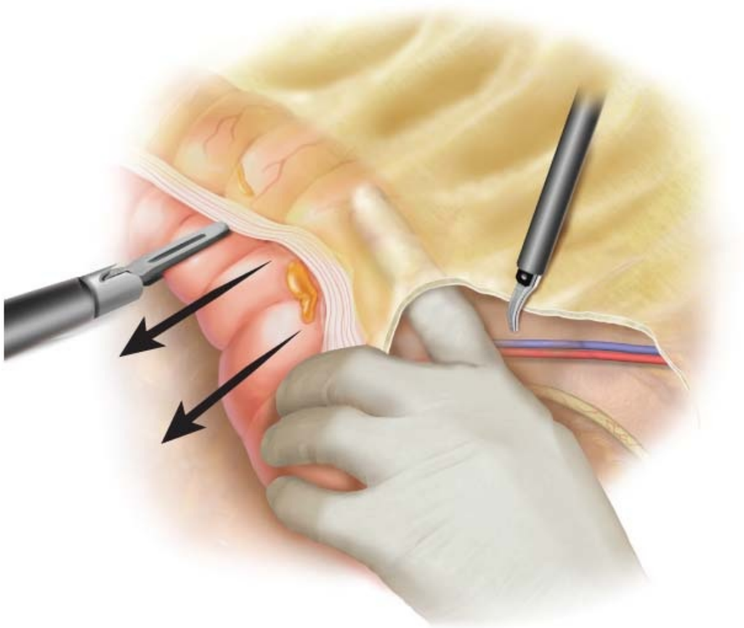


FIGURE 27-17 Lateral mobilization of the left colon.

The splenic flexure and remaining transverse mesocolon are then divided. The assistant stands between the legs, holding the camera with the left hand and the hook cautery with the right hand (Fig. 27-18). This approach is similar to that used to separate the omentum from the proximal transverse colon (Figs. 27-19 and 27-20).

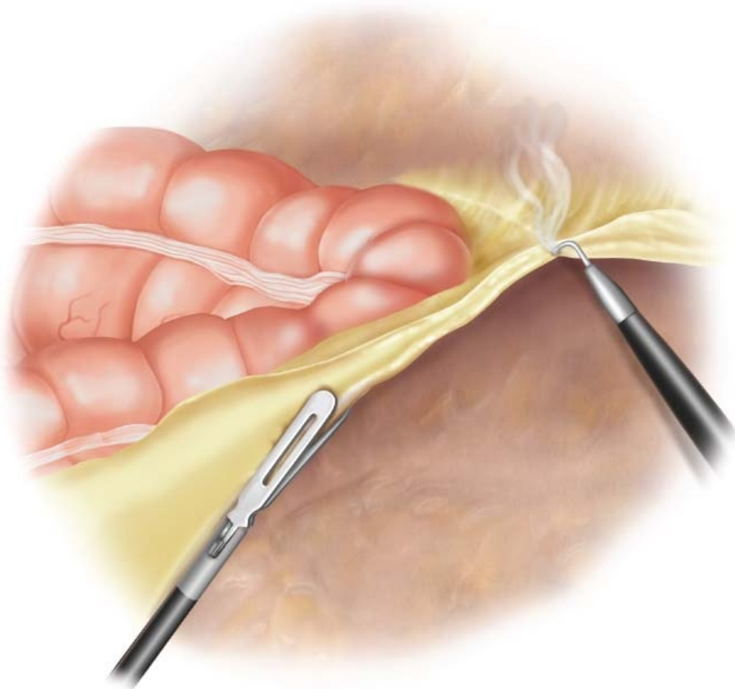


FIGURE 27-18 Takedown of the splenic flexure.

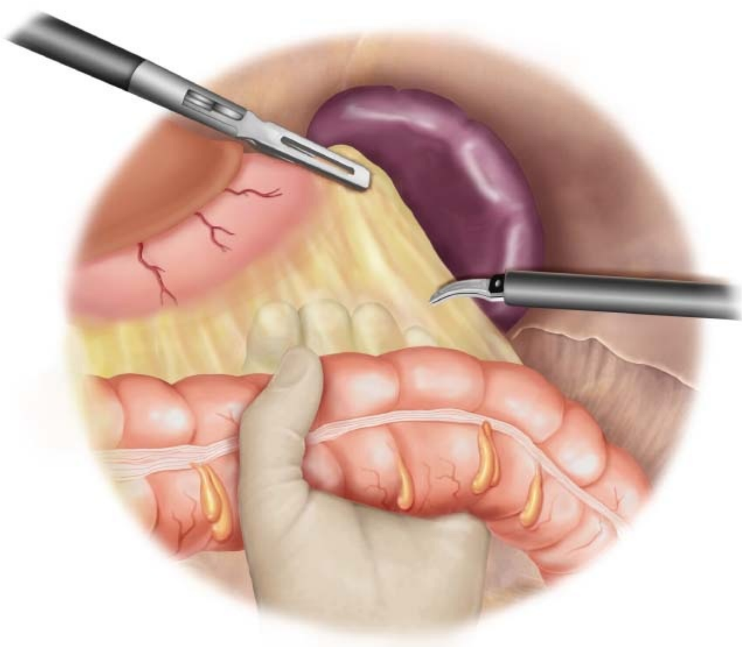


FIGURE 27-19 Takedown of splenocolic attachments.

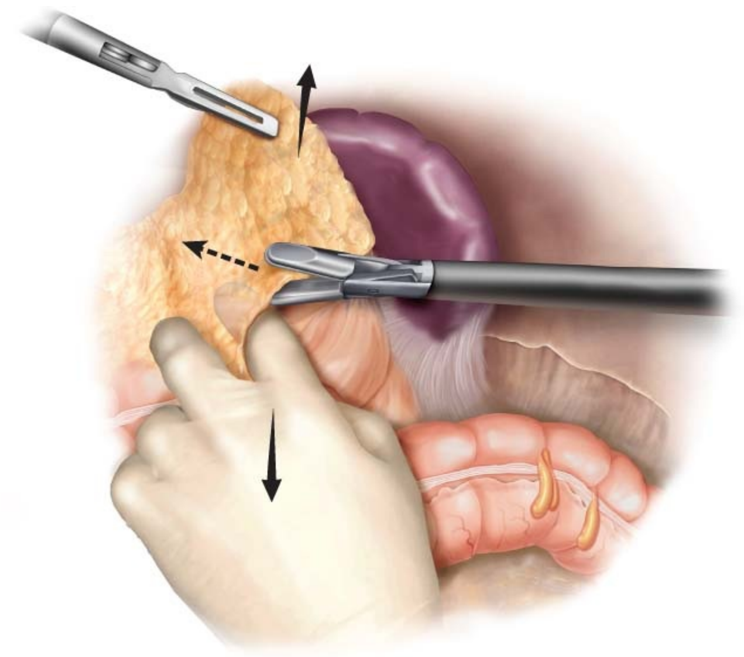


FIGURE 27-20 Separation of omentum into lesser sac.

With the omentum separated, the remaining portion of the distal transverse mesocolon is divided. The assistant elevates the mesentery with a grasper, and the surgeon divides the mesentery with instruments, using the left hand.

After the entire mesocolon has been divided, the retroperitoneum and major pedicles are examined with a sponge to ensure excellent hemostasis. The table is tilted into a Trendelenburg position with the right side up, allowing all of the small intestine to shift to the left upper quadrant. The colon is brought over the small intestine, beginning at the splenic flexure, to the right lower quadrant (Fig. 27-21). The terminal ileal mesentery can be followed up to, and then over the duodenum, with the entire small bowel to the left of midline (Fig. 27-22). This step is critical to ensure proper orientation of the small bowel mesentery for ileoanal pouch construction, and should be performed before moving onto the mobilization of the rectum.

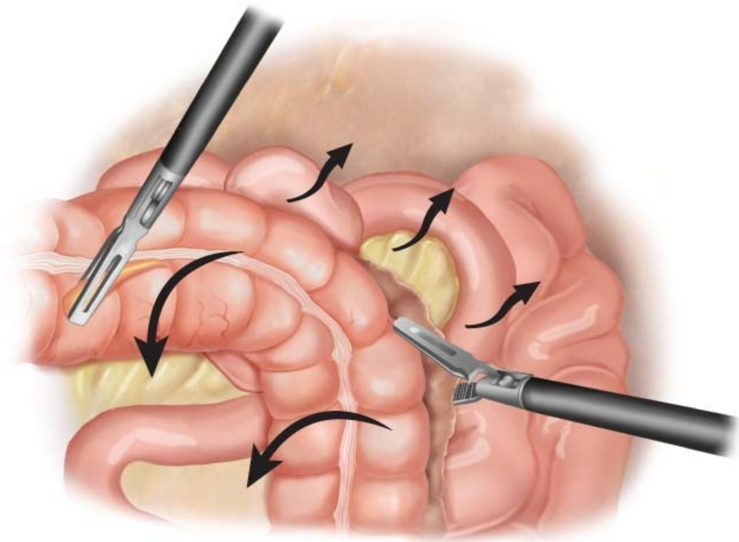


FIGURE 27-21 Mobilization of the colon and its mesentery over the small bowel to the right lower quadrant.

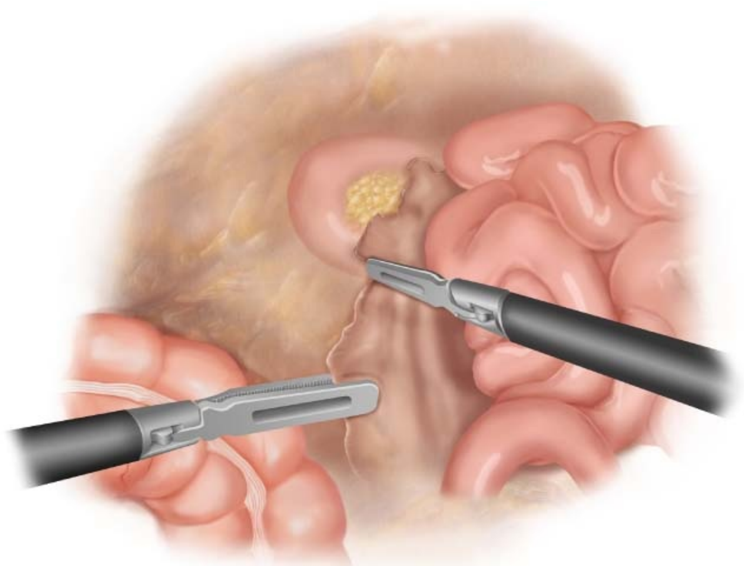


FIGURE 27-22 Verifying proper orientation of the terminal ileal mesentery over the duodenum.

Rectal Mobilization and Transection

The rectal mobilization can be done by a hand-assisted or, a laparoscopic approach, or by an open technique through the Pfannenstiel incision depending on the surgeon's preference, the surgeon's skill with laparoscopic proctectomy, and specific patient characteristics because it relates to the pelvic anatomy. Typically, the right hand can elevate the rectum and posterior mobilization is begun with sharp electrocautery dissection (Fig. 27-23). The surgeon's right hand elevates the rectum while the left hand uses a laparoscopic grasper to provide counter traction. The assistant, standing to the patient's left side, uses the hook cautery or scissors, through the left lateral port, and holds the camera with the right hand through the umbilical port (Fig. 27-24). Care is taken to stay medial to the hypogastric nerve complex. If the IMA and superior hemorrhoidal pedicles have been preserved, then using the same setup, a nonanatomic resection through the mesorectum is performed following the sigmoid vessels into the mesorectum until the dissection is below Waldeyer's fascia. Injury to the hypogastric nerves and nervi erigentes are thus avoided.

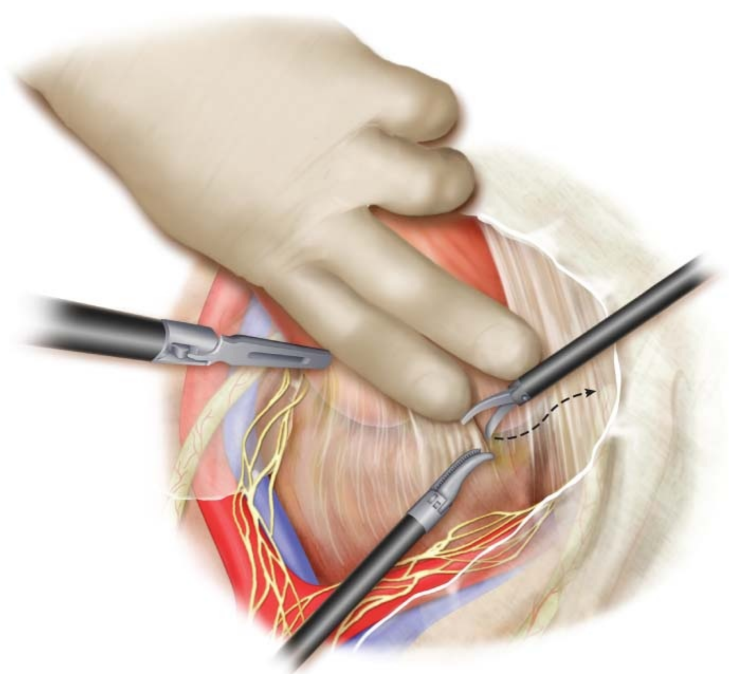


FIGURE 27-23 Initial posterior mesorectal mobilization with preservation of pelvic nerves.

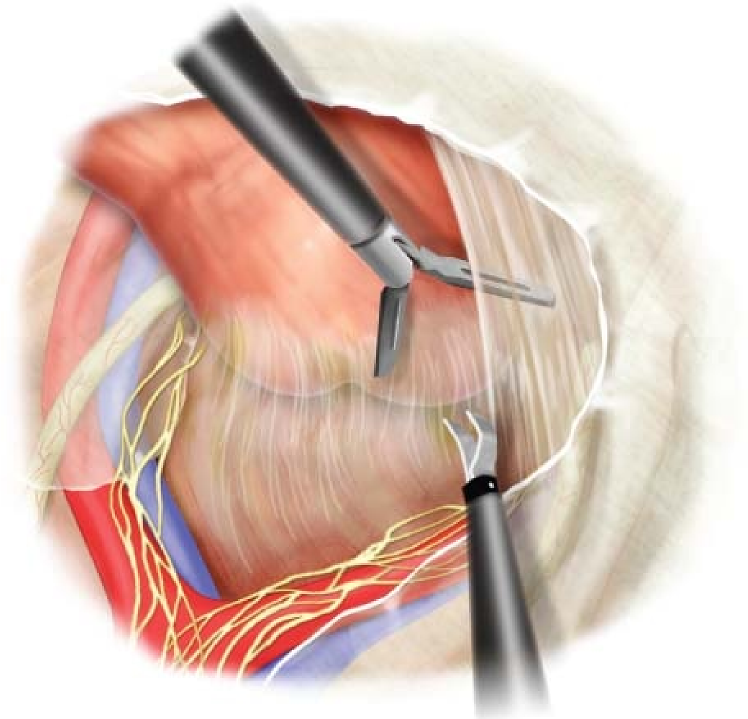


FIGURE 27-24 Mobilization of the mid and distal mesorectum.

p. 262

p. 263

The remainder of the pelvic dissection may then be accomplished, either by a laparoscopic technique, hand-assisted technique, or through the open Pfannenstiel incision. The colon and terminal ileum are delivered through the Pfannenstiel incision (Fig. 27-25). Through the open wound, one should follow the terminal ileal mesentery up to and over the duodenum, confirming proper orientation. The terminal ileal mesentery at the ileocecal valve is divided between clamps and ligated. The terminal ileum is divided with a stapler and tagged with a suture, so that it may be packed out of the pelvis. A moist laparotomy pad is used to keep the small bowel out of the pelvis. The rectal dissection continues and is completed through the open wound. A full circumferential mobilization of the rectum is undertaken down to the levator floor and upper anal canal. A 30-mm stapler is carefully placed transversely across the lower rectum. In the female patient, the vaginal cuff is anteriorly visualized anterior to the rectum and carefully dissected free. A finger is placed within the anal canal to confirm that the staple line is approximately1 cm above the dented line, and a finger is placed into the vagina to ensure that there is no entrapment of the posterior vaginal wall before the stapler is fired.

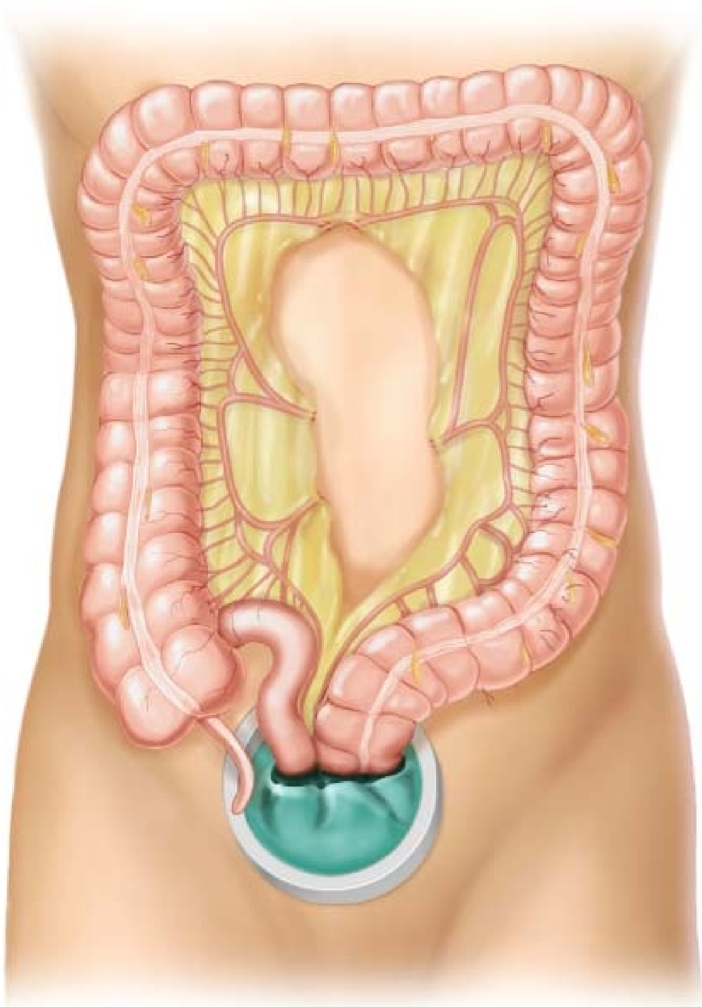


FIGURE 27-25 Completion of resection and construction of ileoanal pouch through the Pfannenstiel incision.

ILEOANAL POUCH CONSTRUCTION, ANASTOMOSIS, AND ABDOMINAL CLOSURE

The small bowel is brought back through the Pfannenstiel incision, and the ileoanal pouch is constructed through the open wound. Two to three firings of the 75-mm linear stapler are utilized to create the J-pouch. A circular stapler anvil is secured through the apex of the “J” with a purse string suture. Once the orientation of the pouch, without twist, is confirmed, the circular stapler is brought through the anus, the anvil is secured, and the stapler is closed. Following the anastomosis, an air leak test is performed. Digital examination should also be performed; and in women, a digital examination should again be undertaken to ensure vaginal wall exclusion.

The ileostomy aperture is completed by splitting the rectus muscle, and opening the posterior rectus sheath and peritoneum. The site for the ileostomy is marked on the bowel edge with chromic and polydioxanone suture to ensure proper orientation of the ileostomy. In women, the peritoneum adjacent to the fallopian tube is sutured to the lateral sidewall. This “oophoropexy” is performed in an attempt to prevent the development of a peritoneal inclusion cyst.

The peritoneum of the Pfannenstiel incision is vertically closed. The rectus muscle is reapproximated loosely with interrupted sutures. The anterior rectus sheath is closed transversely. The incisions are closed with absorbable suture. The wounds are covered and the ileostomy is matured.

POSTOPERATIVE MANAGEMENT

The patient is on a standardized accelerated postoperative care plan. Diet is slowly advanced, the patient is transitioned to oral analgesics, and the bladder catheter is removed on postoperative day 2–4 depending on the procedural details and postoperative recovery. Appropriate education of ileostomy care is initiated before, during and after hospitalization. A water-soluble enema and flexible endoscopy is performed 6 weeks after surgery and plans are made for ileostomy closure approximately 8 weeks following the original procedure.

COMPLICATIONS

Numerous complications can occur following restorative proctocolectomy whether performed laparoscopically, hand-assisted, or by an open technique. The only complication that is unique to a hand-assisted technique compared to conventional open surgery is the risk of small bowel obstruction at the level of the ileostomy, as described. Creation of the ileostomy aperture through the anterior rectus sheath before creation of the Pfannenstiel incision has greatly reduced the risk of this complication.

RESULTS

Extensive colorectal resections and reconstructions, including total abdominal colectomy and total proctocolectomy with ileal pouch-anal anastomosis, are undoubtedly among the most technically challenging operations to perform laparoscopically. This difficulty has made hand-assisted techniques relevant in allowing the adoption of minimally invasive total colorectal resections.

Rivadeneira and colleagues reported 23 prospectively collected cases of restorative proctocolectomy performed using hand-assisted or laparoscopic methods. The authors found that hand-assisted laparoscopic surgery (HALS) was associated with shorter operative times (247 vs. 300 minutes, $P<0.01$), but with otherwise comparable postoperative variables. A similar retrospective review of 23 patients by Nakajima *et al.* reported comparable results, including a shorter operative time of 63 minutes favoring the HALS group. Both case series represent early experiences with HALS total colorectal resections, and, as such, were likely underpowered.

Boushey and colleagues have published the largest such prospective database series to date, in which they compared two groups of patients undergoing HALS (n=45) or laparoscopic (n=85) total abdominal colectomy and total proctocolectomy. Again, the authors found a trend toward reduced operative times, in addition to significantly decreased conversion rates favoring the HALS group (2.2% vs. 7.1%, $P<0.01$). As with segmental resections, this group also demonstrated that non-laparoscopic colorectal staff surgeons performed a much larger proportion of cases using the hand-assisted technique compared to a straight laparoscopic procedure (20% vs. 4.7%, $P = 0.02$).

As part of their multicenter randomized controlled trial comparing HALS to straight laparoscopy, Marcello and colleagues published data pertaining to total colectomies and total proctocolectomies. Although reporting on a small number of patients (n=29), this portion of the trial demonstrated a significant decrease in skin-to-skin operative time associated with HALS of almost 1½ hours (199 vs. 285 minutes, $P = 0.015$). This difference was also evident when the time to colectomy completion was analyzed (127 vs. 184, $P = 0.015$). Despite this significant time saving, this group did not find any significant difference between the two groups in terms of postoperative recovery.

CONCLUSIONS

Hand-assisted laparoscopic restorative proctocolectomy is the procedure of choice for patients requiring proctocolectomy who desire a restorative operation. The procedure as described combines many of the advantages of laparoscopy while allowing the critical portions of the operation to be performed through the Pfannenstiel incision. For surgeons skilled in laparoscopic segmental colectomy and open restorative proctocolectomy, this approach allows for reduction in operative time and a low rate of conversion while maintaining minimally invasive benefits to the patient.

RECOMMENDED REFERENCES AND READINGS

Boushey R, Marcello PW, Martel G, Rusin LC, Roberts PL, Schoetz DJ Jr. Laparoscopic total colectomy: an evolutionary experience. *Dis Colon Rectum* 2007;50:1512–9.

Marcello PW, Fleshman JW, Milsom JW, *et al.* Hand assisted laparoscopic vs. laparoscopic colorectal surgery: a multicenter, prospective, randomized trial. *Dis Colon Rectum* 2008;51:818–28.

Martel G, Boushey RP, Marcello PW. Hand-assisted laparoscopic colorectal surgery: an evidence-based review. *Minerva Chir* 2008;63:373–83.

Milsom J, Bohm, B, Nakajima K, eds. *Laparoscopic Colorectal Surgery*. 2nd ed. New York, NY: Springer-Verlag, 2006.

Nakajima K, Lee SW, Cocilovo C, *et al.* Laparoscopic total colectomy: hand-assisted vs standard technique. *Surg Endosc* 2004;18:582–6.

Rivadeneira DE, Marcello PW, Roberts PL, *et al.* Benefits of hand-assisted laparoscopic restorative proctocolectomy: a comparative study. *Dis Colon Rectum* 2004;47:1371–6.

Chapter 28

Robotic Total Proctocolectomy

Elizabeth C. McLemore and Vikram Attaluri

INDICATIONS

Total proctocolectomy (TPC) with an end ileostomy is suited for only certain populations. Patients who have Crohn's disease or those with ulcerative colitis and are unable to undergo an ileal pouch reconstruction are the most likely groups. Others include synchronous cancer patients or patients with familial adenomatous polyposis with rectal cancer preventing sphincter preservation.

Before the operation, patients should undergo an evaluation with an ostomy nurse. A well-informed patient would be better positioned to care for the ostomy. Also, the preoperative selection of an ileostomy site is also of benefit.

SURGERY

Operative Preparation

A mechanical bowel preparation with oral antibiotics should be given to reduce septic complications.

The patient should be in the lithotomy position in case a perineal approach is needed to perform a mucosectomy. The arms should be tucked.

The patient should be secured to the table with tape across the chest at the level of the shoulders, taking care not to restrict the breathing.

The stoma site should be marked with a scratch from a 16-gauge needle to allow identification after skin preparation.

An orogastric tube and a Foley catheter should be placed to facilitate dissection.

Operative Technique

Although there are multiple methods of performing a robotic TPC, the most efficient method is to perform the colectomy laparoscopically and then perform the proctectomy with robot assistance.

Use of a bipolar energy device is efficient and cost-effective because this device can be used to ligate all major colon mesentery vessels and used to grasp the bowel safely.

Patient positioning during the surgery is indispensable to the operation. Mobilization of the ascending colon is assisted in the Trendelenburg position, followed by reverse Trendelenburg position of the transverse colon, and finally the Trendelenburg position for the sigmoid colon and rectum.

Port Placement

Port placement is initially made to allow for robotic dissection of the pelvis.

A 12-mm port should be placed two fingerbreadths right of the umbilicus—see Fig. 28-1.

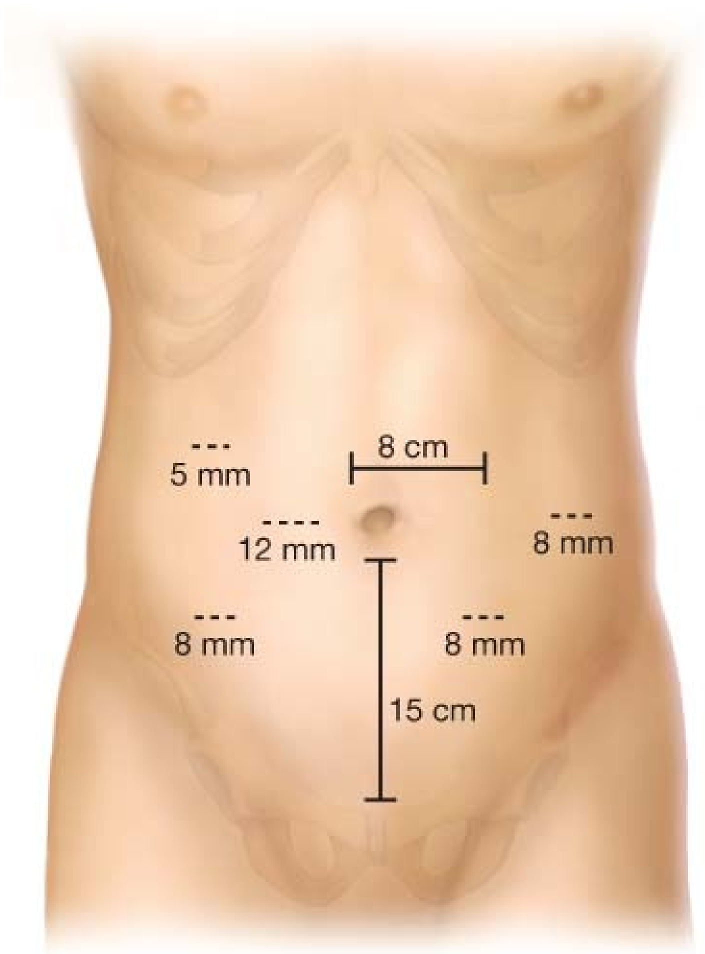


FIGURE 28-1 Port placement.

Robotic 8-mm ports should be placed in the right lower quadrant and the left lower quadrant and the left lateral abdomen. The ports should be 8–10 cm apart from the nearest port.

A 5-mm assistant port can be placed in the right upper quadrant at least 5 cm away from the nearest robotic port.

Additional 5-mm ports can be placed as needed to assist in the dissection, usually in the midline epigastric or suprapubic ports.

p. 267

p. 268

Mobilization

Dissection of the right colon begins with the surgeon at the left side of the patient.

Using the lateral attachments of the ascending colon to provide suspension of the colon and counter traction, dissection begins in a medial-to-lateral manner with ligation of the ileocolic artery.

The lateral attachments are then dissected to meet with the medial dissection. Care is taken to medialize the terminal ileum to ensure it will reach the ileostomy site.

Attention is then turned to the hepatic flexure. The transverse colon is mobilized away from the liver toward the hepatic flexure until the prior dissection is met.

As the dissection continues distally, the surgeon will move to the right side of the patient.

This transition can be assisted because the transverse colon mesentery and omentum is draped over a laparoscopic grasper and the omentum and mesentery can be transected simultaneously.

The dissection then proceeds to the splenic flexure, which is completely mobilized.

The inferior mesenteric vein is then transected at the ligament of Treitz and the colon mobilized distally to the inferior mesenteric artery (IMA).

The patient is then placed into the Trendelenburg position and the IMA is ligated in a medial-to-lateral manner, taking care to avoid injury to the ureter.

Robotic Docking

Once the IMA has been transected and the colon mobilized to the sacral promontory, the robot is docked to the patient.

The robot is brought over the patient’s left hip at a 45-degree angle to the bed—see Fig. 28-2.

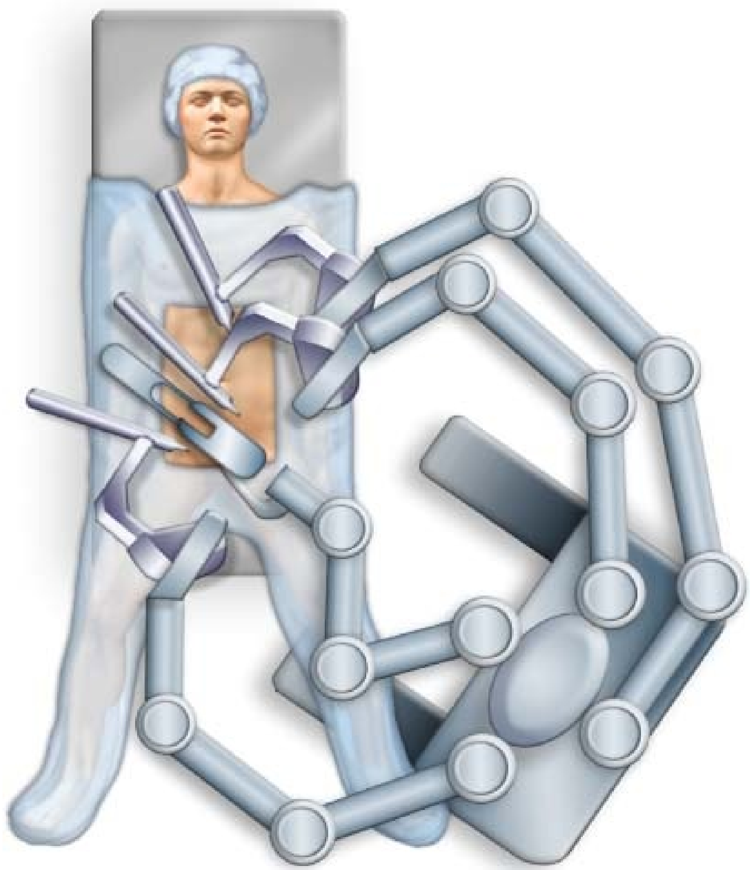


FIGURE 28-2 Robotic docking.

The robot camera and the first arm is to the patient's right with arms 2 and 3 to the patient's left.

A Mayo stand is placed under the drape over the patient's head to prevent inadvertent injury from the robot arms.

Proctectomy

For both inflammatory bowel disease and oncologic surgery, proctectomy is facilitated by dissection in the "Holy Plane," as described by Heald. This is an avascular plane that is often easier to follow than operating within the mesorectum in an effort to avoid nerve injury (see Fig. 28-3).

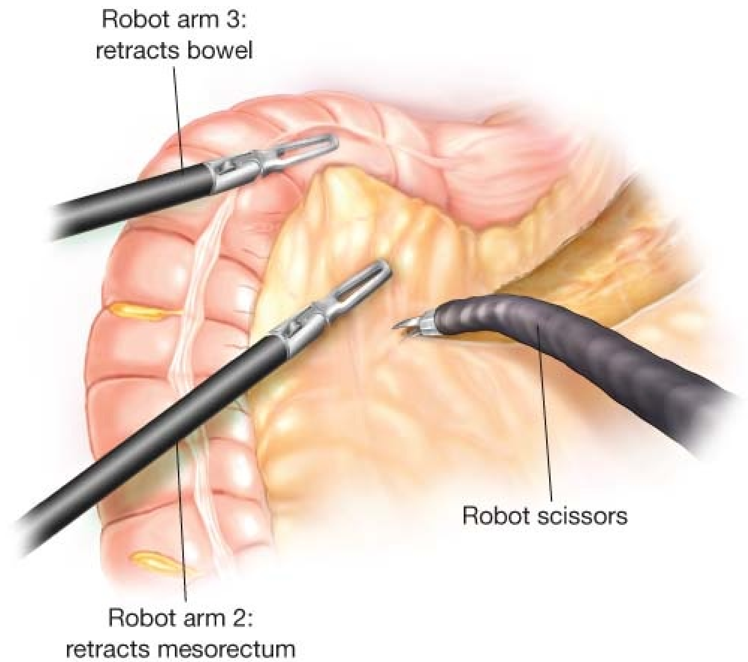


FIGURE 28-3 Dissection in mesorectal plane.

An assistant 5-mm port is used to suction fluid and retract the rectum.

Dissection can be performed similarly to laparoscopic and open techniques using the robotic scissors with electrocautery.

The posterior rectum is dissected first until tension from retraction is lost.

The lateral peritoneal attachments of the rectum are then transected, allowing further retraction of the rectum.

The dissection is carried out circumferentially, taking care to avoid injury to nerves posterior and laterally.

Anteriorly, care is taken to avoid injury to the vagina or prostate.

The rectum is mobilized down to the levators.

Transection

Depending on the indication of the operation, the distal rectum, just above the levators, can be transected with a laparoscopic stapler. This requires the placement of a 12-mm port at either the suprapubic location or the proposed ileostomy site.

Alternatively, the patient can undergo a mucosectomy or intersphincteric resection to completely remove the mucosa.

Because the patient will be undergoing a permanent end ileostomy, an intersphincteric resection is preferred to a mucosectomy because of its ease and less chances of leaving residual mucosa or damaging low pelvic structures.

Extraction

The simplest option for extraction is the proposed ileostomy site. Using a wound protector helps extract the specimen. In addition, one would not need to use a stapler to transect the ileum.

The mesorectum or colon is occasionally too large to extract through the proposed ileostomy site. In this situation, one would first transect the distal ileum with a laparoscopic stapler. The specimen can then be extracted either through the anus in the setting of a mucosectomy or through a low transverse incision. Again, use of a wound protector will aid in this process.

Ileostomy Creation

Ideally, the 12-mm port is placed at the proposed ileostomy site. The distal ileum can be extracted through this port.

After the incision is enlarged, the ileum can be exteriorized taking care to maintain axial orientation to avoid twisting.

POSTOPERATIVE MANAGEMENT

Standard enhanced recovery after surgery pathways can be used for postoperative care.

Most patients can be started on a liquid diet same day of surgery and can be discharged 2–4 days after surgery.

Pain control can usually be achieved without the use of an IV patient-controlled analgesia, and only tylenol, gabapentin, and oral narcotics are needed.

RESULTS

Multiple papers have reported on the feasibility of robot-assisted proctectomy. The limited published experience suggests that although robot-assisted TPC is feasible, it has not yet been proved to be superior. Extrapolating from the more extensive literature on robotic proctectomy, one may theorize that a robotic technique would result in decreased conversion to open procedure.

RECOMMENDED REFERENCES AND READINGS

Baca B, Aghayeva A, Ozben V, *et al.* Robotic total proctocolectomy for ulcerative colitis—a video vignette. *Colorectal Dis* 2015;17(8):736. doi:10.1111/codi.13019.

Buchs NC, Wynn G, Austin R, *et al.* A two centre experience of transanal total mesorectal excision. *Colorectal Dis* 2016;18(12):1154–61.doi:10.1111/codi.13394.

Hanai T, Maeda K, Masumori K, Katsuno H, Matsuoka H. Technique of robotic-assisted total proctocolectomy with lymphadenectomy and ileal pouch-anal anastomosis for transverse colitic cancer of ulcerative colitis, using the single cart position. *Surg Technol Int* 2015;27:86–92.

Mark-Christensen A, Pachler FR, Nørager CB, Jepsen P, Laurberg S, Tøttrup A. Short-term outcome of robot-assisted and open IPAA: an observational single-center study. *Dis Colon Rectum* 2016;59(3):201–7. doi:10.1097/DCR.0000000000000540.

Miller AT, Berian JR, Rubin M, Hurst RD, Fichera A, Umanskiy K. Robotic-assisted proctectomy for inflammatory bowel disease: a case-matched comparison of laparoscopic and robotic technique. *J Gastrointest Surg* 2012;16(3):587–94. doi:10.1007/s11605-011-1692-6.

Pedraza R, Patel CB, Ramos-Valadez DI, Haas EM. Robotic-assisted laparoscopic surgery for restorative proctocolectomy with ileal J pouch-anal anastomosis. *Minim Invasive Ther Allied Technol* 2011;20(4):234–9. doi:10.3109/13645706.2010.536355.

Rencuzogullari A, Gorgun E, Costedio M, *et al.* Case-matched comparison of robotic versus laparoscopic proctectomy for inflammatory bowel disease. *Surg Laparosc Endosc Percutan Tech* 2016;26(3):e37–40. doi:10.1097/SLE.0000000000000269.

Roviello F, Piagnerelli R, Ferrara F, Scheiterle M, De Franco L, Marrelli D. Robotic single docking total colectomy for ulcerative colitis: first experience with a novel technique. *Int J Surg* 2015;21:63–67. doi:10.1016/j.ijsu.2015.07.642.

Zimmern A, Prasad L, Desouza A, Marecik S, Park J, Abcarian H. Robotic colon and rectal surgery: a series of 131 cases. *World J Surg* 2010;34(8):1954–8. doi:10.1007/s00268-010-0591-4.

PART VI

RESTORATIVE PROCTOCOLECTOMY

Chapter 29

Open Restorative Proctocolectomy and Ileal Pouch-Anal Anastomosis

Alexis Grucela, David M. Schwartzberg, Michael J. Grieco, and Mitchell Bernstein

INDICATIONS/CONTRAINDICATIONS

The surgical treatment of ulcerative colitis (UC) has evolved over the past century, from what was initially an unknown disease process, to a surgically curable disease. In the 1950s, total proctocolectomy with Brooke ileostomy or ileo-rectal anastomosis became the standard of care for UC and familial adenomatous polyposis (FAP) through the pioneering work of Alfred Strauss, Sir Brian Brooks, and Rupert Turnbull. The ileo-rectal anastomosis avoided a permanent stoma; however, it left the diseased rectum in situ that continued to be at risk for developing carcinoma. Advances in anastomotic techniques led to the ileal-anal anastomosis, first with an S-shaped ileal reservoir by Sir Alan Parks and John Nicholls from London's St. Mark's Hospital. J-, W-, and H-pouches soon followed from Japan under the guidance of Utsunomiya Kock, Longmire, and Kock. Today, the J-pouch has become the reservoir of choice secondary to its fast and technically easier construction, good functional results, and long-term durability.

Restorative proctocolectomy with ileal J-pouch-anal anastomosis (IPAA) is now the procedure of choice for patients with mucosal ulcerative colitis (MUC) and FAP.

Advantages of IPAA:

- Removes the diseased colon and rectum
- Markedly reduces the risk of colon and rectal cancer
- Preserves the normal route of defecation, thus avoiding the need for a permanent ileostomy

The surgical approach to patients with CUC is divided into two broad categories, elective and emergent. Emergent intervention, usually consisting of total abdominal colectomy with end ileostomy, without proctectomy, is performed for CUC patients for the following indications (Table 29-1):

TABLE 29-1 Indications for Surgery in Ulcerative Colitis

Emergent	Elective
Fulminant colitis	Failure of medical therapy
Toxic megacolon	Dysplasia
Perforation	Malignancy
Hemorrhage	Stricture
	Unacceptable side effects of medications

- Fulminant colitis
- Toxic megacolon
- Colonic perforation
- Massive hemorrhage

p. 271

p. 272

In acutely ill patients, the operative goal is to address the life threatening clinical situation by removing the diseased colon and allowing the patient to restore to a healthier state with improved nutrition, and off of immunosuppressive medications, such as steroids and anti-tumor necrosis factor (anti-TNF)-α agents, prior to the next staged operation to remove the rectum and construct the J-pouch. Staged operations offer these advantages to the patient prior to their IPAA construction:

- Improved overall health
- Improved nutritional status
- Opportunity to be weaned from steroids
- Weaned from biologics and other immunosuppressive medications
- An in -situ rectum without violation of anatomic planes

IPAA is not undertaken during emergent operations because the physiologic milieu of the patient is not the proper setting for a complicated J-pouch construction. The rectum is spared, and proctectomy avoided leaving physiologic pelvic planes untouched for IPAA construction in the future. The increase in the understanding of the pathophysiology of CUC along with the addition of anti-TNF-α medications has resulted in a significant decrease in the number of emergent cases for fulminant colitis per year; however, approximately 25% of newly diagnosed CUC patients will still require proctocolectomy.

Most IPAAs are performed under elective circumstances. Indications for surgery are as follows (Table 29-1):

- CUC refractory to medical management
- Patients who are steroid dependent
- Deleterious side effects of medications
- The development of malignancy or dysplasia-associated lesion or mass
- Stricture
- Patient choice to avoid medication cost

Relative contraindications to IPAA include the following:

- *Advanced age*: Traditionally, age over 70 was considered a contraindication to IPAA because of presumed poor functional outcomes related to incontinence. However, a number of studies have reported acceptable functional results in patients in whom IPAA was performed in their 70s and even 80s.
- *Planned or desired pregnancy in the near-term after IPAA:* IPAA has been shown to have a negative impact on fecundity. Women wishing to become pregnant may elect a staged operation. Laparoscopic procedures have reduced the negative impact on fertility.
- *History of frequent or prolonged perianal sepsis (abscesses, fistulas).*
- *Obesity:* Obesity makes the operation extremely difficult, and mesenteric length is an issue, but in appropriately selected candidates it can be performed successfully.
- *Crohn's disease:* Crohn's disease has historically been considered an absolute contraindication to IPAA. Crohn's enteritis still remains a contraindication along with patients with perianal Crohn's disease. However, it has been shown that in highly select patient populations with Crohn's colitis and rectal sparing, an IPAA can be offered with acceptable outcomes.

Absolute contraindications include the following:

- Frequent incontinence episodes not associated with flares of disease activity

Need for pelvic radiation
Crohn’s enteritis and/or perianal Crohn’s disease

PREOPERATIVE PLANNING

Formal discussions with the patient and family/support system must ensue because operative options and outcomes must be relayed to the patient. Although the goal is to restore intestinal continuity with IPAA, there are patients who will not be able to have a restorative proctocolectomy for anatomic or functional reasons, or the initial diagnosis of Crohn's disease prohibiting pouch formation.

Education on functional results of the IPAA is important, including managing expectations with regards to frequency of bowel movements and potential for seepage, pad usage, or need for chronic anti-diarrheal medications.

Consultation with an enterostomal therapist for preoperative stoma marking and education is important. The preferred site for a diverting loop ileostomy is through the rectus muscle, inferior and to the right of the umbilicus.

There is no routine use of oral antibiotics and mechanical bowel preparation; however, some surgeons prefer one or two tap water enemas the morning of surgery to evacuate the rectum.

If the patient is currently on steroids or has taken them within the last 6 months, stress dose steroids are considered in the perioperative period and tailored to operative findings.

SURGERY

Positioning

The patient should be positioned on the operating room table lying on a padded material to avoid slipping while in Trendelenburg position and avoid nerve damage (i.e., Pink Pad Pigazzi Positioning System, Xodus Medical, New Kensington, PA).

The patient is positioned in modified lithotomy with both arms padded, protected, and tucked against the torso.

The legs are placed in stirrups, which allow the hips and thighs to be flat with respect to the abdomen but the lower leg to flexed at the knee with protection of the head of the fibula and peroneal nerve, while minimizing pressure on the calf (i.e., Yellofins Stirrup, Allen Medical Systems, Acton, MA).

All patients require a padded chest strap placed to secure them to the table. All intravenous lines and electrocardiogram leads should be avoided with the strap.

A forced air warming device is placed over the torso and head.

Rectal irrigation can be performed.

Intravenous antibiotics are administered within 60 minutes of incision and 5,000 units of subcutaneous heparin are administered.

A thoracic epidural catheter can be considered for postoperative pain control.

Lower extremity sequential compression devices are placed and activated prior to the induction of anesthesia.

The abdomen is prepped and draped in the standard fashion.

Technique

A lower midline incision is made and extended cephalad to gain enough exposure to safely mobilize the hepatic and splenic flexure of the colon. The lowest extent of the incision should expose the pubic symphysis. This optimizes the exposure for the pelvic dissection and anastomosis. The upper extent of the incision will vary, contingent upon the body habitus of patient and the location of the splenic flexure. A fascial wound protector is placed (e.g., ALEXIS Wound Protector/Retractor, Applied Medical, Rancho Santa Margarita, CA).

The abdomen is first thoroughly explored for any unexpected findings. Most importantly, the small bowel is inspected for any evidence of Crohn's disease.

The operation is approached in a lateral-to-medial fashion. The entire abdominal colon is first mobilized from its lateral and retroperitoneal attachments. Care is taken to identify the course of both ureters down into the pelvis without violating the retroperitoneal plane.

To avoid multiple repositioning of the operating room table, the right side is started first with the right side elevated and slight Trendelenburg, followed by the left, and then the remaining transverse colon addressed usually with reverse Trendelenburg position.

The mesentery of the colon is divided close to the origin of the vessels with the exception of the right colon. The mesentery of the right colon is divided close to the colon to protect the ileocolic vessel. This vessel may need to be divided in order to achieve maximal length of the small bowel, but it should be preserved initially until it is determined if the vessel must be divided.

The small bowel mesentery is then mobilized up to the third part of the duodenum, to the most superior point possible. It is essential that all the small bowel mesenteric attachments to the duodenum are divided to ensure that maximal small bowel mesenteric length is achieved in order to allow the ileal pouch to reach to the upper anal canal without tension.

The terminal ileum is divided close to the ileocecal valve after removal of the ligament of Treves by a single firing of a linear cutting stapler.

When the abdominal colon is fully mobilized and divided, the patient is placed in steep Trendelenburg position, and the pelvic dissection is begun. A total mesorectal excision is performed. The presacral space is entered, and the superior hemorrhoidal vessel is divided. The rectum is mobilized, and the areolar tissue is divided with cautery, and a nerve sparing dissection is carried out posteriorly down to the pelvic floor (Fig. 29-1).

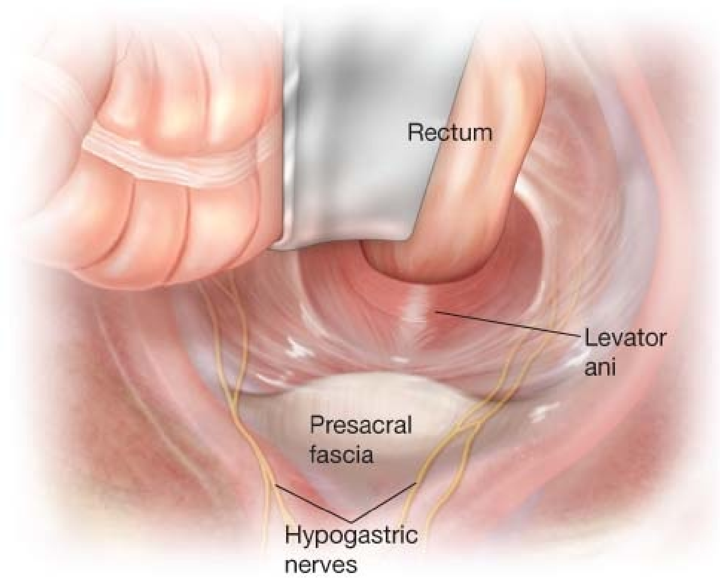


FIGURE 29-1 The rectum is mobilized, and a nerve sparing dissection is carried out posteriorly down to the pelvic floor.

The lateral attachments are divided. The anterior peritoneal reflection is scored, and the plane is opened (Fig. 29-2) and developed between the rectum and vagina in females, and seminal vesicles in males.

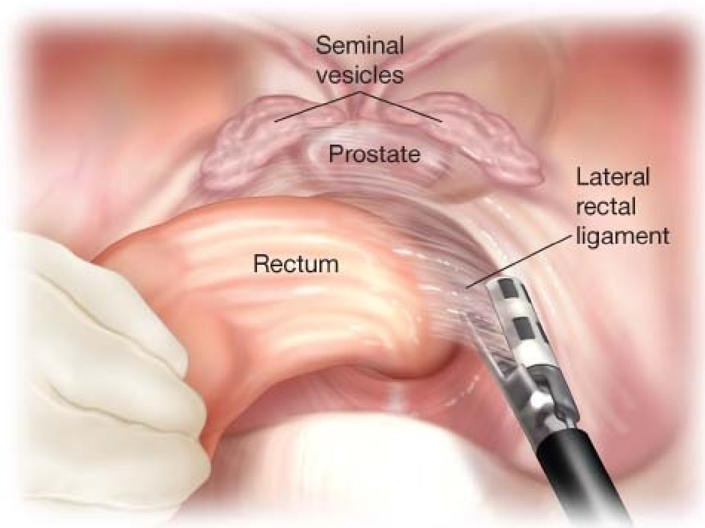


FIGURE 29-2 The lateral attachments are divided, and the anterior peritoneal reflection is then scored and the plane is opened.

A digital examination is performed to ensure that the rectum is dissected circumferentially down to the pelvic floor/top of the anal canal (Fig. 29-3).

p. 274

p. 275

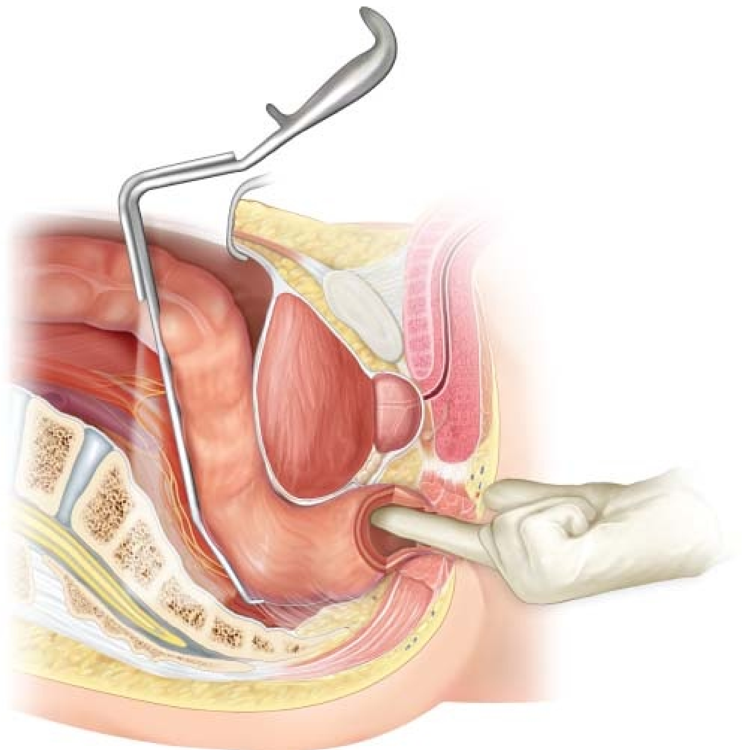


FIGURE 29-3 A digital examination is performed to ensure that the rectum is dissected circumferentially down to the pelvic floor/top of the anal canal.

When performing the double-stapled technique, the rectum is then divided, where the mesorectum ends at the level of the levator ani muscles with a linear stapler (Fig. 29-4).

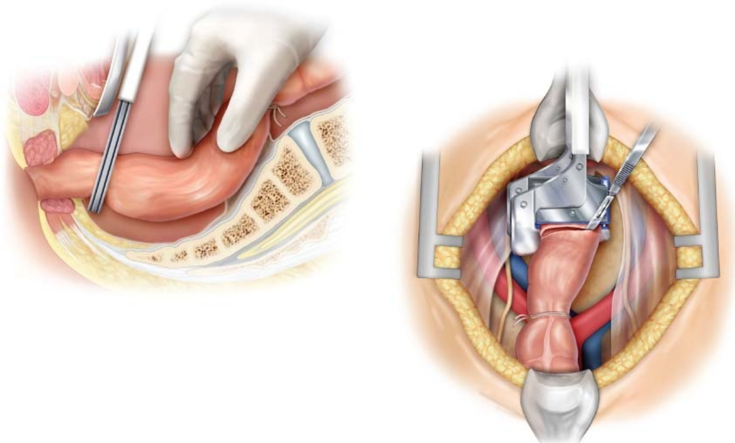


FIGURE 29-4 Stapling across the low rectum at the top of the anal canal in preparation of performing a double-stapled pouch-anal anastomosis.

Before the ileal pouch is constructed, a check of the mesenteric length is performed. Ideally, the apex of the pouch should reach to or below the pubic symphysis.

If there is tension on the mesentery, the following additional mesentery lengthening maneuvers can be performed:

- The anterior peritoneum over the course of the primary vessel supplying the pouch can be scored. This scoring is performed every 1–2 cm along the vessel's length starting near the vessel origin (Fig. 29-5).

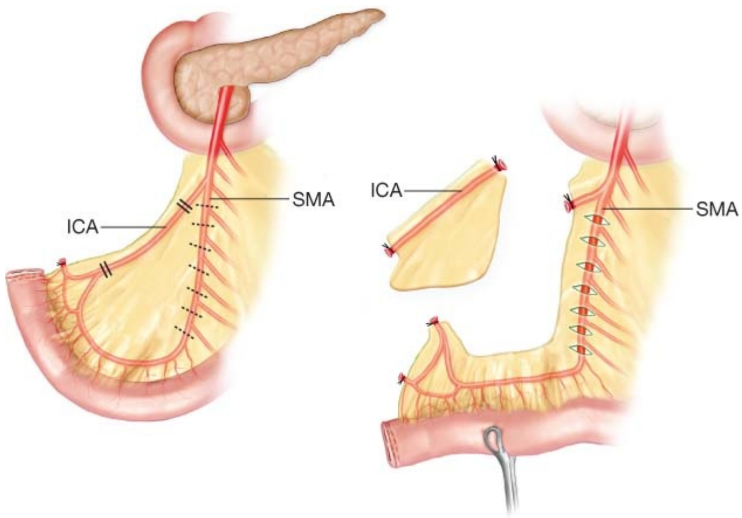


FIGURE 29-5 The anterior peritoneum over the course of the primary vessel supplying the pouch can be scored.

- The ileocolic vessel can be divided; distal ileocolic branches of the superior mesenteric artery are possible, but collateral flow should be confirmed with a vascular bulldog clamp prior to division.
- The additional fat and mesenteric tissue can be removed over the superior mesenteric artery.
- In the distal vessel arcade, near the pouch, small vessels can be carefully divided to construct a mesenteric window. Transient application of bulldog clamp may be helpful to verify adequacy of collateral blood supply after vascular division.
- The J-pouch configuration is favored for its simplicity, emptying, and reservoir capacity; however, if all maneuvers are not helpful, an S-pouch (Fig. 29-6A) is an alternative configuration that gives additional mesenteric length and may allow an anastomosis to be achieved (Fig. 29-6B).

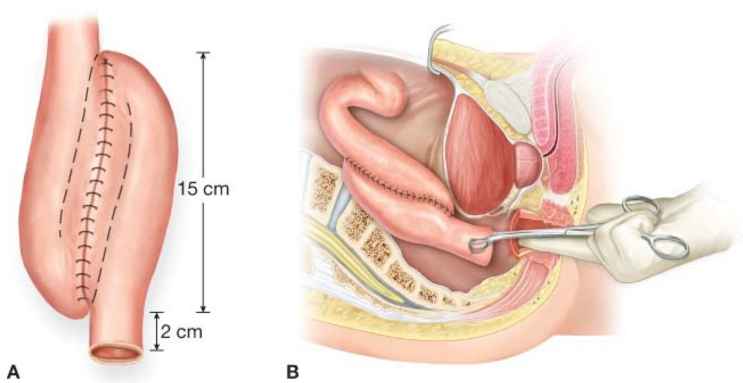


FIGURE 29-6 A. S-pouch construction B. Additional mesenteric length achieved.

The ileal J-pouch is constructed by folding the terminal ileum into a J shape. An enterotomy is made in the apex of the pouch. The common wall of the J-pouch is opened by firing a linear cutting stapler from the apex of the pouch with an arm of the linear cutting stapler placed in each of the J limbs along the antimesenteric border of the small bowel. Ideally, the pouch should be 15–17 cm in length, requiring two firings of the 100-mm linear stapler (Fig. 29-7).

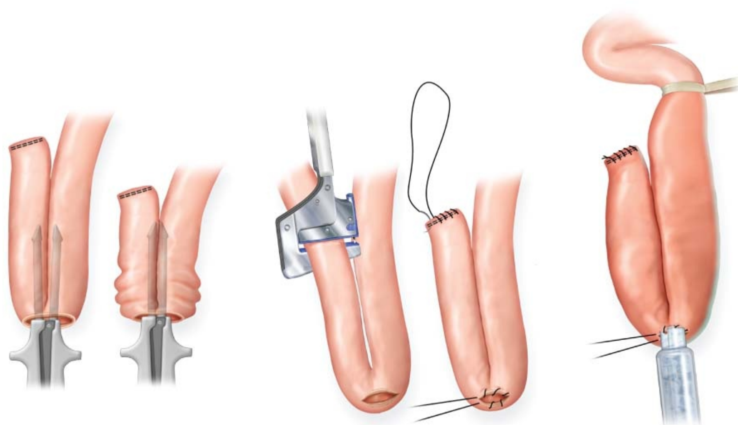


FIGURE 29-7 Construction of the ileal J-pouch by division of the common wall between the afferent and efferent small bowel limbs using a linear cutting stapler.

The tip of the staple line between the pouch limbs is oversewn.

The pouch is inspected for bleeding. It is then insufflated with povidone-iodine solution and checked for leaks. Any questionable areas are oversewn (Fig. 29-7).

Once the pouch is constructed, a hand-sewn purse string suture is placed in the enterotomy, and the anvil of the 28-or 29-mm circular stapler is secured at the apex of the J-pouch (Fig. 29-7).

The circular stapler is the carefully introduced into the anal canal (Fig. 29-8). This is facilitated by the patients’ legs being adducted. In obese patients, Allis clamps, Lone Star retractors (Cooper Surgical, Trumbull, CT), or everting 3-0 absorbable sutures can help expose the anus. A finger is placed into the vagina in females to ensure proper placement. The post of the stapler is brought out posterior to the staple line.

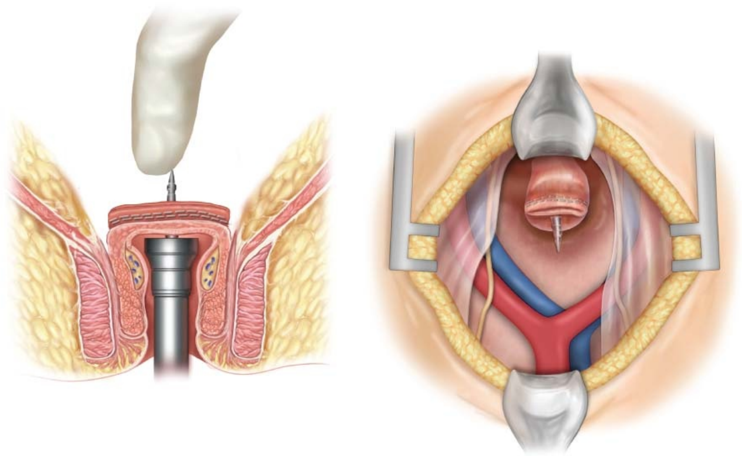


FIGURE 29-8 The circular stapler is carefully introduced into the anal canal.

The pouch is brought down into the pelvis, and the anvil in the J-pouch is connected to the stapler post at the top of the rectum (Fig. 29-9). Care is taken to avoid tension, rotation of the pouch, or proximal small bowel trapped under the cut edge of the small bowel mesentery leading to the pouch. A finger is placed into the vagina in females to ensure the vagina was not caught in the stapler prior to firing (Fig. 29-9).

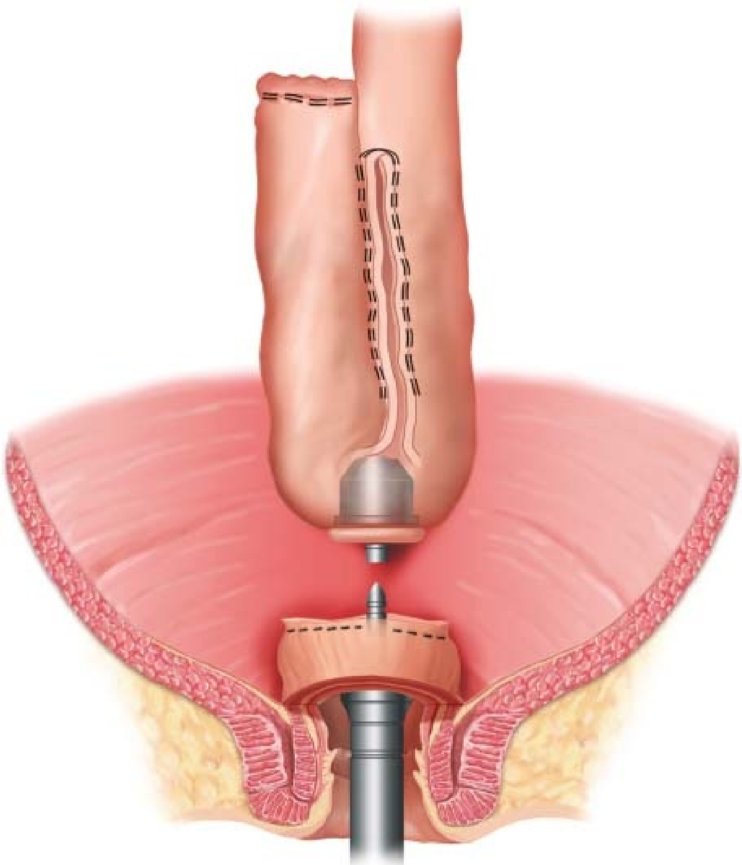


FIGURE 29-9 The pouch is brought down into the pelvis, and the double-stapled anastomosis is fashioned.

An alternative to the double-stapled method is a hand-sewn pouch-anal anastomosis after mucosectomy, or mucosal stripping of the distal most rectum (Table 29-2).

TABLE 29-2 Ileal Pouch-Anal Anastomosis Technique Advantages

Hand-sewn Mucosectomy	Double Stapled
Theoretical removal of all at-risk mucosa	Less technically challenging
Precise placement of anastomosis	Faster
No cuffitis	Les risk of sphincter damage

The cut edge of the small bowel mesentery lies along the aorta with the small bowel following to the patient’s left. The pouch falls into the curve of the sacrum as the mesentery of the pouch stretches to the anal canal.

A leak test is performed by filling the pelvis with saline and occluding the pouch inlet during air insufflation from a bulb syringe or a flexible sigmoidoscope.

After the pouch-anal anastomosis is completed, a diverting loop ileostomy is constructed approximately 20 cm proximal to the pouch (Fig. 29-10).

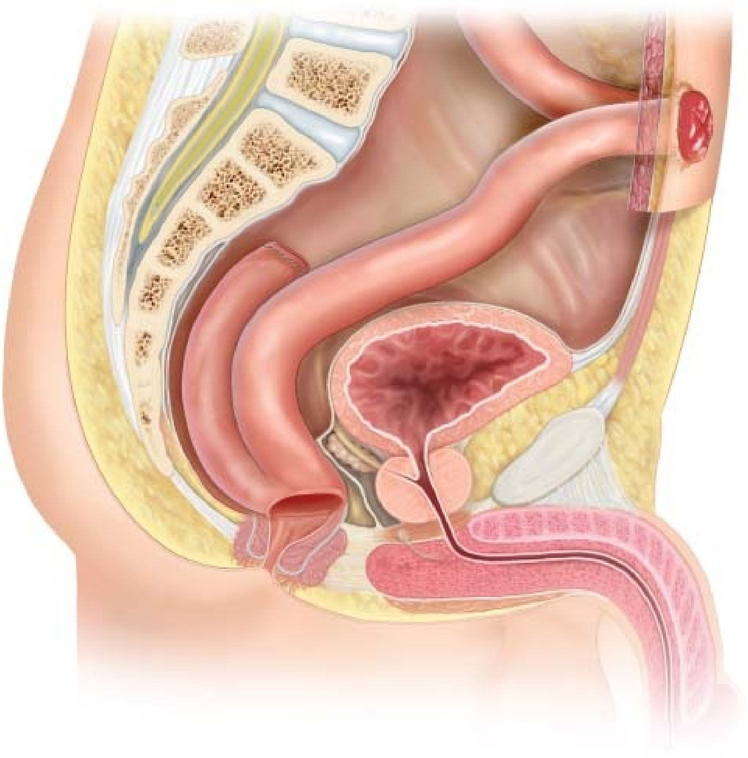


FIGURE 29-10 A diverting loop ileostomy is constructed proximal to the pouch.

A self-suction drain can be placed posterior in the sacral hollow behind the pouch and brought out of the anterior abdominal wall in the left lower quadrant.

POSTOPERATIVE MANAGEMENT

Advances in the understanding of postoperative management have significantly affected postoperative morbidity. In addition, enhanced recovery pathways have made postoperative care more uniform with the goal of faster return of bowel function with euvolemia, decreased narcotic use, early ambulation, and immediate postoperative feeding. Although postoperative management is tailored to each patient, many CUC patients are younger with few comorbidities, and a 3–4 day hospitalization should be expected.

Nasogastric tubes are generally not left; however, if one remains in place at the end of surgery, it should be removed within 24 hours.

Ambulation is started on the day of surgery.

Standard venous thromboembolism prophylaxis is provided with Enoxaparin sodium injection 30–40 mg or 5,000 units of heparin given subcutaneously daily.

Low rate resuscitative intravenous fluids are used in efforts to maintain euvolemia.

The patient is started on a clear liquid diet the night of surgery or postoperative day 1, and if tolerated, is advanced the following day.

The bladder catheter is removed on postoperative day 1.

Pelvic drains are removed at the discretion of the surgeon, generally when output is low and quality is not concerning.

Intravenous antibiotics are discontinued within 24 hours postoperatively.

The loop ileostomy is closed approximately 6–8 weeks after IPAA, as long as there are no major postoperative complications, and no leak demonstrated on a gastrografin enema or endoscopy of the pouch.

COMPLICATIONS

Although IPAA construction remains technically challenging with 30-day morbidities ranging from 20% to 30%, it remains safe with a mortality of less than 1%. Complications can be characterized as early or late (Table 29-3). The most common complication is small bowel obstruction from adhesions due to the large number of raw surfaces present after colectomy, or torsion at the ileostomy. Other common complications include the following:

TABLE 29-3 Complications After Ileal J-Pouch Anal Anastomosis

Early Complications	Late Complications
Small bowel obstruction	Small bowel obstruction
Stricture	Pouch fistula
Bleeding	Pouch dysfunction
Leak	Pouchitis
Pelvic abscess	Sexual dysfunction
	Reduced fecundity

Wound infection

Diverting stoma complications
Pouch leak (incidence of 5–15%)

Abscess

Pelvic sepsis, which can be an early or late complication

- Bleeding

p. 279

p. 280

Pelvic sepsis occurs in 5–24% of patients after IPAA. Computed tomography (CT) is useful in demonstrating pelvic fluid collections or phlegmon. Patients with pelvic phlegmon usually respond to conservative treatment with broad-spectrum antibiotics and bowel rest. Patients with a pelvic abscess associated with anastomotic leak following IPAA should undergo either transanal or CT-guided drainage. These have been shown to be equally effective and result in similar long-term pouch-related outcomes; however, after CT-guided drainage, a fistula may persist at the drainage site. In rare cases, operative washout and drainage could be necessary if clinically warranted.

The most commonly cited risk factor for pelvic sepsis is chronic or high-dose steroid use in the perioperative period. Other risk factors for pelvic sepsis and anastomotic leak are hypoalbuminemia, anemia, hypoxemia, bowel ischemia at the anastomosis, and anastomotic tension. Rarely, pelvic sepsis may lead to pouch excision. There is a higher rate of pouch loss in patients who suffered pelvic sepsis after IPAA, compared with patients who did not experience pelvic sepsis caused by fibrosis and poor pouch function.

Although the data are controversial, the use of anti -TNF-α medications has also been shown in many studies to increase septic complications, most commonly pelvic sepsis. A three-staged operation is generally preferred in these cases to mitigate morbidity. Waiting 4–6 weeks after the last dose of medication has been recommended; however, this is not possible in patients who need urgent or emergent operations.

Late IPAA complications include the following (Table 29-3):

- Anastomotic stricture (incidence of 5–38%)
- Pouch fistulas (incidence of 4–16%)
- Pouchitis, which is the most frequent long-term complication
- Incontinence/poor functional results
- Total pouch failure (incidence 5–8%)

Cuffitis

Retrograde ejaculation in men due to pelvic nerve injury

Reduced fecundity in women

Long-term complications of anastomotic stricture can be treated with intermittent anal dilations. Pouch fistulas and chronic pouchitis contribute to pouch failure, which may require pouch revision or excision with conversion to a permanent ileostomy. In addition, delayed pelvic abscess or pouch fistulas raise the possibility that the patient may carry a diagnosis of Crohn's disease.

The most common late IPAA complication is pouchitis, occurring in 12–70% of patients. It is an acute inflammatory process of the pouch, and in a minority of patients, it can become a chronic process, which may lead to pouch loss and permanent ileostomy (<5%). Pouchitis may represent an element of immune dysfunction unique to CUC patients, as it rarely occurs in FAP patients with an IPAA. Although non-specific, common signs and symptoms of pouchitis include persistent abdominal cramps, increased stool frequency, watery or bloody diarrhea, and flu-like symptoms. Although many patients are treated on clinical grounds alone, accurate diagnosis requires endoscopic visualization of the pouch and histologic evaluation. Although the exact cause of pouchitis is unclear, the successful use of antibiotics lends support to an interaction between pouch bacteria levels and the patient's mucosal immune system. Probiotics may be useful in either treating or perhaps even preventing pouchitis. Most patients with pouchitis respond to antibiotics (such as metronidazole for 10 days). Steroids or immunomodulators may be used in refractory cases. In chronic persistent pouchitis cases, Crohn's disease should be considered. Less than 8% of patients with an IPAA develop chronic pouchitis, and nearly half of those patients eventually require pouch excision.

RESULTS

Quality of life is better or much better compared with that prior to IPAA, and about 96% of patients rate their overall satisfaction as excellent. Average stool frequency is six bowel movements over 24 hours. Most (57–78%) patients are able to control their bowel movement until a convenient time, and more than 75% patients have a least one nocturnal bowel movement. The need for stool bulking and antimotility agents declined compared with pre-J-pouch. Major fecal incontinence occurs less than twice per week. Pads are worn by 28% of patients for protection against seepage. Patients older than 50 years have a higher daytime stool frequency (eight per day) than do patients younger than 50 years (six per day). Men and women have similar stool frequencies postoperatively, but women have more episodes of fecal soilage. Forty percent of patients with minor incontinence at 1 year remain unchanged, 40% improve, and 20% worsen by 10 years.

Both IPAA and end ileostomy patients can live with a good quality of life and are satisfied with their operations (Brooke ileostomy, 93%; IPAA, 95%). However, daily activities (e.g., sexual life, participation in sports, social interaction, work, recreation, family relationships, travel), were more likely to be adversely affected with a Brooke ileostomy than by IPAA.

CONCLUSIONS

Restorative proctocolectomy with IPAA is a technically challenging operation that has endured as the procedure of choice for patients with UC and FAP who undergo elective surgery because of its durability and long-term functional outcomes. For UC patients who undergo an emergent operation, a total abdominal colectomy with end ileostomy is followed by a staged J-pouch creation. Although there are short-term and long-term complications, IPAA revolutionized the treatment standard for UC as it offers a curative approach that is safe and resilient and restores continuity with high patient satisfaction.

RECOMMENDED REFERENCES AND READINGS

Bach SP, Mortensen NJ. Ileal pouch surgery for ulcerative colitis. *World J Gastroenterol* 2007;13:3288–300.

Chapman JR, Larson DW, Wolff BG, *et al.* Ileal pouch-anal anastomosis: does age at the time of surgery affect outcome? *Arch Surg* 2005;140(6):534–9; discussion 539–40.

Cima R, Pemberton JH. Medical and surgical management of chronic ulcerative colitis. *Arch Surg* 2005;140:300–10.

Cohen JL, Strong SA, Hyman NH, *et al.* Practice parameters for the surgical treatment of ulcerative colitis. *Dis Colon Rectum* 2005;48(11):1997–2009.

Delaney CP, Fazio VW, Remzi FH, *et al.* Prospective, age-related analysis of surgical results, functional outcome, and quality of life after ileal pouch-anal anastomosis. *Ann Surg* 2003;238(2):221–8.

Farouk R, Pemberton JH, Wolff BG, Dozois RR, Browning S, Larson D. Functional outcomes after ileal pouch-anal anastomosis for chronic ulcerative colitis. *Ann Surg* 2000;231:919–26.

Fazio VW, Kiran RP, Remzi FH, *et al.* Ileal pouch anal anastomosis: analysis of outcome and quality of life in 3707 patients. *Ann Surg* 2013;257(4):679–85.

Fleshner P, Schoetz D Jr. Surgical management of ulcerative colitis. In: Wolff B, Fleshman J, Beck D, eds. *The ASCRS Textbook of Colon and Rectal Surgery*. New York, NY: Springer; 2007:567–83.

Grucela A, Steinhagen R. Current surgical management of inflammatory bowel disease: ulcerative colitis. *Mt Sinai J Med* 2009;76(6):606–12.

Grucela AL, Bauer JJ, Gorfine SR, Chessin DB. Outcome and long-term function of restorative proctocolectomy for Crohn's disease: comparison to patients with ulcerative colitis. *Colorectal Dis* 2011;13(4):426–30.

Gu J, Remzi FH, Shen B, Vogel JD, Kiran RP. Operative strategy modifies risk of pouch-related outcomes in patients with ulcerative colitis on preoperative anti-tumor necrosis factor-α therapy. *Dis Colon Rectum* 2013;56(11):1243–52.

Hahnloser D, Pemberton JH, Wolff BG, Larson DR, Crownhart BS, Dozois RR. Results at up to 20 years after ileal pouch-anal anastomosis for chronic ulcerative colitis. *Br J Surg* 2007;94(3):333–40.

Hum MA, Baig MK, Wexner SD. *Restorative Proctocolectomy Ileal Pouch Anal Anastomosis* [video]. http://cine-med.com/index.php?id=ACS-2227&subnav=acs. Woodbury, CT: Ciné-Med, Inc; 2003. Accessed December 21, 2009.

Kiely JM, Fazio VW, Remzi FH, Shen B, Kiran RP. Pelvic sepsis after IPAA adversely affects function of the pouch and quality of life. *Dis Colon Rectum* 2012;55(4):387–92.

Kirat HT, Remzi FH, Shen B, Kiran RP. Pelvic abscess associated with anastomotic leak in patients with ileal pouch-anal anastomosis (IPAA): transanastomotic or CT-guided drainage? *Int J Colorectal Dis* 2011;26(11):1469–74.

Kuruvilla K, Osler T, Hyman NH. A comparison of the quality of life of ulcerative colitis patients after IPAA vs ileostomy. *Dis Colon Rectum* 2012;55(11):1131–7.

Lovegrove RE, Constantinides VA, Heriot AG, *et al.* A comparison of hand-sewn versus stapled ileal pouch anal anastomosis (IPAA) following proctocolectomy: a meta-analysis of 4183 patients. *Ann Surg*

2006;244(1):18–26.
McGuire BB, Brannigan AE, O'Connell PR. Ileal pouch-anal anastomosis. *Br J Surg* 2007;94:812–23.
Melton GB, Fazio VW, Kiran RP, *et al.* Long-term outcomes with ileal pouch-anal anastomosis and Crohn's disease pouch retention and implications of delayed diagnosis. *Ann Surg* 2008;248:608–16.
Ording Olsen K, Juul S, Berndtsson I, Oresland T, Laurberg S. Ulcerative colitis: female fecundity before diagnosis, during disease, and after surgery compared with a population sample. *Gastroenterology* 2002;122:15–9.
Shen B. Pouchitis: what every gastroenterologist needs to know. *Clin Gastroenterol Hepatol* 2013;11(12):1538–49.
Walijee A, Walijee J, Morris AM, Higgins PD. Threefold increased risk of infertility: a meta-analysis of infertility after ileal pouch anal anastomosis in ulcerative colitis. *Gut* 2006;55:1575–80.
Yu CS, Pemberton JH, Larson D. Ileal pouch-anal anastomosis in patients with indeterminate colitis: long-term results. *Dis Colon Rectum* 2000;43(11):1487–96.

Chapter 30

Restorative Proctocolectomy: Laparoscopic Proctocolectomy and Ileal Pouch-Anal Anastomosis

Piyush Aggarwal and Tonia Young-Fadok

DEFINITIONS

Extent of Operation

In order to clarify regarding naming conventions, this chapter will use the following terms. *Total colectomy* describes resection of the entire colon, with either an ileorectal anastomosis, (IRA) if bowel continuity is preserved, or Brooke ileostomy and retention of the rectal stump. *Proctocolectomy* refers to surgical removal of the entire colon and the rectum. The word “total” as sometimes used in “total proctocolectomy” is thus redundant and not used in this chapter.

Following proctocolectomy, the terminal ileum is either matured as a Brooke ileostomy or, more commonly, used for a reconstructive procedure to reestablish bowel continuity, in the form of an ileal pouch, which is anastomosed to the anal canal. Increasingly infrequently, it may be used for a continent ileostomy (Kock pouch). Reconstruction with an ileal pouch is referred to by two common terms, *restorative proctocolectomy* and proctocolectomy and *ileal pouch-anal anastomosis* (IPAA). We prefer the latter because it describes the means of restoration of bowel continuity.

Laparoscopic Procedures

Naming conventions for laparoscopic procedures, especially in the field of colorectal surgery, are somewhat open to interpretation. Most surgeons would agree on the following usages. A procedure is *laparoscopic* if the procedure is laparoscopically completed and the main incision is used only for extraction of the specimen. *Laparoscopic-assisted* usually means that a portion of the procedure was extracorporeally performed, such as anastomosis in a right colectomy (although if the incision is the same as used to extract the specimen, this differentiation is splitting hairs). In a *hand-assisted procedure*, a 6–8-cm incision is used to place a device that allows a hand to be inserted into the abdominal cavity to facilitate the procedure. This incision is larger than the typical 3–5-cm incision used for extraction of the specimen in a laparoscopic (-assisted) operation. In a *hybrid procedure*, a portion of the procedure is laparoscopically performed, such as mobilization of the abdominal colon, and then a small incision (infraumbilical midline or Pfannenstiel) is used to facilitate dissection of the rectum or deployment of a stapler. The hand-assist incision may be used for this type of procedure, and thus, many purists consider hand-assisted and hybrid procedures to be similar in terms of incision length.

With regard to laparoscopic proctocolectomy and IPAA, a *laparoscopic-assisted* procedure would generally enlarge a supra-or infraumbilical port-site incision, by extending it to a 3–5-cm periumbilical extraction incision and then create the ileal pouch through this incision. In this chapter, a *completely laparoscopic* proctocolectomy and IPAA involves complete laparoscopic mobilization of the colon and the rectum, transection of the rectum and mesentery intracorporeally, and extraction of the specimen either via the *planned ileostomy site* or via the anus, so that no port site is enlarged and no additional incision is used for specimen extraction. The pouch is still extracorporeally constructed, but the ileostomy site incision is not enlarged to accomplish this goal. We prefer “completely” laparoscopic to “totally” laparoscopic given the confusion with naming conventions and the extent of procedure as noted above when the word “total” is used.

INDICATIONS/CONTRAINDICATIONS

The two most common pathologic diagnoses for which IPAA is undertaken are ulcerative colitis (UC) and familial adenomatous polyposis (FAP). Infrequently, the procedure may be appropriate in an individual with hereditary nonpolyposis colorectal cancer (HNPCC) with a rectal neoplasm, as distinct from the more common right-sided lesions seen in HNPCC, which usually prompt a total colectomy and IRA.

The indications for IPAA in patients with UC are: disease refractory to medical therapy, complications of medications used to treat the disease, inability to wean steroids despite responsiveness of the disease, failure to thrive in pediatric patients, and patient preference in the case of those patients who prefer an operation to long-term medication and surveillance. Some patients with UC have indications for a three-stage procedure, including toxic megacolon, hemorrhage, malnutrition, obesity, and operating within the effective period of an antitumor necrosis factor (anti-TNF) medication. They may ultimately be candidates for a J-pouch, but not at the initial operation.

Many surgeons consider IPAA to be the appropriate recommendation in patients with FAP. Some will consider total colectomy and IRA if there is relative rectal sparing with few rectal polyps. This author's preference is for IPAA in all cases of FAP, but to consider IRA in patients with attenuated FAP with rectal sparing.

The discussion of contraindications will distinguish between contraindications to IPAA, to laparoscopic IPAA (L-IPAA), and to completely laparoscopic IPAA (CL-IPAA). In patients with UC, IPAA may not be appropriate in an emergency situation, such as perforation, toxic megacolon, and hemorrhage, and in debilitated patients with malnutrition, obesity, chronic high-dose steroids, and recent anti-TNF treatment. This decision depends on whether or not the patient is hemodynamically stable, the duration of their symptoms, and the expertise of the surgeon. Consideration must be given to stabilization of the patient and whether or not a total colectomy and Brooke ileostomy (TC&B) may be the safest and most expeditious approach. Procedures performed may range from open TC&B in the unstable patient with perforation to L-IPAA in the stable patient with bleeding but no evidence of malnutrition. Malnutrition (low albumin, low prealbumin, World Health Organization definition of >10% weight loss) should prompt TC&B rather than IPAA. Emerging data suggest that recent administration of biologic medications may increase the risk of pouch complications. It may be best not to perform IPAA in patients within 8 weeks of receiving infliximab or 2 weeks of adalimumab, but instead recommend a three-stage procedure. The one additional contraindication to CL-IPAA is obesity. In obese patients, the resected colorectum cannot be extracted via the ileostomy site without enlarging the incision. Although the enlarged fascial incision can be made smaller with sutures, the enlarged skin incision around the stoma often results in deformity that contributes to difficulty with maintaining an appliance. A racquet shaped modification of the skin opening can relieve the oversizing of the stoma site.

PREOPERATIVE PLANNING

For all patients undergoing elective surgery, preoperative assessment consists of the following steps: evaluation by a trained clinician to exclude issues pertaining to anesthesia, basic blood tests (including electrolytes, complete blood count, and albumin and pre-albumin) when indicated by history, chest X-ray and electrocardiogram when appropriate, type and screen within 72 hours of operation, and pregnancy test when applicable. Patients should consult with stoma nurses to mark the most appropriate site for the planned ileostomy. Bowel preparation may be unnecessary, but there is a movement back to bowel preparation especially for laparoscopic cases. Laparoscopic handling of the bowel is facilitated by a bowel preparation, and the “completely laparoscopic” approach removes 4–6 ft of empty colon through a 3–5-cm incision. The vast majority of patients undergoing this operation have had prior colonoscopies and can suggest which preparation has worked best for them and been tolerated.

On the day of operation, patients who have had a prolonged course of steroids within the preceding 6–12 months, but are now off steroids, receive a dose of methylprednisolone 20 mg intravenously on call to the operating room (OR) and then a rapid taper over 3 days. Patients who are currently taking prednisone receive a 10–20-mg higher dose of methylprednisolone (on mg/mg basis) and then are tapered over 3 days to the preoperative dose. In accordance with Enhanced Recovery after Surgery (ERAS) guidelines, patients are given a carbohydrate load by asking them to take 12 oz of apple juice 2 hours before their scheduled time for surgery. We also prescribe oral acetaminophen, along with gabapentin and celecoxib (titrated to age and renal function, respectively) in the preoperative area.

Surgical Infection Prevention guidelines are followed. All patients are preoperatively given a warming blanket because this contributes to the maintenance of perioperative normothermia.

SURGERY

Positioning

Success of the operation begins with correct positioning. Three key points govern positioning: (a) Steep gravity changes are used, so the patient must be safely secured to the table; (b) there must be access to the perineum for stapled or sutured anastomosis; and (c) the position must facilitate the laparoscopic approach. Thus, the patient is placed in a modified combined synchronous position (modified lithotomy). We use medical grade pink eggcrate foam to ensure that the patient does not slip or slide. This egg crate is taped to the bed *over* a drawer sheet placed beneath the foam to be used for tucking the arms. The legs are placed in padded Allen stirrups and positioned with the thighs parallel with the abdominal wall, so that instruments used in the lower trocars during dissection in the upper abdomen are not hampered by the thighs. The hands are wrapped in foam and tucked adjacent to the torso. A commercial warming device is placed over the chest, followed by a folded blanket (to prevent tearing of the Bair Hugger (3M, MN, US), so it may be used in the recovery room), and linen tape is wrapped around the patient’s chest and around the table three times. A “tilt test” is then performed: the OR table is moved into all the potential extreme positions used during the procedure to ensure that the patient is safely affixed to the table.

A bladder catheter is placed and an orogastric tube is inserted to be removed at the end of the procedure.

Surgical Technique

Rationale

A lateral-to-medial approach is utilized for several reasons. First, the approach is similar to the open approach, and trainees more readily recognize the anatomic landmarks. Second, a medial-to-lateral approach involves sacrificing the ileocolic pedicle. Although these vessels may ultimately be taken to obtain adequate length of the pouch, sometimes the length-limiting structure is the adjacent vessel arcade, and the ileocolic pedicle is preserved until final decisions are made regarding pouch “reach” (the ability of the pouch to be anastomosed to the anal sphincter without tension). Third, in a medial-to-lateral approach, the intra-abdominal colon is devascularized early in the procedure before dissection in the pelvis; a lateral-to-medial approach avoids “dead gut” sitting in the abdomen while the pelvic dissection is completed. Finally, this approach allows for a “division of convenience” of the mesentery, avoiding dissection of the proximal vascular pedicles in a patient whose tissues may be friable from prolonged steroid use.

There are essentially three components to the laparoscopic portion of the procedure: mobilization of the left colon, mobilization of the right colon, and dissection of the rectum in the pelvis. Again, there is a rationale for this approach: The left colon is somewhat more technically challenging than the right, and once this is achieved, mobilization of the right colon is a little bit of a break before the technical challenges of the pelvic dissection! Also, even if the rectal dissection requires an open approach by those surgeons not comfortable with the laparoscopic approach, the subsequent lower midline or Pfannenstiel incision is smaller than a long midline incision required to mobilize the splenic flexure.

Laparoscopic Approach

A cutdown technique is used for insertion of a 10/12-mm blunt port. Our population of colorectal patients is sufficiently complex that a Veress needle technique is never used. After a pneumoperitoneum of 13 mmHg is achieved, the abdominal cavity is explored, and a 5-mm port is placed in the suprapubic midline and one or two additional ports (depending on body mass index [BMI]) are placed in the left lower quadrant. A diskof skin and subcutaneous fat are excised from the premarked ileostomy site in the right lower quadrant, and a 12-mm port is placed through this site.

Left Colon Mobilization

Commencing at the left pelvic brim, the dissection starts immediately medial to the left lateral peritoneal reflection. By leaving the peritoneal reflection "with the patient," the plane of dissection identifies the left ureter, which can be gently swept laterally and protected. The sigmoid colon is mobilized to the midline, and the left lateral peritoneal reflection alongside the descending colon is opened and the descending colon is mobilized medially(Fig. 30-1).

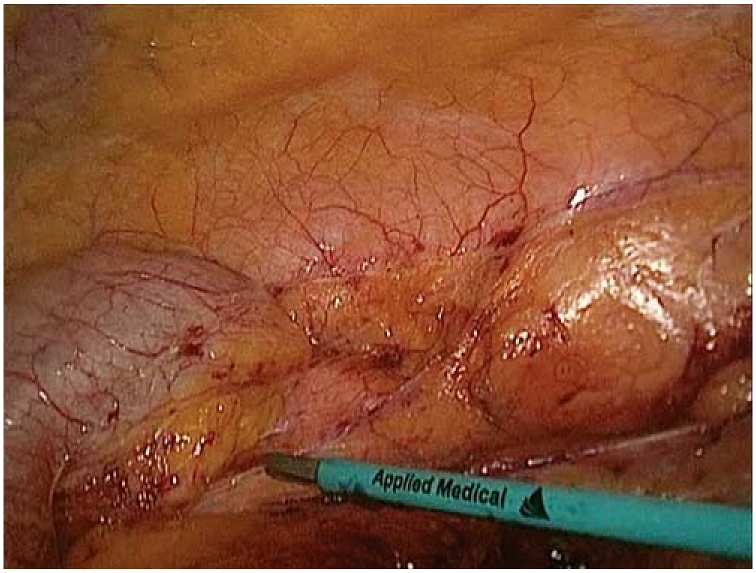


FIGURE 30-1 Left lateral peritoneal reflection.

The splenic flexure may be mobilized by several approaches. The easiest is in the patient with a normal BMI. Laterally, the proximal descending colon is dissected off Gerota's fascia and as the plane of dissection turns medially, the lesser sac is identified, and the omentum is dissected off the distal transverse colon in a retrograde fashion. In heavier patients, the lateral dissection is the same, but instead of proceeding in a retrograde fashion once the plane of dissection has turned around the splenic flexure, attention turns to the mid-transverse colon. The lesser sac is identified and entered above the mid-transverse colon, and the dissection is continued laterally toward the splenic flexure (Fig. 30-2).The lesser sac may be entered above the colon, dividing the gastrocolic attachments and thereby taking the omentum with the specimen, or between the omentum and distal transverse colon, thus preserving the omentum.

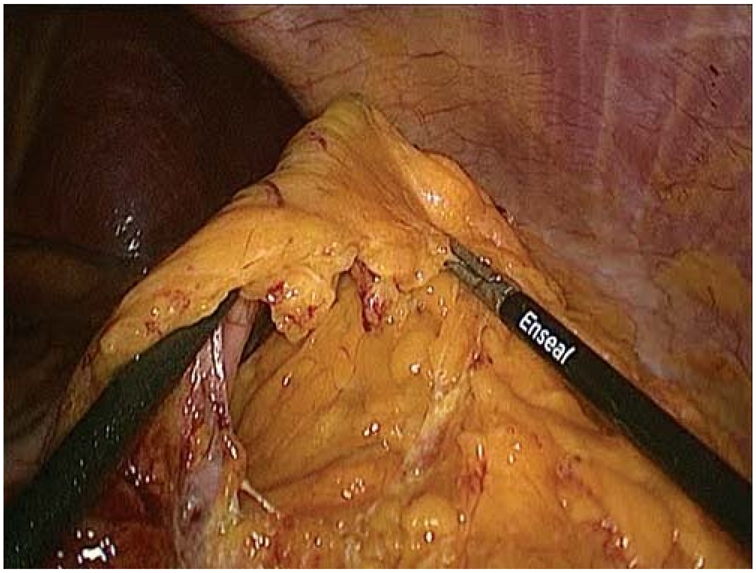


FIGURE 30-2 Dividing gastrocolic attachments superior to the distal transverse colon.

p. 286

p. 287

Right Colon Mobilization

The peritoneum around the base of the terminal ileal mesentery and the cecum is scored, and the correct retroperitoneal plane is entered. In a patient with normal BMI, the ureter may be identified before scoring the peritoneum; in a heavier patient, this step is usually only feasible after peritoneal incision. The right lateral peritoneal reflection alongside the ascending colon is opened, and the ascending colon is mobilized medially to the midline (Fig. 30-3). The medial peritoneal attachments of the terminal ileal mesentery are opened up to the level of the duodenum (Fig. 30-4). Before moving the patient into reverse Trendelenburg, the dissection is checked to ensure that the right colon has been mobilized to the midline.

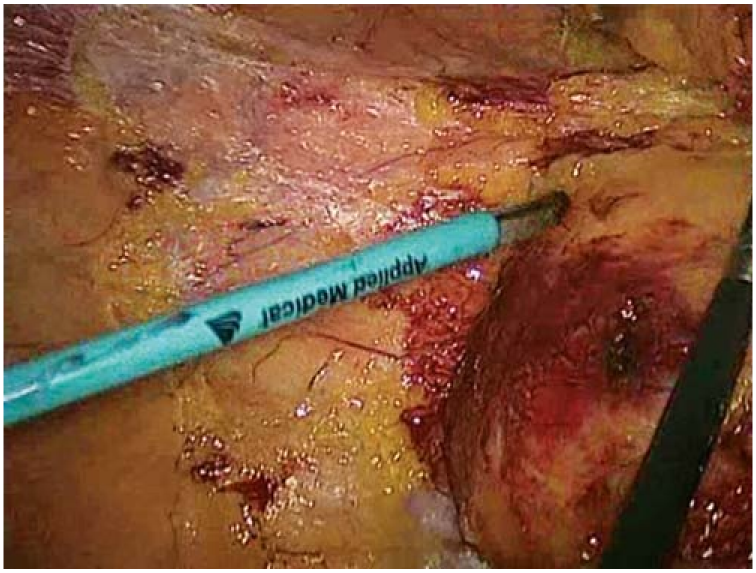


FIGURE 30-3 Entering the correct retroperitoneal plane behind the cecum.

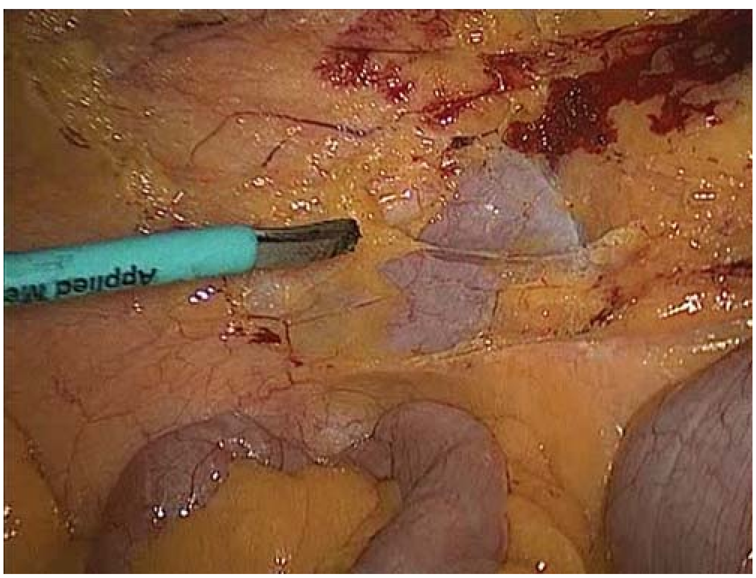


FIGURE 30-4 Exposing the duodenum in the right retroperitoneal plane.

With the patient in reverse Trendelenburg, and the right side still inclined up, the hepatocolic attachments are divided, again taking care to identify and protect the duodenum. The management of the omentum should reflect the treatment of the splenic flexure, whether removing the omentum or leaving it with the patient. This step avoids difficulty when dividing the transverse colon and having to decide upon a point to divide the omentum when the flexures have been approached differently.

approached differently.

Dissection of the Rectum

The dissection of the left lateral peritoneal reflection alongside the distal sigmoid colon at the left pelvic brim is continued distally (Fig. 30-5). The left ureter is again identified to keep it safe from the operative field. The line of dissection is continued over the level of the sacral promontory, scoring the left pararectal peritoneum. Careful inspection will reveal a visual transition between the “white tissue” laterally that stays behind with the patient and the medial “yellow tissue” that marks the boundary of the mesorectal fascial envelope. Scoring the left pararectal peritoneum allows entry into the presacral space at the level of the sacral promontory. This plane is developed with cautery scissors medially and distally as far as retraction and visualization permit—often to the level of the pelvic floor in a patient with normal BMI (Fig. 30-6). Care should be taken to remain in the correct plane and identify the left hypogastric nerve. Attempting to remain too close to the promontory may reveal an areolar tissue plane that is actually posterior to the nerve. Therefore, it is important to identify and remain in a plane that is immediately adjacent to the mesorectum and anterior to the nerve.

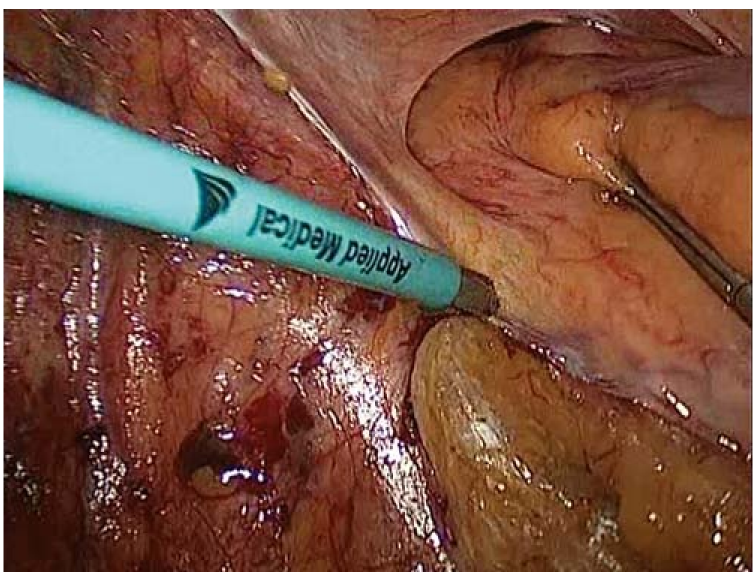


FIGURE 30-5 Commencing the pelvic dissection at the sacral promontory, along the left pararectal peritoneum.

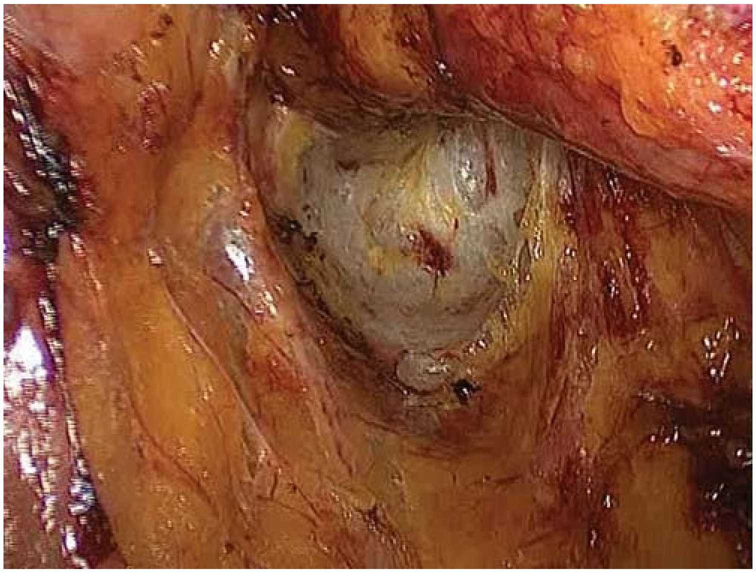


FIGURE 30-6 Posterior dissection in the presacral plane.

Following mobilization of the left side of the rectum, the right pararectal peritoneum is scored after identifying and protecting the right ureter. The presacral plane is entered, and the dissection is joined with that already performed from the left side (Fig. 30-7). Again, the right presacral nerve is protected by remaining immediately posterior to the mesorectal fascia and not immediately on the presacrum; the dissection continues to the pelvic floor.

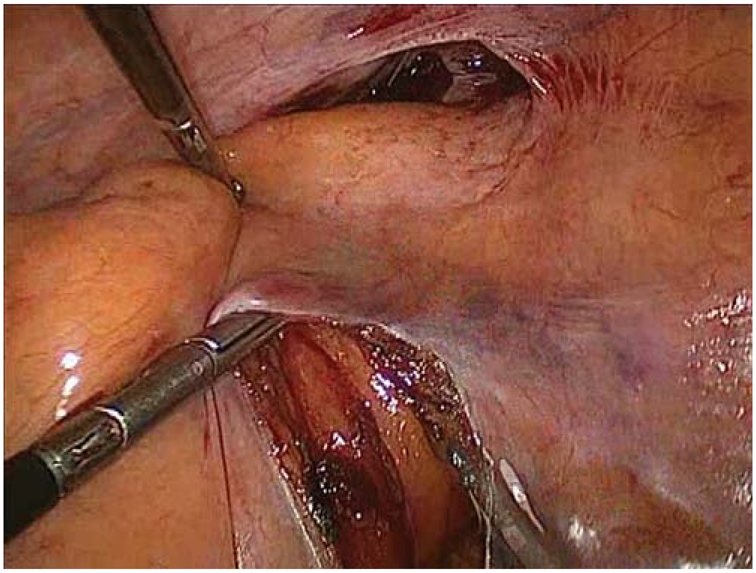


FIGURE 30-7 Entering the developed presacral plane by scoring the right pararectal peritoneum.

Once the rectum is posteriorly and bilaterally mobilized, the anterior dissection proceeds. This is the most challenging portion of the rectal mobilization and is facilitated by prior mobilization of the posterior and lateral aspects of the rectum. In male patients, care should be taken to identify and protect the seminal vesicles and prostate. In female patients, a sponge stick is placed in the vagina to retract it anteriorly to facilitate identification and dissection in the rectovaginal septum. In this manner, the rectum is completely circumferentially dissected down to the level of the pelvic floor. This maneuver will take several position changes, because each quadrant of dissection of the rectum will allow for improved retraction of another quadrant, and thus, dissection proceeds circumferentially.

Once the pelvic floor is reached (the fascia and muscle are easily discerned once at the correct level), a digital rectal examination (with an overglove on the examining hand) is performed to confirm that the correct level of dissection has been reached. In slim patients, this dissection level is often in the intersphincteric groove and care must be taken not to transect *too* close to the dentate line.

At this point, the decision is made regarding stapled anastomosis versus mucosectomy and hand-sewn anastomosis. In most cases, the decision is already made. Our preference is for stapled anastomosis at the top of the anal canal, with preservation of the anal transition zone, to provide better function and less sepsis following this approach. We reserve mucosectomy for UC with rectal cancer or dysplasia, or FAP with polyps in the rectal mucosa of the proximal anal canal, both of which are rare indications.

For a stapled transection of the rectum at the level of the pelvic floor, consideration must be given to appropriate choice of stapler. An articulated laparoscopic stapler is mandatory. The stapler is deployed via the right lower quadrant 12-mm port to produce a transverse staple line. Some surgeons prefer to use a suprapubic port (this preference should be considered ahead of time when the ports are placed). The length of the staple cartridge is usually dictated by the diameter of the pelvis, and thus by the gender of the patient. In female patients, a 45-mm or even a 60-mm cartridge may be used, whereas in male patients with a narrower pelvis, several applications of a 30-mm cartridge are often required (Fig. 30-8).

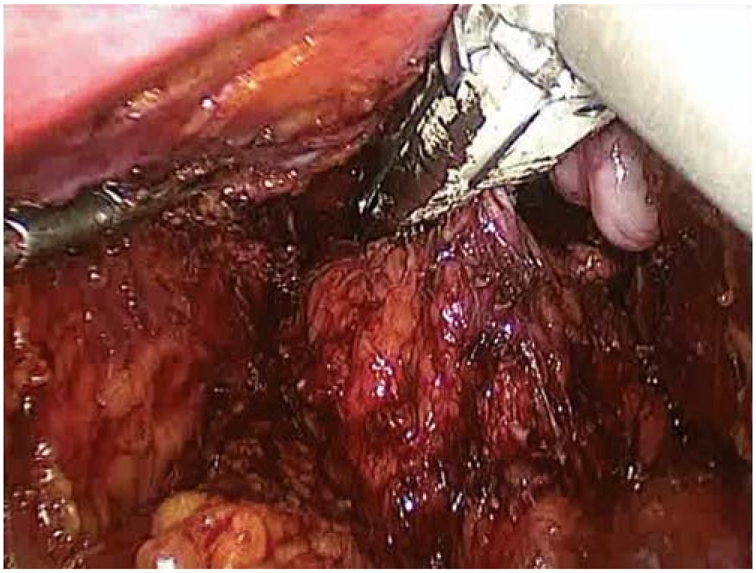


FIGURE 30-8 Stapled transection of the rectum at the pelvic floor using an angled laparoscopic stapler.

Transection of the Mesentery

Once the rectum is transected, the colon and rectum are then a midline structure centered beneath the umbilicus, and in a patient with a normal BMI, the entire colon and rectum can be exteriorized via a 3–5-cm periumbilical incision by extending the supraumbilical port-site incision around the left side of the umbilicus (so as not to interfere with a stoma appliance around the ileostomy), and the mesentery can be extracorporeally transected; this approach is the simplest.

For a "completely laparoscopic" approach, the mesentery is divided intracorporeally. In the relatively rare case when there is a cancer or dysplasia present, the vascular pedicles should be divided at their base. In the majority of patients, the mesentery may be divided where it is most convenient. We start at the top of the sacral promontory, with the mobilized sigmoid colon and use a vessel sealing device to sequentially transect the mesentery from distal to proximal. The transverse colon is often the most technically challenging segment and is usually related to a discrepancy in how the two flexures are approached, with preservation of the omentum at the splenic flexure but mobilization of the omentum with the hepatic flexure. In such cases, transection of the omentum is easiest toward the right side of the transverse colon.

As transection of the mesentery continues toward the right colon, it is prudent to retain the ileocolic pedicle. When this landmark is reached, the mesenteric transection is complete. A grasper is placed on the cut end of the rectum, and the abdominal cavity is inspected to ensure that loops of small bowel do not lie over the colon because they will impede its exteriorization.

Exteriorization and Pouch Creation

The pneumoperitoneum is evacuated, and the 12-mm port through the ileostomy site is removed. To create the ileostomy site, the anterior rectus fascia is incised in a cruciate fashion, the rectus muscle fibers are separated, and the posterior fascia elevated and similarly incised over the same distance. The end of the rectum is then passed up through this incision, and the entire specimen is exteriorized until the distal ileum is reached. The remaining small portion of mesentery is divided close to the colon to preserve the ileocolic pedicle, and the terminal ileum is transected with a linear stapler.

A point on the ileum approximately 15 cm from the cut end is tested to determine if it reaches to the pubis (Fig. 30-9). In a slim patient, the fact that the ileum is exteriorized through a non-midline incision does not affect this test. In a heavier patient with a thicker abdominal wall, this test is less accurate, and experience should determine whether pouch-lengthening techniques are required. Stay sutures are placed to align the antimesenteric border of both limbs of the pouch (Fig. 30-10). A 2-cm enterotomy is made at the antimesenteric edge of the ileum at the apex of the pouch (Fig. 30-11). A 15-cm J-pouch is then constructed by deploying two firings of a 100-mm linear stapler via the enterotomy (Fig. 30-12). The small tongue of redundant tissue created at this apical enterotomy following stapling is excised (Fig. 30-13), and the anvil of a circular stapler is secured within the cut apex of the pouch with a 2-0 monofilament pursestring suture (Fig. 30-14). The blind (efferent) limb of the pouch is tacked to the adjacent afferent limb with imbricating seromuscular 3-0 silk sutures, burying the staple line (Fig. 30-15). These sutures theoretically reduce the risk of leak from this staple line and prevent elongation of the blind end.

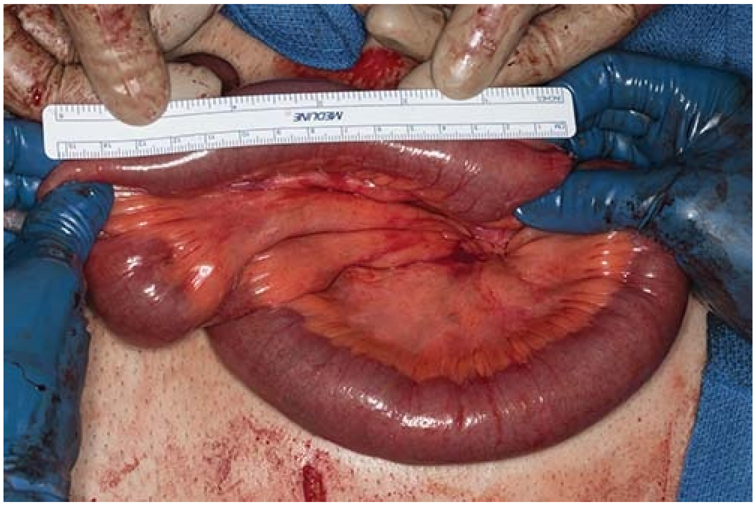


FIGURE 30-9 Measuring terminal ileum for a 15-cm ileal J-pouch.

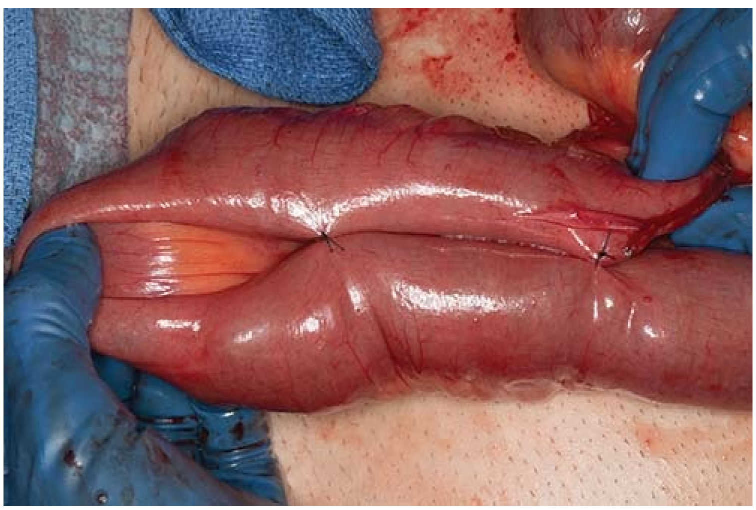


FIGURE 30-10 Aligning the limbs of the J-pouch before stapling.

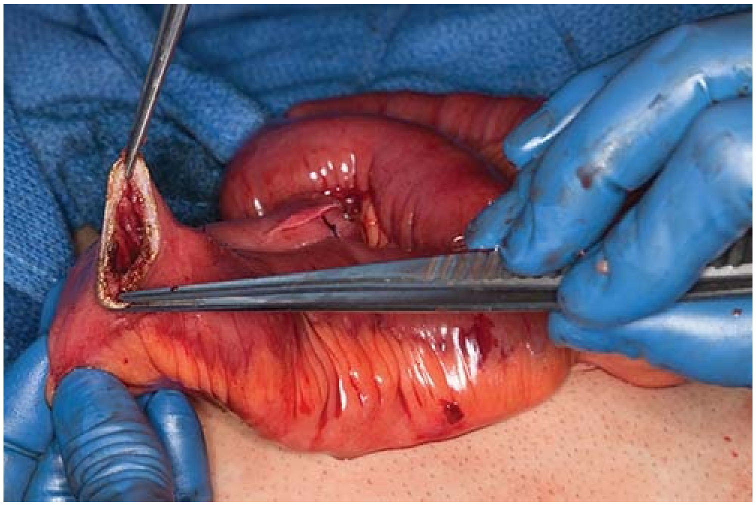


FIGURE 30-11 Enterotomy on the antimesenteric edge of the ileum at the apex of the pouch.

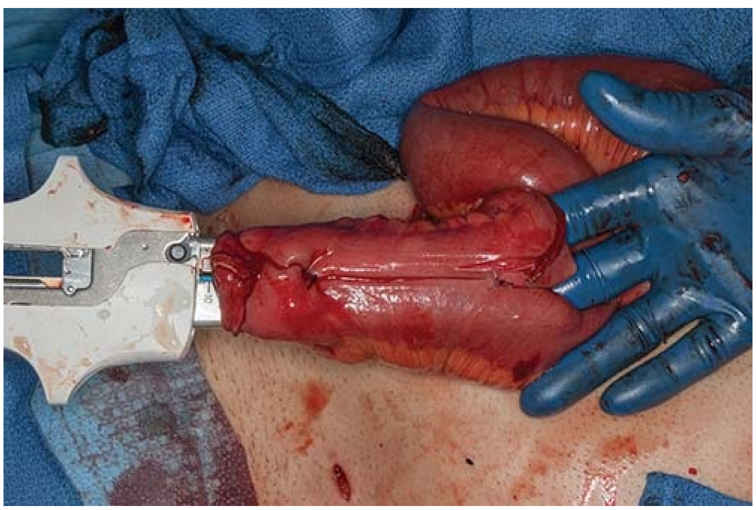


FIGURE 30-12 Creating the ileal J-pouch.

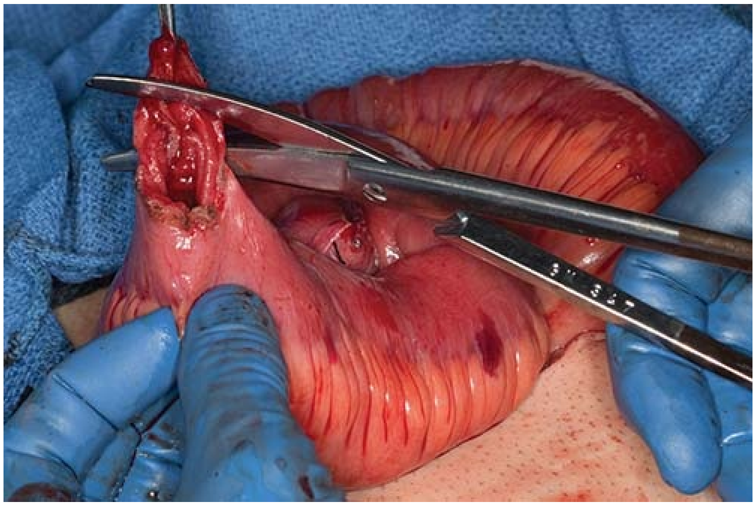


FIGURE 30-13 Excising the tongue of redundant tissue at the apical enterotomy.

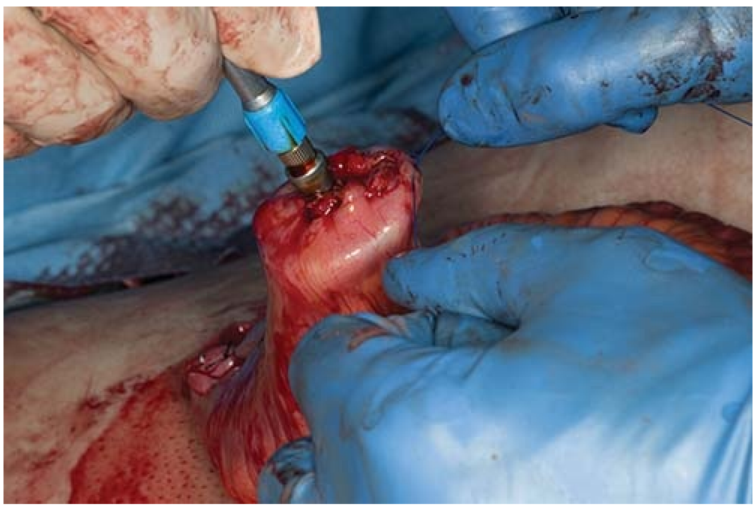


FIGURE 30-14 Securing the anvil of a circular stapler in the apex of the J-pouch with a pursestring suture.

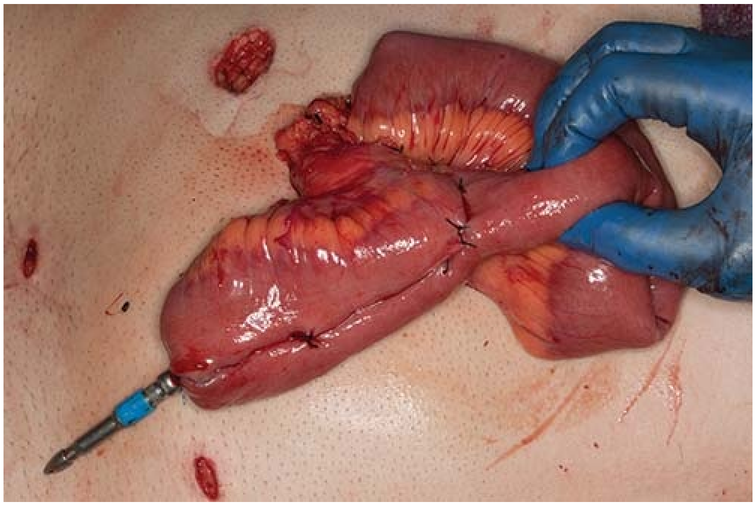


FIGURE 30-15 The blind (efferent or short limb) is tacked to the adjacent afferent (long) limb, burying the staple line.

The pouch is returned to the abdominal cavity, placing the anvil in the pelvis to facilitate finding it again. After irrigation, the fascia of the ileostomy site is closed with sutures, and the port is secured within the incision again between two of the sutures, allowing the pneumoperitoneum to be reestablished.

Creation of the Ileal J-Pouch-Anal Anastomosis

After locating the anvil and pouch, the cut edge of the pouch mesentery is completely traced along its length up to the duodenum to ensure that there is no twisting of the pouch. The anus is gently dilated, and the handle of the stapler is inserted. The spike is brought out *adjacent* to the staple line (rather than *through* the staple line, which can cause separation of the staples for a distance longer than that which is subsequently incorporated within the circular stapling circumference). The anvil is docked onto the handle, and (after again checking the cut edge of the pouch mesentery) the stapler is reapproximated, fired, and removed. Both tissue rings in the device are examined to ensure that they are intact, and the distal ring is sent to pathology as part of the specimen.

A 15-Fr round drain may be placed in the pelvis adjacent to the pouch via the suprapubic port, which is removed. A loop of ileum approximately 10–12 inches proximal to the pouch is chosen for the ileostomy and brought up to the ileostomy site to check for length. The fascial sutures are removed from the ileostomy site and the loop brought up and held securely with a non-crushing bowel clamp. The remaining ports are removed under direct vision. The fascia of the 12-mm supraumbilical port is secured with sutures. All skin incisions are closed with subcuticular monofilament 3-0 suture, and the ileostomy is matured in standard loop fashion with full-thickness 3-0 monofilament sutures. A 20–24-Fr red rubber catheter is transanally placed within the pouch to keep it

Fr red rubber catheter is transanally placed within the pouch to keep it decompressed.

Maneuvers for Pouch Elongation

In some cases, the apex of the pouch does not reach the pelvic floor, causing difficulty in creating a tensionless anastomosis. There are several maneuvers that can be used to enhance the “reach of the pouch.” We start with careful scoring of the peritoneum on each side of the mesentery. These relaxing incisions are usually made along the course of the superior mesenteric artery (SMA), providing an additional 1–2 cm of length (Fig. 30-16). If further length is required, the mesentery of the pouch is transilluminated and the vascular arcade made by SMA and ileocolic pedicle is evaluated (Fig. 30-17). Often it is possible to sacrifice a few intervening or distal vessels for the reach. Infrequently, the length is still limited by the distal SMA. Because we preserve the ileocolic pedicle, it is often possible to transect the distal SMA, after ensuring adequacy of collateral flow, without compromising the blood supply to the pouch (Fig. 30-18). When none of these maneuvers are successful, the pouch can either be used for the ileostomy or be placed in the pelvic cavity with a proximal diverting ileostomy in anticipation of the effect of gravity on in vivo pouch elongation over time. A reattempt in making an anastomosis is then done after an interval of about 6–12 months.

p. 291

p. 292

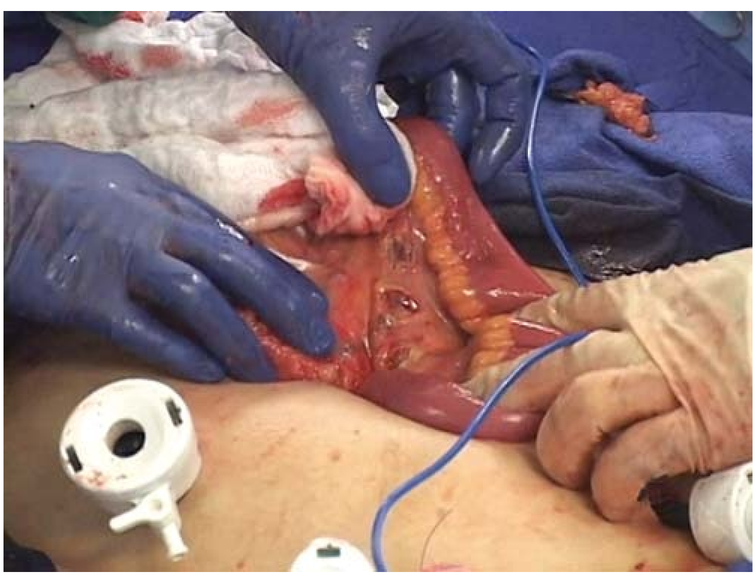


FIGURE 30-16 Relaxing incisions in the peritoneum overlying the vascular supply to the

pouch.

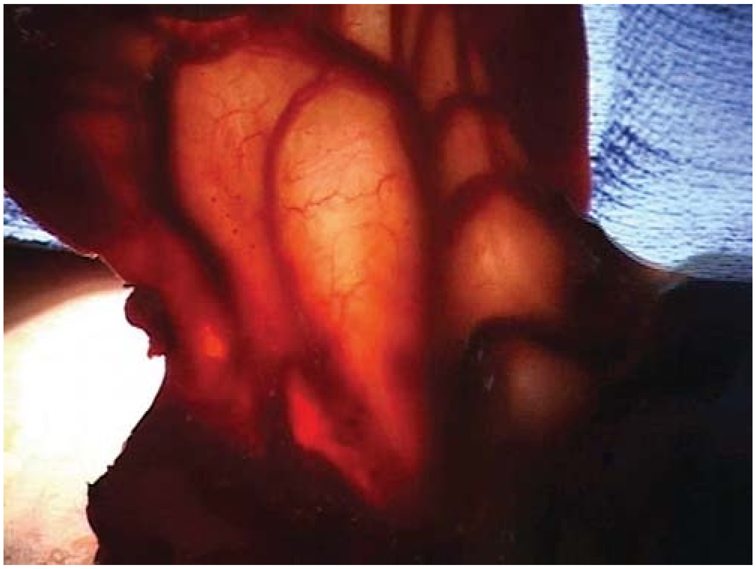


FIGURE 30-17 Back illumination of the pouch to identify the vascular arcades.

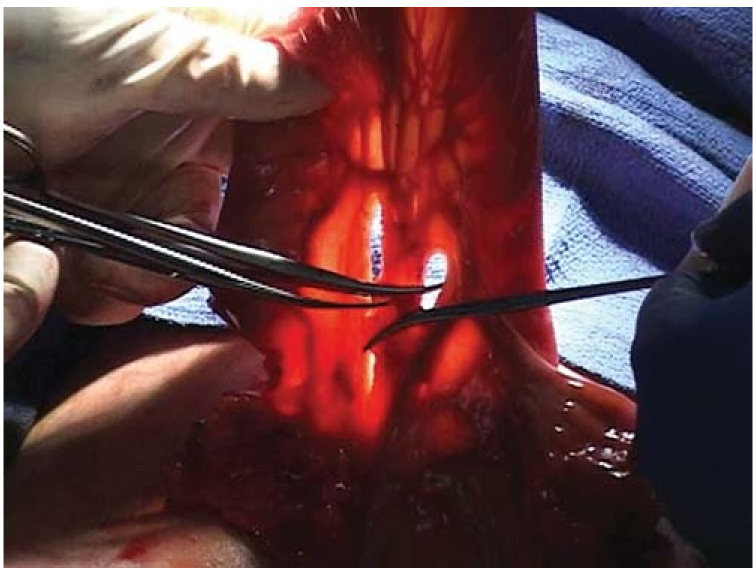


FIGURE 30-18 Division of vessel under greatest tension to achieve elongation of the pouch mesentery and enhance the reach of the pouch.

POSTOPERATIVE MANAGEMENT

The orogastric tube is removed at the end of the procedure. Patient controlled analgesia (PCA) is rarely needed since the introduction of transversus abdominis plane (TAP) and quadratus lumborum (QL) blocks. Scheduled ketorolac and acetaminophen are used. Postoperative antibiotics are not required if ertapenem is used preoperatively because it has 24-hour coverage, but two more doses of ciprofloxacin and metronidazole are given if the patient is penicillin-allergic. Low residue diet is introduced on the day of surgery. PCA is discontinued once patient tolerates solid food while Foley is removed on second postoperative day. Ileostomy care teaching is instituted on postoperative day 1, and home health services are arranged for post-discharge stoma teaching. Patients are discharged when they are tolerating adequate oral intake, and producing <1,000 ml from the ileostomy. All patients are discharged on loperamide 2–4 mg, 30 minutes before meals and at bedtime.

COMPLICATIONS

The potential complications of this completely laparoscopic approach are similar to the standard laparoscopic and open approaches, although some complications may be reduced compared with the open procedure. The commonest immediate complications are postoperative ileus, high output from the ileostomy, partial small bowel obstruction, wound infection, and pouch leak. The wound infection rate may be less with the laparoscopic approach. In the long term, the outcomes are similar to open proctocolectomy with the exception that after a laparoscopic approach patients form fewer adhesions, and this may ultimately translate into fewer episodes of small bowel obstruction and also better maintenance of fecundity in women of child-bearing age.

RESULTS

After the second stage of the operation, with closure of the ileostomy, the vast majority of patients have a pattern of bowel frequency that is acceptable to them, certainly when compared with the frequency and urgency of active colitis. In the surgical literature, the range is four to six bowel movements during the day and zero to two at night. The authors' experience is that teenagers and patients in their 20s will often attain a frequency of three to four bowel movements per day depending on their dietary habits.

CONCLUSIONS

A completely laparoscopic approach is feasible for proctocolectomy and IPAA, meaning that the entire colon and rectum can be mobilized, intracorporeally transected, and then brought out through the ileostomy site, without the need for an additional extraction incision, an incision for a hand-assisted device, or an incision to perform the dissection in the pelvis. This approach is an option for patients of normal BMI and slightly overweight. In heavier patients, the ileostomy extraction site can become larger than required for the ileostomy itself, and it is difficult to judge the “reach” of the pouch in such patients. A lateral-to-medial approach duplicates the tissue planes used for the open approach, allows a choice regarding the level of mesenteric vessel transection, and avoids ischemic bowel sitting in the abdominal cavity while the pelvic dissection is performed. The cosmetic results are favorable, mimicking an appendectomy incision plus three port-site incisions after final closure of the ileostomy.

RECOMMENDED REFERENCES AND READINGS

Ahmed Ali U, Keus F, Heikens JT, *et al.* Open versus laparoscopic (assisted) ileo pouch anal anastomosis for ulcerative colitis and familial adenomatous polyposis. *Cochrane Database Syst Rev* 2009;(1):CD006267.

Bemelman WA. Laparoscopic ileoanal pouch surgery. *Br J Surg* 2010;97:2–3.

Berdah SV, Mardion RB, Grimaud JC, *et al.* Mid-term functional outcome of laparoscopic restorative proctocolectomy: a prospective study of 40 consecutive cases. *J Laparoendosc Adv Surg Tech A* 2009;19:485–8.

Chung TP, Fleshman JW, Birnbaum EH, *et al.* Laparoscopic vs. open total abdominal colectomy for severe colitis: impact on recovery and subsequent completion restorative proctectomy. *Dis Colon Rectum* 2009;52:4–10.

El-Gazzaz GS, Kiran RP, Remzi FH, Hull TL, Geisler DP. Outcomes for case-matched laparoscopically assisted versus open restorative proctocolectomy. *Br J Surg* 2009;96:522–6.

Fichera A, Silvestri MT, Hurst RD, Rubin MA, Michelassi F. Laparoscopic restorative proctocolectomy with ileal pouch anal anastomosis: a comparative observational study on long-term functional results. *J Gastrointest Surg* 2009;13:526–32.

Hasegawa S, Nomura A, Kawamura J, *et al.* Laparoscopic restorative total proctocolectomy with mucosal resection. *Dis Colon Rectum* 2007;50:1152–6.

Indar AA, Efron JE, Young-Fadok TM. Laparoscopic ileal pouch-anal anastomosis reduces abdominal and pelvic adhesions. *Surg Endosc* 2009;23:174–7.

Lawes DA, Young-Fadok TM. Minimally invasive proctocolectomy and ileal pouch-anal anastomosis. In: Frantzides CT, Carlson MA, eds. *Atlas of Minimally Invasive Surgery*. Philadelphia, PA: Saunders Elsevier, 2009:139–46.

McAllister I, Sagar PM, Brayshaw I, Gonsalves S, Williams GL. Laparoscopic restorative proctocolectomy with and without previous subtotal colectomy. *Colorectal Dis* 2009;11:296–301.

Parc Y, Reboul-Marty J, Lefevre J, Shields C, Chafai N, Tiret E. Restorative proctocolectomy and ileal pouch-anal anastomosis annals of surgery. *Ann Surg* 2015;262:849–54.

Polle SW, Dunker MS, Slors JF, *et al.* Body image, cosmesis, quality of life, and functional outcome of hand-assisted laparoscopic versus open restorative proctocolectomy: long-term results of a randomized trial. *Surg Endosc* 2007;21:1301–7.

Rencuzogullari A, Gorgun E, Costedio M, *et al.* Case-matched comparison of robotic versus laparoscopic proctectomy for inflammatory bowel disease. *Surg Laparosc Endosc Percutan Tech* 2016;26:e37–e40.

Rotholtz NA, Aued ML, Lencinas SM, *et al.* Laparoscopic-assisted proctocolectomy using complete intracorporeal dissection. *Surg Endosc* 2008;22:1303–8.

Vivas D, Khaikin M, Wexner SD. Laparoscopic proctocolectomy and Brooke ileostomy. In: Asbun HJ, Young-Fadok TM, eds. *American College of Surgeons Multimedia Atlas of Surgery: Colorectal Surgery Volume*. Chicago, IL: American College of Surgeons, 2008:111–6.

Young-Fadok TM, Nunoo-Mensah JW. Laparoscopic proctocolectomy and ileal pouch-anal anastomosis (IPAA). In: Asbun JH, Young-Fadok TM, eds. *American College of Surgeons Multimedia Atlas of*

Surgery: Colorectal Surgery Volume. Chicago, IL: American College of Surgeons, 2008:117–29.

Chapter 31

Proctocolectomy (Hand Assist)

Kyle G. Cologne and Sang W. Lee

INDICATIONS/CONTRAINDICATIONS

This procedure is primarily indicated for the treatment of ulcerative colitis (UC) and polyposis syndromes involving the rectum—such as familial adenomatous polyposis, although it may also be indicated in select cases of Crohn's disease. The techniques described in this chapter can be used for any component of the procedure as well.

Laparoscopic or minimally invasive surgery has seen increasing adoption, although the most recent database studies show about 50% adoption nationwide. Utilization rates are lower for rectal surgery, particularly with some new questions being raised about the pathologic specimen quality in short-term follow-up of randomized trials (American College of Surgeons Oncology Group Z6051 and Australasian Laparoscopic Cancer of the Rectum). Because laparoscopic surgery can be a challenging procedure, particularly for total proctocolectomy, hand assistance can not only make it more feasible but also dramatically decrease operating time. This technique still maintains the benefits of laparoscopic surgery of shorter length of hospital stay, decreased pain, and earlier return to normal activity. Furthermore, this method allows a number of options (laparoscopic, open, or hand assist) to be used with the technique we describe.

PREOPERATIVE PLANNING

Any procedure starts with a complete history and physical examination. Particular attention should be paid to the following elements, which may affect certain aspects of care:

Status and detailed description of the sphincter mechanism/function, bowel habits, and the relationship of any polyps or tumors to the dentate line. Qualitative description of resting and squeeze pressures and any history of perianal abscesses or fistula (in patients with UC).

Prior abdominal procedures and the location of any prior abdominal scars.

Other comorbid conditions, particularly cardiac or respiratory conditions, as well as the presence of factors that increase the risk of surgery including anemia, malnutrition (including a severity indicator), weight loss, smoking status, and a frailty assessment. These conditions may alter any plan for a primary anastomosis and should favor consideration of some type of stoma.

Genetic counseling, if indicated.

If there is a tumor present, particularly in the rectum, it should be adequately staged, including magnetic resonance imaging or ultrasound, to determine the need for neoadjuvant chemoradiotherapy. Rectal cancer is particularly difficult to stage in the setting of UC given the submucosal spread of the cancer. The authors favor preoperative over treatment if there is any question, given the significant functional problems of postoperative adjuvant radiation if administered after ileoanal pouch-anal restoration of intestinal continuity. A computed tomography scan is also indicated for distant staging. Any type of minimally invasive approach may not be advisable in the setting of bowel obstruction, adjacent organ involvement, or multiple prior abdominal procedures.

Endoscopic evaluation of the entire colon is essential to determine the disease location and severity. This step is particularly important in polyposis syndromes if a rectal mucosectomy is being considered. It is the authors' practice to routinely perform at least a flexible sigmoidoscopy in the office to reevaluate this incredibly important aspect if the initial procedure performed elsewhere results in an unwanted surprise.

Preoperative marking by an experienced enterostomal therapist is extremely important because it can prevent many difficulties in the perioperative period. It should be done even if a temporary stoma is planned or is being considered, because it is much better to determine proper placement before the patient is anesthetized.

There has been a pendulum swing in recent years back in favor of bowel preparation. The authors routinely use mechanical preparation, but there remains disagreement on the use of nonabsorbable oral antibiotic preparations. The mechanical prep makes the colon easier to manipulate and extract using a minimally invasive approach. It also facilitates intraoperative endoscopy if needed. If less than a total proctocolectomy is performed, it also allows a defunctioning stoma without a column of stool above this. Touted advantages of the oral antibiotic prep include a decrease in surgical site infections, although this remains controversial.

Appropriate evaluation in an anesthesia clinic can be invaluable, particularly for high-risk patients with multiple comorbidities. It has been well established that multidisciplinary care of these patients with early involvement of additional specialists results in better outcomes and shorter lengths of hospital stay.

Preoperative involvement of other specialists, such as from gynecology and urology, is advisable if it seems there is involvement of adjacent organs.

Carbohydrate-loading beverages are used to prevent postoperative hyperglycemia. These also help prevent fluid and electrolyte disturbances and maintain homeostasis given the additional volume of liquid consumed up to 2 hours before general anesthesia.

Great importance is placed on patient empowerment and education of the enhanced recovery protocol, so that the patients can be their own advocates during and after their hospital stay.

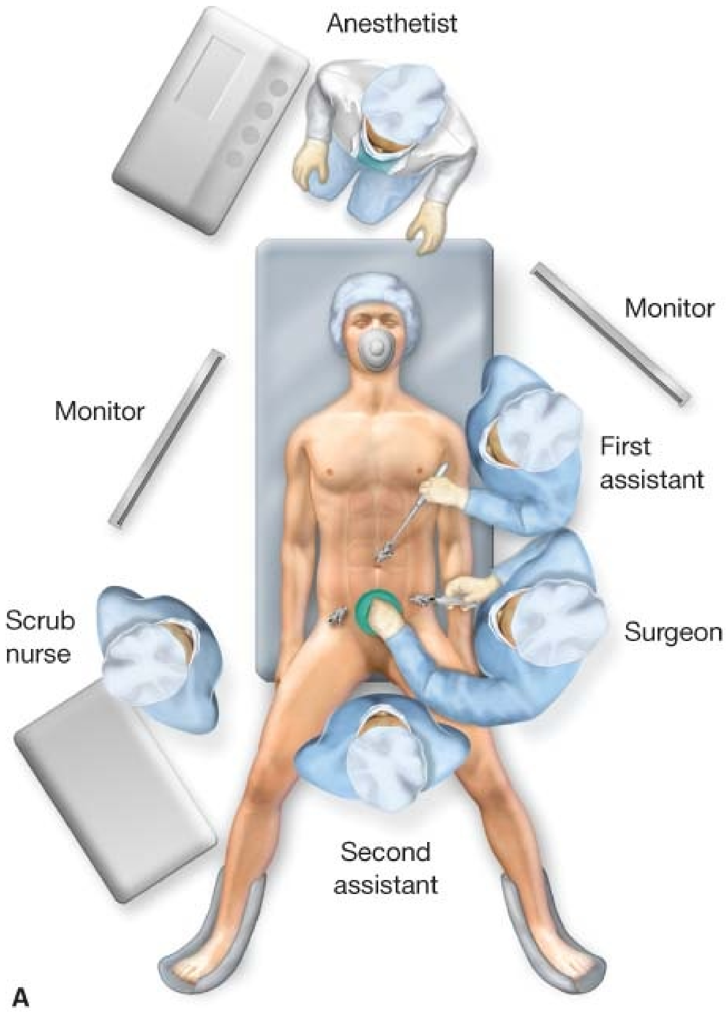
Patients are instructed to use chlorhexidine soap or wipes (provided at a preoperative visit) at least twice while at home to decrease skin flora levels before surgery.

SURGERY

Before Incision

When the patient arrives at the hospital on the day of surgery, there are several important steps that occur. If the anesthesia team is agreeable, clear liquids are allowed up until 2 hours before anesthesia induction unless a contraindication such as gastroparesis exists. In addition, all patients receive subcutaneous heparin and consideration is given to addition of a single dose of alvimopan (that can be postoperatively continued in the event of conversion to an open procedure). The evidence for routine use in laparoscopic procedures is controversial, so the authors do not routinely give it if the procedure is completed with the hand-assist technique. Chlorhexidine wipes are also used (as a third application in addition to what the patient has already done at home) to wipe patients down in the preoperative holding area to decrease skin bacteria. This step is also separate from the official prep that patients get in the operating room.

Before induction of general anesthesia, sequential compression boots are placed. Normothermia is maintained and a warming device is used at all times. Patients are positioned in the modified lithotomy position. Arms are tucked at the side; and in high-risk patients, a noninvasive monitor (esophageal Doppler) is used for goal-directed therapy or plethysmography variance impedance monitor. A beanbag is used to allow steep Trendelenburg positioning—ensuring to pad all pressure points. In nonobese patients, a gel pad can be used because it does not require any additional taping. With positioning, it is essential to check that both knees are in line with the opposite shoulder and that the stirrups are lowered as much as possible to avoid collision with instruments during the procedure. Access to the anal verge is also required in case a hand-sewn anal anastomosis is required as well as to facilitate intraoperative endoscopic assessment if needed (Fig. 31-1).


Anesthetist
Monitor
Monitor
First
assistant
Scrub
nurse
Surgeon
Second
assistant

A

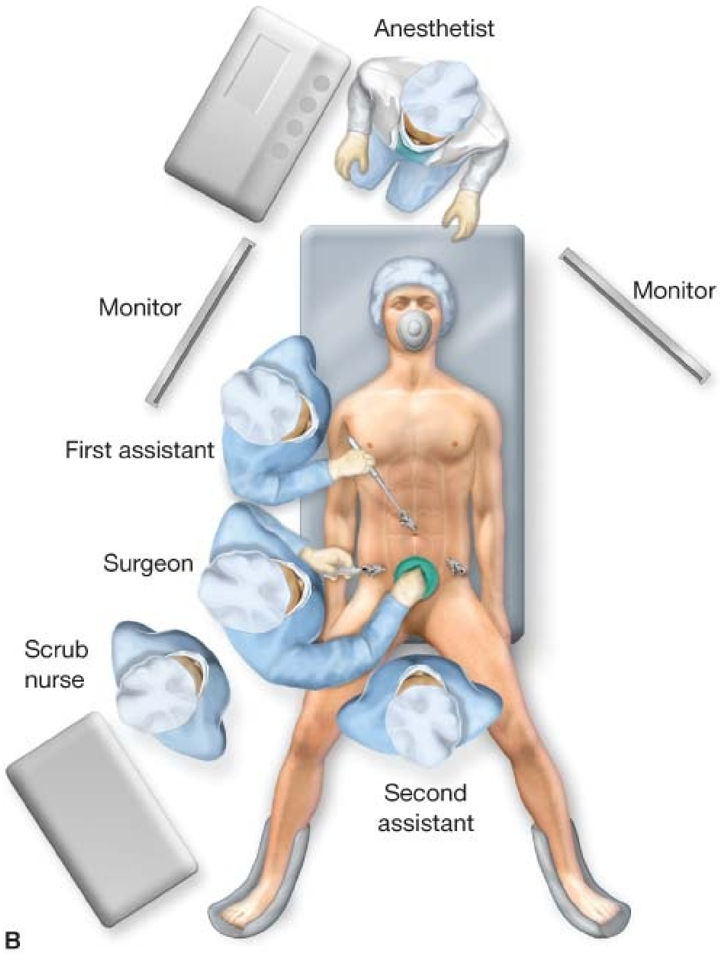


FIGURE 31-1 Operating room personnel setup. A. Right colon. B. Left colon and rectum.

A bladder catheter is placed, although this step does not need to be done on the field after sterile preparation unless ureteral stents are needed. The authors have selectively used stents. Chlorhexidine solution is used to prep the abdomen from the nipples to the mid thigh. If a hand-sewn anastomosis is possible, the perineum is also fully prepped, although this prep is not routinely required.

Incision, Port, and Equipment Placement

Port placement is incredibly important for ergonomic flow of the procedure. A Pfannenstiel incision allows use of the surgeon's hand to facilitate rapid total colectomy, and this port then can be used for proctectomy under direct visualization or with laparoscopic assistance. This incision has a low hernia formation rate and should be made large enough to comfortably admit the operating surgeon's hand. A good rule is to make the incision the same length as the surgeon's glove size (e.g., size 7 glove requires a 7-cm incision). This incision should be made about two fingerbreadths above the pubic symphysis:

incision should be made about two fingerbreadths above the pubic symphysis, and after raising subfascial flaps, the peritoneum and muscle should be divided in the midline all the way to the pubis and as far up as the umbilicus to ensure adequate exposure without compromising the comfort of the surgeon's hand during a long procedure. The main disadvantage of this incision location is that if conversion to open is required, it results in an inverted T incision. If conversion is likely, an alternative is to place the hand-assist device through a lower midline or upper abdominal incision.

p. 296

---

p. 297

After placement of the hand port, the abdomen can then be insufflated and an additional camera port (10 mm) is placed near the umbilicus. With the abdomen insufflated, a four-quadrant inspection is then performed routinely to rule out any unexpected findings or metastatic disease. Additional 5-mm working ports are then placed laterally. To reach all quadrants of the abdomen, often a total of four working ports are required: lower ports about two fingerbreadths medial to the anterior superior iliac spines and upper ports about one palm breadth above these. Try to avoid placement of a port near the ileostomy or stoma site, because this can contribute to pouching difficulties. Although the port can be placed directly through the planned stoma site, this often creates a mechanical disadvantage because the placement is too medial for optimum use. The authors therefore do not routinely practice this method (Fig. 31-2).

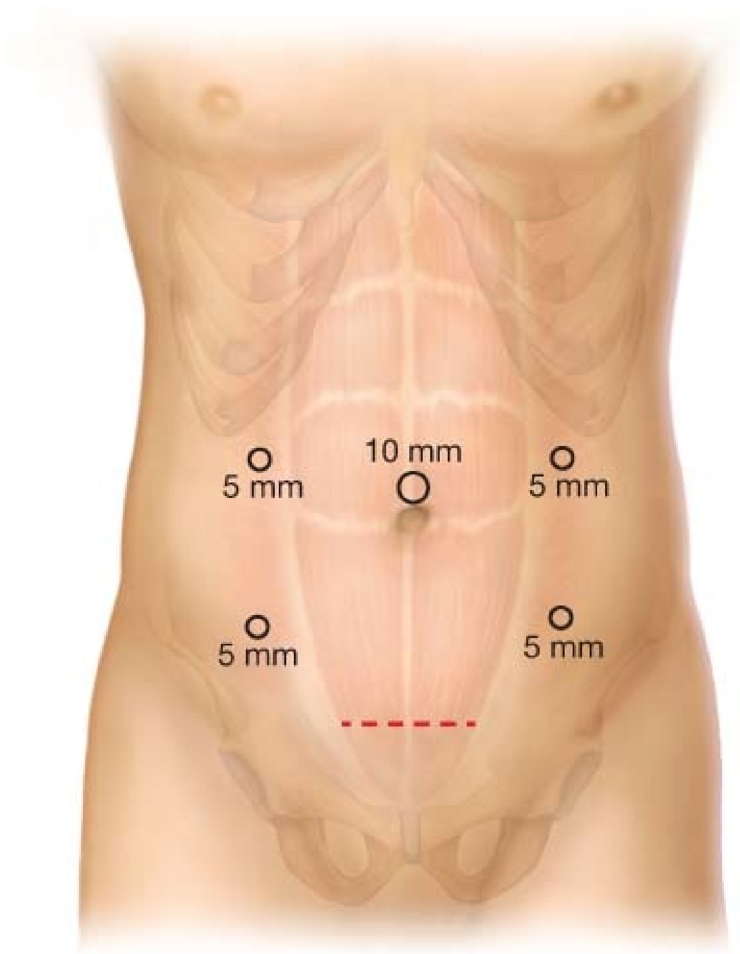


FIGURE 31-2 Standard port placement.

Monitors need to be positioned on both sides of the patient, with the ability to move them more toward the head or the feet as the dissection proceeds throughout the case. Enough space should be created so that the surgeon can move freely along the arms as well, which means the operating table should be enough distance away from the anesthesia machine and any energy generator, insufflation, and camera equipment to allow this to happen.

Typically, the operating surgeon will begin by standing on the right side of the patient and use his or her right hand through the hand assist and an instrument through one of the ports in the left hand. A camera operator can then stand either beside the surgeon or between the legs. A teaching surgeon may instead stand between the legs and then can use the right hand in the abdomen to expose for a trainee or resident surgeon who can use two ports as does the operating surgeon while the teaching surgeon also operates the camera.

Hand Assisting

The hand can be a very useful tool, if appropriately used. Part of the learning curve for hand-assist surgery is learning how to keep it out of the field of view of the camera. Use of the C-shape configuration of the hand with maximal thumb keeps the hand up and away from the camera vision, which stays below this. The hand should hover from above for most of the dissection, with the exception of the lateral division of the colonic attachments, at which point the dissecting instruments may either need to be placed through the fingers or above the hand, as it pulls the colon away from these attachments.

Splenic Flexure

The authors and the editors find it most time efficient to begin with takedown of the splenic flexure. After the abdomen is insufflated, the omentum and transverse colon are set up for this, and it eliminates the need for additional positioning. The reverse Trendelenburg position can be used. The gastrocolic omentum is divided to enter the lesser sac (or if preservation of the omentum is desired, the omentum can be placed over the liver and the avascular plane is divided to enter the lesser sac from below—Fig. 31-3). After entry into the lesser sac (as confirmed by visualization of the posterior aspect of the stomach), the distal transverse colon is progressively retracted caudally with the inserted hand. An energy device is used to take down any attachments heading toward the splenic flexure. This is continued all the way around until the white line of Toldt is visualized on the lateral aspect of the descending colon. In particularly challenging cases where the planes are not clear, an alternate approach is to identify the inferior border of the pancreas using a medial-to-lateral approach near the origin of the inferior mesenteric vein (IMV). This maneuver allows entry into the lesser sac from below, which can then facilitate taking down the lateral attachments later.

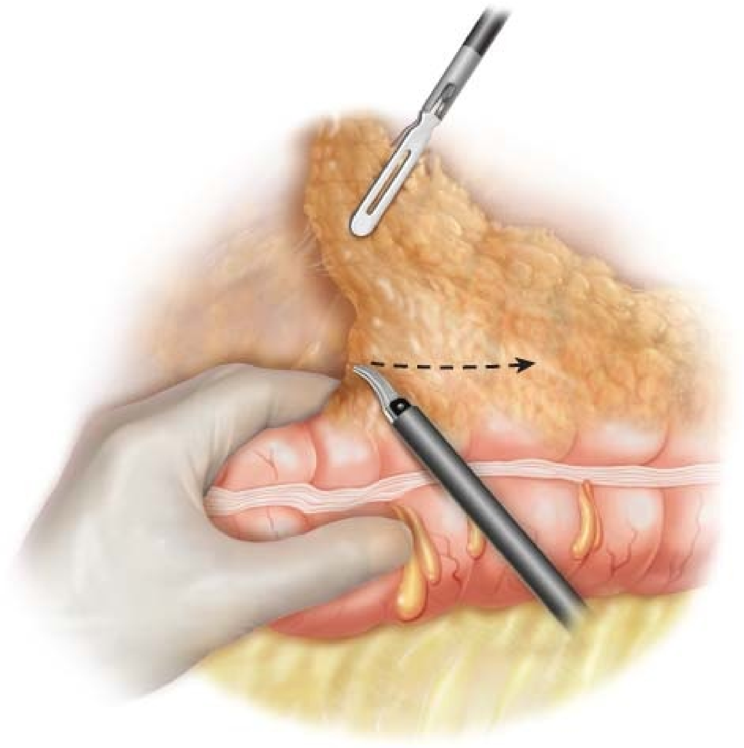


FIGURE 31-3 Dissection of the omentum off the transverse colon.

The Left Colon

The position of the patient is then changed to dissect the left colon. Trendelenburg position and right side down help retract the small bowel to the right of the abdomen. This positioning allows a clear view of the inferior mesenteric artery (IMA) pedicle, left colon mesentery, and ligament of Treitz (including the IMV). The inserted hand is used to create upward and lateral traction on the sigmoid colon to expose the IMA pedicle. The avascular plane is entered by identifying the “spine of the book,” where the peritoneal reflection slides over the underlying retroperitoneum at the level of the sacral promontory. Entry into the correct plane is confirmed when small bubbles are seen as the pneumoperitoneum dissects the avascular plane. One can then “follow the bubbles” of this avascular plane, separating the retroperitoneum (which should remain covered with an intact Toldt’s fascia—an extension of the endopelvic fascia). Several phrases have been used to describe this process—including “purple goes down.” One must be cognizant of the abrupt turn that happens underneath the IMA pedicle and superior rectal artery—and make a distinct effort to dissect upward—or the dissection will continue into the retroperitoneum and risk injury to the ureter and other structures (Fig. 31-4). In obese patients, use of an inserted laparotomy sponge or radiofrequency-tagged towel can facilitate exposure and retraction of the small bowel as well as cleaning of the laparoscope without removing it from the port. These are two of the biggest potential advantages of this approach that significantly reduce operating time.

p. 298

p. 299

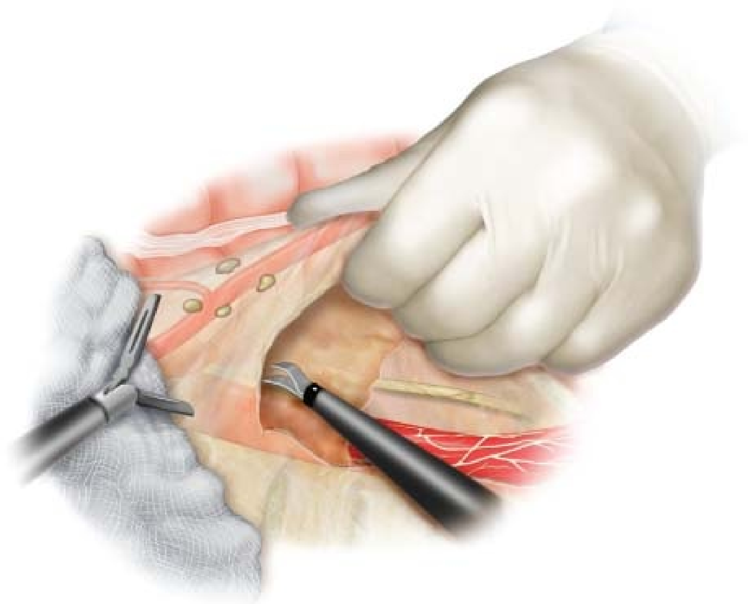


FIGURE 31-4 Relationship of the left colon, vascular pedicle, and ureter.

After entry into the correct plane, the IMA pedicle is dissected toward its origin. High ligation is required in instances of malignancy, but is not routinely required for benign diseases such as UC. Nonetheless, leaving a large bulk of tissue on the IMA pedicle *in situ* can create difficulty with a restorative procedure, because it inhibits reach into the pelvis of the neorectum or a pouch. The IMA is therefore usually ligated near its origin, after identification of the ureter and preservation of the hypogastric nerve bundles (Fig. 31-5).

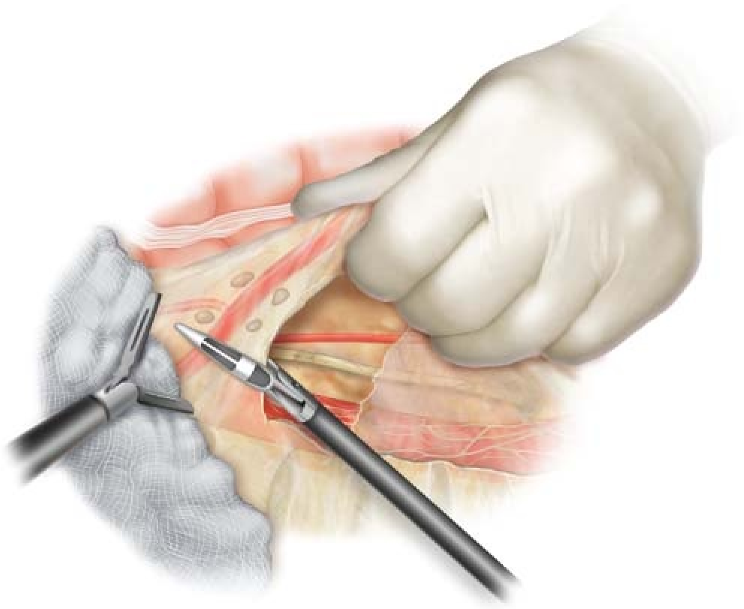


FIGURE 31-5 Division of the inferior mesentery artery pedicle.

p. 299

p. 300

The Ureter

The identification of the ureter is a critical step in the operation, because no vascular bundle should be divided before identification of this structure. The ureter typically crosses the pelvic brim at the location of the bifurcation of the internal iliac artery. It is located medial to the gonadal vessels and the psoas tendon and lateral to the branches of the internal iliac artery. If it cannot be identified, it may be retracted cephalad with the IMA pedicle (a clue to this is that the endopelvic or Toldt’s fascia is not intact), or more medial or lateral to the surgeon’s field of view. If it cannot be identified, a different approach should be used. The ureter can alternatively be identified using a lateral-to-medial approach (sometimes this can be difficult with the hand that may get in the way), or near the IMV more cephalad within the left colon mesentery. The avascular plane of the colon mesentery here is scored and the IMV is lifted up. The ureter usually can be found in the retroperitoneum just below this structure. After identification, it is swept downward, and the dissection carried caudally to reconnect with the original dissection plane near the sacral promontory. If all of these maneuvers fail to identify the ureter, the hand port can be removed and it can be identified using an open approach through the Pfannenstiel incision.

After the ureter is identified, the IMA pedicle is divided—usually at the level of the bifurcation with the left colic artery. A “high ligation” can be done just proximal to this branch point, or the two vessels can be divided individually. The vascular division can be done with an appropriate energy device, with clips, or with a stapler. The authors prefer an energy device with overlapping burns, with use of an adjunct means such as an endoloop if there is failure to control the pedicle because of calcified vessels or a mechanical device failure.

With the IMA vascular pedicle divided, the hand is used to anteriorly lift the colon and a medial-to-lateral approach is used to dissect the colon off the underlying retroperitoneum and Gerota's fascia. This maneuver continues as far up as possible—because dissection in the medial-to-lateral plane facilitates later rapid dissection of the remaining lateral attachments along the white line of Toldt. The IMV is also dissected all the way up to the ligament of Treitz and divided there as well—thereby disconnecting the colon mesentery from any attachments to the retroperitoneum. High ligation of the IMV at the inferior portion of the pancreas is critical to obtain additional length on the neorectum (if a low anterior resection and coloanal anastomosis is performed). The lateral attachments of the left colon are then taken down with the energy device. This component should only take a minute or two as most of the dissection has already been done from below. The dissection proceeds until it connects to the splenic flexure mobilization—leaving only the attachments of the transverse mesocolon in place at this location. Because the transverse colon tends to be the most difficult and confusing part of this operation, the authors leave this step for the last.

The Right Colon

Next the patient is repositioned and the small bowel is retracted to the patient's left side to facilitate exposure of the right colon. A traditional right colectomy is performed using a medial-to-lateral approach. Often at this point, the surgeon will change sides and hands—standing to the left side of the patient while inserting the left hand in the abdomen and using the right hand as a dissection tool. Alternatively, a teaching surgeon can remain between the legs and use the left hand as a retractor and drive the camera for the operating surgeon who stands on the left.

The ileocolic pedicle is identified by placing lateral and upward traction on the cecum. The same "spine of the book" is scored along the peritoneum. There is often a more yellow color to the colonic mesentery and a whitish color to the retroperitoneal fat. This recognition can help identify the correct plane and again one "follows the bubbles" of the avascular plane underneath the ileocolic pedicle. The duodenum is identified and swept down. Just as the ureter is the critical structure to identify on the left before division of any vascular pedicle, so too the duodenum must be adequately protected and visualized before division of any vascular pedicle on the right side. When adequate length has been obtained, this structure can be divided with an energy device, clips, or a stapler. A medial-to-lateral dissection is done all the way out to the lateral abdominal wall and above to the second portion of the duodenum. Again, the more dissection that is done from the medial aspect, the easier the subsequent release from the lateral plane will be.

The previous entry into the lesser sac is identified, and the remainder of the transverse colon is dissected free to complete entry into the lesser sac. The duodenum is reacquired and the hepatic flexure is released from its attachments to the retroperitoneum. This step is facilitated by use of the hand to retract the colon caudally. Dissection proceeds from a cranial-to-caudal direction around the corner to the ascending colon and down toward the cecum—releasing any remaining lateral attachments. As the dissection gets closer to the cecum, it often is easier to put the colon back in its original location and complete the last aspect of the dissection from below—with the terminal ileum and cecum approached from the bottom up. Care must be taken in this location not to injure the right ureter as it passes close to the mesentery of the small bowel. To facilitate creation of an ileal pouch-anal anastomosis, the cut edge of the small bowel mesentery must be mobilized all the way up to the inferior border of the duodenum. Once this is completed, the only remaining attachments of the abdominal colon should be along the transverse mesocolon.

The Transverse Colon (The Great Divide)

As stated earlier, the transverse colon is the most difficult aspect of a minimally invasive procedure. At this point, the only remaining attachments of the transverse colon are along the transverse mesocolon. The hand is used to hold the colon up. The cut edge of the colonic mesentery either on the right or left side is identified, where the previous dissection left off. This cut edge is followed across the middle colic vessels, which are divided, and entry into the lesser sac is completed. Use of a systematic approach ensures there are no remaining attachments of the abdominal colon, which can then be pulled down toward the hand port. The authors find that at this point, it actually creates significant additional room and facilitates pelvic dissection if the colon is divided with a stapler at the rectosigmoid junction and the terminal ileum is divided at the ileocecal valve. The colon can then be removed as a separate specimen and attention focused on the rectal dissection.

Rectal Dissection

The principles of total mesorectal excision (TME) made famous by R. J. Heald remain critical to performing a proctectomy. The technical aspects of rectal dissection remain the same whether this is performed via an open approach through the Pfannenstiel incision, a laparoscopic approach, or a combination thereof.

The dissection begins in the posterior avascular plane that was previously

The dissection begins in the posterior avascular plane that was previously identified before the IMA vascular pedicle ligation. Again, care is taken to avoid injury to the hypogastric nerves as they descend into the pelvis. The dissection is carried down all the way to the levator floor, which is visualized after division of the tough tissue of Waldeyer's fascia. This point is approximately at the level of the coccyx. Anterior dissection in men proceeds along Denonvilliers' fascia, keeping this and the associated neurovascular bundles intact near the seminal vesicles and prostate. In women, the equivalent endopelvic fascia is followed and the more whitish tissues of the rectovaginal septum are dissected free and away from the rectum. The "lateral ligaments" are dissected to complete the TME. Although mostly these are filmy tissues containing only connective tissue, they can harbor collateral vessels that can bleed extensively in cases of advanced malignancy. However, in normal instances, bleeding during this point of the dissection suggests a plane that is either too medial (within the mesorectum) or to lateral in the pelvic sidewall. Such bleeding should prompt reorientation, adjustment of the retractors, and a search for a more "holy" or avascular plane to avoid nerve damage or decreased specimen quality. These tissues should also be dissected down to the level of the pelvic floor, which should be directly visualized. A good rule is to dissect as distally as possible. Incomplete lateral dissection makes passage of a stapler difficult, because there remains too much bulk to transect and which can inadvertently result in a more proximal transection with a compromised distal margin.

The rectal dissection overall can be quite difficult and daunting but is often facilitated by several tips. First, circumferential division of the peritoneal reflection allows more complete retraction and visualization of the proper avascular planes. Second, the hand-assist device may provide options in the dissection. For the posterior dissection, the top of the rectal "stump" can be wrapped in laparotomy pads and brought up through the gel portion of the hand-assist device (Fig. 31-6). This cephalad retraction provides superb exposure to then perform the posterior dissection, even in very obese men with a narrow pelvis. In cases of adequate retraction, a monopolar energy device is all that is required for adequate dissection. If exposure is imperfect, an energy device can facilitate dissection, although care must be taken because this device may allow the surgeon to get outside the avascular planes. In a difficult, deep pelvis, however, this tool can be invaluable. Every effort should be made to perform the dissection in a controlled manner, because blind, blunt "ripping" the specimen out creates more bleeding, with decreased specimen quality. Although not part of the scope of this chapter, a transanal total mesorectal excision (TaTME) approach may be considered for cases where exposure is difficult from above. The anterior dissection can be completed after dropping the specimen back inside the abdomen (Fig. 31-7).

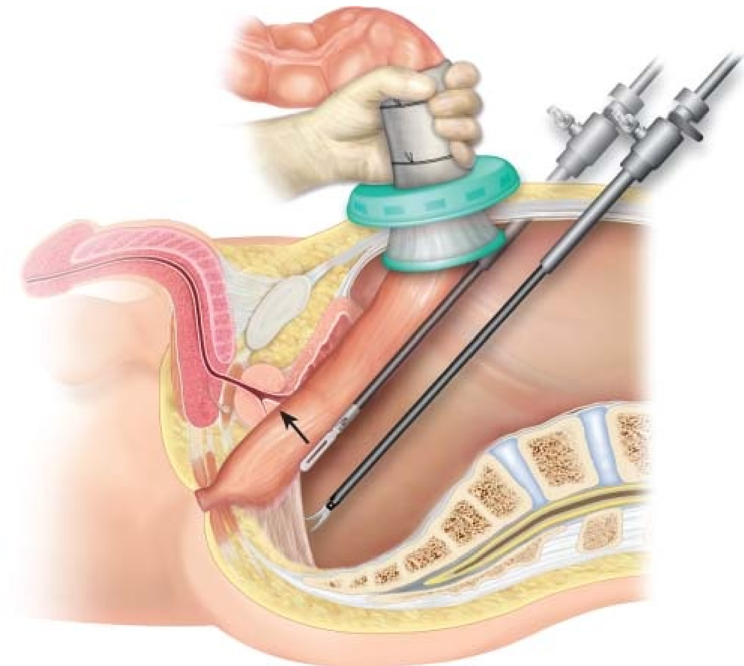


FIGURE 31-6 Cephalad retraction of the rectal "stump" through a hand-assist device.

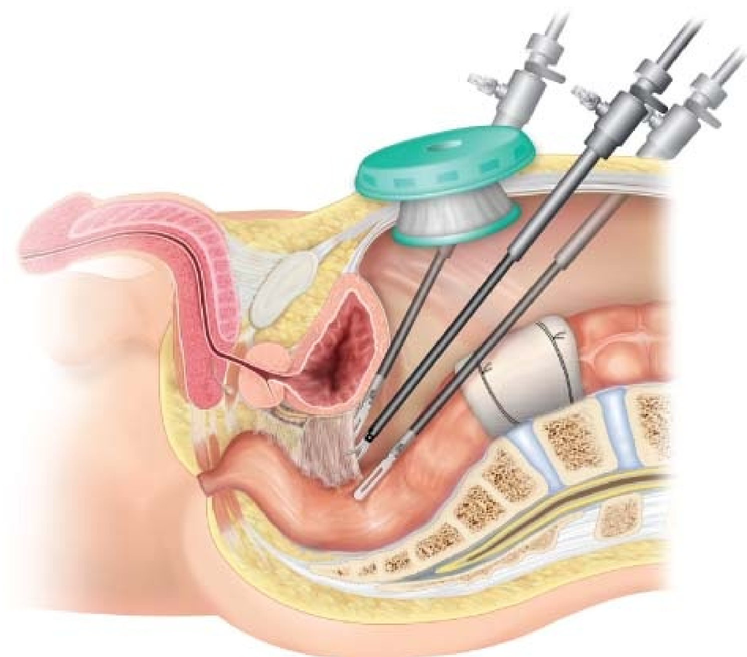


FIGURE 31-7 Completion of the anterior dissection after dropping the "stump" back inside the abdomen.

There remain several options to complete the rectal dissection according to the

There remain several options to complete the rectal dissection according to the preference, experience, and comfort level of the surgeon. Some of them are discussed here.

p. 301

---

p. 302

The Open Approach

The rectal dissection can be performed by removing the cap of the hand-assist device and using it as a wound protector. This approach, we have found, is greatly facilitated by use of lighted straight retractors (rather than the traditional St. Mark’s retractors). This maneuver allows two retractors to be used to create the appropriate amount of tension and counter tension without obscuring view, because they are more maneuverable than the bulkier St. Mark’s. Towels or laparotomy pads can be used to keep the small bowel out of the pelvis and the stapled off end of the rectal stump (after specimen removal) can be used to further manipulate the tissues. An open TA stapler can be used to divide the specimen after TME. Adequate division of the peritoneum in the midline all the way up to the umbilicus ensures that enough space will be available to see and insert the stapler. Alternatively, a transanal division or TaTME approach can be used if a bulky tumor exists and it is not possible to divide the specimen from above.

The Laparoscopic Approach

As previously stated, the rectal stump can be delivered through the hand-assist device after wrapping the end with a laparotomy pad. The posterior dissection virtually does itself as the amount of retraction with this technique is far greater than any other method. Once completed, either the hand can be used or laparoscopic graspers inserted to perform the lateral and anterior parts of the dissection. The energy device or hook diathermy is used in this approach. One of the difficulties with a laparoscopic approach is the problem of using a laparoscopic stapler deep within the pelvis. This hybrid or hand-assist approach allows more stapling options and can alleviate this problem.

Anastomosis/J-pouch

After complete removal of the rectum, hemostasis is obtained by placing a laparotomy pad in the pelvis. Topical hemostatic agents can be used, as needed, as well while attention is turned to creation of the anastomosis. If performing an ileoanal pouch, there are a few key steps that are worth mentioning. Adequate length must be ensured for a tension-free anastomosis. If the pouch reaches beyond the pubic symphysis, this usually is adequate for a stapled coloanal anastomosis. The terminal ileum is examined for the point that allows maximum reach. Typically, this distance is somewhere between 15 and 20 cm proximal to the ileocecal valve. This leaves adequate length to create a 12-to 15-cm ileoanal pouch. If there seems to be tension on the proposed location, several lengthening maneuvers can be done. These include the following:

Ensure the cut edge of the ileal mesentery is mobilized all the way to the inferior border of the duodenum.

The peritoneal surface can be sequentially scored (on both sides). Each incision is created over the central portion of the pouch mesentery, and can gain about 0.5 cm in length. Care is taken not to injure any underlying vascular structures.

Selective ligation of redundant central branches or vascular arcades can be performed, as long as there appears to be adequate collateral blood supply.

An S-pouch can give an extra few centimeters of distal reach; however, over time this may elongate and create a degree of pouch outlet obstruction.

If the pouch cannot reach despite all these maneuvers, it may simply be created and placed in the pelvis (without anastomosis). Over time, it will fill with mucus and usually elongate/descend into the pelvis. This step can facilitate future anastomosis. Adhesion barrier films may be placed at this time.

Once adequate length is ensured, an enterotomy is created in the most distal aspect of the pouch. A gastrointestinal anastomosis stapler is used to create a J-pouch. Care must be taken to ensure the small bowel mesentery is out of the way. Typically, the mesentery is posteriorly positioned, which aids in construction of the pouch. An exception to this practice would be if there is concern about damage to the vagina during proctectomy. Placement of the mesentery in an anterior location can protect against a pouch vaginal fistula, which is extremely difficult to fix. Any excess bowel length after creation of a 12-to 15-cm reservoir is removed with an additional firing of the GIA stapler. The editors prefer a 20cm × 20cm J pouch either a stapled or hand-sewn anastomosis can then be performed. Care must again be taken to avoid other structures (particularly the vagina) in any stapled anastomosis; drains may be placed in the pelvis.

With rare exception, coloanal anastomoses should be protected with a diverting stoma. With a pouch, particularly in an obese patient, stoma construction can be challenging. It often requires a much more proximal location that is prone to high output. Preoperative location marking is crucial to success.

POSTOPERATIVE MANAGEMENT

All patients are postoperatively managed with an enhanced recovery protocol. Diet is advanced as tolerated and a multimodal pain regimen is used. Narcotics are used sparingly to prevent a narcotic-associated ileus. The bladder catheter is routinely removed on postoperative day (POD) 2. This precaution results in a low rate of urinary retention, which can be treated by reinsertion and repeat voiding trial before discharge. If placed, drains are removed on POD 1 or 2. Patients meet with an enterostomal therapist during the first few days in the hospital and early social work consultation is obtained for supplies. If high stoma output is noted, this is managed with a protocol to shorten length of hospital stay and prevent readmissions.

COMPLICATIONS

Total proctocolectomy can be a highly morbid procedure. Some of the more commonly encountered problems are briefly discussed here.

Wound complications can occur with increased frequency in obese patients. Although the Pfannenstiel incision has a relatively low complication rate, care must be taken during closure. We typically close the posterior portion of the fascia at the upper aspect of the incision to prevent bowel herniation there, because this can be particularly difficult to diagnose. Care also must be taken to prevent a rectus sheath hematoma, because this can lead to secondary infections as well. Use of a wound protector and appropriate antibiotics has markedly decreased the risk of wound infection. Glove change and separate fascial closure instrument trays have also been used, although the overall evidence regarding their use is poor.

Bleeding

There are several points during the surgery at which bleeding can occur. Vascular pedicle ligation with failed energy devices can result in rapid, massive bleeding and can rarely require emergent conversion to an open approach. Care should be taken to meticulously control these structures. Available clips, staplers, or Endoloops (Ethicon, Cincinnati, OH) can provide reinforcement when energy devices fail—which typically implies a calcified vessel. The hand-assist technique allows use of a laparotomy pad direct pressure on an area while appropriate tools are obtained. Splenic injury or capsule rupture can occur from vigorous retraction of the colon during splenic flexure mobilization. In addition, the planes around the pancreas can be violated and result in bleeding from the parenchyma or tributaries to the portal venous system. These too can result in rapid, massive bleeding. Finally, bleeding during proctectomy can occur at several locations. Presacral venous bleeding is the most feared. If this is encountered, one must be prepared and get the appropriate tools. The first step is to pack the pelvis with laparotomy pads under pressure. Only one or two attempts to stop the bleeding are possible, because of the large volume of blood that can be lost. Tacks and an appropriate delivery system work very well and can be placed into the sacrum because the tacks can tamponade the retracted vessels. Suture tied down through the bony structures is another method, and a hernia tacker can also be used. Use of an additional suction device is useful to identify the exact site of bleeding. One or two attempts should be made to control this. If unsuccessful, the pelvis should be packed, the operation aborted, and the patient brought back to the operating room in 24 hours, at which point bleeding usually will have stopped.

Ureter

Ureteral injury should be rare if it is identified before transection of the vascular pedicles and during mobilization of the small bowel mesentery near the terminal ileum on the right. If there is any question, the described techniques can be used to identify the ureter. If there is any suspicion of injury, indigo carmine can be injected intravenously and cystoscopy performed to visualize ureteral jets. In addition, ureteral stents can be passed to either identify the ureter or determine whether transection has occurred. Prompt diagnosis and repair usually does not result in long-term sequelae. A delayed diagnosis is much more problematic.

Bowel Injury

Injury to adjacent structures can be due to a variety of reasons. It can be from thermal injury from an energy device, mechanical trauma from a dissecting tool, retraction or tearing during mobilization, and puncture from trochar injury or during instrument insertion. For this reason, instruments should be inserted under direct vision, particularly if any resistance is encountered. Care should also be taken to prevent injury when handling the bowel. If detected at the time of surgery, any injury or deserosalization can be easily repaired. Delayed diagnosis should be suspected in the case of unexplained fever, more than expected abdominal pain, or leukocytosis.

RESULTS

A few small randomized controlled trials have investigated the differences between open and hand-assisted colectomy. These studies have demonstrated that the procedure is not only safe but is associated with a number of short-term benefits, such as shorter length of hospital stay, decreased blood loss, and improved pain scores. One of the main disadvantages of laparoscopic colectomy is the dramatic increase in operative time required for the procedure. The hand-assist laparoscopic surgery (HALS) has shown that not only are operative times shorter but conversion rates may be lower and there is no difference in other outcomes. Although the HALS is associated with increased incision length and increased inflammatory markers compared with the laparoscopic approach, the significance of these is unclear because they do not seem to translate into any difference in short-and intermediate-term outcomes.

CONCLUSIONS

HALS is very safe and effective; and seems to maintain many of the benefits of minimally invasive surgery, while alleviating some of the disadvantages of a laparoscopic approach.

RECOMMENDED REFERENCES AND READINGS

Bonjer HJ, Hop WC, Nelson H, *et al.* Laparoscopically assisted vs open colectomy for colon cancer: a meta-analysis. *Arch Surg* 2007;142(3):298–303.

Champagne BJ, Lee EC, Valerian B, Armstrong D, Ambroze W, Orangio G. A novel end point to assess a resident's ability to perform hand-assisted versus straight laparoscopy for left colectomy: is there really a difference? *J Am Coll Surg* 2008;207(4):554–9.

Chang YJ, Marcello PW, Rusin LC, Roberts PL, Schoetz DJ. Hand-assisted laparoscopic sigmoid colectomy: helping hand or hindrance? *Surg Endosc* 2005;19(5):656–61.

Marcello PW, Fleshman JW, Milsom JW, *et al.* Hand-assisted laparoscopic vs. laparoscopic colorectal surgery: a multicenter, prospective, randomized trial. *Dis Colon Rectum* 2008;51(6):818–26.

Meshikhes AW. Controversy of hand-assisted laparoscopic colorectal surgery. *World J Gastroenterol* 2010;16(45):5662–8.

Nakajima K, Lee SW, Cocilovo C, *et al.* Hand-assisted laparoscopic colorectal surgery using GelPort. *Surg Endosc* 2004;18(1):102–5.

Nakajima K, Milsom JW, Margolin DA, Szilagy EJ. Use of the surgical towel in colorectal hand-assisted laparoscopic surgery (HALS). *Surg Endosc* 2004;18(3):552–3.

Sonoda T, Pandey S, Trencheva K, Lee S, Milsom J. Longterm complications of hand-assisted versus laparoscopic colectomy. *J Am Coll Surg* 2009;208(1):62–6.

Tjandra JJ, Chan MK, Yeh CH. Laparoscopic-vs. hand-assisted ultralow anterior resection: a prospective study. *Dis Colon Rectum* 2008;51(1):26–31.

Chapter 32

Pouch Configuration

Paris P. Tekkis and Constantinos Simillis

INDICATIONS/CONTRAINDICATIONS

The only reason for restorative proctocolectomy, through the formation of an ileal pouch-anal anastomosis (IPAA), is to avoid a permanent ileostomy. A conventional proctocolectomy gives otherwise excellent results. The main causes for creating an IPAA would be after proctocolectomy for ulcerative colitis (UC) or for familial adenomatous polyposis (FAP). An IPAA should be avoided when the small bowel is involved in the disease process (as in Crohn's disease), or when the anal canal is diseased (as with Crohn's disease or anal cancer), and in patients with poor anal sphincter function.

In the absence of medical contraindications to the formation of an IPAA, the choice between a restorative and a conventional proctocolectomy lies largely with the patient. To make an informed decision, the patient should be aware of the risks of an IPAA, including failure and complication rates, total treatment time, the possibility of pouchitis, and the likely functional outcome. A pouch support nurse, stoma therapist, and patient-support group can offer valuable advice to the patient during this decision-making process.

The creation of a pouch allows the formation of a reservoir for stool. Evidence from comparative and physiological studies of patients who have had either a straight ileoanal anastomosis (IAA) or an IPAA demonstrated decreased frequency of defecation, increased capacity and compliance, decreased propulsive drive, and overall, improved functional results with an IPAA. Furthermore, studies demonstrated an inverse relationship between reservoir volumes and frequency of defecation.

When the operation was first reported by Parks and Nicholls, a three-loop form of reservoir was used. This "S" pouch was connected to the anal canal after a mucosectomy by an anastomosis between a point just above the dentate line and a segment of the terminal ileum projecting from the reservoir for a few centimeters. Parks stated that his main aim was to avoid incontinence, and to do so he favored this form of reconstruction. Although this goal was achieved, as reported in the first few publications, the price paid was failure of spontaneous evacuation in at least half of the patients having the procedure, because the "S" pouch was associated with the need to catheterize the pouch for emptying. This problem was radiologically shown to be due to presence of the 5-cm efferent limb, which acted as an impedance to outflow.

The two-loop reservoir described by Utsunomiya did not have this feature, being directly joined to the anal canal without an efferent limb. Evacuation was spontaneous in almost all patients. For this reason, and for its ease of construction by linear stapling, the two-loop, or “J” pouch, quickly became the most widely used reconstruction. Subsequently, Nicholls developed a four-loop “W” pouch with the intention of achieving increased reservoir volume, and, therefore, decreased frequency of defecation compared to the “J” pouch, and did not require intubation unlike the “S” pouch (Fig. 32-1). Other pouch configurations have included the “H” reservoir described by Fonkalsrud, and the Kock “K” design used with IAA.

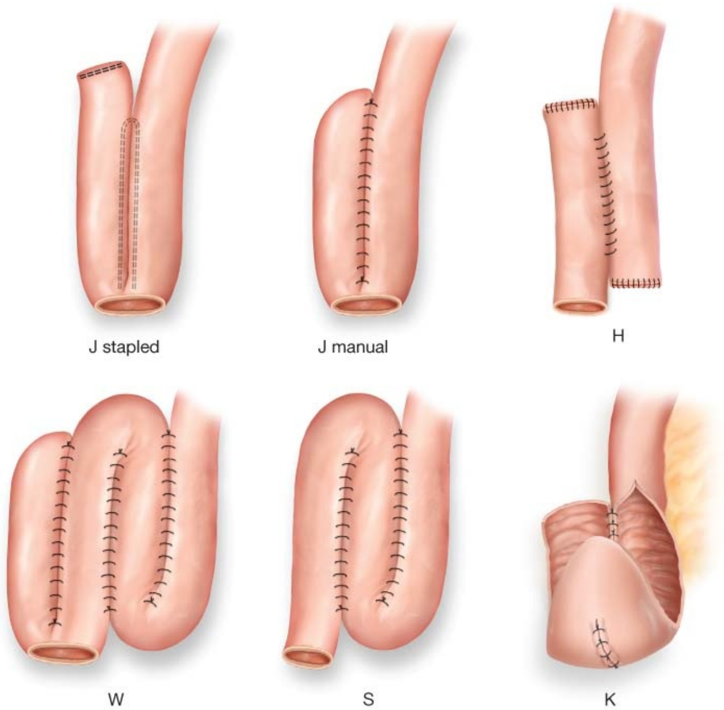


FIGURE 32-1 Various pouch designs.

PREOPERATIVE PLANNING

Preoperative patient education is invaluable using written materials, pouch support nurses, stoma therapists, and patient-support groups. As long as an IAA is possible, there is no particular preoperative planning required for the reservoir. There are no particular indications other than the surgeon’s preference in choosing which pouch should be used other than the “S” reservoir, which has been virtually relegated to use in patients where the pouch does not reach. If the outlet becomes a problem, a transanal advancement works well to straighten the outlet. The choice of configuration is unaffected by general factors such as the patient’s disease activity level or comorbidities. There are no local anatomic or pathologic factors, which would influence the choice of pouch design. Thus, the width of the pelvis, mobility of the mesentery, state of the anal sphincter, and the extensiveness of any adhesions do not influence the choice of reservoir. In current practice, the “J” and, to a much lesser extent, the “W” reservoirs are the most common types of pouches used. The subsequent technical descriptions are confined to these pouch types. The length of small intestine used for each version is similar and the mobility of the mesentery that determines whether there will be some tension on the anastomosis is also similar for both “J” and “W” reservoirs.

SURGERY

General Precautions

Perioperative prophylactic antibiotics, especially in immunosuppressed patients

Anti-thromboembolism prophylaxis using subcutaneous heparin, and pneumatic compression stockings

Stopping antiplatelet agents (e.g., aspirin or clopidogrel) 1 week before surgery

Preoperative bowel preparation to clear the colon and rectum of fecal material

Cross-matched blood

Consider a central venous line insertion for total parenteral nutrition (TPN) in the malnourished patient

Intraoperative orogastric or nasogastric tube insertion

Epidural anesthetic or patient-controlled analgesia for pain control

Bladder catheterization

Insertion of a proctoscope or irrigation through a catheter before starting the operation to drain the bowel of as much liquid feces and flatus as possible

p. 306

p. 307

Positioning

The reverse Trendelenburg position with the legs raised in Lloyd–Davies-type stirrups should be used to allow access to the anus. The tip of the coccyx should lie over the end of the operating table to gain adequate exposure of the perineum. Whether an open or laparoscopic technique is used, this position gives excellent access to the abdomen and suitable deployment of surgeon and the assistants around the patient.

General Considerations of Pouch Construction

There are three principles that should be observed in constructing a reservoir:

Minimal tension of the small bowel mesentery: To minimize tension, adhesiolysis, and mobilization of the mesentery as extensively as possible, combined with division of selected mesenteric vessels if necessary, should be performed and combined with a trial descent.

Adequate volume of the pouch: To achieve adequate capacity, a minimum length of small bowel of 30–40 cm is generally preferred.

Absence of distal ileal segment: Using the apex of a folded pair of loops as the point for the enterostomy to form the IAA will avoid any distal ileal segment.

Mobilization of the Mesentery

An assessment of the mobility of the small bowel to descend to the pelvis is made by holding the apex of a loop of terminal ileum intended to form part of the IAA down into the pelvis. This most mobile point is around 15 cm from the ileocecal junction. If there is no evidence of tension, no further mobilization of the mesentery is carried out. If, however, there is some tension, then further mobilization of the mesentery is required. This goal is achieved in three ways (Fig. 32-2):

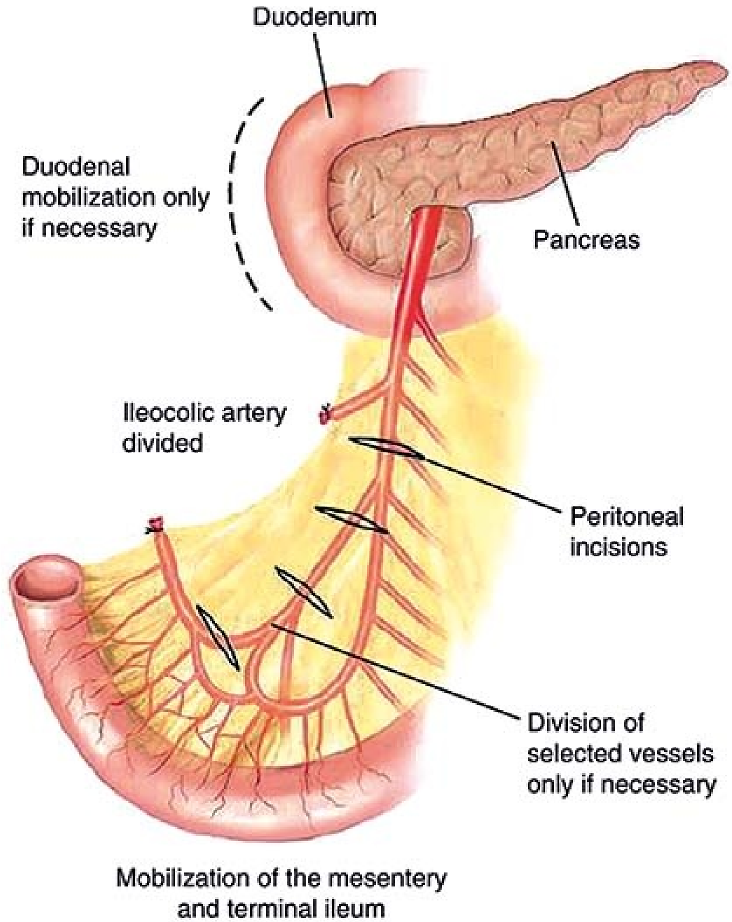


FIGURE 32-2 Mobilization of the mesentery.

Duodenal mobilization: It may be necessary to mobilize the duodenum using Kocher's maneuver. The uncinate process of the pancreas can be freed from the origin of the superior mesenteric artery and vein if necessary. Care should be taken to avoid damage to the superior mesenteric vein or its major tributaries.

Transverse incisions of the peritoneum: Four or five small transverse cuts made in the peritoneum on each side of the mesentery result in lengthening by 1–2 cm.

Division of selected vessels: If, despite these maneuvers, there is still tension restricting descent of the apex of the terminal ileal loop into the pelvis, then division of a selected restraining vessel in one of the vascular arcades will be necessary. This maneuver must be done with great care to avoid small bowel ischemia. The vessel restraining the mobility of the mesentery is identified by putting gentle stretch on the mesentery and using transillumination. The vessel is then dissected from its connective tissue bed. A bulldog clamp is applied to the vessel and the end of the terminal ileum is inspected to see whether there is adequate perfusion. If vascularity is satisfactory, the vessel is then divided. Fluorescence imaging may be used to verify adequate perfusion before vascular division. This maneuver is rarely necessary if a stapled IAA is used.

Trial Descent

A trial descent of the small bowel, testing its ability to descend to the level of the anal canal, is recommended, where the bowel has been divided to leave an open anal stump as would have been done in patients in whom a manual IAA with mucosectomy is intended. It is not possible to perform trial descent if the anorectal stump has been closed by a transverse stapler in preparation for a stapled IAA; but in this circumstance, there is less tension on the mesentery because the IAA will be at a slightly higher level. The trial descent is undertaken jointly by abdominal and perineal operators. A stay suture is placed on the apex of the loop selected for the IAA and this is passed through the pelvis and anal canal to be taken by the perineal operator. Gentle traction is applied and the small bowel is drawn down to the anal canal. If it reaches the dentate line, it will do so after the pouch is formed. If it does not, then further mobilization is necessary as described earlier (Fig. 32-3). Alternatively, a trial descent can be undertaken with transanal digital palpation while the apex of the intended pouch is delivered to the distal pelvis. Regardless of the method employed, it is desirable to confirm sufficient reach before pouch construction.

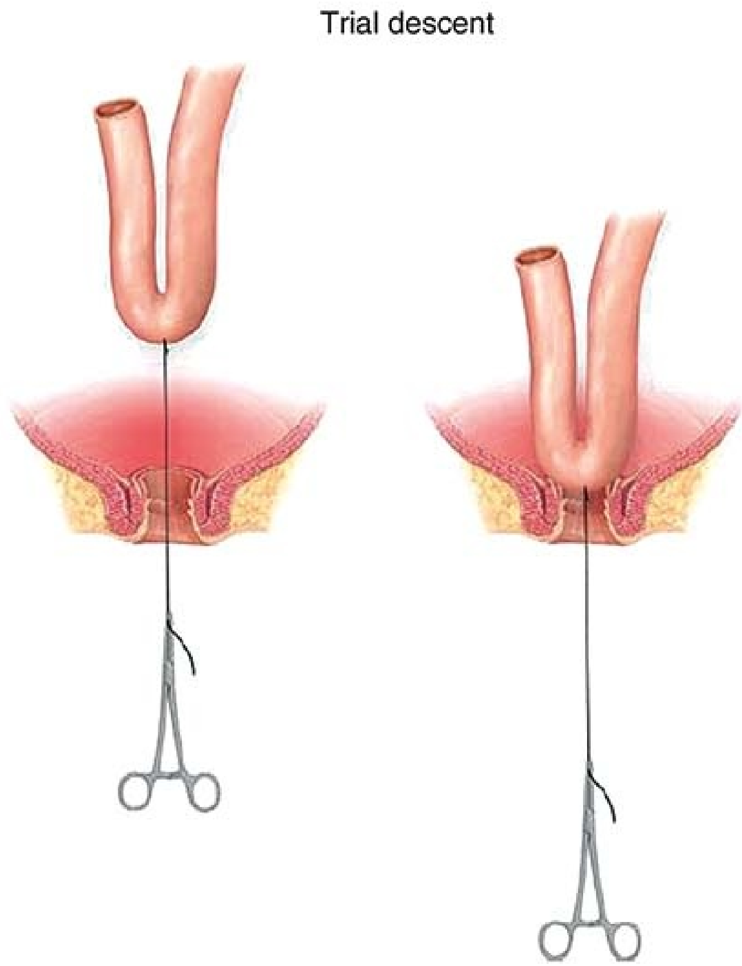


FIGURE 32-3 Trial descent before making the pouch.

"S" Pouch

The original three-limb "S" pouch used 25 cm of terminal ileum with a 5-cm distal conduit for the IAA. This pouch design was associated with a significantly greater need for pouch intubation to facilitate emptying, and soon fell out of favor. If an "S" pouch is used, however, the distal ileal segment should be kept to a minimum of 2 cm to reduce the need for intubation. The "S" pouch may be preferred by some surgeons because the efferent limb fits well into the anal canal and the body of the pouch lies on the levators; whereas the blunt end of a "J" pouch may be distorted by being forced into the tight muscular tube of the stripped anus.

"K" Pouch

To create a "K" pouch, two 15-cm ileal segments are sutured side to side and split open. A finger-wide opening is left distally to the suture line. The "K" split open. A finger-wide opening is left distally to the suture line. The "K" pouch is formed by folding the opened bowel upward along a transverse axis. The corners of the created pouch are pushed inward between the mesenteric leaves, bringing the posterior aspect of the pouch anteriorly and the opening for the IAA distally.

"H" Pouch

The full thickness of the ileum is anastomosed to the free edge of the anal mucosa at the dentate line and the ileum is divided 25 cm proximal to the peritoneal reflection. After the two ends of the ileum are closed, a side-to-side ileo-ileal anastomosis is constructed over a distance of 20 cm using the GIA stapling instrument. The anastomosis is extended to the peritoneal reflection, thus leaving only about 8–12 cm of ileum between the reservoir and the IAA.

Stapled "J" Pouch

The "J" pouch has become the design of choice because of its ease of construction by stapling in preference to the "S" and "W" pouches, which require a more time-consuming hand-sewn construction. Larger "J" pouch are being favored since the description of the "W" design. A "J" pouch should have a volume of at least 300 ml at the time of construction. A 20×20 cm loop achieves an intraoperative volume of more than 300 ml with a postoperative capacity of 380 ml. Once adequate mesenteric length is assured, the pouch is constructed by stapling or manual suturing (Fig. 32-4). Most surgeons now use the former technique, but stapling may result in a short distal stump (the "dog ear") that can perforate and fistulize.

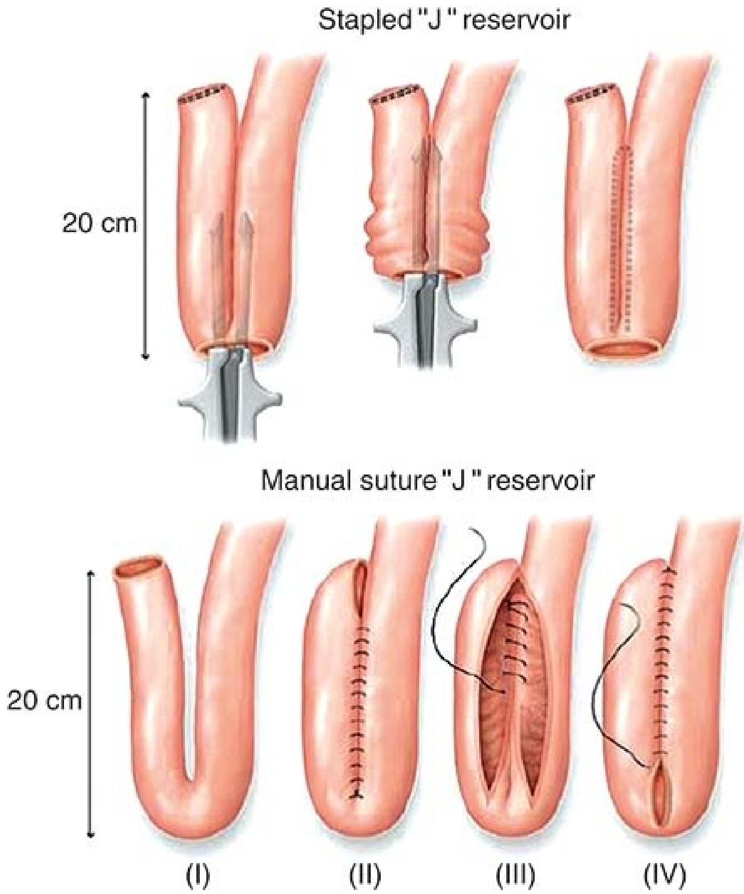


FIGURE 32-4 Construction of the "J" pouch; stapled and manual techniques.

To form a stapled "J" pouch, three stay sutures can be placed on the antimesenteric border of the ileum to ensure that the staple line is truly antimesenteric. The limbs of the pouch should each measure 20 cm in length. A transverse enterotomy not more than 3 cm long is made at the apex of the folded loops. The procedure is performed entirely through this enterotomy, accordioning the limbs of the ileum over the stapler. A 10-cm linear cutting stapler is introduced into the two loops of the ileum and the limbs are advanced as far as possible. The stapler is closed and an inspection is made to ascertain that no mesenteric vessels are included in the shafts of the stapler. If not, the instrument is fired. A second stapler is introduced and advanced beyond the now open loops of ileum and closed and fired. The number of cartridges required to form a stapled "J" pouch will usually be two of a 90-mm or 100-mm stapler; three of the 75-mm stapler; and four of the 50-mm stapler. The aim should be to achieve a pouch of 17–20 cm limb length.

The pouch may be everted through its mesentery to expose the posterior staple line to exclude for any defect and to assess hemostasis. The integrity and capacity of the pouch are tested by placing a non-crushing clamp over the afferent limb while injecting saline into the pouch through a catheter introduced through the apical enterotomy. The terminal ileum will have been closed by a transverse stapler applied before constructing the pouch. This results in a "dog ear" at its most distal part, which is oversewn. Care should be taken to ensure that it is no more than 2 cm in length and is intact because fistula formation can occur from leakage at that point.

Sutured "J" Pouch

The two loops are approximated using a seromuscular continuous suture of absorbable material. The bowel is then opened and a full-thickness continuous suture is undertaken from the posterior layer coming round to the anterior layer of the two loops. In this manner, the "dog ear" deformity is completely avoided because the anatomic end of the terminal ileum is incorporated end to side into the pouch. The suture is continued to the apex of the pouch and terminated at a point that leaves the enterotomy for the IAA just able to take two fingers comfortably. If a stapled IAA is intended, however, the last few sutures up to this point should be interrupted to avoid unravelling of the continuous suture line, which may occur if it is cut by the knife of the circular stapler. It takes about 30 minutes to construct a sutured "J" pouch, but its advantages include maximizing the pouch volume by using all the bowel length for constructing the reservoir, avoiding the "dog ear" with its risk of fistulation, and lowering the cost. It may, however, result in more contamination.

"W" Pouch

It is not practical to construct a four-loop pouch by stapling. The terminal 40 cm of the ileum is folded into four 10-cm loops. The proximal two limbs are offset from the distal two limbs by about 2 cm. The loops are united using a continuous absorbable suture. The bowel is then opened along the suture lines and a full-thickness suture is applied along the posterior layer of the pouch. As with the "J" construction, this is continued onto the anterior surface of the pouch finally to leave an aperture for the IAA, which comfortably takes two fingers.

Harms *et al.* suggested that it is better to construct the W-pouch with a slightly longer distal loop so that it fits more comfortably into the pelvis for IAA, rather than using four equal lengths of ileum. These authors suggest a configuration measuring 11, 13, 10, and 10 cm. Thus, the distal enterotomy forms an apex, which is used for the IAAs. This detail is a modification of the abovementioned description. The integrity and capacity of the pouch should then be checked by distending it with saline as for the "J" pouch.

Ileoanal Anastomosis

Ileoanal Anastomosis

In the description of pouch construction, the technique of the IAA requires some mention. This issue is relevant to the degree of mobilization of the mesentery required and to the completeness of removal of the disease, whether UC or FAP. A manual anastomosis with mucosectomy is more distal and may result in increased tension in some cases. Conversely, it results in minimal remaining disease and it can be accurately placed under direct vision. Although it is believed that function after a manual IAA with mucosectomy is less satisfactory than after a stapled anastomosis, comparative studies of the two techniques showed no significant difference.

In the case of a stapled IAA, although there is the advantage of less liability to tension owing to a more proximal IAA, there is the danger of making it too proximal such that a length of inflamed rectal mucosa is left in the patient. This consideration may not matter in most cases; but in some patients with severe inflammation and ulceration, function after closure of the ileostomy may be poor with anal burning, urgency, and bleeding because of the presence of the inflamed mucosa itself and the frequent passage of small-volume stool secondary to incomplete emptying of the pouch owing to the presence of the distal anorectal stump. A stapled IAA must therefore be sufficiently distal to avoid this complication.

A meta-analysis published in 2006, based on 21 studies and 4,183 patients, compared hand-sewn versus stapled IAA and found no significant difference in the incidence of postoperative complications between the two groups, including anastomotic leak, pelvic sepsis, pouch-related fistula, pouchitis, anastomotic stricture, and pouch failure. There was no significant difference between the two techniques with regard to stool frequency per 24 hours, defecation at night, use of antidiarrheal medication, seepage during the daytime, and daytime pad usage. However, the meta-analysis demonstrated significantly more frequent nocturnal seepage, incontinence of liquid stool, and use of pads overnight with hand-sewn IAA compared to stapled IAA, and this correlated with significantly reduced resting and squeeze pressures of the hand-sewn IAA. Others have found significantly higher rates of sepsis, fecal incontinence, and ultimate failure with a hand-sewn IPAA.

Stapled Ileoanal Anastomosis

For the stapled anastomosis of a stapled “J” pouch to the anorectal stump, a purse string suture is placed in the distal opening of the pouch and the anvil of the circular stapler (CEEA 28 or 29 mm) is inserted into the pouch and the suture is tied. The stapler is inserted into the anus and the anastomosis performed by firing it in the normal way.

For the stapled anastomosis of a hand-sutured “J” pouch, the technique differs in one important aspect (which was described earlier): the last few sutures of the anterior wall of the pouch should be placed in an interrupted manner to prevent cutting and unravelling of the continuous suture. Otherwise, the insertion of the purse string suture and firing of the instrument are identical.

Sutured Ileoanal Anastomosis

A sutured IAA requires a mucosectomy, which is undertaken through the anus after division of the bowel. If the anorectal stump is short, the entire residual mucosa is very accessible to endoanal removal, which is effected by scissor excision facilitated by submucosal injection of saline solution containing adrenaline (1:300,000). The pouch is then brought down to the anal level by traction of two sutures (2.0 Vicryl on a 26-mm taper-cut needle—W9350, Johnson & Johnson, Blue Ash, OH), which have already been placed at the right and left edges of the enterotomy. The needles are not removed and having drawn the sutures through the anus, each suture is placed in turn into the anal canal at the level of the mucosectomy at the 3 and 9 o’clock positions. Having placed these initial sutures, the remaining sutures (12 in all; one for each hour of the clock) are inserted.

POSTOPERATIVE MANAGEMENT

Perioperative prophylactic antibiotics are used either as a single dose or as multiple doses, especially in immunosuppressed patients.

Anti-thromboembolism prophylaxis using subcutaneous heparin and pneumatic compression stockings.

Epidural anesthetic or patient-controlled analgesia is used.

If prolonged ileus or malnutrition, consider TPN.

Monitor and replace fluid losses in liquid stool to prevent dehydration and electrolyte disturbances.

Dietitian input to provide valuable education regarding dietary modifications recommended following IPAA. Meals high in carbohydrates can help thicken stool output, and frequent small meals throughout the day may prevent large small bowel loads and subsequent urgency.

Stoma nurse specialists are called upon to provide specialized training in stoma care.

Antimotility agents and bulking agents can be used to help slow the passage of stool.

COMPLICATIONS

Morbidity occurs in 20–40% of patients. Complications can be classified into those general to any surgery and those specific to restorative proctocolectomy. Any patient undergoing major surgery is at risk of developing general complications such as infections of the chest, wound and urinary tract, cardiorespiratory complications, thromboembolic disease, and hemorrhage.

The most important complication specific to restorative proctocolectomy is pelvic sepsis, usually due to a degree of breakdown of the IAA in the early postoperative period. If the clinical presentation is delayed, the patient may develop a fistula into the vagina or the perineum months to years after the primary restorative proctocolectomy. The occurrence of pelvic sepsis is not related to the type of reservoir. When manual and stapled IAAs have been compared, there is no difference in the incidence of this complication. Fistula may also occur directly from the reservoir of a stapled "J" pouch developing leakage from the "dog ear" stapled line at the point of distal division of the ileum.

Failure, defined by excision of the pouch or by the need for a permanent or indefinite ileostomy, progressively occurs with time, being approximately 10% at 10 years and rising to 15% or more at 20 years. Failure is due to sepsis in 50%, poor function in 30%, and pouchitis in 10%. There is no evidence that failure is related to the type of pouch. Pouchitis occurs in as many as 50% of patients and there is no difference in the propensity of any reservoir design to pouchitis. Typical symptoms of pouchitis include diarrhea, abdominal cramping, anorexia, fecal urgency, tenesmus, and rectal bleeding, and the condition is readily treated with antibiotics.

An updated meta-analysis performed by the authors for the purpose of this chapter, including 25 comparative studies and 2,831 patients who underwent different pouch designs, identified a significantly higher rate of pouchitis with "J" pouch compared to "W" pouch, and a significantly higher rate of reoperations with "J" pouch compared to "K" pouch designs. Otherwise, there were no significant differences between the different pouch designs with regard to anastomotic dehiscence/leak, anastomotic stricture, wound infection, pelvic sepsis, pouch fistula, small bowel obstruction, pouch ischemia, hemorrhage, reoperation rate, sexual dysfunction, pouchitis, and pouch failure (Table 32-1). Other long-term complications of IPAA include female infertility and neoplastic transformation.

TABLE 32-1 Adverse Outcomes by Reservoir Design

Outcome	No. of patients	No. of studies	Odds ratio (95% CI)	P-value
Anastomotic dehiscence				
J vs. W	360	7	1.00(0.33, 3.04)	1.00
S vs. W	210	4	1.57(0.54, 4.58)	0.41
S vs. J	736	5	1.89(0.71, 4.99)	0.20
K vs. J	55	1	1.76(0.27, 11.47)	0.55
Anastomotic stricture				
J vs. W	484	8	0.75(0.30, 1.87)	0.53
S vs. W	179	3	1.75(0.64, 4.83)	0.28
S vs. J	119	2	2.00(0.50, 7.97)	0.33
K vs. J	55	1	1.12(0.07, 18.86)	0.94
Wound infection				
J vs. W	299	7	0.48(0.18, 1.29)	0.15
S vs. W	119	3	0.78(0.14, 4.39)	0.78
S vs. J	582	3	1.39(0.91, 2.13)	0.12
Pelvic sepsis				

J vs. W	326	6	1.46(0.66, 3.24)	0.35
S vs. W	179	3	3.06(0.97, 9.70)	0.06
S vs. J	621	3	1.22(0.35, 4.32)	0.75
K vs. J	55	1	0.39(0.02, 9.79)	0.57
Pouch fistula				
J vs. W	471	8	0.63(0.21, 1.85)	0.40
S vs. W	69	2	0.97(0.19, 4.88)	0.97
S vs. J	655	4	0.75(0.37, 1.52)	0.42
K vs. J	103	1	0.16(0.01, 3.20)	0.23
Small bowel obstruction				
J vs. W	556	10	0.91(0.51, 1.62)	0.74
S vs. W	210	4	1.28(0.38, 4.35)	0.69
S vs. J	736	5	0.78(0.30, 2.04)	0.62
K vs. J	158	2	0.50(0.15, 1.69)	0.26
Pouch ischemia				
J vs. W	79	2	2.66(0.10, 70.11)	0.56
S vs. W	38	1	4.86(0.19,	0.34

			127.52)	
S vs. J	111	2	1.29(0.10, 16.96)	0.84
Hemorrhage				
J vs. W	276	4	1.59(0.44, 5.73)	0.48
S vs. W	129	2	0.39(0.05, 3.26)	0.38
S vs. J	621	3	0.81(0.40, 1.63)	0.56
K vs. J	55	1	0.36(0.01, 9.19)	0.54
Reoperation				
J vs. W	363	5	1.55(0.61, 3.91)	0.36
S vs. W	129	2	1.19(0.32, 4.48)	0.80
S vs. J	694	4	0.86(0.38, 1.99)	0.73
K vs. J	158	2	0.30(0.10, 0.88)	0.03
Sexual dysfunction				
J vs. W	76	2	5.47(0.25, 120.37)	0.28
S vs. W	114	2	2.15(0.22, 21.52)	0.51
S vs. J	683	4	0.96(0.58, 1.59)	0.87
Pouchitis				
J vs. W	389	6	2.69(1.26,	

[illegible]	[illegible]	[illegible]	[illegible] 5.72)	0.01
S vs. W	72	2	1.25(0.38, 4.16)	0.72
S vs. J	689	4	0.85(0.39, 1.87)	0.69
K vs. J	158	2	1.04(0.22, 4.88)	0.96
Pouch failure				
J vs. W	354	5	1.89(0.51, 6.92)	0.34
S vs. W	91	1	4.89(0.26, 90.20)	0.29
S vs. J	656	3	0.72(0.41, 1.28)	0.26
K vs. J	156	2	1.11(0.11, 11.58)	0.93

OR values <1 favor design 1; values >1 favor design 2.
P-values in bold are of statistical significance.
OR, odds ratio.
Source: Unpublished data from Simillis et al. (2016).

RESULTS

The results following different reservoir designs are essentially those relating to function. Reservoir configurations have been developed to improve frequency of defecation as the main aim. Set against this is the need to simplify the method of construction as far as possible. Various authors have critically reviewed the results and reported a low incidence of complications, bowel frequency of four to seven movements in 24 hours, without emptying problems.

Pouch volume is directly related to the length of ileum used for pouch construction. Volume is not, however, the only predictor of outcome: small bowel motility, bacterial overgrowth, anal function, pouch evacuation, and villous atrophy index are also important determinants of outcome. Nevertheless, most data suggest that a large capacity and compliant pouch are probably the most important variables in achieving low bowel frequency, provided anal sphincter function is preserved.

The shape of the “J” pouch more closely resembles the normal rectum than the “S” or “W” pouches. None of the large clinical series indicate that catheterization is necessary, although frequency of defecation with the 15×15 cm “J” pouch, and particularly with the 10×10 cm “J” pouch, does seem to be greater than with the “S” pouch. There is, however, tremendous variation in the frequency of defecation from day to day, which is influenced a great deal by dietary intake.

There is a long period of ileal adaptation after “J” pouch construction and frequency of defecation falls substantially with time. Likewise, the volume of the “J” pouch increases with time, reaching a maximum by 2 years. Soiling, nocturnal defecation, discrimination, and deferment of defecation also improve. Studies demonstrated a progressive improvement in the functional score over a period of at least 2 years.

Although the “J” design is the most widely used by surgeons because of its simple design and ease of fashioning, some surgeons may prefer the “W” design owing to the chance of better function. There is some evidence that in the long term, function following the “J” and “W” configurations may be different, with some studies reporting decreased night evacuation and decreased overall frequency of defecation with a “W” compared to a “J” pouch.

The meta-analysis performed in 2016 (including 25 comparative studies and 2,831 patients) demonstrated significantly more frequent passage of stools with a “J” pouch compared to a “W” pouch, “S” pouch, and “K” pouch (Table 32-2). This finding may be related to a significantly lower pouch volume of the “J” pouch, as shown by the meta-analysis, compared to “W” and “K” pouches. Furthermore, the meta-analysis identified a significantly higher proportion of patients with “J” pouch using pads during the night compared to patients with “S” and “K” pouches. There was also a significantly higher use of antidiarrheal medications among patients with “J” pouch compared to patients with “W” and “S” pouches. In addition, more patients with “J” pouch had urgency compared to patients with “K” pouch, and patients with “J” pouch had increased daytime stool frequency compared to patients with “S” pouch. On the other hand, significantly more patients with “S” pouch needed to catheterize the pouch for emptying compared to patients with “J” or “W” pouches. Otherwise, there were no other significant differences between the pouch designs with regard to daytime and nighttime stool frequency, daytime and nighttime seepage, 24-hour and daytime pad usage, urgency, and incontinence.

TABLE 32-2 Functional Outcomes by Reservoir Design

Outcome	No. of patients	No. of studies	OR/WMD (95% CI)	P-value
Maximum pouch volume				
J vs. W	157	4	−59.89 (−119.07, −0.71)	0.05
S vs. W	158	4	−15.66 (−78.98, 47.66)	0.63
S vs. J	104	4	73.75 (−34.94, 182.44)	0.18
K vs. J	85	2	83.96 (56.76, 111.16)	<0.01
Stool frequency per 24 h				
J vs. W	258	6	0.73 (0.09, 1.37)	0.02
S vs. W	166	3	1.02 (−0.27, 2.31)	0.12
S vs. J	889	6	−1.10 (−1.42, −0.77)	<0.01
K vs. J	30	1	−1.40 (−2.64, 0.16)	0.03

			−0.16)	
Stool frequency (day time)				
J vs. W	323	5	0.78 (−0.24, 1.79)	0.13
S vs. W	38	1	0.00 (−2.63, 2.63)	1.00
S vs. J	540	2	−1.93 (−2.65, −1.20)	<0.01
K vs. J	141	2	−0.20 (−1.54, 1.14)	0.77
Stool frequency (night)				
J vs. W	384	6	0.20 (−0.05, 0.45)	0.12
S vs. W	138	3	0.40 (−0.12, 0.92)	0.14
S vs. J	603	4	−0.33 (−0.96, 0.30)	0.31
Seepage (day time)				
J vs. W	166	3	2.18 (0.21, 22.55)	0.51
S vs. W	50	1	2.33 (0.34, 15.95)	0.39
S vs. J	502	1	0.83 (0.54, 1.26)	0.38
K vs. J	412	1	1.07 (0.21, 5.53)	0.94
Seepage (night)				
J vs. W	166	3	1.06 (0.46, 2.45)	0.89

S vs. W	50	1	2.67 (0.60, 11.76)	0.20
S vs. J	502	1	1.11 (0.77, 1.61)	0.58
K vs. J	412	1	0.38 (0.23, 0.61)	<0.01
Pad usage per 24 h				
J vs. W	238	4	1.72 (0.42, 7.07)	0.45
S vs. J	76	1	3.90 (0.81, 18.71)	0.09
S vs. J	156	2	1.26 (0.49, 3.24)	0.63
Daytime pad usage				
J vs. W	79	2	1.62 (0.36, 7.24)	0.53
S vs. J	537	2	1.17 (0.16, 8.29)	0.88
K vs. J	412	1	0.68 (0.29, 1.56)	0.36
Nighttime pad usage				
J vs. W	79	2	1.56 (0.39, 6.20)	0.53
S vs. J	537	2	0.69 (0.48, 1.00)	0.05
K vs. J	412	1	0.51 (0.30, 0.86)	0.01
Urgency				
J vs. W	385	7	1.03 (0.49, 2.15)	0.94

			2.15)	
S vs. W	167	3	1.01 (0.12, 8.52)	0.99
S vs. J	884	6	0.74 (0.36, 1.50)	0.40
K vs. J	412	1	0.49 (0.28, 0.86)	0.01
Incontinence				
J vs. W	422	7	1.98 (0.79, 4.98)	0.15
S vs. W	257	5	2.78 (0.66, 11.74)	0.16
S vs. J	919	7	0.75 (0.43, 1.30)	0.30
Antidiarrheal medication				
J vs. W	389	7	3.27 (1.90, 5.63)	<0.01
S vs. W	207	4	0.83 (0.28, 2.52)	0.75
S vs. J	516	8	0.33 (0.15, 0.76)	<0.01
K vs. J	412	1	0.73 (0.30, 1.78)	0.49
Pouch intubation				
J vs. W	271	4	0.23 (0.05, 1.17)	0.08
S vs. W	207	4	16.29 (4.70, 56.38)	<0.01
S vs. J	396	5	18.15 (4.14,	<0.01

79.70)

OR values <1 favor design 1; values >1 favor design 2.
WMD negative values favor design 1; positive values favor design 2.
P-values in bold are of statistical significance.
OR, odds ratio; WMD, weighted mean difference.
Source: Unpublished data from Simillis et al. (2016).

CONCLUSIONS

A pouch reservoir is used in restorative proctocolectomy to achieve better function than follows a straight ileoanal reconstruction. The configuration used should be simple to construct, with adequate capacitance and emptying characteristics. Adequate mobilization of the mesentery is essential in all types of reconstructions. The “J” design is the most commonly used in clinical practice because of its greater ease of construction and comparable complication rates. However, there are advantages that may be potentially be offset by a possible increase in stool frequency and higher use of antidiarrheal medications related to the “J” pouch, as compared to the other pouch designs.

RECOMMENDED REFERENCES AND READINGS

Block M, Börjesson L, Lindholm E, Oresland T. Pouch design and long-term functional outcome after ileal pouch–anal anastomosis. *Br J Surg* 2009;96:527–32.

de Zeeuw S, Ahmed Ali U, Donders RA, Hueting WE, Keus F, van Laarhoven CJ. Update of complications and functional outcome of the ileo-pouch anal anastomosis: overview of evidence and meta-analysis of 96 observational studies. *Int J Colorectal Dis* 2012;27(7):843–53.

Fonkalsrud E. Endorectal ileal pullthrough with lateral ileal reservoir for benign colorectal disease. *Ann Surg* 1981;194:761–6.

Hahnloser D, Pemberton JH, Wolff BG, Larson DR, Crownhart BS, Dozois RR. Results at up to 20 years after ileal pouch-anal anastomosis for chronic ulcerative colitis. *Br J Surg* 2007;94:333–40.

Harms BA, Hamilton JW, Yamamoto DT, Starling JR. Quadruple-loop (W) ileal pouch reconstruction after proctocolectomy: analysis and functional results. *Surgery* 1987;102(4):561–7.

Heikens JT, de Vries J, van Laarhoven CJ. Quality of life, health-related quality of life and health status in patients having restorative proctocolectomy with ileal pouch-anal anastomosis for ulcerative colitis: a systematic review. *Colorectal Dis* 2012;14(5):536–44.

Keighley MR, Yoshioka K, Kmiot W, Heyen F. Physiological parameters influencing function in restorative proctocolectomy and ileo-pouch-anal anastomosis. *Br J Surg* 1988;75(10):997–1002.

Lazorthes F, Fages P, Chiotasso P, Lemozy J, Bloom E. Resection of the rectum with construction of colonic reservoir and coloanal anastomosis for carcinoma of the rectum. *Br J Surg* 1986;73:136–8.

Lindquist K. Anal manometry with microtransducer technique before and after restorative proctocolectomy. Sphincter function and clinical correlations. *Dis Colon Rectum* 1990;33(2):91–7.

Lovegrove R, Heriot AG, Constantinides V, *et al.* Meta-analysis of short-term and long-term outcomes of J, W and S ileal reservoirs for restorative proctocolectomy. *Colorectal Dis* 2007;9(4):310–20.

Lovegrove RE, Constantinides VA, Heriot AG, *et al.* A comparison of hand-sewn versus stapled ileal pouch anal anastomosis (IPAA) following proctocolectomy: a meta-analysis of 4183 patients. *Ann Surg* 2006;244:18–26.

Martin L, Fischer JE. Preservation of anorectal continence following total colectomy. *Ann Surg* 1982;196:700–4.

McGuire BB, Brannigan AE, O'Connell PR. Ileal pouch–anal anastomosis. *Br J Surg* 2007;94:812–23.

Nasmyth DG, Williams NS, Johnston D. Comparison of the function of triplicated and duplicated pelvic ileal reservoirs after mucosal proctectomy and ileoanal anastomosis for ulcerative colitis and adenomatous polyposis. *Br J Surg* 1986;73(5):361–6.

Nicholls J, Pescatori M, Motson RW, Pezim ME. Restorative proctocolectomy with a three-loop ileal reservoir for ulcerative colitis and familial adenomatous polyposis. Clinical results in 66 patients followed for up to 6 years. *Ann Surg* 1984;199(4):383–8.

Nicholls RJ, Lubowski DZ. Restorative proctocolectomy: the four loop W reservoir. *Br J Surg* 1987;74:564–6.

Nicholls RJ, Pezim ME. Restorative proctocolectomy with ileal reservoir for ulcerative colitis and familial adenomatous polyposis: a comparison of three reservoir designs. *Br J Surg* 1985;72:470–4.

O'Connell PR, Pemberton JH, Brown ML, Kelly KA. Determinants of stool frequency after ileal pouch-anal anastomosis. *Am J Surg* 1987;153(2):157–64.
Oresland T, Fasth S, Nordgren S, Akervall S, Hultén L. Pouch size: the important functional determinant after restorative proctocolectomy. *Br J Surg* 1990;77(3):265–9.
Oresland T, Fasth S, Nordgren S, Hulten L. The clinical and functional outcome after restorative proctocolectomy. *Int J Colorectal Dis* 1989;4:50–6.
Parc R, Tiret E, Frileux P, Moszkowski E, Loygue J. Resection and coloanal anastomosis with colonic reservoir for rectal carcinoma. *Br J Surg* 1986;73(2):139–41.
Parks A, Nicholls RJ. Proctocolectomy without ileostomy for ulcerative colitis. *Br Med J* 1978;2:85–8.
Parks AG, Nicholls RJ, Belliveau P. Proctocolectomy with ileal reservoir and anal anastomosis. *Br J Surg* 1980;67(8):533–8.
Pescatori M, Manhire A, Bartram CI. Evacuation pouchography in the evaluation of ileoanal reservoir function. *Dis Colon Rectum* 1983;26(6):365–8.
Sofo L, Caprino P, Sacchetti F, Bossola M. Restorative proctocolectomy with ileal pouch-anal anastomosis for ulcerative colitis: a narrative review. *World J Gastrointest Surg* 2016;8(8):556–63.
Stryker SJ, Kelly KA, Phillips SF, Dozois RR, Beart RW Jr. Anal and neorectal function after ileal pouch-anal anastomosis. *Ann Surg* 1986;203(1):55–61.
Taylor BM, Cranley B, Kelly KA, Phillips SF, Beart RW Jr, Dozois RR. A clinico-physiological comparison of ileal pouch-anal and straight ileoanal anastomoses. *Ann Surg* 1983;198(4):462–8.
Tekkis PP, Lovegrove RE, Tilney HS, *et al.* Long-term failure and function after restorative proctocolectomy—a multi-centre study of patients from the UK National Ileal Pouch Registry. *Colorectal Dis* 2010;12(5):433–4.
Tulchinsky H, Hawley PR, Nicholls RJ. Long-term failure after restorative proctocolectomy for ulcerative colitis. *Ann Surg* 2003;238(2):229–34.
Utsunomiya J, Iwama T, Imago M, *et al.* Total colectomy, mucosal proctectomy and ileoanal anastomosis. *Dis Colon Rectum* 1980;23:459–66.
Wade A, Mathiason MA, Brekke EF, Kothari SN. Quality of life after ileoanal pouch: a comparison of J and W pouches. *J Gastrointest Surg* 2009;13:1260–5.
Wu XR, Kirat HT, Kalady MF, *et al.* Restorative Proctocolectomy With a Handsewn IPAA: S-Pouch or J-Pouch? *Dis Colon Rectum* 2015;58:205–13.

Chapter 33

Robotic Restorative Proctocolectomy

Meagan M. Costedio

INDICATIONS

Restorative proctocolectomy is a technique used to reestablish intestinal continuity in patients who require complete removal of the colon and rectum. The most common indications for surgery include inflammatory bowel disease (IBD), familial adenomatous polyposis (FAP), and hereditary nonpolyposis colorectal cancer (HNPCC). The most common indications for total proctocolectomy (TPC) with ileal pouch-anal anastomosis (IPAA) are ulcerative colitis (UC) refractory to medical management, inability to tolerate medications or patient preference not to be on long term medical treatment. Other indications are IBD-associated low-or high-grade dysplasia, which are associated with a 10–40% risk of cancer at the time of surgery. Total colonic Hirschsprung's disease is an example of a congenital indication for TPC. Crohn's colitis is a controversial indication for TPC/IPAA. In the setting of isolated colorectal Crohn's disease, pouch retention is 70–80% at 10 years with favorable quality-of-life scores, which is acceptable if performed with appropriate counseling.

Restorative proctocolectomy is also used to treat or prevent cancers in patients with colon cancer syndromes. TPC is indicated in patients with FAP with greater than 20 rectal polyps, or rectal polyps not amenable to endoscopic resection. This surgery is recommended when the patient is able to make an informed decision as long as he or she is asymptomatic and having yearly screening; teens to early twenties. Surgery should be performed sooner for symptoms, or high-grade dysplasia noted on endoscopic biopsy. For patients with Lynch syndrome or HNPCC, restorative proctocolectomy is offered after the development of a rectal cancer with positive genetic testing or multiple first-degree relatives with associated cancers. In the absence of rectal pathology, a total abdominal colectomy (TAC) with ileorectal anastomosis is appropriate.

Restorative proctocolectomy is commonly performed in a staged manner. A one-staged approach describes a TPC/IPAA without protective diverting loop ileostomy. This approach may potentially be cautiously used in highly selected, healthy, very well-informed patients. In the two-staged approach, the TPC/IPAA is performed with a diverting loop ileostomy, which is then reversed in a second operation in the absence of complications. The three-staged approach is most commonly used in medically refractory UC, obesity, or where the diagnosis is in question. This method entails a TAC with end ileostomy, followed by a completion proctectomy ileal pouch-anal anastomosis (CP/IPAA) with diverting loop ileostomy followed by closure of the loop ileostomy. The modified two-staged approach includes the first staged TAC with end ileostomy, followed by CP/IPAA without diverting ileostomy.

Staging is at the discretion of the surgeon taking into consideration the comorbidities of the patient. Preoperative factors of malnutrition, high-dose steroid use, or failure of biologic therapy lead to a two-or three-staged approach. A diverting loop ileostomy is commonly used even in healthy patients, as the sequelae of anastomotic leakage at the pouch-anal anastomosis are significant and have permanent adverse functional consequences. If patients with UC or Crohn’s disease develop dysplasia, either low or high grade, TPC/IPAA with high ligation of all vessels is recommended. A one-staged approach may potentially be considered for patients with FAP or HNPCC who are in good health and/or patients in whom the surgical indication is dysplasia or cancer who are not immunocompromised.

The minimally invasive approach to either the colectomy or the proctectomy is associated with decreased morbidity as well as improved fecundity in female patients with IBD. Data suggest that the robotic approach may take longer and cost more, but is safe with a potential decrease in conversion to open surgery. The robot is beneficial with the proctectomy, possibly decreasing the rate of conversion to open. The new generation of equipment allows multiquadrant surgery and a robotic colectomy is possible. This approach appears to be safe to perform this operation.

CONTRAINDICATIONS

Crohn's disease with known active small bowel and/or perianal involvement is an absolute contraindication for restorative proctocolectomy. Patients with preoperative continence issues should have extensive counseling and consider permanent stoma. In the setting of distal rectal cancer, an intersphincteric resection is an absolute contraindication to IPAA. Pouch radiation is contraindicated because of significant functional issues with radiation enteritis. Obesity is another relative contraindication to restoration of continuity, because the small bowel mesentery often will not reach to the perineum. There is no clear-cut body mass index that precludes IPAA. Mesenteric shortening depends on the morphology of the patient. Consent should be obtained from obese patients and they should be educated about the strong possibility of a three-stage procedure or a permanent ileostomy because of their anatomy.

PREOPERATIVE PLANNING

The most important portion of preoperative planning is the consent process in patients with IBD. It is important to describe all of the risks and benefits and possible complications of the procedure. Consent requires mention of the possibility of a permanent stoma, subsequent diagnosis of Crohn's disease, impotence, decreased fecundity, and pouchitis. It is also important to discuss the practical implications of living with a J-pouch. The average patient will have six to eight bowel movements per day, with good continence and decreased urgency. It is imperative to have trained stoma site marking and education, optimally with a stoma nurse. Nutrition is optimized as much as possible, although that can be very difficult with IBD. It is also helpful to have patients and their families speak with patients who have J-pouches.

Once the patient understands the ramifications of this procedure, the operative staging is decided and for patients with IBD the plan for the immunosuppressant medications is created. When patients are acutely ill in the hospital and the total colectomy is urgently performed, stress-dose intravenous (IV) steroids are given, which are then weaned down to the preoperative home dose at the time of discharge. When the patient presents on an elective basis, steroids can be weaned down by 5 mg/week until symptoms are intolerable. It is crucial that the patients understand that malnutrition is just as dangerous as the medications, so it is not beneficial to wean or stop immunosuppressant medications if symptoms are severe. Locally active medications are continued until the time of surgery. Biologics are stopped if symptoms are not improved with use. If symptoms are helped with biologics, it is beneficial to wait a minimum of four to five half-lives of the medication if possible to perform the operation. If patients are dependent on these medications, it is best to perform surgery at the time of the next scheduled dosing. 6-mercaptopurine, azathioprine, and methotrexate can be continued up to the time of surgery.

A complete comprehensive history and physical examination is performed with particular attention to the anal exam looking for signs of Crohn's disease. Particular attention should be directed to the discussion of immunomodulator medications, nutritional issues, history of blood clots or anesthetic issues. Preoperative labs including complete metabolic panel (CMP), complete blood count, and type and screen should be checked. The CMP is important to evaluate liver function because UC can be linked to primary sclerosing cholangitis. If malnutrition is a concern, a prealbumin is a good measure of acute malnutrition. A chest X-ray, electrocardiogram, and/or pregnancy test should be performed in appropriate patients. For patients with cancer, appropriate preoperative staging and carcinoembryonic antigen test should be performed before any procedure. If radiation is being considered in patients with rectal cancer, it should be given before surgery.

The nontoxic patient is given an oral cathartic and oral antibiotic bowel preparation. If patients are having copious liquid bowel movements because of IBD, clear liquids the day before surgery will suffice. The patient is asked to perform a Hibiclens rinse the night before as well as the morning of the surgery. Prophylactic heparin or Lovenox is injected subcutaneously before the surgery. One dose of an antibiotic that covers gram-negative as well as gram-positive bacteria is given within 1 hour of the incision, and not continued postoperatively. If steroids were taken within 6 months of the operation, a stress dose of steroids is given before incision.

SURGERY

Positioning

The patient is positioned on the operating room table in the modified lithotomy position with both arms tucked and the patient fixed to the table at the chest and the stirrups. The anus should be positioned off the end of the table. The hips are close to the straight position so that the knees do not interfere with the robotic arms. If the plan is for a total colectomy or double-stapled J-pouch creation, split leg extenders are a good alternative. Split leg extenders allow the surgeon access to the upper quadrants of the abdomen without interference from the stirrups and knees, although access to the perineum is difficult. A warming device is applied across the chest after fixation, and an orogastric tube and urinary catheter are placed. Sequential compression devices (SCDs) are started before induction of anesthesia.

The robot should be set up in a large operating theater, which should be able to accommodate the added equipment. The surgeon cart can be located in any area of the room with added space. The vision cart is usually placed to the left of the patient near the head close to the energy device console so that energy can be transferred quickly. Added laparoscopic monitors are required and should be placed opposite the vision cart. The assistant is seated to the right side of the patient, with the scrub nurse and instrument table to the right foot of the patient (Fig. 33-1). Starting a robotic program is labor intensive because the surgeon, nurses, assistants, and scrub technicians require hands-on training. It is beneficial to have a mechanical expert for the robotic system available for assistance with setup as well as equipment malfunctions.

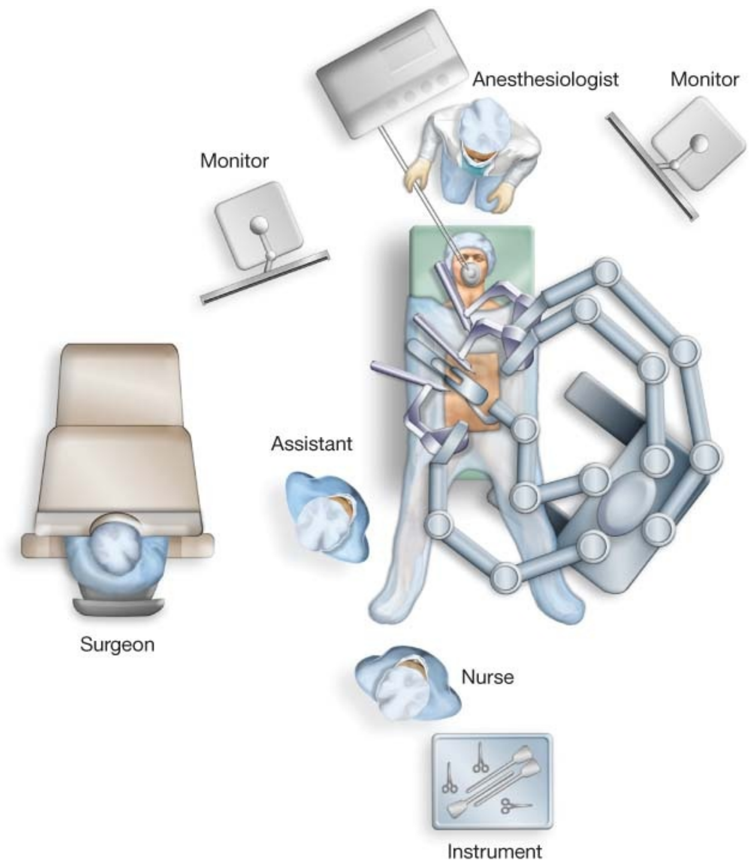


FIGURE 33-1 Room setup for da Vinci SI.

Technique

A common misconception regarding the use of robotics in colorectal surgery is that the robot changes the procedure from the laparoscopic approach. The robot is another tool in the surgeon's toolbox to allow the surgeon complete the surgery in a minimally invasive manner. The port placement may be different when using the robot, but the surgical approach is the same based on the surgeon. This chapter focuses on port placement and instrument choices specific to the most common robotic platforms.

Robotic Systems

The current systems available are the daVinci S, SI, and XI models (Intuitive Surgical, Sunnyvale, CA). The S and SI are older models and are very good for surgeries that focus on one or two quadrants of the abdomen. The XI is a more recent model that is specifically designed for multiquadrant procedures with minimal redocking. Table 33-1 demonstrates the major differences between the systems. A key difference between the systems is that the XI camera can be placed through any of the 8-mm ports, and it also autofocuses. The room setup is similar to the S/SI as far as the surgeon's console and the vision cart. The patient cart is docked 90 degrees directly to the left or right of the patient depending on the operation (Fig. 33-2). A movable operating table can be connected with the system and then the patient position can be adjusted at any point of the operation even while the robot is docked.

TABLE 33-1 Differences in Robotic Systems

da Vinci Surgical System	S (2006)	Si (2009)	Xi (2014)
3D HD camera 12 mm	✓	✓	
3D HD camera 8 mm			✓
Four arms	✓	✓	✓
EndoWrist instrumentation	✓	✓	✓
8-mm ports	✓	✓	✓
FireFly		✓	✓
Single site		✓	✓
Skills simulator		✓	✓
Dual console		✓	✓
Suction/irrigation		✓	✓
Stapler		✓	✓
Vessel sealer		✓	✓
5-mm ports			✓
Multiquadrant access			✓

FIGURE 33-2 Photo of patient cart placement for da Vinci XI. The remainder of the room setup remains similar to SI.

S/SI: Port Placement, Positioning, and Instruments

It is possible to robotically perform a colectomy with the SI, but it is difficult because of the limitations of the robot in reaching multiple quadrants. The authors' preference is to laparoscopically perform the colectomy and use the robot for the proctectomy. Port placement for robotic completion proctectomy is surgeon dependent, but the author's preferred method is as follows: a 12-mm balloon port is placed through the umbilicus using a Hasson technique. Eight-mm robotic ports are placed in the right and left lower quadrant in the midclavicular line. The right-sided port can be adjusted to be included in the stoma site if there is 5–8 cm of space from the umbilical port. A third 8-mm robotic port is placed in the left anterior axillary position more in line with the umbilical port and a 5-mm assistant port can be placed in the corresponding position in the right anterior axillary line (Fig. 33-3). In an obese patient with difficult anatomy, a second 5-mm assistant port can be placed in the right upper quadrant. The patient cart is docked at a 45-degree angle to the left foot of the bed (Fig. 33-1). The patient table is tilted in the Trendelenburg and right side down position until the small bowel is adequately retracted. The robot is then docked and the arms are directed to the pelvis under direct vision. Arm 1 is docked to the right lower quadrant (RLQ) port with the monopolar scissor. Arm

2 is docked to the left lower quadrant midclavicular line port with the bipolar fenestrated grasper. Arm 3 is docked to the left anterior axillary line port with an atraumatic grasper (Fig. 33-4). The vessel-sealing device is available with the SI; but because the major vessels were taken during the first operation, it is an unnecessary added expense for this procedure. The assistant sits to the right side of the patient and uses a bowel grasper or suction irrigator. If a second assistant port is utilized, the left hand of the assistant will retract the rectum with either a tie around the rectum, or a bowel grasper. The right hand of the assistant can retract in the pelvis and suction cautery smoke and fluid.

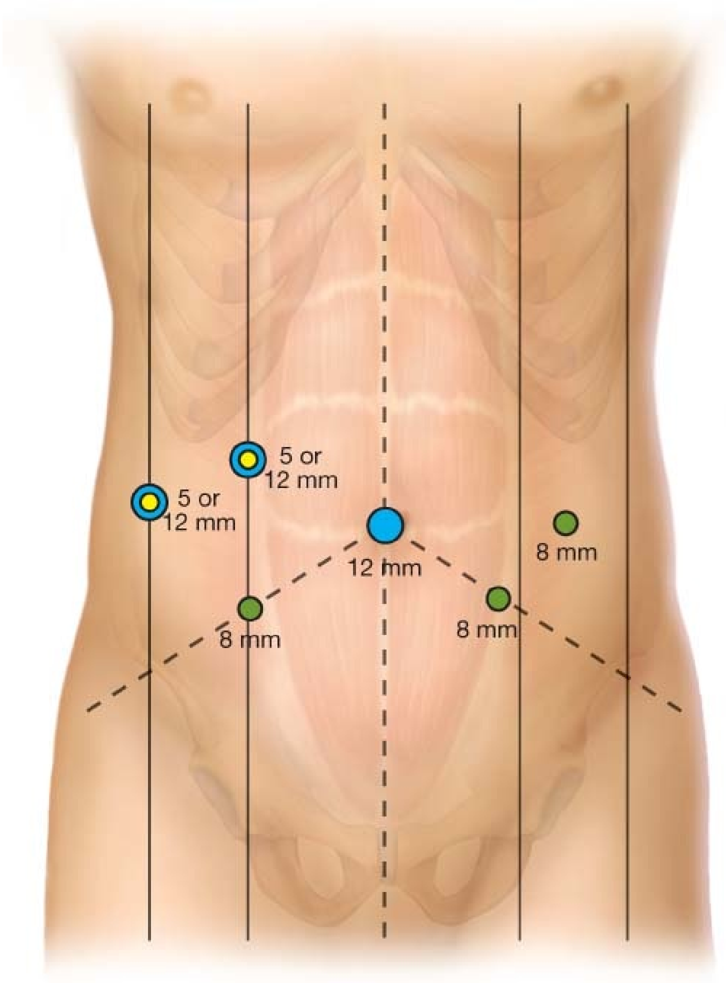


FIGURE 33-3 Completion proctectomy port placement using da Vinci SI. Monopolar scissors are used in the right lower quadrant, bipolar fenestrated grasper in the left midclavicular line port and Cadiere forceps in the left axillary line port.

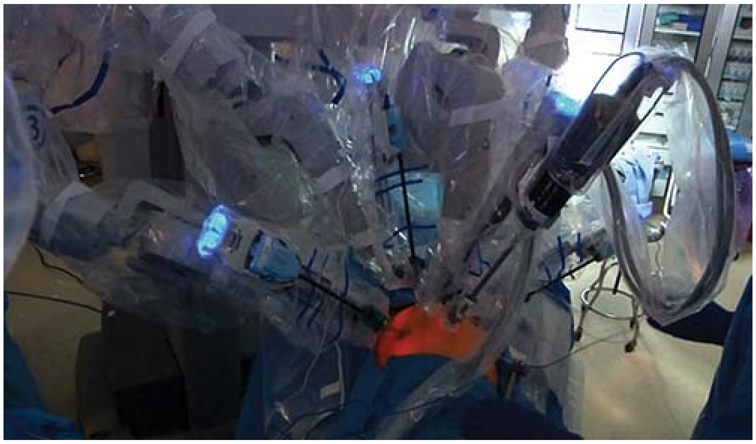


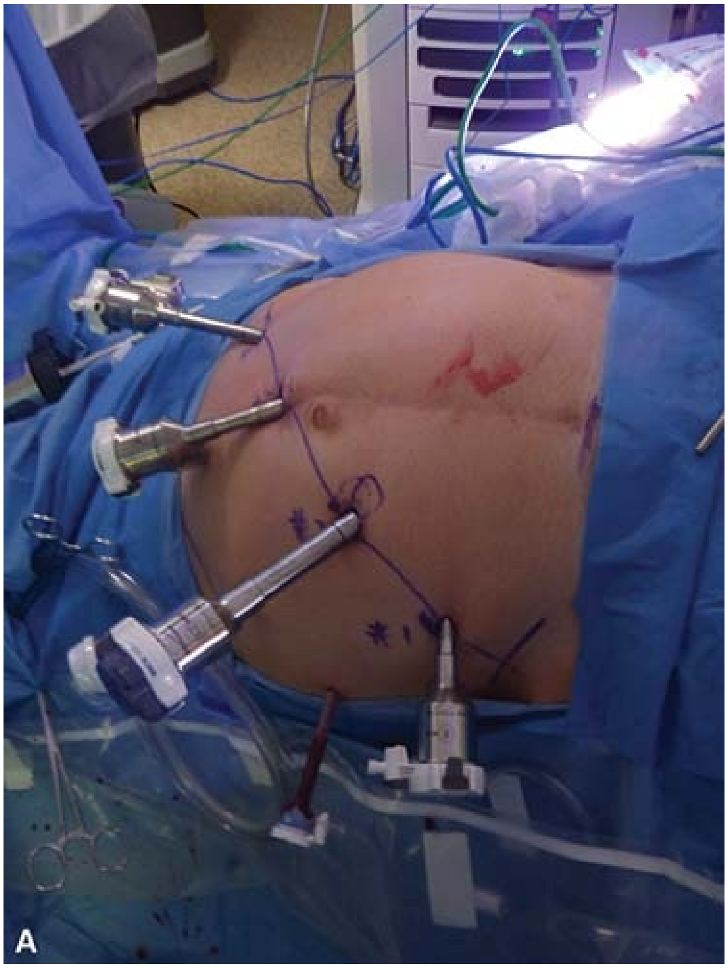
FIGURE 33-4 da Vinci SI docked for completion proctectomy with instruments in place.

p. 320

p. 321

XI: Port Placement, Positioning, and Instruments

The port placement is significantly different from that described with the SI. There are two options for this procedure: an angled or straight port placement. For the angled approach, an 8-mm port is placed in the right iliac fossa, and a straight line is drawn to the left midclavicular line at the costal margin. The remaining three 8-mm ports are best located below and to the right of the umbilicus; possibly the stoma site, above and to the left of the umbilicus and in the left upper quadrant optimally 8 cm apart. A 5-mm assistant port is placed in the right anterior axillary line (Fig. 33-5A). One of the right-sided ports, optimally the port at the stoma site, can be changed to a 12-mm port with a reducer to allow either the laparoscopic or robotic stapler. If added retraction is necessary, a wound protector or single port device can be placed through the stoma site to allow stapling as well as an added port for retraction.


A

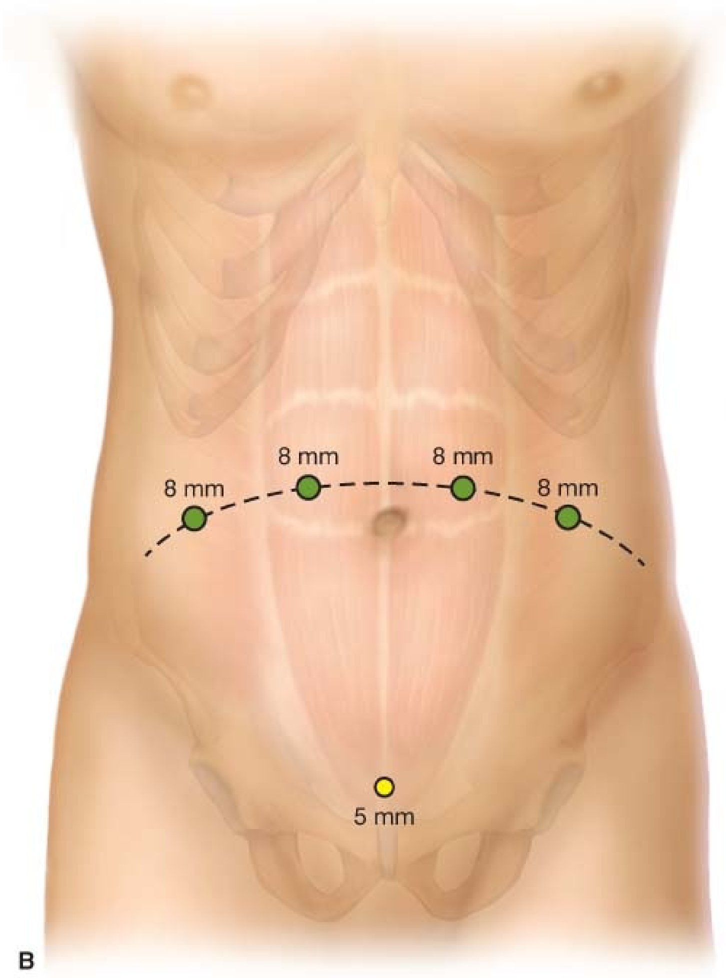


FIGURE 33-5 A. Angled completion proctectomy port placement for da Vinci XI. B. Straight completion proctectomy port placement for da Vinci XI.

In the straight arrangement, 8-mm ports are placed in a slightly curved line across the mid abdomen spaced 5–8 cm apart (Fig. 33-5B); a 5-mm suprapubic assistant port is placed. For both of the port placement strategies, the robot is driven in from the left lateral position and the laser crosshairs are set for the port that will house the camera (Fig. 33-6). The patient is placed in the left side down and Trendelenburg position if the surgery is to start at the right colon, and the camera is inserted. The scope is pointed at the hepatic flexure and "targeting" is performed. The boom is then adjusted to the correct configuration for the ileocolic ligation and hepatic flexure takedown and the arms are docked. A monopolar scissor or vessel-sealing device is used through the arm docked in the left upper quadrant, and the camera is placed through the next port. The next arm is docked to the third port in line from left to right with a fenestrated bipolar forceps, and a Cadiere forceps is utilized in the RLQ port.

FIGURE 33-6 XI docking with laser crosshairs over the camera port.

p. 321

p. 322

The robot can be reconfigured for the splenic flexure as well as the pelvis, which changes the boom and arm directions. The monopolar scissor or vessel-sealing device is inserted through the RLQ port, the camera through the next port, the bipolar fenestrated grasper through the third port, and the Cadiere forceps from the most left lateral port. A key difference between the systems is that the camera can be placed through any of the 8-mm ports; therefore, the instruments can be changed giving the right rather than the left hand two instruments.

p. 322

p. 323

General Principles

The author prefers the medial-to-lateral approach to robotic colectomy. The small bowel is retracted toward the patient's head with the terminal ileum in the pelvis. The ileocolic pedicle is lifted, dissected, the duodenum is identified, and the vessels are controlled with the vessel-sealing device, or clip.

The plane between the posterior aspect of the mesentery and the retroperitoneum is bluntly developed to the hepatic flexure in a lateral dissection. The cecum and terminal ileum are retracted cephalad, the prior defined plane is entered, and the lateral attachments are divided with cautery or the vessel-sealing device. At this point, the small bowel mesentery is dissected free from the retroperitoneum up to the duodenum to maximize the J-pouch reach.

The robot is undocked and the table is moved into the reverse Trendelenburg position, after which the robot is redocked with the instruments in the same position, after which the robot is redocked with the instruments in the same orientation. The hepatocolic attachments are divided. In the case of cancer, the lesser sac is entered and the lesser omentum is dissected from the colon. The omentum may be resected with the specimen at this step or spared. The mesentery of the transverse colon can then be taken in a high ligation with care not to injure the fourth portion of the duodenum at the ligament of Treitz. In the case of benign disease, the lesser omentum and transverse colonic mesentery can be simultaneously divided with the vessel-sealing device close to the colonic wall. In benign disease, the splenic flexure is reduced by dividing the omental attachments followed by the splenocolic attachments. Once Gerota's fascia is encountered, the left colon mesentery can be bluntly dissected free. The colon is medialized and the mesentery is taken along the left and sigmoid colon after identification of the left ureter.

In oncologic cases, the author prefers to take the left-sided vessels from the medial-to-lateral position. The robot is again undocked and the patient is returned to the Trendelenburg position. The inferior mesenteric artery (IMA) is identified and the right-sided peritoneum is scored with the cautery. The inferior hypogastric nerves are swept posteriorly and the left ureter is identified. The IMA is isolated and carefully divided in a high ligation. The posterior aspect of the left colonic mesentery is bluntly swept from the retroperitoneum and Gerota's fascia and the inferior mesenteric vein is taken. The mesenteric dissections meet and the colon is completely freed from the splenic flexure.

The robot is undocked and the table is placed in the steep Trendelenburg position. The boom of the patient cart is turned so that the robot is directed toward the pelvis. The posterior presacral plane is dissected whether or not the procedure is being performed for cancer. The plane is avascular and this leaves room for the pouch. The posterior plane is dissected down to the levator muscle and the peritoneum is bilaterally scored and around the anterior peritoneal reflection. Except in cases of anterior cancers, the dissection continues to the pelvic floor posterior to Denonvilliers' fascia. Once the dissection reaches the pelvic floor circumferentially, the dissection is complete. The author prefers a double-stapled configuration in most cases because of improved function. A mucosectomy and hand-sewn IPAA is an option in cases of dysplasia of the anal mucosa, high polyp burden of the anal canal, or stapler failure.

The RLQ port that will become the ileostomy site is enlarged to a 12-mm port. Either a robotic stapler or an articulating laparoscopic stapler can be used. It is difficult to maneuver a 60-mm stapler even in a large pelvis. The author chooses to use a 45-mm stapler that usually requires one reload to complete the staple line. The rectum is then grasped and the 12-mm port site is enlarged. The anterior rectus sheath is vertically scored, the muscles are split, and the posterior sheath is scored. A wound protector is placed and the entire colon and rectum are removed through this site.

J-Pouch Creation

Two important requirements for any J-pouch are adequate reach and vascular supply. Tricks for maximizing the reach of the pouch to the anus include taking a tethering vessel and/or scoring the mesentery (Fig. 33-7). If a restorative proctocolectomy is being performed for dysplasia or cancer, then high ligation of the ileocolic and middle colic arteries and the IMA are required. When surgery is performed for refractory IBD, high ligation of the vessels is not necessary. The J-pouch can survive from either the terminal branch of the superior mesenteric artery (SMA) or the ileocolic pedicle. If vascular ligation is required for reach, the author chooses to have the pouch vascular supply routinely coming from the last branch of the SMA (Fig. 33-7).

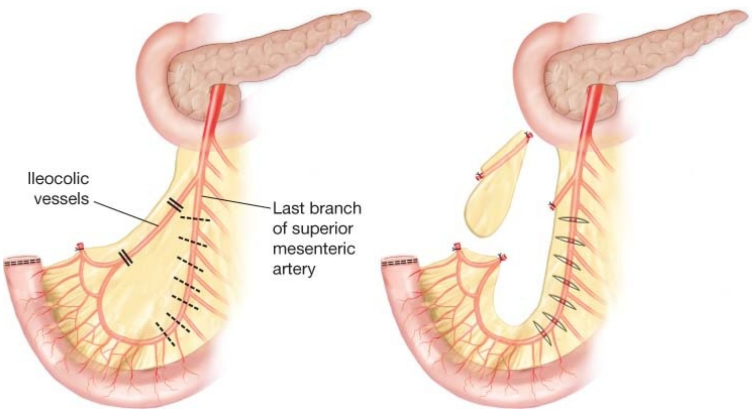


FIGURE 33-7 Small bowel mesentery with vascular supply and mesenteric scoring.

The small bowel is extracted through the wound protector and transected just proximal to the ileocecal valve in benign disease. The bowel is then angulated to create a 15-to 18-cm pouch. The bottom of the J-pouch is then brought down toward the pelvis. If it reaches the pubic tubercle, it will usually reach the anal canal because it is stretched through the abdominal wall to get through the stoma site. An enterotomy is made at the point of maximal reach and two to three firings of a 100-mm linear stapler are performed to create the pouch. The tip of the J-pouch is stapled and oversewn and the pouch is assessed for leaks with saline and or betadine (Fig. 33-8). A circular stapler anvil is purse stringed in place through the enterotomy and the pouch is returned to the abdominal cavity.

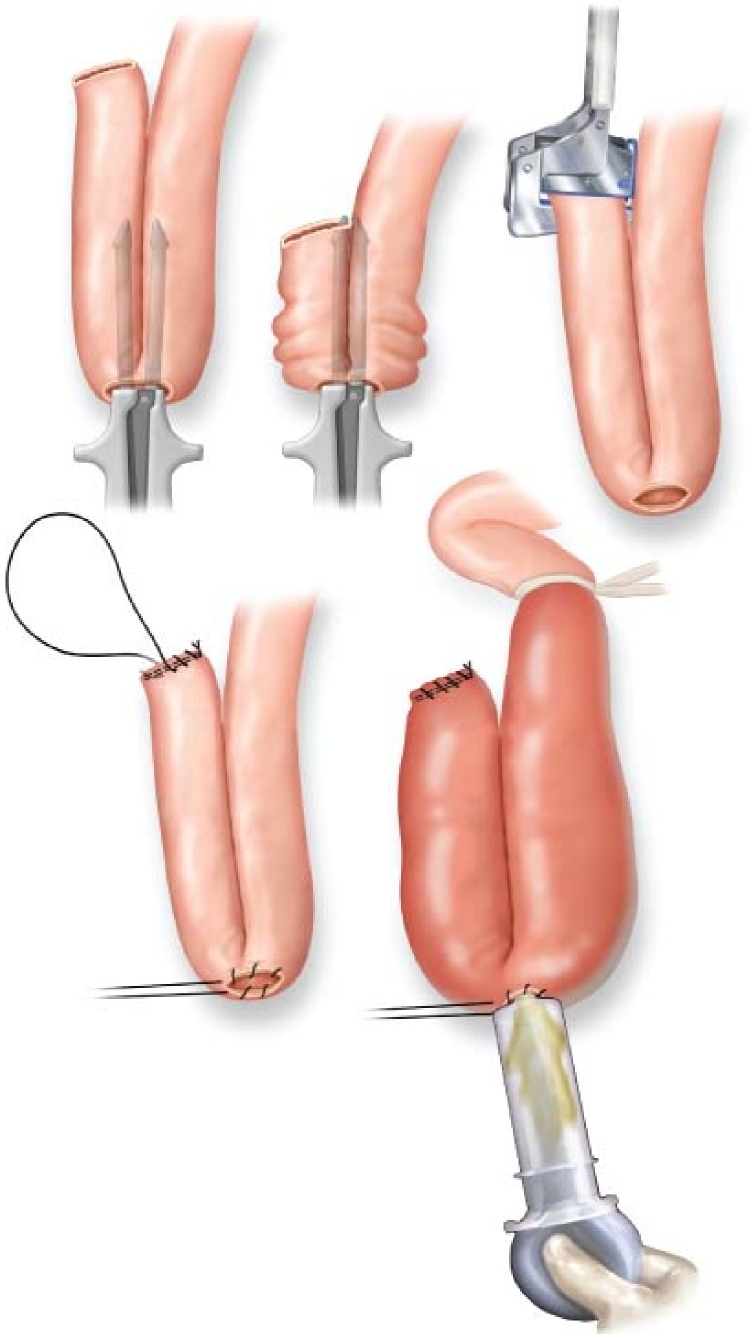


FIGURE 33-8 J-pouch creation.

The author completes the anastomosis under laparoscopic guidance. The patient is placed in the left side down and Trendelenburg position and the mesenteric orientation is ensured to be straight. A twist in the mesentery is a catastrophic complication that could lead to ischemia of the pouch. The circular stapler is carefully introduced through the anus; in women, it is imperative to make sure that the posterior wall of the vagina is dissected free from the rectum.

The spike is opened at the posterior aspect of the staple line and the anvil is docked again ensuring correct mesenteric orientation. The stapler is fired and both donuts are checked to ensure completeness. After anastomotic creation, a flexible pouchoscopy is performed, the pelvis is filled with fluid, and the pouch is filled with air to check for leak. The pouch can also be checked for staple line bleeding. A drain is placed posterior to the pouch and a loop of small bowel approximately 15 cm from the pouch is chosen as the loop ileostomy and marked proximally and distally. The editor (SDW)'s preference is to utilize a more proximal location to facilitate subsequent ileostomy closure. The location of ileum selected should be based on tension-free delivery rather than on mathematical calculation.

POSTOPERATIVE MANAGEMENT

The patient is admitted to the floor with maintenance IV fluids, intravenous narcotics, urinary catheter, and SCDs. The patient is mobilized the night of surgery and prophylactic anticoagulation is started the same night. The bladder catheter is maintained for 2 days, or the morning after surgery if rectal surgery was not performed, if urine output is adequate, and the patient is mobile. Clear liquids are started the night of surgery and diet is advanced as the stoma begins to function. The stoma nurse changes the appliance and starts ostomy teaching on postoperative day 1. If the patient was not taking steroids before surgery, but received a stress dose of steroids at the time of the surgery, then either the steroids are stopped postoperatively or rapidly weaned to off over 3 days. If the patient was on steroids preoperatively, IV steroids are weaned down to the preoperative oral dosing over 72 hours, and the patient is discharged on the preoperative dose which is weaned by 5 mg/week to off unless there is a history of adrenal insufficiency. If the patient was on IV steroids before surgery, then steroids are weaned down to 40 mg of oral prednisone, which is then weaned on a weekly 5 mg taper.

It is beneficial to have a nutritionist see the patient in the hospital to discuss hydration solutions and appropriate foods to prevent dehydration as well as obstruction at the stoma. There is also extensive teaching on measuring stoma output, and the use of diphenoxylate or loperamide for high stoma output in an attempt to prevent readmission related to dehydration.

COMPLICATIONS

The most common complications of restorative proctocolectomy are dehydration, urinary tract infection, wound infection, parastomal hernia, deep vein thrombosis, pulmonary embolus and portal vein thrombosis (PVT). With aggressive counseling, antidiarrheals, and outpatient follow-up, readmission can often be prevented with early identification of the first three complications mentioned. PVT is a common complication in patients with IBD who present with abdominal pain, ileus, and/or high stoma output with abdominal bloating; computed tomography (CT) scan is the best way to diagnose PVT. There is controversy over whether to treat this condition with anticoagulants, particularly when they are small or subsegmental. When the patient is having symptoms that are attributable to the clot, anecdotally the symptoms improve with treatment. The risk of impotence or retrograde ejaculation in men and decreased fecundity in women are lower with the minimally invasive approach.

The most lasting complication of restorative proctocolectomy is leakage. The pouch most commonly leaks at either the tip of the J-pouch or at the IPAA. The tip of the J-pouch leak is most often detected with CT scan and presents with an abdominal abscess rather than pelvic. This leak needs to be drained or repaired urgently or repaired before stoma closure because it is ischemic in origin, and will rarely heal without intervention. The IPAA leak is more damaging to the function of the pouch long term, but often can heal with drainage alone. This complication is best diagnosed by CT scan with rectal contrast. The best mode of drainage is by examination under anesthesia with drain placement through the anus into the defect. The drain is maintained for weeks to months and downsized every 6 weeks until it can be removed once the cavity is collapsed. The stoma is left in situ until the cavity is completely healed or down to a chronic tract that can be opened to the pouch.

A long-term complication of restorative proctocolectomy is pouchitis. Pouchitis can happen any time after pouch creation and can be treated with a 2-week course of antibiotics. Unfortunately, some patients develop refractory pouchitis, which is treated with probiotics, long-term antibiotics, and possibly immunosuppressant medications. Patients with refractory pouchitis may ultimately request a stoma with or without pouch excision.

RESULTS

Patients report an average of six to eight bowel movements per 24-hour period. The urgency associated with UC is alleviated by this operation, and patients are able to enjoy social activities again. Minor incontinence to liquid stool mostly at night affects 30% of patients. Half of the patients with pouchitis take antidiarrheal medications to regulate their bowels. Five percent of patients end up with a permanent stoma related to surgical complications, Crohn's disease, or poor function. Overall, 10–15% of patients who have a J-pouch for UC will ultimately be reclassified as having Crohn's disease. Ninety-five percent of patients with a J-pouch would recommend the surgery to someone else. The robotic approach appears to have recovery benefits similar to that of laparoscopy, and long-term functional outcomes are similar to those of open surgery and laparoscopy albeit at significantly increased cost associated with the robot.

CONCLUSIONS

Restorative proctocolectomy is a good option to maintain intestinal continuity in patients with UC, FAP, and cancer syndromes with acceptable quality-of-life outcomes. In appropriate patients, the minimally invasive approach has short-term recovery benefits. Currently the robot does increase cost, but if it enables the surgeon to complete the surgery minimally invasive fashion, there is a role for its use.

RECOMMENDED REFERENCES AND READINGS

Ahmed Ali U, Keus F, Heikens JT, *et al.* Open versus laparoscopic (assisted) ileo pouch-anal anastomosis for ulcerative colitis and familial adenomatous polyposis. *Cochrane Database Syst Rev* 2009;(1):CD006267.

Bemelman WA. Laparoscopic ileoanal pouch surgery. *Br J Surg* 2010;97:2–3.

Hartley JE, Fazio VW, Remzi FH, *et al.* Analysis of the outcome of ileal pouch-anal anastomosis in patients with Crohn's disease. *Dis Colon Rectum* 2004;47(11):1808–15.

Morelli L, Guadagni S, Di Franco G, *et al.* Use of the new Da Vinci Xi during robotic rectal resection for cancer: technical considerations and early experience. *Int J Colorectal Dis* 2015;30(9):1281–3.

Peterson CY, McLemore EC, Horgan S, Talamini MA, Ramamoorthy SL. Technical aspects of robotic proctectomy. *Surg Laparosc Endosc Percutan Tech* 2012;22(3):189–93.

Rencuzogullari A, Gorgun E, Costedio M, *et al.* Case-matched comparison of robotic versus laparoscopic proctectomy for inflammatory bowel disease. *Surg Laparosc Endosc Percutan Tech* 2016;26(3):e37–40.

Roviello F, Piagnerelli R, Ferrara F, Scheiterle M, De Franco L, Marrelli D. Robotic single docking total colectomy for ulcerative colitis: first experience with a novel technique. *Int J Surg* 2015;21:63–7.

PART VII

ABDOMINOPERINEAL RESECTION

Chapter 34

Open Abdominoperineal Resection

Wolfgang B. Gaertner and Genevieve B. Melton-Meaux

INDICATIONS/CONTRAINDICATIONS

Abdominoperineal resection (APR) is generally performed for patients who have rectal adenocarcinoma, but it may also be performed for benign conditions such as inflammatory bowel diseases or fecal incontinence and is sometimes appropriate for other anorectal and pelvic malignancies or as a salvage procedure for anal cancer. The technique discussed in this chapter is intended to achieve radical clearance of anorectal malignancies; more conservative techniques of APR used for benign conditions are not discussed here in detail. Both open and minimally invasive approaches are used for APR of rectal cancer and have been proved to be safe. The current role of minimally invasive techniques for proctectomy remains under study. This chapter focuses on the operative technique used during an open approach for APR. The principles and techniques described here are applicable with minor modifications to extended operations for rectal cancer such as en bloc sacrectomy, vaginectomy, or full pelvic exenteration.

The decision whether to perform anterior resection (AR) with colorectal anastomosis versus an APR and permanent colostomy is dependent on oncologic considerations, technical considerations, the surgeon's operative skills and experience, anticipated functional outcomes, and patients' desires. Important oncologic and technical considerations include preoperative level of the lesion in the rectum and, in particular, its relationship to the anal sphincter complex and levator ani muscles, pretreatment stage of the cancer including any local organ invasion or distant spread, histology predictors of poor outcome, threatened or involved margins, and the tumor response to neoadjuvant therapy. In general, obesity and the narrow male pelvis add to the technical challenges. Both open APR and AR curative-intent radical resections for rectal cancer use the same total mesorectal excision (TME) technique to mobilize the rectum with its mesorectum and achieve proximal, lateral, and radial margin clearance. Although a 2-cm distal mural margin has traditionally been recommended, a negative distal margin of 5 mm to 1 cm has shown similar oncologic results. Furthermore, a 5-cm distal mesorectal margin becomes impossible for patients undergoing radical resection of distal rectal tumors. The choice of APR versus

AR is primarily dependent on the surgeon´s ability to achieve a negative distal mural and mesorectal clearance and perform a reliable sphincter-preserving anastomosis. In general, the more distal the anastomosis is located, the higher the risk of anastomotic complications and poor function. Pelvic radiation also increases the risk of anastomotic problems and worsens functional outcomes. Although patients understandably may prefer a sphincter-preserving proctectomy to APR, they should be informed that sphincter preservation is not uniformly associated with better quality of life. It is generally counterproductive to compromise oncologic control in a heroic attempt to avoid a permanent colostomy because recurrences and poor functional results are associated with increased rates of cancer recurrence and poor quality of life. The ultimate decision whether to perform a sphincter-preserving proctectomy often relies on the intraoperative evaluation of the tumor once the rectum has been completely mobilized without risking "coning" if an APR is performed.

PREOPERATIVE PLANNING

Assessment and Staging

All patients with a newly diagnosed rectal cancer should undergo full clinical assessment as well as pretreatment staging with full colonoscopy; computed tomography (CT) of the chest, abdomen, and pelvis; magnetic resonance (MR) of the pelvis and a carcinoembryonic antigen level to assess the tumor and search for synchronous lesions and metastatic disease. A full discussion of this topic is beyond the scope of this chapter. A history of pain with defecation may be indicative of involvement of the anal sphincters, whereas tenesmus may suggest a large or possibly fixed tumor. It is important to assess preoperative bowel function, including the presence of fecal incontinence as well as baseline sexual and urinary function. For distal rectal cancers, digital rectal examination can define tumor size, location from the anal verge, relationship to the anorectal ring, orientation within the anal canal (anterior, posterior, left, or right), and relative fixation (fixed, tethered, or mobile). Confirmation of these characteristics and biopsy for histologic confirmation of the diagnosis of rectal adenocarcinoma may be achieved by either flexible sigmoidoscopy or rigid proctoscopy. The latter method is preferred by some surgeons as the most accurate method to assess precise distance and location of the lesion from the anal verge or dentate line. Complete colonoscopy is essential to exclude synchronous lesions or other colonic diseases.

Primary tumor staging has become increasingly important to determine whether neoadjuvant chemoradiotherapy is indicated. Although CT scanning is the mainstay for initial assessment of distant disease and is useful to assess gross pelvic abnormalities such as direct extension to adjacent organs, it is not adequate for primary rectal tumor staging. ERUS may be useful to stage early lesions and can be used to assess tumor depth within the rectal wall (T1 and T2) and enlarged mesorectal lymph nodes (N-stage). However, MR of the pelvis should be considered using a protocol specific for staging rectal cancer. Pelvic MR has several advantages as compared to ERUS: (a) it is less operator dependent; (b) it provides a larger field of view beyond a few centimeters of the tumor including the pelvic sidewall and other adjacent structures; (c) it is more accurate in assessing lymph node involvement; and (d) it provides anatomically relevant information to the surgeon. Not surprisingly, pelvic MR has become the preferred method for local staging of rectal cancer.

In the United States, most advanced mid and low rectal cancers with evidence of lymph node involvement and/or transmural spread of the primary tumor are treated with neoadjuvant chemoradiotherapy followed 8–12 weeks later by radical surgical resection. Tattooing the distal edge of the tumor is useful to guide the subsequent resection and selection of a distal margin should a complete clinical response to neoadjuvant therapy occur. The rationale for neoadjuvant therapy is to decrease the risk of local recurrence and thus improve survival. Postoperative adjuvant chemotherapy is generally used as well to decrease the risk of distant metastases. In many parts of the world, the North American approach is criticized for potentially overtreating many patients. Many other protocols in the world call for use of less morbid, short-course neoadjuvant radiotherapy followed by radical surgery or for radical surgery alone if preoperative MR suggests that TME can clear the rectal cancer adequately.

Role of the Multidisciplinary Team

Although the colorectal surgeon has the primary responsibility to assess and direct the treatment of a patient with rectal cancer, appropriate decision making to optimize outcomes is greatly enhanced by a multidisciplinary team focused on rectal cancer care. Preoperative consultation with other specialty colleagues to plan treatment, achieve optimal oncologic outcome with the least morbidity, and to implement a coordinated and safe operation is essential. For the majority of advanced stage rectal cancers, medical and radiation oncologists will oversee a course of neoadjuvant chemoradiation. If there is involvement of the genitourinary tract or sacrum, preoperative consultation with a urologist, neurosurgeon, or an orthopedic surgeon is advised. Patients with distal or mid rectal cancer should be seen preoperatively by an enterostomal therapist for counseling and marking of the abdominal wall for any potential stomas. In cases where it is not clear whether the procedure will be an APR versus AR and low anastomosis with a diverting ileostomy, both sides of the abdomen should be marked. Perineal wound closure may require plastic surgical consultation to plan a rotational myocutaneous flap. The new American College of Surgeons Commission on Cancer National Accreditation Program for Rectal Cancer Standards requires that every patient with rectal cancer is presented twice at the multidisciplinary tumor conference.

SURGERY

Special Surgical Considerations

Pelvic Floor Anatomy

APR requires that the surgeon be intimately familiar with the anatomy of the pelvis and, in particular, the pelvic floor and perineum (Figs. 34-1 and 34-2). The perineum is the area between the thighs extending from the pubis to the coccyx. Its upper boundary is the lower surface of the levator ani muscles. It is typically divided into an anterior urogenital region and a posterior anal region. The pelvic floor is a funnel-shaped, bilateral muscular plate that includes the three muscles of the levator ani (puborectalis, pubococcygeus, and iliococcygeus muscles) as well as the coccygeus muscle. The levator ani muscles are attached anteriorly to the pubis just lateral to the symphysis and posteriorly to the ischial spine. The puborectalis is a muscular loop without attachments to the coccyx with anterior fibers merging into the external sphincter. The pubococcygeus and iliococcygeus muscles arise from the arcus tendineus that extends from the pubis to the ischial spine. They insert on the ventral and lateral surfaces of the coccyx as well as into the anococcygeal raphe. The coccygeus muscle arises from the ischial spine and inserts into the lateral surface of the caudal part of the sacrum and the coccyx (Fig. 34-2). The pelvic floor muscles are covered by a parietal endopelvic fascial layer on their pelvic surface. The presacral Waldeyer’s fascia is a thickened part of the parietal fascia that covers presacral vessels and nerves and is attached to S3 and S4 sacral segments. Anteriorly, Denonvilliers’ fascia separates the rectum from the seminal vesicles and prostate (Fig. 34-3).

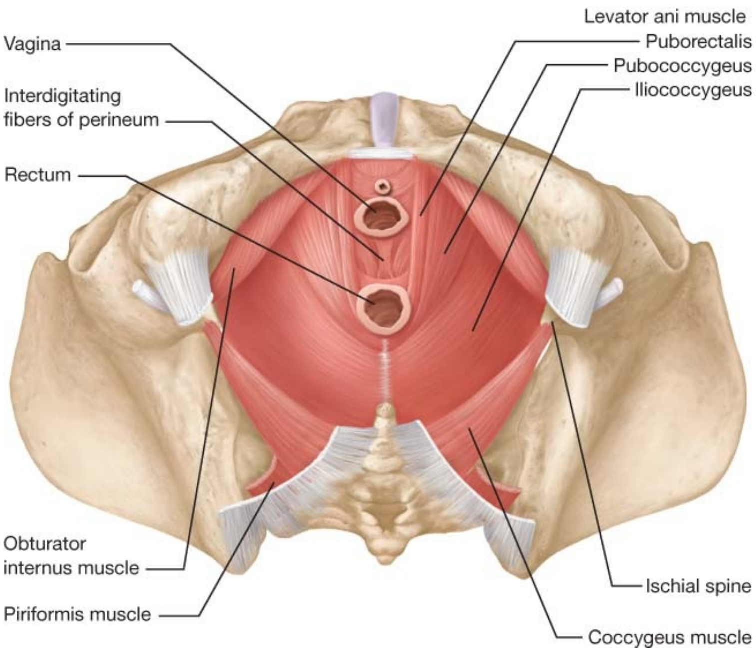


FIGURE 34-1 Caudal view of the pelvic floor muscles.

p. 329

p. 330

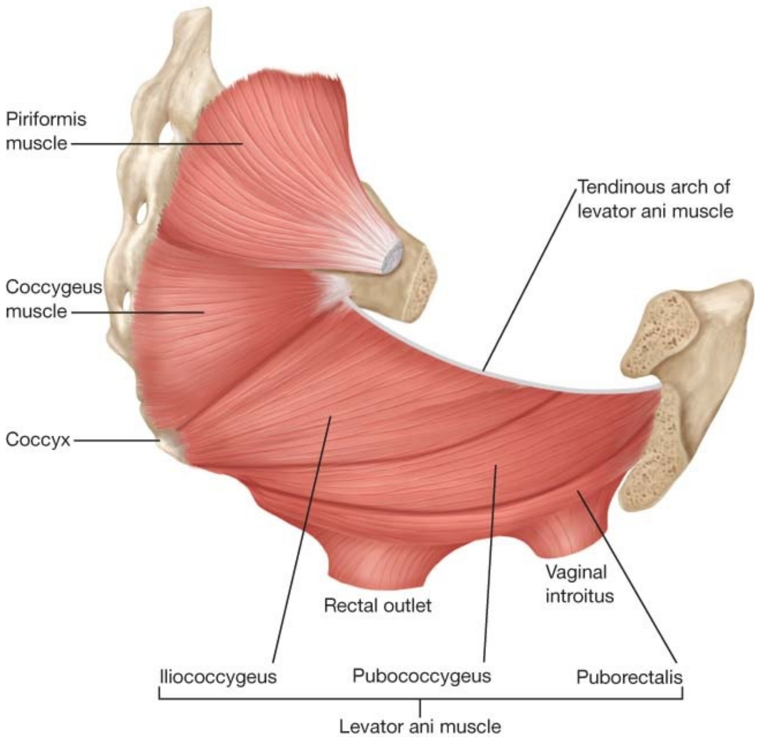


FIGURE 34-2 Lateral view of the pelvic floor muscles.

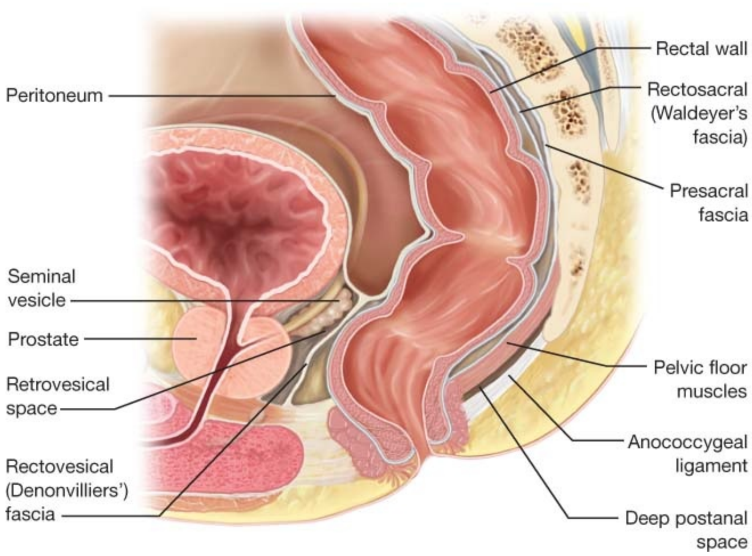


FIGURE 34-3 Lateral view of the parietal fascia in the pelvis (presacral, retrorectal, rectovesical).

Oncologic Insight—The "Waist"

Curative-intent APR is associated with higher rates of perforation, positive margins, and local recurrence than the rates observed after AR. These poor outcomes seem independent of tumor stage or size. Some authors have suggested that distal rectal cancers have a different biology and routes of spread compared to proximal lesions. For instance, 25% of transmural cancers in the distal half of the rectum have lateral pelvic lymph node metastases located well beyond the dissection plane followed by TME. Although this problem may explain some of the poor outcomes observed after APR, there is increasing concern that the poor results may be due in large part to anatomic and technical considerations not previously considered. Specifically, it has been suggested that the poor outcomes after APR are due to the close proximity of the cancer to the circumferential resection margin at the level of the anorectum distal to the levator muscle sling. As opposed to a more proximal rectal cancer that is surrounded by the mesorectum enveloped within the endopelvic fascial plane, cancer in the distal anorectum has no comparable tissue surrounding it (Fig. 34-4). Nagtegaal *et al.* assessed cancers <5 cm from the anal verge and found that there was little or no levator and sphincter muscles surrounding the specimen at the level of the cancer. This area has now been termed the “waist” in an APR specimen. Salerno *et al.* found that the location of the “waist” was between 35 and 42 mm proximal to the anal verge, a site that correlates with the puborectalis muscle.

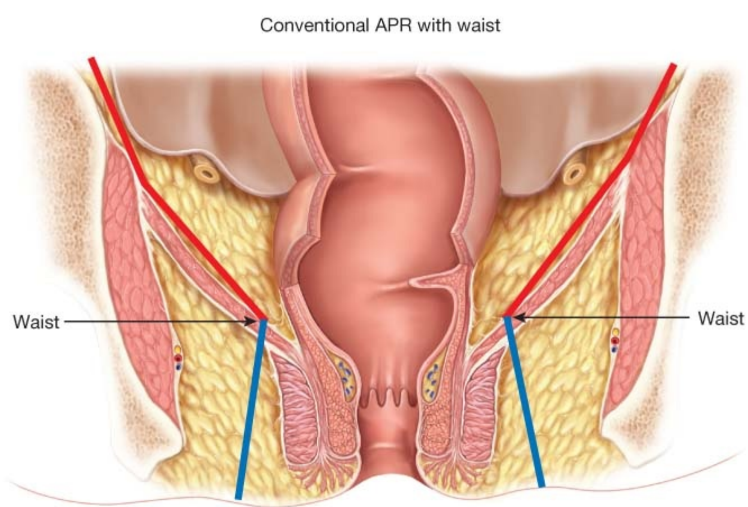


FIGURE 34-4 Conventional abdominoperineal resection (APR) dissection planes resulting in “waist.”

p. 330

p. 331

It is possible that a well-intentioned surgeon focused on performing a low anastomosis after TME for a distal rectal cancer may follow the mesorectum distally to the point where it thins and blends with the intersphincteric plane leaving almost no surrounding tissues on the cancer-bearing anorectum where it is excised, that is, at the "waist." This maneuver is thought to result in high local recurrence rates. We agree with others that it is reasonable to modify the technique for radical APR to eliminate the "waist" and improve oncologic outcomes. The modifications described in detail include (a) stopping the abdominal dissection at the proximal level of the levator muscles and then (b) performing a more radical perineal excision of the levators including the puborectalis. Thus, instead of following the levators distally and inward to the anorectal ring, the surgeon can purposefully dissect through the levators laterally along the sidewall and include the soft tissue around the proximal aspect of the anorectal ring as part of the intact APR specimen. When properly done, the specimen will appear as a "cylinder" rather than a "waist." Holm terms this modified technique of APR for distal rectal cancers as a "total ischioanal excision" (Fig. 34-5). Like Holm, the authors also believe that this modified technique is greatly facilitated by undertaking the perineal dissection with the patient in the prone jackknife position. The editors do not subscribe to this preference.

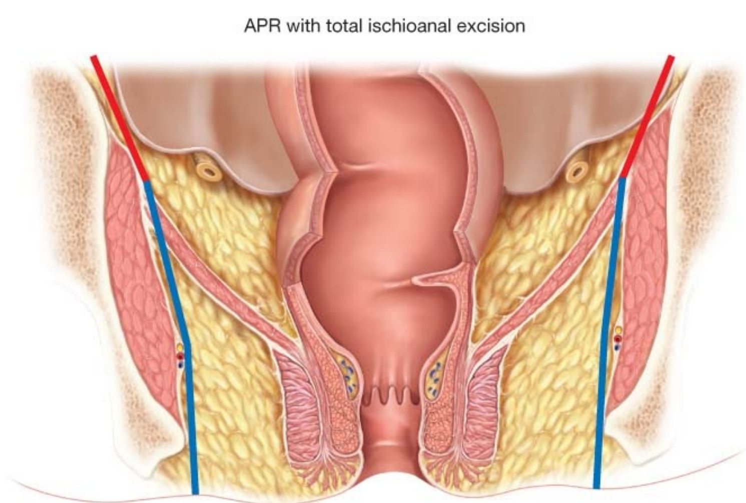


FIGURE 34-5 Suggested oncologic dissection planes with total ischioanal excision. APR, abdominoperineal resection.

Peter McDonald and John Northover recently recovered old films from the archives of St. Mark's Hospital in London, England, showing Percy Lockhart-Mummery performing a perineal excision, William Gabriel doing a perineoabdominal excision, and Oswald Lloyd-Davies undertaking a synchronous combined abdominoperineal excision of the rectum. In the films, after an extensive perineal incision and coccygectomy, the pelvis was cleared with lateral division of the levator muscles posterolaterally and the anterior dissection was carried up to the pouch of Douglas (Fig. 34-6). One wonders why modern surgeons abandoned this more radical perineal phase in favor of the more conservative “conventional APR dissection” that predisposes to “the waist” of an APR specimen. We speculate that the recent emphasis to do more distal low and ultralow anastomoses predisposed surgeons to alter what may be a key component of the deep pelvic dissection during an APR. Normally, when the dissection of a rectal cancer that is clearly amenable to resection and anastomosis reaches the level of the levators, the surgeon selects a site for division of the rectum such that there will be an adequate distal margin, thus leaving the levators intact. We suggest that modern surgeons inappropriately apply the same basic technique used for low AR to the pelvic dissection for APR. Thus, when the dissection reaches the level of the levators, they follow the pelvic floor inward close to the anorectal wall before again widening the dissection plane at the level of the ischiorectal fossas. This technique unintentionally creates the “waist” in the specimen. When this method is utilized for more distal rectal cancers at or near the level of the puborectalis, surgeons may increase the likelihood of local recurrence by not adequately clearing the soft tissues from the pelvis at the level of the cancer. Indeed, a less radical APR can be done using the intersphincteric plane (Fig. 34-7A). Such technique may be appropriate for APR for proximal and mid rectal cancers in patients with poor sphincter function or some other contraindication for a sphincter-preserving proctectomy and may be the preferred APR technique for benign diseases such as inflammatory bowel disease. However, for distal rectal cancers requiring APR, the surgeon is advised to consciously avoid the tendency to “cone in” on the dissection plane at the level of the levators. Conversely, the extralevator plane (Fig. 34-7B) may be appropriate and necessary for locally invasive distal rectal tumors to achieve a R0 resection.

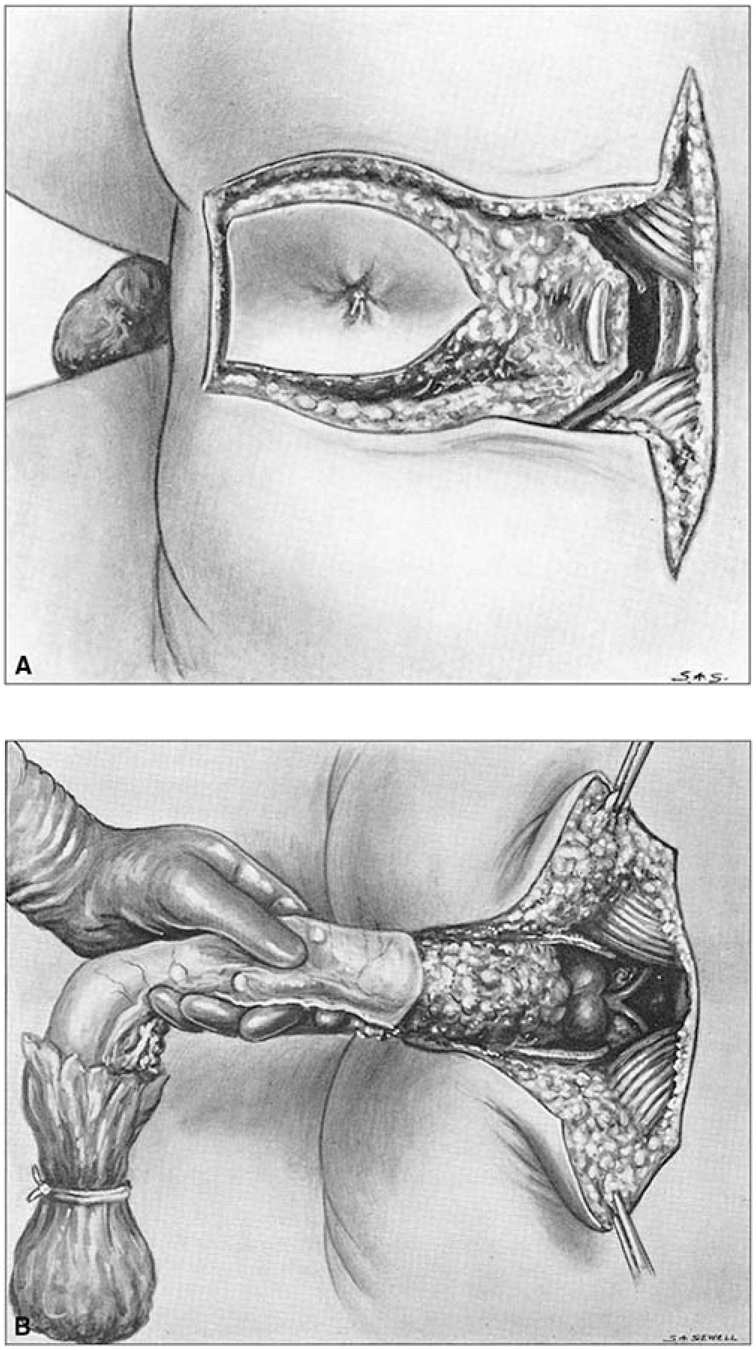


FIGURE 34-6 Drawings from St. Mark's hospital showing (A) extensive perineal dissection with coccygectomy and (B) completion of posterior and lateral dissection with delivery of specimen before proceeding with final anterior dissection.

(Courtesy of Dr. John Northover, St. Mark's Hospital.)

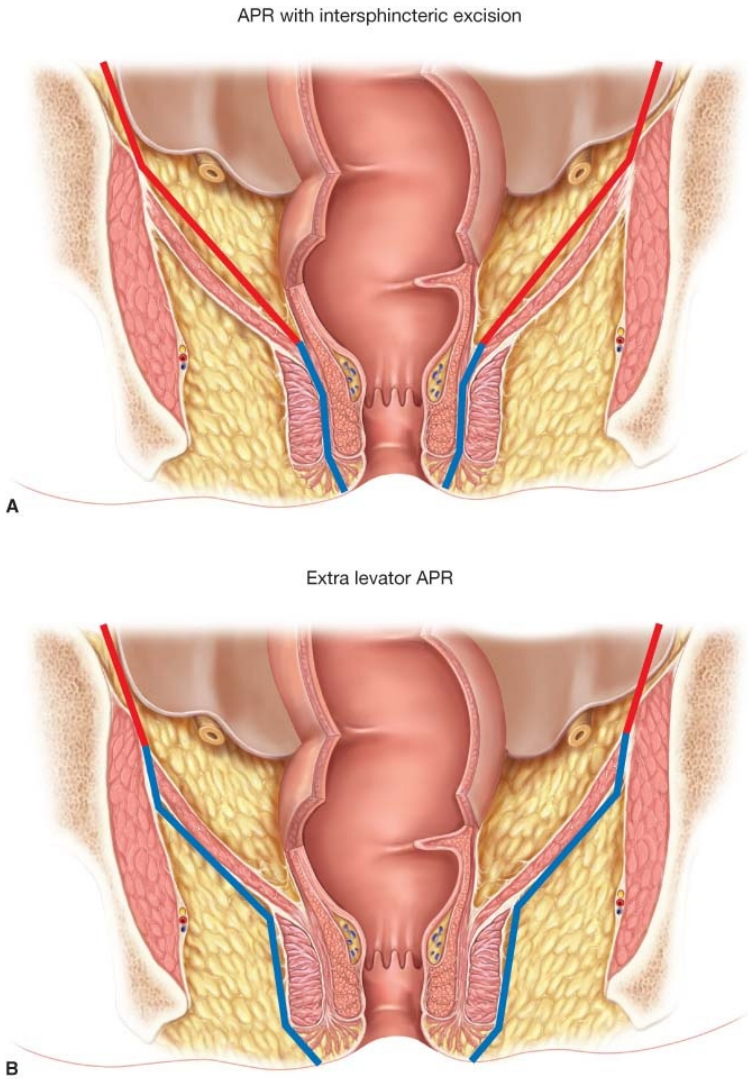


FIGURE 34-7 Anatomic depiction of (A) intersphincteric and (B) extralevator dissection planes.

p. 332

p. 333

Sequential versus Synchronous APR and Patient Positioning

APR includes abdominal and perineal phases, which may be done sequentially or synchronously. The perineal phase can be done in modified lithotomy, lateral, or prone jackknife position. The authors prefer the sequential approach beginning with the abdominal portion of the procedure with the patient in modified lithotomy position, followed by the perineal portion with the patient in the prone jackknife position. We find that this position greatly improves exposure of the perineal field and improves access for an assistant surgeon. This sequential approach is particularly helpful for obese or heavily muscled patients, those with a deep anal canal, those for whom a concomitant vaginectomy or sacrectomy is planned, and those with distal tumors where anterior and anterolateral clearance may be difficult to achieve. In cases where perineal wound closure is achieved by the use of a vertical rectus abdominis muscle flap, the patient is generally repositioned in modified lithotomy following the APR. Alternatively, the flap can be developed during the initial abdominal phase of the APR and left within the abdomen for subsequent retrieval after the APR. The main disadvantages of the sequential approach are not having simultaneous access to both operative fields, the time required to change positions, and the potential dangers associated with changing position of an anesthetized patient. If we anticipate that the rectal resection will be unusually difficult because of lateral fixation, we use the synchronous two-team technique. The patient is carefully positioned with the buttocks elevated on a pad such that the perineum extends over the edge of the operating table; retractors are used to spread the buttocks and to expose the anorectum.

Perineal Wound Management

Perineal wound complications are common after APR. They range in severity from minor to serious and occur both in the immediate postoperative period and during long-term follow-up. Radical APR results in a large pelvic “dead space” that predisposes to the development of postoperative pelvic seromas, hematomas, and abscesses, as well as to adhesive bowel obstruction as loops of intestine adhere to the presacrum deep in the pelvis. Neoadjuvant radiation and extended resections accompanying APR such as en bloc sacrectomy significantly increase the risk of perineal wound problems and make subsequent reoperation more hazardous. To minimize the risk of pelvic fluid collections, most surgeons routinely place a large closed suction drain in the pelvis. Many surgeons also routinely mobilize a pedicle of omentum and place it in the pelvis to fill the “dead space” and keep the small bowel from adhering to the distal sacrum. In the authors’ and editors’ experiences, this maneuver is rarely effective. Today, the authors and the editors increasingly utilize myocutaneous flaps such as the vertical rectus abdominis, gracilis, or gluteus flaps to fill the pelvis, to close large perineal defects, and simultaneously reconstruct the perineum and vagina. Rectus abdominis flaps have been widely reported with consistently good results. Although less widely reported, the use of bilateral gracilis flaps and inferior gluteal flaps both have good results when used for the perineum. The authors’ and the editors’ practices are to strongly consider the use of a myocutaneous flap in patients undergoing APR for rectal cancer in the setting of neoadjuvant radiation, extended or multivisceral resections, recurrent cancer, and in patients with additional comorbidities such as obesity, long-standing or poorly controlled diabetes mellitus, or smoking, which could adversely impact wound healing. The detailed use of such flaps is beyond the scope of this chapter.

Technique

Operative Preliminaries

Generally, outpatient mechanical bowel preparation is performed the day before the operation. In recent years, the need for a full bowel preparation has been questioned, although most colorectal surgeons in the United States still use at least a modified preparation such as enemas before radical surgery for rectal cancer. APR is usually performed under general anesthesia, and the use of an epidural catheter or bilateral transversus abdominis plane blocks with a long-acting anesthetic is highly recommended to provide postoperative analgesia. Perioperative prophylaxis for deep venous thromboembolism is standard and an intravenous antibiotic is administered within 30 minutes of the incision.

After administration of general endotracheal anesthesia, a bladder catheter is inserted and ureteral stents may be placed to facilitate intraoperative identification and protection of the ureters. This is especially useful in the presence of a bulky primary rectal cancer invading other organs or a pelvic recurrence. An orogastric tube is inserted for decompression of the stomach. Patients are placed in the modified lithotomy position with the buttocks brought down to the edge of the table and legs placed into Yellofin stirrups (Allen, Allen Medical, Acton, MA). In general, the hips should be slightly flexed and abducted, with the feet positioned to be flat within the stirrups. Proper alignment is maintained with an imaginary line that keeps the ankle, knee, and opposite shoulder in alignment. The risk of peroneal nerve injury can be minimized by avoiding pressure along the lateral aspect of the leg by checking that a hand can be inserted between the posterolateral portion of each leg and the stirrup.

A preoperative briefing allows the surgeon to share the plan with the entire operative team and is used to confirm the presence of appropriate instruments including self-retaining retractors such as Balfour, Bookwalter, Omni-track; St. Mark’s and Wylie handheld retractors, a variety of staplers, and additional long instruments for the narrow pelvis. Headlights or lighted retractors facilitate deep pelvic dissection (Thompson Surgical, Traverse City, MI). The assistance of an experienced second surgeon or a highly trained technician is invaluable.

The surgeon can then reassess the rectal cancer by digital rectal examination and proctosigmoidoscopy to irrigate the rectum and confirm the degree of involvement of the anal sphincter or other organs and structures, the level of the distal edge of the tumor, and the response of the tumor to chemoradiotherapy. The abdomen and perineum, including the vagina in women, should be prepped into the field. A midline incision is used.

Step 1: Mobilization of the Colon

Through a midline incision, the abdomen is explored to identify and preferably exclude metastatic disease or other unexpected pathology. The small bowel is packed into the upper abdomen, the patient is placed in a slight Trendelenburg position, and a self-retaining retractor is placed. Although some surgeons practice a medial-to-lateral “no-touch” approach and divide the inferior mesenteric vessels before lateral mobilization, we typically begin by laterally mobilizing the colon. The sigmoid colon is retracted to the right and the peritoneal attachments are incised along the avascular plane (white line of Toldt) distally into the pelvis and as far proximally as needed to ensure sufficient mobilization so that a tension-free end descending colostomy can be constructed. Generally, this mobilization includes a portion of the descending colon but complete takedown of the splenic flexure, as we do routinely if a low anastomosis is planned, is often unnecessary for APR. The left ureter and gonadal vessels are identified and preserved by using sharp and gentle blunt dissection to separate the retroperitoneal tissues from the left colonic mesentery.

Step 2: Ligation of the Inferior Mesenteric Artery

The mobilized rectosigmoid is retracted anteriorly and to the left to expose the inferior mesenteric artery (IMA). Transillumination of the mesentery facilitates identification of an avascular space adjacent to the IMA at the base of the mesentery. The peritoneum overlying this space is incised on either side of the IMA and, after identifying the right ureter, the peritoneal incision is extended on the right side of the mesentery to the pelvic brim. Surgeons vary in opinion about the precise level of IMA ligation for rectal cancer resection. Some surgeons prefer a high ligation of the IMA at its origin from the aorta, suggesting that this level of transection not only maximizes the mesenteric lymph node harvest but also improves oncologic outcomes. Other surgeons prefer a low ligation of the IMA just distal to the left colic artery, suggesting that this approach ensures better blood supply to the proximal colon and prevents nerve injury at the base of the IMA, thus minimizing functional impairment (Fig. 34-8). At present, there is not enough evidence to recommend one approach over the other. After ligation of the proximal vascular pedicle, it is convenient to clamp, divide, and ligate the mesentery to the colon at the descending-sigmoid junction where the colon is then divided with a linear stapler.

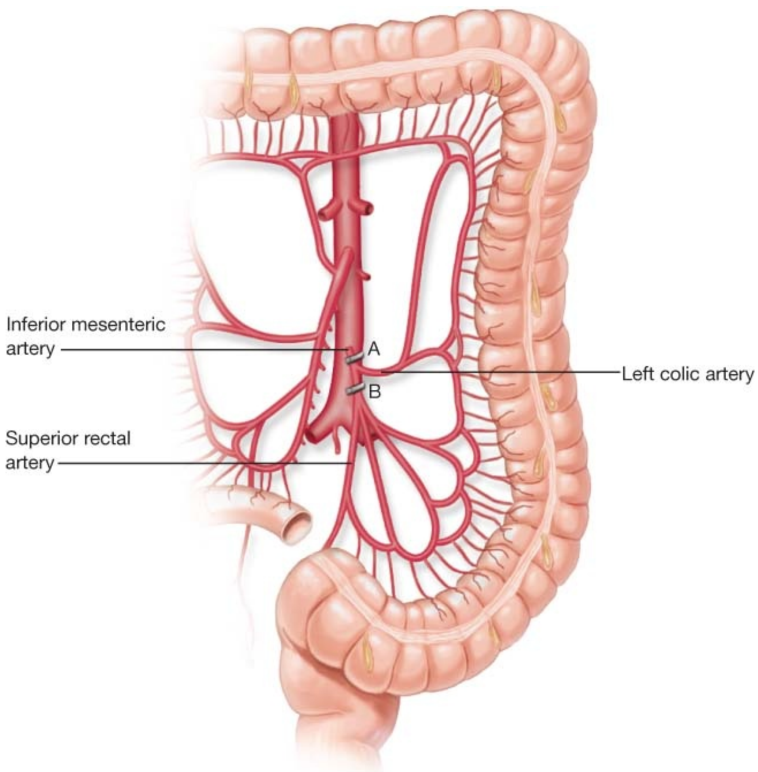


FIGURE 34-8 Anatomic depiction of vascular ligation techniques. “High ligation” refers to ligation of the inferior mesenteric artery near its origin (A). “Low ligation” refers most commonly to ligation of the superior rectal artery (B).

Step 3: Total Mesorectal Excision, Preservation of Autonomic Nerves, and Mobilization to the Levators

TME along the areolar plane between the visceral fascia of the mesorectum and the parietal fascia of the pelvis is a standard component of APR for rectal cancer. The sigmoid with its intact and fully mobilized mesentery is anteriorly and inferiorly retracted toward the pubis to expose an avascular plane posterior to the rectum at the level of the common iliac vessels. Sharp incision of the pelvic peritoneum in this avascular plane while traction is placed on the rectosigmoid typically allows air to enter the areolar tissue posterior and lateral to the rectum in the retrorectal space. The surgeon follows the air, sharply posteriorly and laterally dividing the loose areolar tissue. Traction with the nonoperating hand and appropriate repositioning of handheld retractors is essential to keep the plane of the mesorectal dissection in view and accessible to sharp division with scissors or cautery. During the retrorectal portion of the mesorectal dissection, the hypogastric nerves are identified at the sacral promontory. These nerves descend into the presacral space in a wishbone shape and must be preserved to maintain postoperative sexual and urinary function. As the dissection proceeds posteriorly, the rectosacral (Waldeyer's) fascia located at the level of the third sacral vertebra is divided sharply, and the dissection proceeds distally. As noted, to avoid creating a "waist" in the APR specimen, the dissection is purposefully stopped at the proximal level of the levator muscles just as the mesorectum begins to taper and thin. This transition usually occurs at the level of the fifth sacral vertebra and we find it usually corresponds to the level where the rectum changes its course from posterior to anterior. At that level, the rectum is mobilized in a posterior-to-lateral direction, with care taken to maintain the integrity of the endopelvic fascial envelope encasing the bilobed mesorectum and not to dissect further distally than the proximal levator, which will now be posterolaterally visible in the depths of the pelvis.

Exposure for the anterior dissection is facilitated by reducing the angle of the Trendelenburg position or even shifting the patient to a reverse Trendelenburg position. The anterolateral dissection is begun by incising the peritoneum of the rectovesical or rectouterine pouch in the midline and dividing soft tissue attachments anterolaterally to connect to the lateral dissection. Most often, the middle rectal artery is not present as a distinct vessel and the anterolateral dissection at the level of the proximal levator is done with electrocautery with minimal bleeding. Occasionally, however, the middle rectal artery is large enough that ligation is necessary. During this phase of the dissection, the nervi erigentes are identified and preserved on the lateral pelvic sidewalls. A conscious effort is made to avoid dissecting centrally into the pelvis along the levator or distally beyond the proximal levator.

Step 4a: Sequential Abdominoperineal Resection—Abdominal Closure and Colostomy Formation

In cases were a sequential approach is used, the abdominal phase is completed before positioning the patient prone. A circular incision 2–3 cm in diameter is made at the previously marked stoma site, usually in the left lower quadrant of the abdominal wall. The skin aperture, subcutaneous tissue, and fascia are kept in alignment to dissect a straight tract. The anterior rectus fascia is exposed and a cruciate incision is placed. The rectus muscle is split with a clamp to expose the posterior rectus sheath, which is then opened to create an aperture of adequate size (typically, two fingerbreadths) to accommodate passage of the appropriately mobilized descending colon. A Babcock clamp is placed through the aperture to deliver the staple-closed end of the descending colon through the abdominal wall. Care is taken to avoid twisting the colonic mesentery. Tension-free elevation of the descending colon 2–3 cm above the skin level is ideal to ensure that an adequate stoma can be performed.

The surgeon should identify the position of both ureters to be sure that they are not vulnerable to injury during the perineal dissection. If they are close to the anticipated line of resection, it may be useful to mobilize them out of the field of dissection or to encircle them with a vessel loop to aid their identification during the perineal dissection. The operative field is irrigated, hemostasis is assured, and correct sponge and needle counts are confirmed. We generally place a large closed suction drain in the pelvis through a separate abdominal stab wound placed in an area that will not interfere with the stoma or a planned rectus abdominis flap for perineal wound closure. Typically, we suture the distal end of the drain to the proximal end of the sigmoid colon that will be retrieved and resected en bloc during the perineal phase. If desired, a rectus abdominis myocutaneous flap can be prepared at this time. The abdomen is closed and the colostomy is then matured using a Brooke eversion technique with interrupted absorbable sutures to construct a budded, everted os that will more easily pouch. The patient is then positioned prone.

Step 4b: Synchronous Two-Team Abdominoperineal Resection—Completion of Abdominal Dissection

If a synchronous two-team approach is used, the patient remains in the modified lithotomy position. As the pelvic surgeon initiates the perineal dissection as described subsequently, the abdominal surgeon may proceed with additional distal posterior mobilization of the rectum to the level of the coccyx and with further anterior and anterolateral dissection of the rectum. Deep pelvic retractors are used to protect the seminal vesicles and prostate in men or the vagina in women. Heald *et al.* considered Denonvilliers' fascia as the most anterior limit of the mesorectum, and thus it should be removed with the specimen during TME. We similarly excise Denonvilliers' fascia for circumferential and anterior rectal tumors to obtain a negative circumferential margin. For posterior tumors, the Denonvilliers' fascia may be incised in the midline anteriorly and then the visceral fascia propria of the rectum is followed, thus sparing the parietal Denonvilliers' fascia to minimize risk of injury to nearby pelvic nerves. The abdominal and perineal surgeons must work synchronously to develop proper dissection planes vital for curative and safe en bloc excision of the tumor without compromising curability. Performing the perineal phase with the patient in the lithotomy position can be very demanding technically. It is easy for the perineal surgeon to dissect slightly too posteriorly into the presacral fascia and cause venous bleeding. This can be avoided if the abdominal surgeon guides the perineal surgeon's posterior dissection into the presacral plane. It is similarly important that the abdominal surgeon protects the seminal vesicles and prostate or the vagina as the perineal surgeon performs the anterior dissection, an area difficult to visualize well in lithotomy.

The elements of the perineal dissection, whether done in modified lithotomy position or in prone position, are similar. As noted earlier, the major challenge during the synchronous technique is to avoid the tendency to follow the levator plate and dissect centrally, thus creating a “waist” in the specimen at the level of the puborectalis, which is associated with increased local recurrence rates. It is for this reason that we prefer the sequential approach. On occasion, the synchronous technique is necessary, but this approach demands the collaboration of two experienced surgeons.

Step 5: Perineal Dissection

After carefully positioning the patient prone over a hip roll with the table jackknifed and the buttocks spread by tape, the distal anorectum is irrigated to remove feces or tumor debris, and the perineum is prepped (including the vagina in women). The anus is then closed with a purse string suture to minimize the risk of spillage of the operative field. In the absence of local spread beyond the anorectum, the landmarks used for dissection include the coccyx posteriorly, the perineal body anteriorly, and the ischial tuberosities laterally (Fig. 34-9). An elliptical incision is made incorporating these landmarks. A LoneStar retractor (Cooper Surgical, Trumbull, CT) is placed to separate the skin edges and the incision is deepened to the level of the ischiorectal fat bilaterally. A variety of retractors including self-retaining springs, deep Gelpi retractors, and Deavers (Symmetry Surgical, Antioch, TN) are used to maintain visualization as the dissection proceeds (Fig. 34-10). Branches of the inferior rectal vessels within the ischiorectal fossa typically can be controlled with electrocautery.

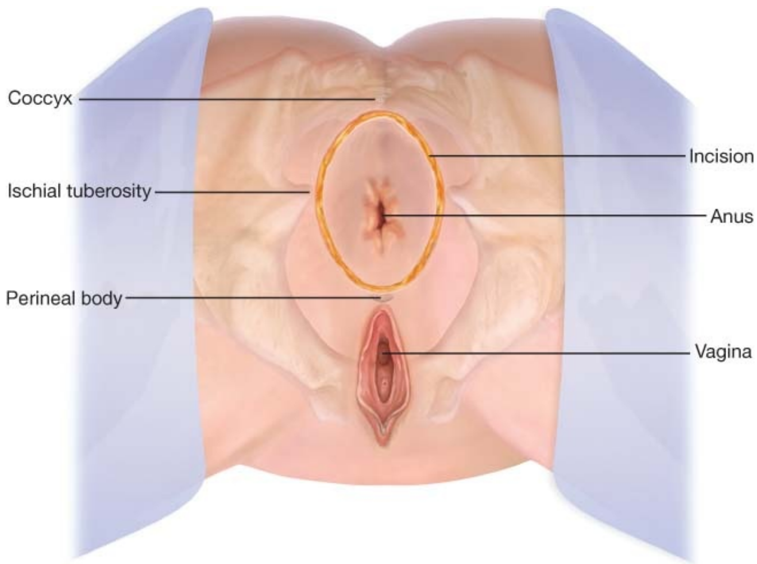


FIGURE 34-9 Landmarks for perineal incision relative to the ischial spines, coccyx, and perineal body.

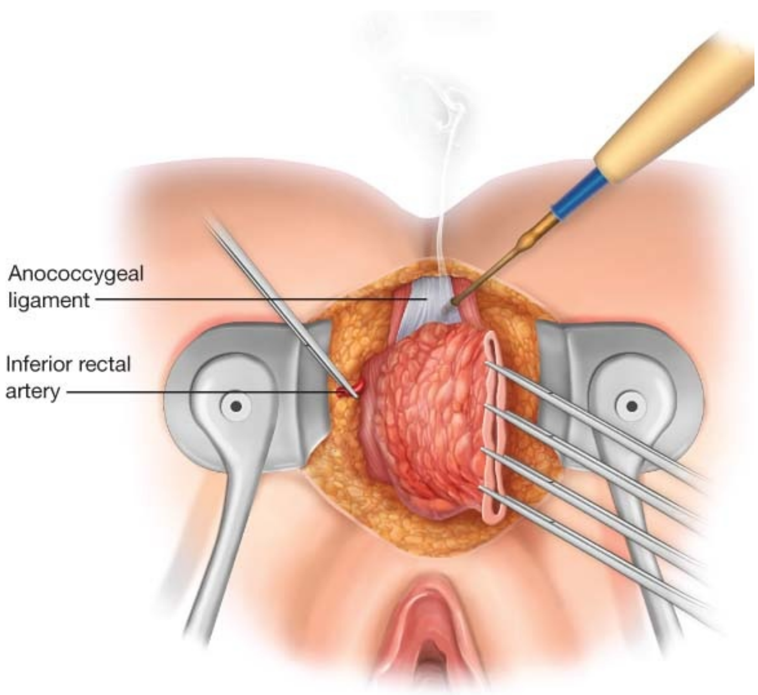


FIGURE 34-10 Extension of perineal dissection to the pelvic floor with incision through the anococcygeal ligament to enter the true pelvis.

To assure adequate lateral clearance and avoid the “waist” problem described earlier, the surgeon directs the dissection in each ischiorectal fossa through the fat to the levator ani muscles laterally and the coccyx posteriorly. The posterior dissection is performed first beginning in the midline, leaving the more challenging anterior dissection until the last. The anorectum is anteriorly retracted and the postanal space is entered by sharply dividing the anococcygeal ligament at the tip of the coccyx. If needed, for exposure, a coccygectomy can easily be done usually with electrocautery and a heavy scissors or a periosteal elevator.

Once the true pelvis is entered posteriorly, a finger can be inserted to “hook” the levator ani muscles, which are then divided along the pelvic bone posterolaterally and then laterally (Fig. 34-11). This avoids narrowing the dissection plane and avoids the “waist” problem. Although some surgeons divide the muscle with cautery, we prefer to maintain absolute hemostasis by either using a LigaSure device (Covidien-Medtronic, Minneapolis, MN) or by clamping, dividing, and suture ligating the coccygeus, iliococcygeus, pubococcygeus, and puborectalis muscles. At this point in the operation, the perineal dissection has merged with the previously performed abdominal presacral dissection. The lateral resection margin is extended anterolaterally. When about two-thirds of the planned resection is complete, we generally find it convenient to retrieve the mobilized rectosigmoid with the attached drain and gently deliver it through the large posterior pelvic wound (Fig. 34-12). This maneuver provides better exposure for the remaining anterior dissection, which is often the most challenging part of the APR.

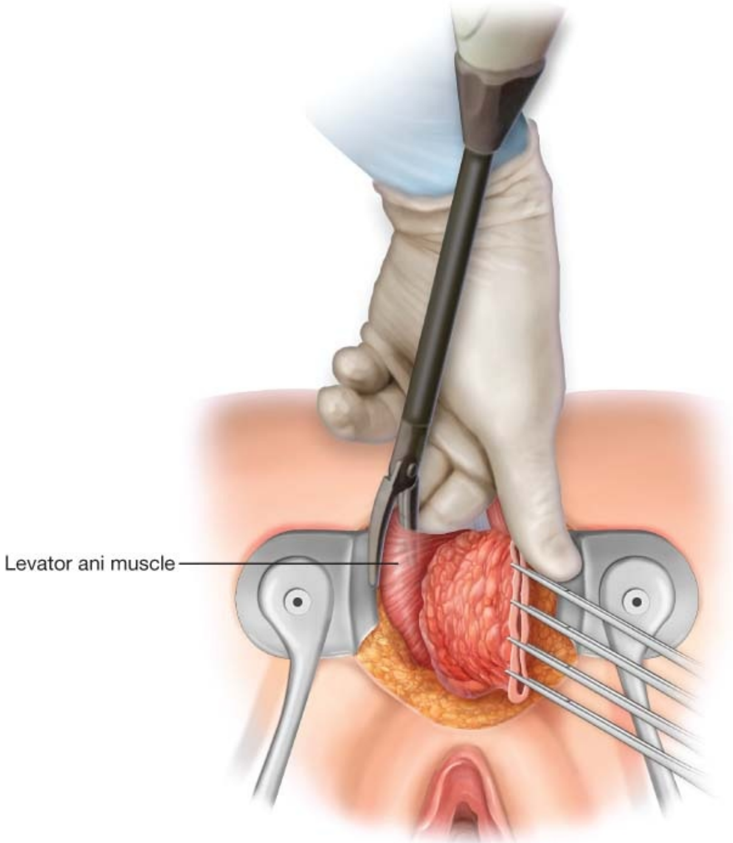


FIGURE 34-11 The lateral portion of the perineal dissection is completed by dividing the levator muscles from posterior to anterior on each side.

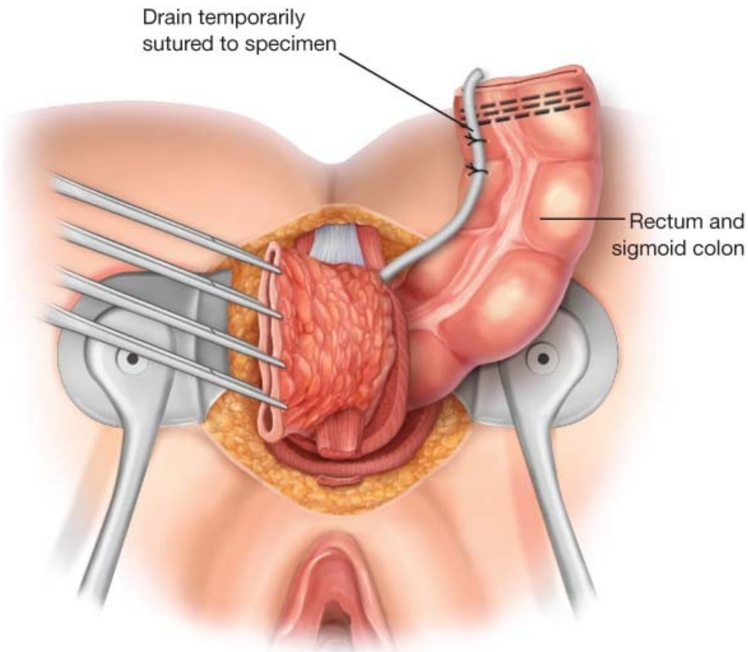


FIGURE 34-12 The anterior portion of the perineal dissection is typically performed with the proximal colon and rectum delivered through the posterior/lateral pelvic defect with the attached pelvic drain. The rectourethralis muscle (or rectovaginal septum) are the remaining structures that are divided. Care should be taken not to violate the prostatic capsule (or posterior vaginal wall in women).

The anterior perineal incision is deepened using the posterior border of the superficial transverse perineal muscle as the guide to the rectoprostatic or rectovaginal plane. Allis clamps are used to maintain countertraction between the perineal body anteriorly and the everted specimen posteriorly as the surgeon develops the anterior dissection plane. In a female patient, an anterior lesion may necessitate a posterior-wall vaginectomy to ensure adequate margins. If a vaginectomy is not required, the rectovaginal septum is dissected proximally, often with a guiding digit in the vagina to avoid inadvertent vaginal perforation. In a male patient, anterior dissection is facilitated by palpating the Foley catheter to help avoid injury to the urethra and the prostate. The median raphe of the rectourethralis and puborectalis is divided, and the remaining attachments are divided.

Before sending the specimen for pathology examination, the surgeon should inspect it for completeness of margins and for any sign of perforation. It should appear as a “cylinder” with an intact bilobar mesorectum and overlying smooth surface. A poor-quality specimen with clefts and defects along the mesorectal fascia or a “waist” is associated with higher rates of recurrence. The specimen should never be opened by the surgeon because such a maneuver would compromise the ability of the pathologist to generate optimal prognostic information.

Step 6: Perineal Wound Closure

The pelvis is irrigated and hemostasis ensured. The transabdominal drain is trimmed to fit into the pelvis. Primary perineal wound closure may be undertaken in several layers with 2-0 and 3-0 absorbable sutures, but, because the levator muscles were divided laterally along the pelvic bones, it is only possible to reapproximate the subcutaneous tissues and the skin. This excision leaves a large “dead space” deep in the pelvis that predisposes to postoperative morbidity. To overcome the perineal wound morbidity, we increasingly use myocutaneous flaps as discussed earlier.

POSTOPERATIVE MANAGEMENT

The orogastric or nasogastric tube is routinely removed at the end of the procedure. If there was no extensive dissection or manipulation of the small bowel, the patient may begin a liquid diet the day of surgery with advancement to a low-residue diet once bowel function returns. Postoperative antibiotics are not continued past 24 hours. The patient should be maintained on postoperative venous thromboembolism prophylaxis with subcutaneous heparin or low-molecular-weight heparin and this is typically continued for 30 days in patients with inflammatory bowel disease and cancer. Because the pelvic dissection is extensive, it is highly recommended that the urinary catheter be left in place until postoperative day 3. The pelvic drain is typically removed before discharge from the hospital.

Perioperative mortality following APR is 2–3%, primarily as a result of cardiopulmonary events. Despite major improvement in mortality in recent decades, both immediate and long-term morbidity remain high in modern series. Postoperative abdominal and perineal wound morbidity occurs in up to 50%. The majority are infections and most can be managed with local wound care and closure by secondary intention or CT-guided drainage of pelvic collections. In some instances, abscesses spontaneously drain through the perineum or abdominal wound and cause wound disruption, fistulas, and delayed healing. Vacuum-assisted closure dressings (KCI Medical, Bridgewater, NJ) or reoperation may be needed to resolve the issue.

Genitourinary complications occur in up to 50% of patients. Although the majority of these are minor, including urinary tract infection, some patients suffer troublesome urinary retention and incontinence following APR. In most cases, voiding dysfunction is temporary with resolution in the first 3–6 months following surgery. Ureteral or bladder injury can occur but typically can be managed readily without long-term consequences if discovered and addressed at the time of surgery. Sexual dysfunction is estimated to occur in up to 50% of men following rectal cancer resection. Women also commonly have sexual dysfunction, although the exact incidence is not known.

Other long-term morbidity specific to APR includes stoma-related problems such as stricture, as well as parastomal and perineal hernias. Small-bowel obstruction from adhesions deep in the pelvis is a common cause for reoperation. All patients experience significant body-image changes after APR; and for some, this change is a major and lasting impediment to full recovery. Five-year survival rates after APR by stage are reported from 78% to 100% for stage I disease, 45–73% for stage II disease, and 22–66% for stage III disease. When adjusted for tumor stage, rates of overall survival, local recurrence, and disease-specific survival are better in patients with proper TME excision.

CONCLUSIONS

APR remains an important procedure for distal and advanced rectal cancers, particularly for those cancers invading and abutting the anal sphincter. The importance of maintaining proper planes of dissection with TME and careful wide perineal dissection avoiding a waist in the specimen are important technical considerations in performing APR. Surgeons should have candid discussions with patients with respect to expected functional and oncologic outcomes following APR.

RECOMMENDED REFERENCES AND READINGS

Chessin DB, Hartley J, Cohen AM, *et al.* Rectus flap reconstruction decreases perineal wound complications after pelvic chemoradiation and surgery: a cohort study. *Ann Surg Oncol* 2005;12(2):104–10.

denDulk M, Marijnen CA, Putter H, *et al.* Risk factors for adverse outcome in patients with rectal cancer treated with an abdominoperineal resection in the total mesorectal excision trial. *Ann Surg* 2007;246(1):83–90.

Fleshman J, Branda M, Sargent DJ, *et al.* Effect of laparoscopic-assisted resection vs open resection of stage II or III rectal cancer on pathologic outcomes: the ACOSOG Z6051randomized clinical trial. *JAMA* 2015;314(13):1346–55.

Heald RJ, Husband EM, Ryall RD. The mesorectum in rectal cancer surgery—the clue to pelvic recurrence? *Br J Surg* 1982;69(10):613–6.

Hojo K, Koyama Y, Moriya Y. Lymphatic spread and its prognostic value in patients with rectal cancer. *Am J Surg* 1982;144(3):350–4.

Holm T, Ljung A, Haggmark T, Jurell G, Lagergren J. Extended abdominoperineal resection with gluteus maximus flap reconstruction of the pelvic floor for rectal cancer. *Br J Surg* 2007;94(2):232–8.

Lange MM, Buunen M, van de Velde CJ, Lange JF. Level of arterial ligation in rectal cancer surgery: low tie preferred over high tie. A review. *Dis Colon Rectum* 2008;51(7):1139–45.

MERCURY Study Group. Diagnostic accuracy of preoperative magnetic resonance imaging in predicting curative resection of rectal cancer: prospective observational study. *BMJ* 2006;333(7572):779.

Nagtegaal ID, van de Velde CJ, Marijnen CA, *et al.* Low rectal cancer: a call for a change of approach in abdominoperineal resection. *J Clin Oncol* 2005;23(36):9257–64.

Northover JM. Personal communication to Rothenberger, D. A., 2003.

Pachler J, Wille-Jorgensen P. Quality of life after rectal resection for cancer, with or without permanent colostomy. *Cochrane Database Syst Rev* 2005;(2):CD004323.

Quirke P, Steele R, Monson J, *et al.* Effect of the plane of surgery achieved on local recurrence in patients with operable rectal cancer: a prospective study using data from the MRC CR07 and NCIC-CTG CO16 randomized clinical trial. *Lancet* 2009;373(9666):821–8.

Ricciardi R, Virnig BA, Madoff RD, Rothenberger DA, Baxter NN. The status of radical proctectomy and sphincter-sparing surgery in the United States. *Dis Colon Rectum* 2007;50(8):1119–27; discussion 1126–7.

Salerno G, Chandler I, Wotherspoon A, Thomas K, Moran B, Brown G. Sites of surgical wasting in the abdominoperineal specimen. *Br J Surg* 2008;95(9):1147–54.

Valentini V, Aristei C, Glimelius B, *et al.* Multidisciplinary rectal cancer management: 2nd European Rectal Cancer Consensus Conference (EURECA-CC2). *Radiother Oncol* 2009;92(2):148–63.

Wexner SD, Berho ME. The Rationale for and Reality of the New National Accreditation Program for Rectal Cancer. *Dis Colon Rectum* 2017;60(6):595–602.

Chapter 35

Laparoscopic Abdominoperineal Resection

John H. Marks and Joseph L. Frenkel

INTRODUCTION

While discussing laparoscopic abdominoperineal resection (APR), two major issues come to the forefront. One is the role of laparoscopic surgery in the treatment of rectal cancer, and the other is the indications for APR for low rectal cancer.

The issues of paramount importance regarding laparoscopic surgery in the treatment of rectal cancer include proper performance of TME, as well as visualization and retraction during deep pelvic dissection. The last issue, transection of the distal rectum to perform an anastomosis, is a major one in laparoscopically performing sphincter-preserving surgery in the low rectum. However, this point becomes moot in performing an APR because there is no anastomosis after the sphincter mechanism is excised.

Having performed over 350 laparoscopic TMEs with a local recurrence rate of 3% overall, we feel confident that the laparoscopic approach will be validated as a safe option for rectal cancer. This approach clearly affords a much better visualization in the pelvis and exactness of dissection. In this chapter, we highlight the methods we use to laparoscopically accomplish this operation.

INDICATIONS

Clearly, the issue of sphincter preservation surgery versus permanent colostomy has to do with the level of the rectal cancer, bulk of the tumor, and the patient's baseline continence. Indications for permanent colostomy include patients with incontinence, patient preference for lifestyle reasons, or direct involvement of the puborectalis. The advent of preoperative chemoradiation therapy has allowed us to alter these indications, greatly diminishing the need for APR. In a multimodal rectal cancer treatment program having treated over 800 cases, we have been able to obtain a sphincter preservation rate of 93%. In the large national trials, APR rates in the past decade have still ranged from 25% to 60%.

Our treatment algorithm for sphincter preservation employing neoadjuvant chemoradiation for low rectal cancers is shown in Figure 35-1. In the properly motivated patient with good sphincter function, the decision regarding sphincter preservation is based on tumor characteristics after completion of neoadjuvant therapy. Only patients whose cancers remained fixed in the distal third of the rectum after completion of chemoradiation therapy undergo APR. Keys to expanded sphincter preservation include (a) *basing decisions regarding sphincter preservation on the downstaged rectal cancer after completion of neoadjuvant therapy,* (b) a higher dose of radiation therapy to improve downstaging of the rectal cancer to our ideal level of 5,580 cGy, (c) allowing 8–12 weeks following radiation before making a decision regarding surgery, and (d) transanal abdominal transanal (TATA) resection technique for tumors in the distal third of the rectum, which includes an intersphincteric dissection beginning at the dentate line, assuming an adequate distal margin.

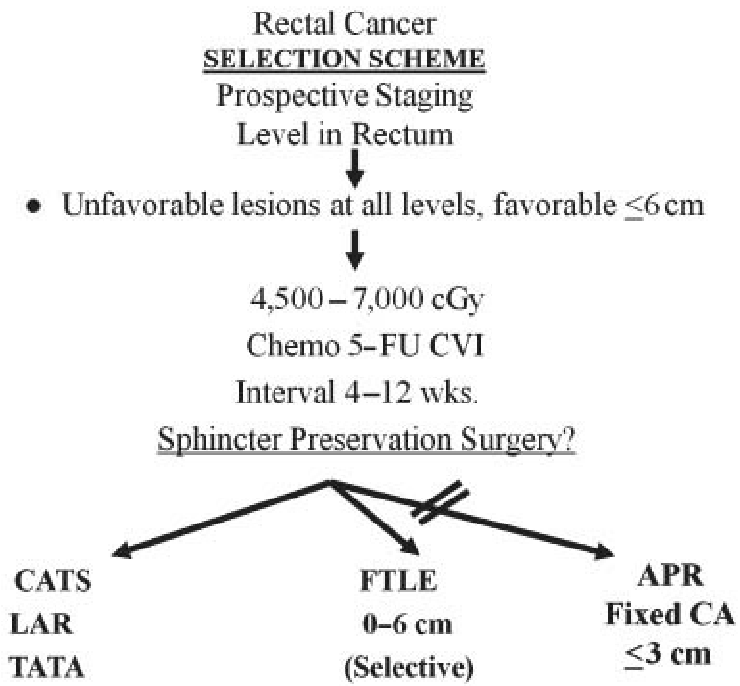


FIGURE 35-1 Selection scheme for sphincter preservation employing neoadjuvant chemoradiation for low rectal cancers. APR, abdominoperineal resection; CA, carcinoma; CATS, combined abdominotranssacral proctosigmoidectomy; CVI, continuous venous infusion; FTLE, full-thickness local excision; FU, fluorouracil; LAR, low anterior resection; TATA, transanal abdominal transanal.

It is important to emphasize that the indications for laparoscopic APR are exactly the same as they are for an open APR. Clearly, it is poor trade for the patient to gain the benefits of laparoscopy at the expense of a permanent colostomy.

PREOPERATIVE PLANNING

Patients undergo a standard oncologic evaluation including computed tomography scan of the abdomen and the pelvis and basic lab work, including liver function studies, complete blood cell count, metabolic profile coagulation studies, blood chemistries, and carcinoembryonic antigen level. Endorectal ultrasound is also performed. Oftentimes this assessment is coupled with a magnetic resonance imaging of the pelvis. In patients older than 60 years and in those individuals with coronary artery disease, hypertension, and diabetes, or in smokers, a full preoperative cardiac evaluation is undertaken.

Digital rectal examination and flexible sigmoidoscopic evaluation are performed in the office. Patients are then seen at 3-week intervals during their neoadjuvant treatment until the time of surgery. Final decisions regarding sphincter preservation are made on the basis of digital rectal and flexible endoscopic evaluation between 8 and 12 weeks following their neoadjuvant therapy. In general, patients are treated with 4,500 cGy of radiation to the entire pelvis with a boost of 1,000 cGy to the tumor in the presacral hollow. The limits of this chapter preclude us from being more expansive in this regard. All patients undergo a full bowel preparation and are seen by a stoma nurse preoperatively and marked for a permanent colostomy. This is an essential point because the positioning and function of the stoma will have a major impact on the patient's quality of life.

SURGERY

Positioning

Generally, patients are positioned in lithotomy. The exception to this rule is the patient with a very large bulky tumor that may require coccygectomy to obtain adequate exposure to the pelvis. In this case, the operation is started with the patient in a right Sims' position. It is essential that patients are secured firmly to the table because both extreme Trendelenburg and airplaning the table to the "right side down" position will be utilized. This achieves proper retraction of the small bowel, so we can see into the pelvis clearly and position the small bowel out of the way. Shown in Figure 35-2 is our method of securing the patient to the operating room table as well as the overall setup of the operating room that facilitates the procedure.

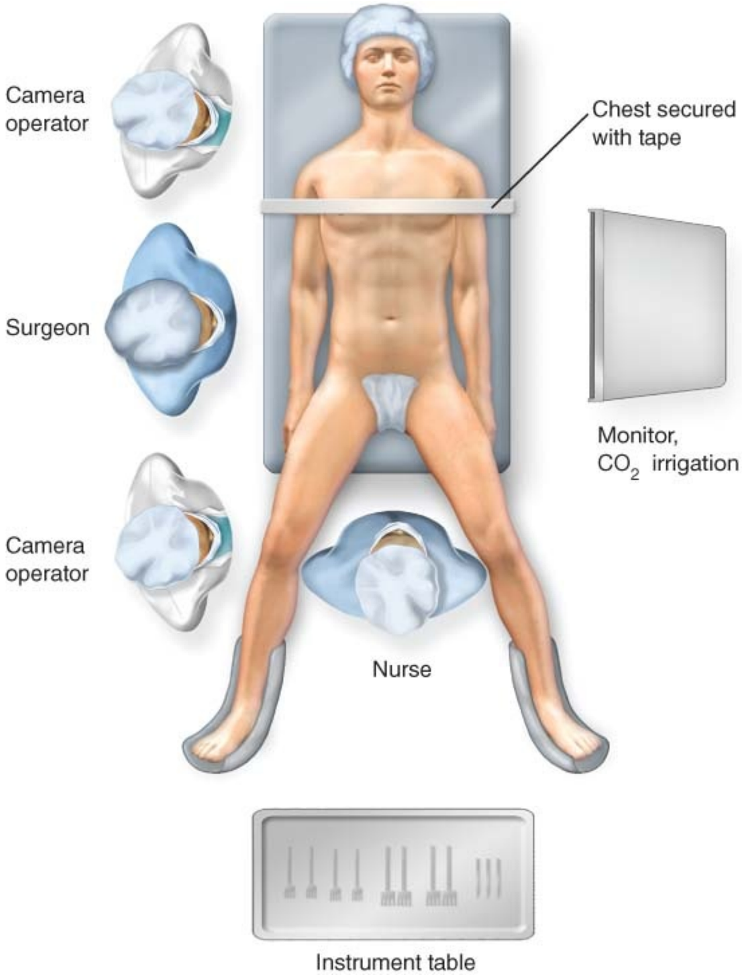


FIGURE 35-2 Setup of operating room to facilitate procedure.

With the patient in supine position, a strong strap of tape is used to secure the chest to the table. We feel strongly that pads on the shoulders should be avoided because this will predispose the patient to brachial plexus injury.

Technique

Perineal Dissection

It is our preference to start the operation perineally and then proceed abdominally (rendering the operation a perineal-abdominal resection rather than an APR). This is the same strategy that we use in open operations. This order dramatically facilitates the laparoscopic operation, because the most challenging portion of the laparoscopic procedure, the distal-most rectal dissection, has already been done from the perineal approach.

After induction of anesthesia, the patient is placed in stirrups and digital examination is carried out to verify the location of the tumor and make the final determination regarding the need for permanent colostomy. The perineum is prepped and an O-Vicryl suture is used to place a purse string suture around the anal canal, so there is no soilage to the field at the time of surgery. The abdomen and perineum are fully prepped and draped. We find that securing the drapes around the perineum with a few interrupted 2-0 nylon sutures keeps the drapes from moving even when the patient is placed in extended lithotomy position.

As the procedure commences, the patient is put in an exaggerated lithotomy position to gain access to the perineum. A lighted suction device (Vital Vue, Covidien, Norwalk, CT) greatly facilitates the dissection. Electrocautery is used to incise the skin with a 1-cm margin around the anal canal; the size and position of this incision can be adjusted on the basis of tumor location. Dissection continues circumferentially into the fat of the perirectal space. The safest area for the initial approach into the pelvis is the posterior midline. The anococcygeal ligament is incised and the dissection is extended through the levators. At this point, a finger can be placed through the pelvic floor and one can excise a portion of the levators with an adequate margin. In doing this dissection, it is imperative to avoid coning in on the rectum at the levators, because it is this area where tumor margins are at greatest risk. Once one has entered into the plane above the levators, the dissection is brought around circumferentially, taking care in the male patient to avoid going into the prostate anteriorly. Special attention needs to be paid to the infraprostatic urethra in this region to avoid injury. In a straightforward case, the anterior portion of the dissection is the most challenging, and in the male patient it is the last part to be addressed. In the event that there is tumor fixity or a large bulky cancer in another quadrant, it is better to leave this to the end of the dissection having dissected around the right or left so that the best decisions can be made in terms of where to transect. When operating for cure, any area of fixity requires that the adjacent tissue be excised en bloc.

It is well worth noting that in women the vagina is always prepped so that a finger can be placed here to help guide the anterior dissection. The posterior wall of the vagina does not need to be routinely excised when performing an APR in women unless there is an anterior fixation.

Once the perineal portion of the operation is completed, a sponge is placed into the wound and a Tegaderm placed over the pad to avoid leakage of gas during insufflation for the laparoscopic portion. The legs are taken out of extended lithotomy and the thighs are placed flat with the abdomen to avoid the right thigh getting in the surgeon's way when performing the laparoscopic aspect of the surgery. Gowns, gloves, and instruments are changed and the abdominal portion commences.

Laparoscopic Abdominal Portion

There are two aspects to the laparoscopic portion of the dissection: the abdominal portion and the pelvic dissection, a laparoscopic TME. Port positions are shown in Figure 35-3. The patient's body habitus will determine whether we use the port site 4 (5 mm) for the eventual stoma site. It is generally ill advised to make any compromises in the ultimate location of a stoma in an effort to accommodate a port site used for a retractor, and the relative morbidity of an additional 5-mm port in the left lower quadrant is minimal. If the port site is not going to be used as the eventual stoma site, we like to move it well away so that it will not be underneath the stoma wafer because this position would predispose it to infection.

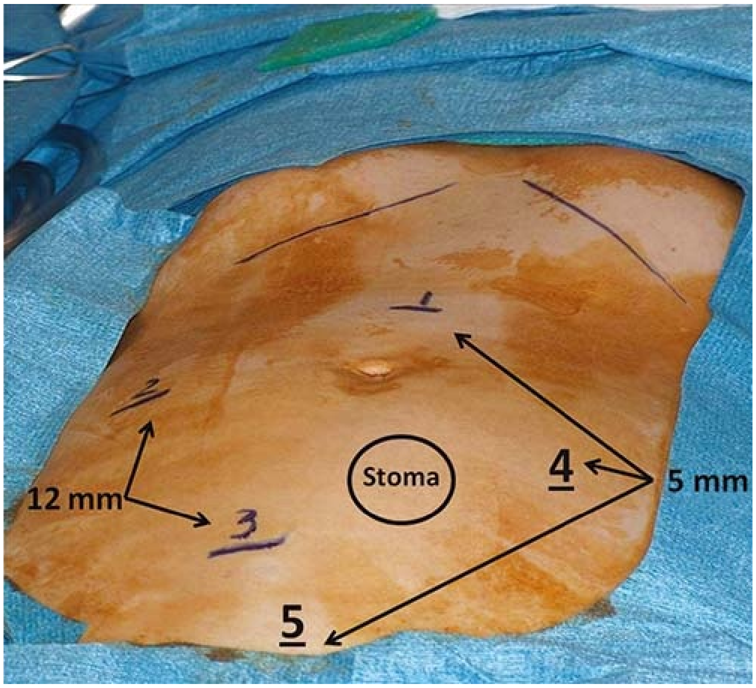


FIGURE 35-3 Port positions.

Laparoscopic Abdominal Dissection

Once the ports are placed, the 10-mm, 30° camera is utilized for a full exploration of the abdominal cavity. The splenic flexure does not need to be taken down for an APR. The patient is put in steep Trendelenburg right side down position to get the small bowel out of the pelvis. We perform the left colon mobilization in a medial-to-lateral approach. The medial aspect of the retroperitoneum is incised from the sacral promontory to the duodenal-jejunal junction, the hypogastric nerves are identified inferior to the inferior mesenteric artery (IMA) and swept posteriorly (Fig. 35-4). This is the essential landmark to assure that one is in the proper plane. There are areolar planes both posterior and anterior to the hypogastric nerves and one wants to be certain that they are anterior to avoid sexual or bladder dysfunction (Fig. 35-5). As the hypogastric nerves are swept down and the dissection is taken out laterally, the left ureter is identified. The dissection is taken up above the IMA. The IMV is dissected free from posterior retroperitoneal attachments leaving this intact. The IMV does not need to be ligated when performing an APR, but dissecting out along this plane will facilitate putting the surgeon in the proper space for the rest of the mobilization.

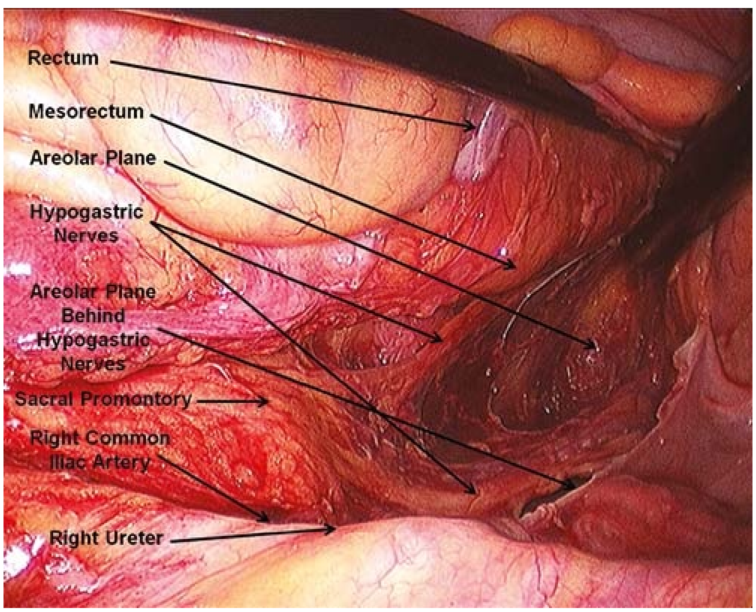


FIGURE 35-4 Posterior dissection.

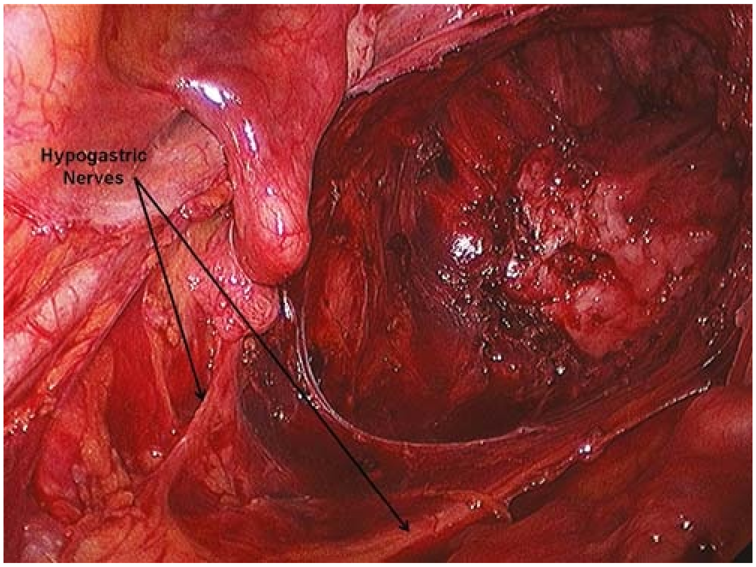


FIGURE 35-5 Total mesorectal excision.

Once the mesentery of the left colon is mobilized fully in a medial-to-lateral manner, the area of transection in the sigmoid colon is marked using a stitch placed intracorporeally for future recognition. The mesentery is transected by dividing the IMA distal to the take-off of the left colic artery and extending the transection line to the sigmoid colon. We typically use a vessel-sealing system (LigaSure, Covidien, Norwalk, CT) to accomplish this maneuver, but it can also be done with a vascular stapling device or by dissecting out the vessel and placing clips or ties on it. Intracorporeal vascular control will facilitate the subsequent stoma creation.

The lateral attachments are incised along the white line of Toldt and in this way the colon is fully mobilized. The proximal extent of this dissection is taken to the splenic flexure, but the splenic flexure itself is not fully released. In some patients with a long redundant sigmoid colon, it is not necessary to do this more proximal release. Lastly, the sigmoid is transected with an Endo-GIA stapler. Once this is complete, attention is turned to the pelvis.

Laparoscopic Total Mesorectal Excision

The essential points to a laparoscopic TME are highlighted in Table 35-1.

TABLE 35-1 Key Points to Laparoscopic Total Mesorectal Excision
1. Three-dimensional retraction
2. Opening the box
3. Standardized dissection plan—posterior to anterior
4. Retraction with suction device

A key to successful pelvic dissection has to do with minimizing blood in the field because this will make it difficult to both keep the endoscope lens clean and absorb light that significantly impairs visualization. The operation is started with the camera in the port 2. The surgeon's left hand utilizes a laparoscopic Babcock grasper in the port 1, while the right hand uses laparoscopic scissors in port 3. Through the port 4 in the left lower quadrant, a retracting grasper is placed and positioned anteriorly to hold up the pouch of Douglas and put the tissue on stretch in a manner similar to that done with a St. Marks retractor in open surgery. A suprapubic 5-mm port is placed and through this the first assistant uses a 5-mm suction device to retract the right pelvic sidewall laterally as well as aspirate at the time of activation of the energy source to clear the smoke and small amounts of blood that come onto the field. It is helpful to keep the area dry to facilitate a safe dissection and to minimize obscuring the view in the pelvis.

The incision along the retroperitoneum that went from the sacral promontory to the duodenum-jejunal junction is extended (Figs. 35-6 and 35-7) down along the right pararectal sulcus in the avascular crevice, which is identified. This dissection is best done with a pair of scissors or a hook with electrocautery as they are thinner and thus are more precise than other instruments. A single cell layer of the retroperitoneum is incised down the right pararectal sulcus anteriorly, and then similarly down the left pararectal sulcus. Once this is opened (which we refer to as "opening the box"), a more substantial dissection can be carried out. This step entails additional retraction and duplication of steps to accomplish.

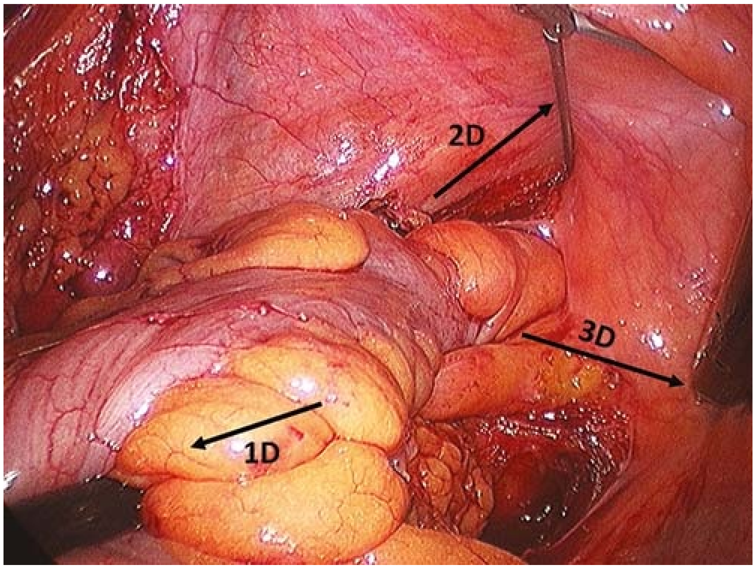


FIGURE 35-6 3D retraction.

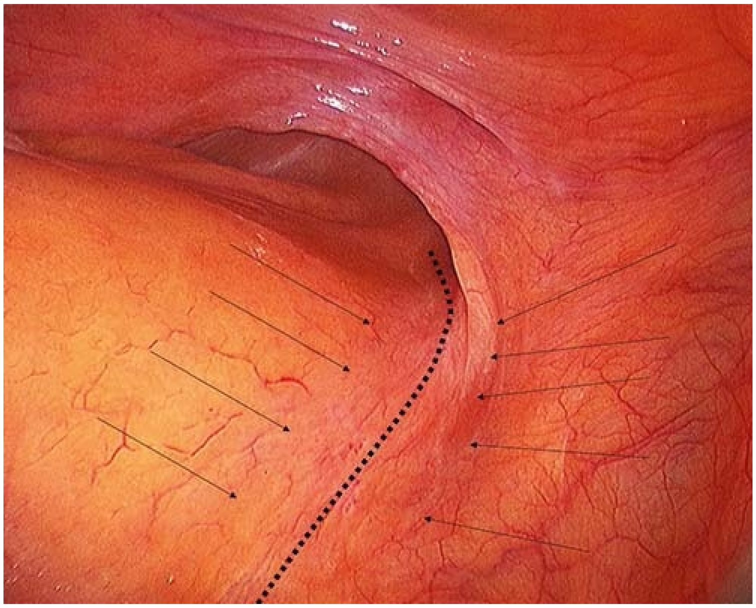


FIGURE 35-7 Line of incision.

Once the space is opened, the dissection continues posteriorly using sharp dissection with diathermy scissors or another energy device. The presacral space is dissected and opened anterior to the hypogastric nerves, which are visualized and protected. The grasper in the surgeon's left hand is used to anteriorly retract the rectum, with a suprapubic retractor placed, and finally using the suction to retract the lateral rectal tissues to the side. The dissection is carried out posteriorly extending to the level of the levators, after which it is brought around to the right side following the nerves for direction. By retracting as one comes along the right side with the left hand grasping the rectum and the suprapubic suction retractor of the assistant pulling out tissue laterally to the right, the areolar tissue plane is put in sharp contrast. Quite often, the perineal dissection can be entered from above posteriorly. This option is an additional advantage of starting the operation transanally, which facilitates the laparoscopic approach.

Dissection is then anteriorly undertaken. Oftentimes the retractor 4 needs to be repositioned to get exposure and the assistant using the suction device in port 5 retracts anterior and laterally while the hand of the surgeon is pulling in a contralateral manner toward the left shoulder. Once this is completed, the dissection is brought around in a similar manner on the left side. Again, following the hypogastric nerves, one stays anterior to this with the suprapubic retractor placed laterally while the port 1 retractor is in the surgeon’s left hand superiorly retracting the mesorectum. The energy source is brought down along the areolar plane anterior to the nerves and the dissection is connected to the front, completing the TME.

Once this step is completed, the rectum can be brought out of the pelvis and the area inspected. If the dissection has been fully completed and the rectum brought out of the pelvis without difficulty, it is passed back down into the pelvis. Next, the previously placed proximal staple line of the sigmoid colon is brought out through the stoma site in the left lower quadrant through a standard muscle-splitting technique. All port sites are closed and the stoma is matured. Gloves are changed and the specimen is removed through the perineal wound.

At times when the anterior portion of the dissection is particularly difficult from above, the abdomen is desufflated, the sigmoid colon is delivered posterior to the rectum through the perineal wound, and brought out. In this way, the rectum is everted and leaves the last bit of adherence to be put on tension. This can then be completed from below without difficulty.

After delivery of the specimen, the pelvic floor is closed using interrupted 0-Vicryl sutures. A drain is placed via a separate stab wound through the perineum. The skin is closed with 2-0 nylon suture in a vertical mattress manner. It should be noted that if there is a very large defect from extensive growth of tumor into the sidewall or vagina, consideration should always be given to muscle flap reconstruction at that time. The best flap is the right rectus abdominus muscle, in which case the entire operation would not have been done laparoscopically but through a midline laparotomy.

POSTOPERATIVE MANAGEMENT AND COMPLICATIONS

Postoperative management and complications are quite similar to those noted after open APR. We do not routinely employ nasogastric tube decompression. A bladder catheter is generally left in place until postoperative day 5 or taken out the night before discharge if the patients are going home sooner. Patients are generally started on clear liquid diet the day of or the day after surgery and then advanced to a gastrointestinal soft diet the following day if their abdomen is nondistended, or they are not having excessive nausea or eructation. Perioperative antibiotics are used. It is important that the patient undergoes education with the stoma nurse regarding colostomy care. The perineal wound and the sutures in the perineum are generally left in place for at least 3 weeks. If there is any question about proper healing, they are taken out one at a time so that there is no problem with wound dehiscence.

RESULTS

Between January 1997 and October 2010, we performed 370 laparoscopic TMEs, including laparoscopic APR, low anterior resection, proctectomy, total proctocolectomy, and TATA. Because the TATA procedure involves an intersphincteric dissection from the dentate line for tumors as low as 5 mm beneath the anorectal ring, we are able to avoid an APR in the majority of our patients with low rectal tumors. The only real distinction between APR and TATA is the perineal dissection, with the laparoscopic portion of the procedure being virtually the same. We have performed 49 laparoscopic APRs for rectal adenocarcinoma (42), anal squamous cell carcinoma (4), anal gland carcinoma (1), radiation proctitis (1), and Crohn’s disease (1). All procedures were elective and the average estimated blood loss (EBL) was 320 ml; there were no significant intraoperative complications or conversion. The average number of lymph nodes harvested was ten and the average length of stay was 6.4 days; there was no postoperative mortality. Postoperative complications included urinary retention, anemia requiring transfusion, deep vein thrombosis, prolonged ileus, erectile dysfunction, and perineal wound issues.

CONCLUSIONS

Laparoscopic APR and TME offer a significant secondary benefit for patients with rectal cancer. Clearly of paramount concern in the rectal cancer patient is the ability to have the cancer properly controlled, not metastasize elsewhere, and not develop a local recurrence. It is imperative that the surgeon never lose sight of these points. That said, the secondary benefits of less trauma to the abdomen, recovering more quickly from surgery, as well as potential benefits of decreased bowel obstruction, less blood loss and transfusions, and the immediate diminution of pain make laparoscopic APR a real benefit to patients requiring an APR. The ACOSOG Z6051 trial and *CO*lorectal cancer *L*aparoscopic or *O*pen *R*esection II trial reports will possibly be complete by the time of publication of this chapter and the issues regarding the safety and adequacy of laparoscopic TME and APR will likely be firmly established. Our experience, as well as that of other centers in the world, clearly shows that this procedure is safe and feasible. These trials will establish the general application of these techniques.

The major technical point we tried to highlight in this chapter is the significant benefit of opening the peritoneum, which facilitates the surgeons staying in the proper plane laparoscopically when doing a TME. We have found that, in particular, the three-dimensional retraction technique as described earlier is essential in terms of improving our visualization and outcomes for full TME in laparoscopic surgery of the rectum.

RECOMMENDED REFERENCES AND READINGS

Baker R, White E, Titu L, Duthie GS, Lee PW, Monson JR. Does laparoscopic abdominoperineal resection of the rectum compromise long-term survival? *Dis Colon Rectum* 2002;45:1481–5.

Chmielik E, Bujko K, Nasierowska-Guttmejer A, *et al.* Distal intramural spread of rectal cancer after preoperative radiotherapy: the results of a multicenter randomized clinical study. *Int J Radiat Oncol Biol Phys* 2006;65:182–8.

Nelson H, Sargent DJ, Wieand HS, et al; Clinical Outcomes of Surgical Therapy Study Group. A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med* 2004;350:2050–9.

Folkesson J, Birgisson H, Pahlman L, Cedermark B, Glimelius B, Gunnarsson U. Swedish rectal cancer trial: long lasting benefits from radiotherapy on survival and local recurrence rate. *J Clin Oncol* 2005;23:5644–60.

Jensen L, Altaf R, Harling H, *et al.* Clinical outcome in 520 consecutive Danish rectal cancer patients treated with short course preoperative radiotherapy. *Eur J Surg Oncol* 2010;36:237–43.

Leroy J, Jamali F, Forbes L, *et al.* Laparoscopic total mesorectal excision (TME) for rectal cancer surgery: long-term outcomes. *Surg Endosc* 2004;18:281–9.

Marks G, Bannon J, Marks J. Transanal-abdominal transanal-radical proctosigmoidectomy with coloanal anastomosis for distal rectal cancer. In: Baker R, Fischer J, Nyhus L, eds. *Mastery of Surgery*. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins, 1996:1524–31.

Marks J, Mizrahi B, Dalane S, Nweze I, Marks G. Laparoscopic transanal abdominal transanal resection with sphincter preservation for rectal cancer in the distal 3 cm of the rectum after neoadjuvant therapy. *Surg Endosc* 2010;24:2700–7.

Mehigan B, Monson J. Laparoscopic rectal-abdominoperineal resection. *Surg Oncol Clin N Am* 2001;10:611–23.

Ng S, Leung K, Lee J, *et al.* Laparoscopic-assisted versus open abdominoperineal resection for low rectal cancer: a prospective randomized trial. *Ann Surg Oncol* 2008;15:2418–25.

Roh M, Colangelo L, O’Connell M, *et al.* Preoperative multimodality therapy improves disease-free survival in patients with carcinoma of the rectum: NSABP R-03. *J Clin Oncol* 2009;27:5124–30.

Cedermark B, Dahlberg M, Glimelius B, Påhlman L, Rutqvist LE, Wilking N; Swedish Rectal Cancer Trial. Improved survival with preoperative radiotherapy in resectable rectal cancer. *N Engl J Med* 1997;336:980–7.

Chapter 36

Hand-Assisted Laparoscopic Abdominoperineal Resection

Walter J. Peters Jr and Winston M. T. Chan

INDICATIONS/CONTRAINDICATIONS

Advancements in surgical technique, improvements in neoadjuvant therapy, and a redefinition of what constitutes an adequate distal margin of resection have resulted in an increase in sphincter-sparing procedures for malignancies of the rectum. Despite these advances, there are still patients for whom an abdominoperineal resection (APR) is the most appropriate operation.

Several recent randomized trials of open versus laparoscopic proctectomy, performed by expert, highly motivated and credentialed surgeons, reported APR in 13–23% of patients with cancers within 12 cm of the anal verge and 10% of patients with tumors up to 15 cm above the anal verge. APR is appropriate for recurrent rectal or anal cancer, anorectal melanoma not amenable to local excision, and for the patient for whom a sphincter-sparing procedure is not appropriate because of the depth of invasion into the anal sphincter, severe comorbidities or functional issues such as incontinence or impaired physical mobility.

PREOPERATIVE PLANNING

Accurate staging of rectal cancer requires assessment by digital rectal examination, rigid proctoscopy to determine the exact distance of the tumor above the anal verge, and complete colonoscopy to identify synchronous lesions. Radiologic staging should include a magnetic resonance imaging (MRI) performed with a specific rectal cancer protocol to accurately stage the primary tumor and to evaluate the status of the circumferential radial margin. MRI has replaced transrectal ultrasound for staging of the primary tumor because of superior visualization of the circumferential resection margin (CRM) and nodes proximal to the primary tumor. Computed tomography scans of the chest, abdomen, and pelvis complete the staging for distant disease.

The results of the clinical staging should then be discussed by a multidisciplinary team (MDT) including specialists in medical oncology, radiation oncology, radiology, pathology, and surgeons specializing in proctectomy for cancer. Depending on the clinical stage and the radiologic assessment for threatened circumferential margins, neoadjuvant therapy may be appropriate. For the past two decades, neoadjuvant therapy has typically consisted of radiation given in doses of 4,500–5,040 cGy with concomitant 5-FU. Alternative approaches have recently been suggested and are currently undergoing clinic trials. These variations include neoadjuvant chemotherapy with FOLFOX and total neoadjuvant therapy. If the initial staging indicated a threatened margin that might require extending the surgical procedure beyond the usual planes of dissection, reimaging with MRI may be helpful in planning the resection. This fact is especially true in the case of an APR where the surgeon has the option of performing an extralevator abdominoperineal excision to obtain a negative margin. The timing of surgery will depend on the type of neoadjuvant therapy recommended by the MDT, but it is typically performed at least 8 weeks after completion of radiation therapy to allow time for tumor regression.

Assessment should also focus on identifying barriers to recovery that can be addressed preoperatively to improve the quality of recovery. These interventions may include nutritional support, physical rehabilitation, smoking cessation, and planning for postdischarge care for patients unlikely to be able to be discharged to their home. Patient education should also begin during the preoperative planning phase to allay patient fears and to set expectations for the pace of recovery. For patients anticipated to require a colostomy, preoperative teaching has been shown to decrease anxiety and to allow patients to quickly become self-sufficient.

SURGERY

Hand-assisted laparoscopic (HAL) APR consists of two separate operations. The abdominal procedure consists of mobilization of the descending colon and rectum, proximal vascular ligation, lymphadenectomy via total mesorectal excision (TME) and creation of a permanent colostomy. The perineal procedure consists of excision of the perianal skin, anal canal, levator ani muscles, distal rectum, and, occasionally, the coccyx or distal sacrum. The two procedures may be performed synchronously by two surgical teams, including two surgeons experienced in rectal resections for cancer. The perineal dissection, which is vitally important to the oncologic outcome, should not be relegated to an inexperienced surgeon. The synchronous approach allows simultaneous dissection of the distal rectum from above and below, shortening operative times and allowing the two surgeons to assist each other in identifying the correct planes of dissection. The two stages may also be sequentially performed by a single surgical team. The abdominal procedure is traditionally performed first, but it is also possible to begin with the perineal dissection and proceed to the abdominal portion. If the stages are performed sequentially, the perineal procedure may be performed either in the lithotomy position or in the prone-jackknife position.

Positioning

The patient is positioned in low stirrups for the abdominal phase of the procedure. This position offers maximal flexibility by allowing the surgeon to stand between the legs, if necessary, for a difficult splenic flexure. It also allows access to the anus and vagina for the rare occasions when passage of a dilator or proctoscope facilitates identification of planes in a difficult, fibrotic pelvis. Care must be taken to avoid pressure at the lateral leg below the fibular head to avoid peroneal nerve injury. The hips should be nearly straight with flexion of no more than 10 degrees to avoid the thighs or stirrup padding interfering with the surgeon’s ability to operate in the upper abdomen. Ureteral catheters are utilized in selected cases, when the tumor abuts the ureter or in cases of recurrent cancer. The patient’s right arm must be tucked at the side to allow both the surgeon and camera operator to stand on the right side for isolation and division of the inferior mesenteric artery (IMA). The left arm may be placed on an arm board if preferred for vascular access or if the patient’s size makes tucking both arms difficult.

Many surgeons prefer to keep the patient in the lithotomy position for the perineal dissection, even if performing it sequentially rather than synchronously. This method avoids the need for repositioning the patient in mid-procedure and may shorten total operative time. The disadvantages of the low lithotomy position are significant and include ergonomic challenges for the surgeon and assistant because of the confined space between the patient’s thighs, difficulty maintaining a sterile field and limitations on the extent to which the incision can be made posteriorly in the event coccygectomy is required. Exposure and visibility may be worsened further if the patient shifts position while in steep Trendelenburg position during the abdominal portion of the procedure.

The advantages of the prone-jackknife position are significant. Both the surgeon and assistant have a clear view of the well-lighted operative field and can operate standing comfortably without the contortions necessary when the patient is in stirrups. There is no difficulty extending the incision posteriorly if coccygectomy or distal sacrectomy is required. It is much easier to maintain a sterile field; and wound closure can be done more precisely, which has decreased the incidence of perineal wound complications in our personal experience.

The patient is positioned prone with the anterior iliac spines supported on a gel roll and the buttocks retracted with wide strips of adhesive tape attached to the bed (Fig. 36-1). After closing the anus with a heavy, monofilament purse string suture, hair can be removed from the surrounding skin and a sterile prep and drape accomplished. This is a surgical field in which hair removal cannot be adequately performed until the patient is asleep and positioned on the operating table.

FIGURE 36-1 Positioning for the prone perineal dissection. The iliac crests are supported by a gel roll and chest rolls allow for chest expansion. The buttocks are retracted with tape. This patient had extensive perianal Paget’s disease with invasive adenocarcinoma in the low rectum and anal canal.

Traditionally, the abdominal procedure was performed first. Following abdominal closure and maturation of the colostomy, the patient was then turned to the prone-jackknife position. With the recent renewed interest in a transanal approach to TME, we have found it useful to begin with the perineal dissection and dissect as far cephalad as possible. When the limits of dissection are reached, the closed anus and distal rectum are pushed cephalad, a Betadine-soaked sponge is placed in the deep pelvis, and the perineal wound is closed. The patient is then turned and placed in low stirrups, or occasionally supine, for the abdominal portion of the procedure. This approach offers the same potential advantages as suggested for a transanal TME with improved visualization of the distal rectum and levator ani (Figs. 36-2 and 36-3). It also allows the surgeon to address the most critical portion of the oncologic procedure early in the case rather than after mobilizing the descending colon, dividing the IMA and dissecting the proximal and mid rectum.

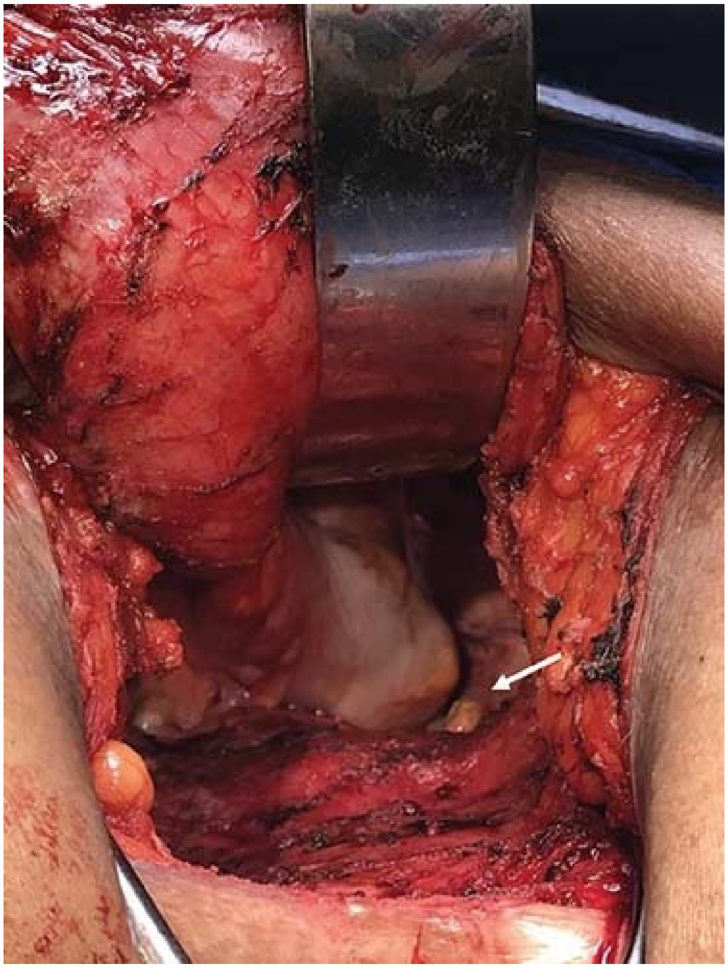


FIGURE 36-2 The sigmoid colon is seen through the completed anterior dissection. Note the glistening intact mesorectal fascia as the rectum has rotated as it retracted posteriorly and to the left. The right ovary is marked with an arrow.

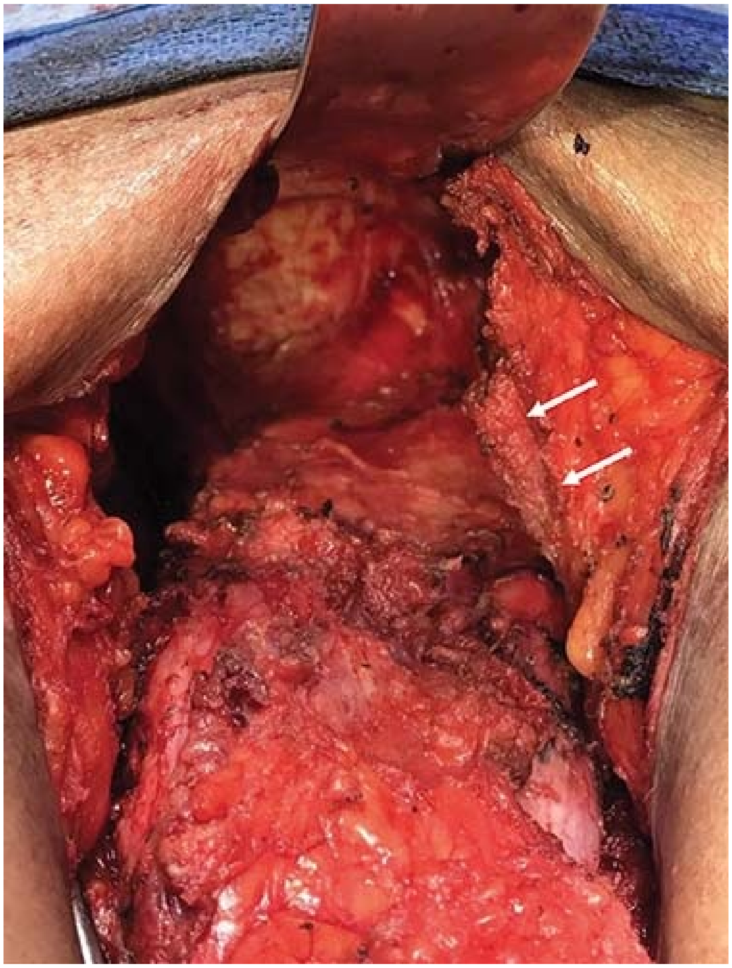


FIGURE 36-3 Presacral fascia as seen from the perineal approach with the patient prone. The cut edge of the right levator is marked with arrows.

Abdominal Technique

Trocar Placement

Placement of the hand-access incision and laparoscopic trocars should allow the surgeon to operate in all quadrants of the abdominal cavity. The ideal position for an individual case may vary depending on the surgeon's dominant hand, the need for the surgeon to serve as a teaching assistant, or patient characteristics such as preexisting scars or ostomies. For most cases, it is the authors' preference to place the hand port through a periumbilical incision in a patient of normal habitus.[1] A 12-mm trocar is placed in the suprapubic position, approximately 2 cm above the pubic bone and 5-mm trocars are placed in the left and right mid-abdominal positions lateral to the rectus sheath. It is ideal to have approximately one handbreadth between the trocars and the hand-access device to allow a wide range of motion at each trocar without colliding with the hand port. The surgeon stands to the patient's right side, placing the left hand through the hand port and operating through the suprapubic trocar. The table should be rolled toward the surgeon so that gravity will assist in retracting the small bowel toward the right side of the abdomen. It is important to keep the height of the table low enough that the surgeon can operate with the shoulders relaxed and the elbows at an angle greater than 90 degrees to reduce fatigue and lessen the risk of long-term injuries to the neck and shoulders.

p. 353

---

p. 354

Transversus Abdominus Plane Block

If a transversus abdominus plane (TAP) block has not been preoperatively performed by the anesthesiologist, it is performed under direct laparoscopic guidance. The anesthetic agent(s) of choice may differ based on the formulary available at an institution. A mixture of bupivacaine 0.5%, 150 mg (30 ml) and liposomal bupivacaine, 266 mg (20 ml) will provide abdominal wall hypesthesia for up to 72 hours. A 5-mm 30-degree camera is placed in the left mid-abdominal trocar and a syringe with a 22-gauge needle is passed through the abdominal wall in the lateral right upper quadrant (RUQ) until it indents the peritoneum. It is then withdrawn slightly and approximately 5–10 ml of the anesthetic mixture is infiltrated into the plane between the transversus abdominus muscle and the internal oblique muscle. Correct placement of the anesthetic is noted by seeing a diffuse bulge in the abdominal wall with the transversus fibers being pushed toward the abdominal cavity. If the fibers separate or become obscured by a wheal forming beneath the peritoneum, the injection is too deep. If no bulge is noted, the injection is most likely too superficial. This process is repeated at three or four sites in the RUQ until 20 ml of the anesthetic solution has been infiltrated. The camera is then moved to the right mid-abdominal trocar and the process is repeated to place the block in the left upper quadrant. The remaining 10 ml of anesthetic can be reserved to infiltrate the perineal wound.

Exploration of the Abdomen

The camera is then moved back to the left mid-abdominal site and a visual exploration of the abdomen is performed. The omentum and parietal peritoneal surfaces can be inspected visually; and the left hand, placed through the access device, can palpate the bowel and abdominal wall. Careful attention must be paid to the surface of the liver. Small nodules that were not visible on preoperative imaging may be present on the surface of the liver. Liver lesions can be biopsied, if necessary, by passing a percutaneous biopsy needle through the upper abdominal wall or using a laparoscopic biopsy forceps to remove a capsular nodule. The surgeon's intra-abdominal hand is used to provide maximal exposure of the liver surfaces as well as to palpate the parenchyma for deeper lesions. Any areas identified as abnormal on imaging should be examined before proceeding with resection.

Mobilization of the Left Colon

The quality of the end descending colostomy created during APR is a significant measure by which the patient will judge the operation as a success or as a failure. A properly constructed colostomy requires the end of the descending colon to reach the skin of the abdominal wall at the optimal site, as selected by the patient and wound ostomy care nurse (WOCN), with no tension. This requirement mandates that at least the descending colon be mobilized and, in some patients, the entire splenic flexure must be mobilized. This mobilization may be performed in either a medial-to-lateral or lateral-to-medial manner. The lateral-to-medial approach is more familiar to surgeons trained initially in open colectomy. The medial-to-lateral approach offers immediate entry into the correct retrocolic plane, earlier identification of the left ureter, and early isolation of the IMA.

The lateral-to-medial mobilization is begun at the level of the proximal sigmoid-descending colon junction by incising the peritoneum lateral to the colon with an energy device placed through the suprapubic trocar. The choice of whether to use monopolar scissors, an ultrasonic dissector, or an advanced bipolar device is one of surgeon's preference. An articulating advanced bipolar device is helpful for this portion of the procedure. The dissection is kept superficial at this level because of the frequency with which false planes created by secondary adhesions between the epiploica and the peritoneum can make identification of the correct plane difficult. As the dissection is carried cephalad, the colon is gently retracted medially, exposing Gerota's fascia. It is possible to drift too far laterally and roll the left kidney medially along with the colon. If the peritoneal incision is kept close to the descending colon, the separation of mesocolic fat from the underlying Gerota's fascia provides the most consistent identification of the correct plane for mobilization. The dissection may be continued around the splenic flexure if needed to bring the distal descending colon up to the abdominal wall without tension. In this case, raising the patient's head into a reverse-Trendelenburg position will facilitate exposure. The distal transverse colon and splenic flexure are freed from the overlying omentum with an energy device and the attachments to the retroperitoneum are divided to release the flexure.

release the flexure.

After identifying the correct plane of dissection over Gerota's fascia, the distal descending colon and sigmoid are medially rolled off the retroperitoneum. Dissection is medially undertaken until the left ureter is identified as it crosses the iliac artery. As the ureter is traced distally, there is a tendency to free the lateral pelvic peritoneum from the pelvic sidewall and enter the wrong plane.

The camera is then moved to the right mid-abdominal trocar and the camera operator moves to stand to the surgeon's left on the patient's right side. The surgeon grasps the mesosigmoid at the level of the sacral promontory and lifts it anteriorly. This maneuver elevates the superior hemorrhoidal artery off the retroperitoneum and creates a triangular bare area at the base of the mesosigmoid. In patients of normal build, a slight indentation will be noted at the base of the mesentery, between the superior hemorrhoidal artery and the promontory. The peritoneum is incised parallel to the course of the artery and just posterior to the artery (Fig. 36-4). Gentle, downward blunt dissection is used to sweep retroperitoneal fat and sympathetic nerve fibers posteriorly away from the superior hemorrhoidal artery. (This step is the initial one in a medial-to-lateral mobilization.) Small veins encountered in this area may cause troublesome bleeding that may obscure visualization of the ureter. They may be controlled with very judicious use of energy until the ureter is again visualized, looking behind the superior hemorrhoidal artery. The superior hemorrhoidal artery is then dissected cephalad and the left colic artery and IMA are exposed. If there is any suspicious lymphadenopathy noted, the IMA should be isolated and divided at its origin from the aorta. If no lymphadenopathy is seen or palpated and there is concern regarding the blood supply to the descending colon, the superior hemorrhoidal artery may be divided just below the origin of the left colic artery. Many advanced energy devices have been approved for the control of vessels of up to 7 mm diameter and can be used to divide the IMA or superior hemorrhoidal artery. It is also possible to place a clip across the vessel before division with an energy device, as the 12-mm suprapubic port allows in-line access to the proximal vessels. A laparoscopic stapling device with a vascular cartridge may also be used to divide the major vessels.

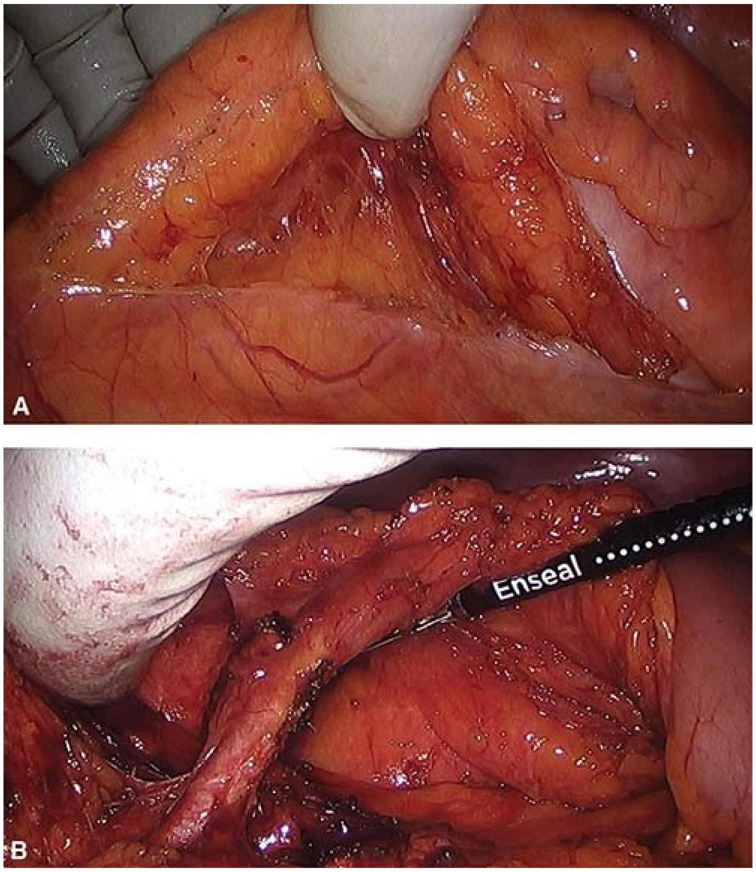


FIGURE 36-4 A. The peritoneum has been incised at the base of the mesosigmoid to begin the isolation of the inferior mesenteric artery. B. The IMA has been isolated and is ready for proximal division.

p. 355

---

p. 356

Next, the inferior mesenteric vein (IMV) must be divided. The vein is identified by placing downward traction on the descending colon mesentery, which results in the vein tenting the overlying peritoneum. It is followed proximally and divided adjacent to the duodenum with an advanced energy device, a stapler, or clips (Fig. 36-5). It will need to be divided a second time more distally once the site of transection of the colon is chosen and the descending colon mesentery divided from the base of the mesentery to the bowel wall. Once the IMV is divided, any remaining attachment of the descending mesocolon to the retroperitoneum can be divided with energy or bluntly with a gentle downward sweeping motion.

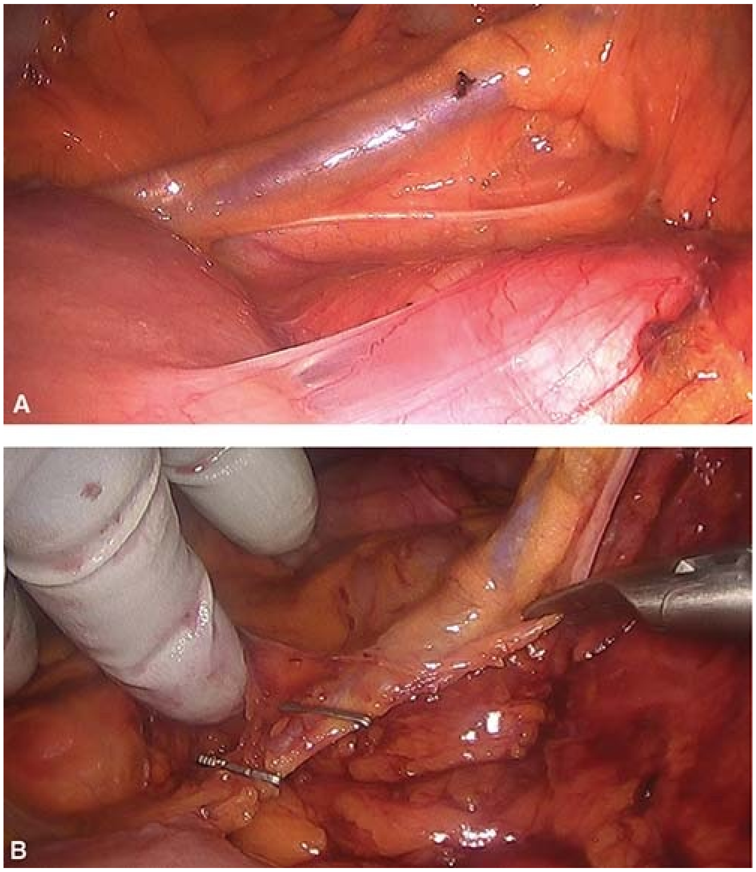


FIGURE 36-5 A. The Inferior Mesenteric Vein (IMV) is seen adjacent to the third portion of the duodenum. B. It has been isolated, clipped and ready for division.

Following complete mobilization of the left colon and division of the major vessels, the rectosigmoid colon is retracted anteriorly by placing the surgeon's hand behind the sigmoid mesentery and pushing toward the pubis. The retroperitoneal tissue, including sympathetic nerve fibers, may still be adherent to the mesosigmoid at the level of the sacral promontory and must be gently swept down to expose the posterior aspect of the proximal mesorectal fascia. Gentle digital traction applied in a cephalad direction to the retroperitoneal tissues at the promontory will place the sympathetic nerve trunks under mild tension and facilitate their identification. The loose areolar fibers of the avascular presacral plane are then exposed. This portion of the dissection may be accomplished with monopolar cautery, delivered with a spatula tip or a J-tip. The advantage of monopolar cautery is that it allows tissue to separate on contact and does not require as much space as the jaws of an advanced energy device. It is also adequate to ensure hemostasis if the surgeon is dissecting in the proper plane. Therefore, significant bleeding may indicate that the surgeon needs to reevaluate the plane of dissection (Fig. 36-6).

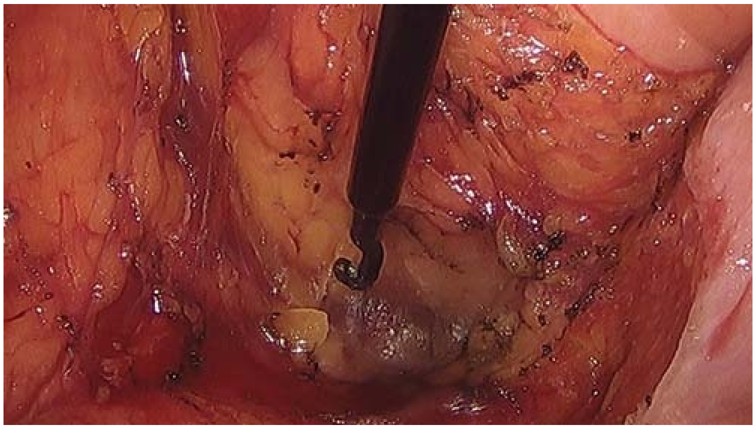


FIGURE 36-6 Mobilization of the mesorectum performed with monopolar cautery in the upper pelvis. Loose areolar tissue with mild edema indicates the proper plane. Note that the hand is retracting the rectum anteriorly but is not visible in the field.

The dissection proceeds distally in the presacral plane while using the hand to anteriorly retract the mesorectal envelope. The plane is bilaterally broadened, remembering that the shape of the pelvis is an oval tipped in a clockwise manner as the surgeon looks toward the pelvis. If the lateral peritoneal attachments are left intact as long as possible, blood and abdominal fluid tend to remain trapped in the anterior cul-de-sac rather than pooling at the depths of the presacral plane where they interfere with exposure and the use of cautery. After mobilizing the posterior hemi-circumference of the mesorectum as far distally as possible, the peritoneum is incised laterally down to the anterior reflection on both sides of the mesorectum and the two incisions are brought to meet at the midline of the cul-de-sac. For patients requiring APR for cancer, the tumor will be encountered below the peritoneal reflection. The dissection below this point will vary depending on presurgical imaging and treatment planning. The plane of dissection will be chosen with consideration for any threatened circumferential margins identified on MRI. Traditional APR resulted in a specimen with a narrow waist at the level of the levator ani. The cylindrical specimen produced by an extralevator APR reduces the risk of a positive margin but leaves a large defect in the pelvic floor that cannot be closed primarily. Preoperative MRI can identify those patients in whom one or both levator ani muscles are threatened by tumor and allow the surgeon to anticipate the level at which the levators should be divided to provide an adequate oncologic margin while avoiding an unnecessarily radical excision. Likewise, the anterior dissection in a male patient would typically be performed between the anterior rectum and perirectal fat and Denonvilliers’ fascia. This plane protects the parasympathetic nerve fibers from

Denonvilliers' fascia. This plane protects the parasympathetic nerve fibers from injury as they course between the Denonvilliers' fascia and the seminal vesicles. If the anterior margin is threatened by tumor, the dissection may proceed anterior to the Denonvilliers' fascia providing protection against a positive margin, but exposing the seminal vesicles and increasing the risk of postoperative bladder and erectile dysfunction. In a female patient, the dissection is performed in the rectovaginal septum, avoiding entry into the vagina unless tumor is threatening, or invading, the vaginal wall.

The anterior dissection is performed with the surgeon's hand posteriorly retracting the rectal wall to provide exposure. If a normal-sized or enlarged uterus is present, additional exposure can be obtained by passing a heavy monofilament suture on a Keith needle through the abdominal wall immediately above the pubis. The suture is then passed posteriorly through one broad ligament and anteriorly through the opposite broad ligament, creating a sling with which to suspend the uterus. The suture is then passed back through the abdominal wall where the two ends of the suture can be clamped snug against the abdominal wall to maintain retraction of the uterus. In a male patient or in the case of a female patient with an atrophic or absent uterus, anterior retraction can be obtained by passing a 5-mm Babcock clamp down the left mid-abdominal trocar and using it in an opened position to provide leverage on the posterior aspect of the prostate or vagina.

The posterior dissection is carried cephalad until encountering Waldeyer's fascia. Waldeyer's fascia is typically encountered at the level where the sacrum curves anteriorly and is identified as a condensed layer of tissue providing much greater resistance to dissection than the areolar tissue found more cephalad in the presacral plane. Although it is possible to separate the proximal presacral space using gentle blunt dissection with a finger, an instrument, or a suction device, Waldeyer's fascia will usually not yield to such a maneuver. Persistent attempts to bluntly divide Waldeyer's fascia will frequently result in tearing the presacral fascia and the underlying sacral veins, producing severe bleeding that is difficult to control. For this reason, Waldeyer's fascia must be divided sharply or with an energy device.

The lateral dissection is carried down bilaterally onto the levator ani muscle. The proper plane of dissection is typically most difficult to identify laterally and anterolaterally. It is essential that the surgeon maintain a proper reference to the horizon and realize that the patient's pelvis is tilted toward the right. Otherwise, there is a tendency to dissect into the pelvic sidewall on the left and to leave the lateral mesorectum on the right side. It is important to decide before surgery how far to carry the dissection onto the levators. If preoperative imaging has identified tumor adjacent to the levator muscle, the dissection should stop proximal to the area of tumor involvement. The levator can be incised from above, if adequate exposure can be obtained, or divided from below during the perineal portion of the procedure. Continuing the dissection until encountering the tumor should be avoided because this results in a “waisted” specimen and increases the risk of a positive CRM.

Once the pelvic dissection has been completed to the pelvic floor, attention is turned to creation of the colostomy. The mesentery of the colon must be divided from the point of transection of the superior hemorrhoidal artery or IMA up to the descending/sigmoid colon junction. This can be performed intracorporeally with an advanced energy device or, except in the case of a morbidly obese patient, through the hand-access device. If there is any question about the vascular supply and viability of the descending colon, the marginal artery may be divided sharply to observe the presence or absence of arterial bleeding at the margin of resection. Some surgeons prefer to use fluorescent angiography with Indocyanine green to confirm perfusion, but the role of this newer technology is not yet well defined. The colon is then divided at the descending/sigmoid junction with a linear cutting stapler. If the surgeon prefers to use a closed suction drain in the pelvis, the distal end of the drain can be sutured to the sigmoid colon so that the drain will be pulled deep into the pelvis as the specimen is withdrawn through the perineal wound. The drain is brought out through the lower abdominal wall at a site that will not interfere with the colostomy appliance. A lap pad is then tightly packed into the low pelvis, behind the mesorectum, to facilitate entry into the pelvis from below as well as to tamponade any minor bleeding.

The skin is then excised at the site previously marked for the colostomy and a vertical incision carried straight downward to the anterior rectus sheath. There is no need to core out the subcutaneous fat, because the fat is easily compressed. The anterior rectus sheath is then incised vertically for approximately 3 cm. The rectus fibers are separated bluntly to expose the posterior sheath or peritoneum, which is then incised for a similar distance. The aperture should accommodate two fingers. The proximal end of the divided colon is then brought through the abdominal wall with a Babcock clamp. Recent randomized trials suggest that the risk of peristomal hernia can be safely reduced by placing a retromuscular patch of light-weight polypropylene mesh at the stoma site, but a previous trial of a biologic reinforcement of the stoma site was unsuccessful in reducing the risk of hernia formation.

The fascia is closed at any trocar site larger than 5 mm, the remaining 5-mm trocars are removed, and the midline hand-access site is closed with a running absorbable suture. The skin is closed with subcuticular suture or staples. The colostomy is then matured with an interrupted 3-0 absorbable braided suture. The stoma appliance is placed and the pelvic drain, if present, is connected to a bulb suction device.

Perineal Technique

The patient is positioned in the prone-jackknife position as previously described.

The anus is closed with a purse string of heavy monofilament suture before performing skin preparation and draping. An elliptical incision is made in the perianal skin. Dissection is carried cephalad between the external anal sphincter and the ischiorectal fat (Fig. 36-7). The plane chosen for dissection will depend on the results of preoperative imaging and the identification of threatened margins (Figs. 36-8 and 36-9). Typically, the easiest point at which to enter the pelvis is in the posterior midline, just anterior to the tip of the coccyx. In the case of a large, bulky tumor or threatened posterior margin, dissection may be carried posteriorly onto the posterior surface of the coccyx and the sacro-coccygeal ligament divided with cautery or a rongeur. After entering the pelvis, the lap sponge previously placed during the abdominal dissection is removed. This allows room for the surgeon's finger to be inserted into the pelvis to palpate the upper surface of the levator muscle and to guide division of the levators from below. The anterior dissection is the most difficult, especially in the male patient. In female patients, palpation of the posterior vaginal wall is helpful to avoid inadvertent entry into the vagina. In male patients, it is helpful to complete the dissection posteriorly and laterally. The specimen can then be withdrawn through the posterior perineal defect, allowing exposure of the proper anterior plane from the cephalad side of the remaining attachments.

FIGURE 36-7 The anus is sutured to prevent spillage. Once the elliptical incision is through the

dermis, two Gelpi retractors provide excellent exposure and can be repositioned as the dissection proceeds cephalad. The dissection on the right has exposed the outer surface of the external sphincter (arrow).

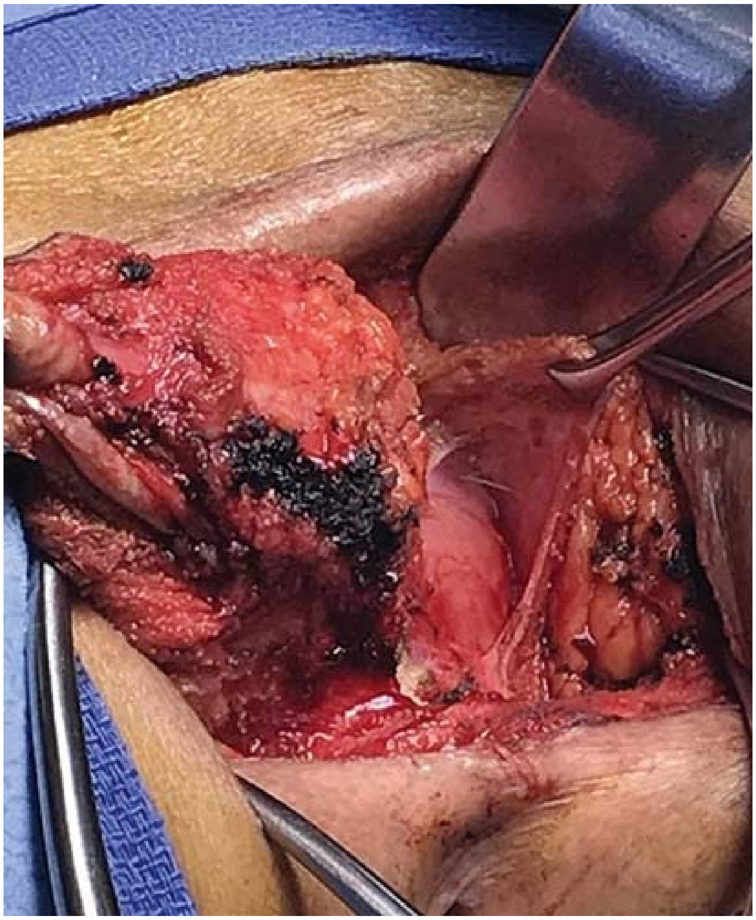


FIGURE 36-8 The right levator has been divided and retracted with an Allis clamp, exposing the plane between the mesorectal fascia and the pelvic sidewall.

FIGURE 36-9 The left levator ani is exposed to allow an extralevator resection. The right levator has been divided to allow the distal rectum to be retracted to the right with downward traction.

p. 358

p. 359

If a drain had been placed in the pelvis during the abdominal dissection, it is now positioned. The levator ani are approximated, if possible, with heavy absorbable suture. The wound is then closed in layers, approximating ischiorectal fat and skin with absorbable suture.

[1]For morbidly obese patients in whom the umbilicus has descended onto a pannus, the incision should be made at the mid-abdominal level. For cases in which the senior surgeon wishes to provide the hand-assisted exposure as a teaching assistant, a Pfannenstiel incision may be more useful.

POSTOPERATIVE MANAGEMENT

Enhanced recovery protocols utilize an evidence-based, MDT approach to minimize the physiological and psychological impact of surgery and to improve the quality of recovery.

Optimal intraoperative management emphasizes goal-directed fluid management and avoidance of narcotics. The use of regional anesthetic techniques will reduce the need for perioperative narcotics. A TAP block can be performed under direct laparoscopic visual guidance in the initial stages of a HAL APR. This technique requires minimal time to perform and allows the block to take effect during the operation. Alternative regional anesthetic options are placement of an epidural catheter and placement of a single-dose spinal anesthetic block.

Postoperatively, patients should continue to be managed on an evidence-driven protocol. There is no justification for the routine use of a nasogastric tube. Early ambulation may begin on the day of surgery. Patients may be allowed a diet beginning on the day of surgery. A multimodality analgesic regimen should be used to minimize the amount of narcotic required for adequate pain control. These regimens may vary from institution to institution depending on drug availability, but typically include acetaminophen, a nonsteroidal anti-inflammatory drug and a gamma-aminobutyric acid analog such as gabapentin. Some physicians prefer to offer patient-controlled analgesia with a narcotic in the immediate postoperative period, but this should be transitioned to oral narcotic analgesia as soon as possible. Other novel agents in use in some institutions include intravenous lidocaine infusion or low-dose ketamine, both of which have been found to reduce narcotic usage for postsurgical pain.

COMPLICATIONS

APR is prone to a multitude of potential morbidity because of the magnitude of the procedure. The overall risk of morbidity is more likely associated with the use of evidence-based care paths than with the choice of operative approach, whether laparoscopic, hand-assisted, or open. The hand-assisted approach does have a greater risk of incisional hernia and superficial surgical site infection than a straight laparoscopic one because of the necessity of the hand-access incision.

RESULTS

Systematic reviews have found that hand-assisted colorectal resections (HALS) offer similar advantages as laparoscopic surgery when compared to open surgery, such as faster postoperative recovery and decreased length of hospital stay. When compared to laparoscopic procedures, HALS offers shorter operative times, lower conversion rates, and perhaps a flatter learning curve with no significant difference in postoperative outcomes such as length of hospital stay, surgical site infection, return of bowel function, and mortality. The technique also provides the surgeon the benefit of tactile sensation, which is useful for complicated disease processes such as locally advanced cancer where differentiating between soft compliant tissue and hard immobile tumor to achieve an adequate negative margin is critical.

The role of any minimally invasive technique in the treatment of rectal cancer has been rigorously studied and vigorously debated. Multicenter randomized controlled trials comparing minimally invasive and open proctectomy have yielded conflicting results in different groups of patients:

The *C*omparison of *O*pen versus laparoscopic surgery for mid or low *RE*ctal cancer *A*fter *N*eoadjuvant chemoradiotherapy (COREAN) trial (2014) studied stages II and III mid and low rectal cancer requiring neoadjuvant chemoradiation therapy and found equivalent 3-year disease-free survival.

The *CO*lorectal cancer *L*aparoscopic or *O*pen *R*esection (COLOR) II trial (2015) studied low, mid, and high rectal cancer of all stages and concluded that the techniques were equivalent for the primary endpoint of 3-year locoregional recurrence. One-third of these patients had tumors in the upper third of the rectum, 29% were stage I, and 41% had not received preoperative radiation.

The US American College of Surgeons Oncology Group (ACOSOG) Z6051 trial (2015) studied stages II and III rectal cancers below 12 cm and could not establish non-inferiority of laparoscopic proctectomy based on a composite nonstatistical validated surrogate pathologic endpoint of complete mesorectal excision, negative CRM, and negative distal margin. All patients received preoperative radiation and 50% of patients had cancers located in the low rectum.

The Australasian Laparoscopic Cancer of the Rectum Trial (ALaCaRT) (Australia, 2015) studied low, mid, and high rectal cancer of all stages, using the same nonvalidated composite pathologic endpoint as the Z6051 trial and could not confirm non-inferiority for laparoscopic proctectomy. Cancers of the upper rectum comprised only 20% of this population, but only 50% received preoperative radiation.

The contradictory conclusions from these four trials may well result from differences in the populations studied. More advanced cancers and those in the low rectum may be less suitable for an oncologic resection using any minimally invasive technique. All surgeons performing proctectomy for rectal cancer should closely monitor the oncologic quality of resection as evaluated by negative CRM and completeness of TME to ensure that patients are receiving the most appropriate care.

CONCLUSIONS

APR remains the surgical procedure of choice for many patients with primary or recurrent malignant tumors involving the low rectum and anal canal.

HAL APR offers the advantages of minimally invasive surgery, including faster recovery and shorter hospital stay, when compared to open surgery for patients requiring resection of the rectum and anus.

HAL APR offers the advantages of decreased conversion rate and shorter operative times when compared to laparoscopic APR.

Uncertainty over the optimal surgical approach to cancers of the low rectum mandates that surgeons measure outcomes to assure their patients receive the highest quality care possible.

Optimal management of the rectal cancer patient requires an MDT approach to treatment planning, precise surgical technique, and protocol-driven, evidence-based perioperative care.

RECOMMENDED REFERENCES AND READINGS

Aalbers AG, Biere SS, van Berge Henegouwen MI, Bemelman WA. Hand-assisted or laparoscopic-assisted approach in colorectal surgery: a systematic review and meta-analysis [review]. *Surg Endosc* 2008;22(8):1769–80. doi:10.1007/s00464-008-9857-4. PubMed PMID: 18437486.

Aalbers AG, Doeksen A, Van Berge Henegouwen MI, Bemelman WA. Hand-assisted laparoscopic versus open approach in colorectal surgery: a systematic review [review]. *Colorectal Dis* 2010;12(4):287–95. doi:10.1111/j.1463-1318.2009.01827.x. PubMed PMID: 19320665.

AbbasMA, Chang GJ, Read TE,et al. Optimizing rectal cancer management: analysis of current evidence.*Dis Colon Rectum* 2014;57(2):252–9. PMID: 24401889.

Bonjer HJ, Deijen CL, Abis GA, *et al.* A randomized trial of laparoscopic versus open surgery for rectal cancer. *N Engl J Med* 2015;372(14):1324–32. doi:10.1056/NEJMoa1414882. PubMed PMID: 25830422.

Ding J, Xia Y, Liao GQ, *et al.* Hand-assisted laparoscopic surgery versus open surgery for colorectal disease: a systematic review and meta-analysis [review]. *Am J Surg* 2014;207(1):109–19. doi:10.1016/j.amjsurg.2013.04.013. PubMed PMID: 24119890.

Fleshman J, Branda M, Sargent DJ, *et al.* Effect of laparoscopic-assisted resection vs open resection of Stage II or III rectal cancer on pathologic outcomes: the ACOSOG Z6051randomized clinical trial. *JAMA* 2015;314(13):1346–55. doi:10.1001/jama.2015.10529. PubMed PMID: 26441179.

Jeong SY, Park JW, Nam BH, *et al.* Open versus laparoscopic surgery for mid-rectal or low-rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): survival outcomes of an open-label, non-inferiority, randomised controlled trial. *Lancet Oncol* 2014;15(7):767–74. doi:10.1016/S1470-2045(14)70205-0.

Kang SB, Park JW, Jeong SY, *et al.* Open versus laparoscopic surgery for mid or low rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): short-term outcomes of an open-label randomised controlled trial. *Lancet Oncol* 2010;11(7):637–45. doi:10.1016/S1470-2045(10)70131-5. PubMed PMID: 20610322.

Martínez-Pérez A, Carra MC, Brunetti F, de’Angelis N. Pathologic outcomes of laparoscopic vs open mesorectal excision for rectal cancer: a systematic review and meta-analysis. *JAMA Surg* 2017;152(4):e165665. doi:10.1001/jamasurg.2016.5665. PubMed PMID: 28196217.

McEvoy MD, Scott MJ, Gordon DB, *et al.* American Society for Enhanced Recovery (ASER) and Perioperative Quality Initiative (POQI) joint consensus statement on optimal analgesia within an enhanced recovery pathway for colorectal surgery: Part 1-from the preoperative period to PACU. *Perioper Med (Lond)* 2017;6:8. doi:10.1186/s13741-017-0064-5. PubMed PMID: 28413629.

Moloo H, Haggar F, Coyle D, *et al.* Hand assisted laparoscopic surgery versus conventional laparoscopy for colorectal surgery [review]. *Cochrane Database Syst Rev* 2010;(10):CD006585. doi:10.1002/14651858.CD006585.pub2. PubMed PMID: 20927747.

Monson JR, Weiser MR, Buie WD, *et al.* Practice parameters for the management of rectal cancer (revised). *Dis Colon Rectum* 2013;56(5):535–50. doi:10.1097/DCR.0b013e31828cb66c. PubMed PMID: 23575392.

Scott MJ, McEvoy MD, Gordon DB, *et al.* American Society for Enhanced Recovery (ASER) and Perioperative Quality Initiative (POQI) joint consensus statement on optimal analgesia within an enhanced recovery pathway for colorectal surgery: Part 2-from PACU to the transition home. *Perioper Med (Lond)* 2017;6:7. doi:10.1186/s13741-017-0063-6. PubMed PMID: 28413628.

Stevenson AR, Solomon MJ, Lumley JW, *et al.* Effect of laparoscopic-assisted resection vs open resection on pathological outcomes in rectal cancer: the ALaCaRT randomized clinical trial. *JAMA* 2015;314(13):1356–63. doi:10.1001/jama.2015.12009. PubMed PMID: 26441180.

Tjandra JJ, Chan MK, Yeh CH. Laparoscopic-vs. hand-assisted ultralow anterior resection: a prospective study. *Dis Colon Rectum* 2008;51(1):26–31. PubMed PMID: 18085339.

Chapter 37

Robotic Abdominoperineal Resection (APR)

Se-Jin Baek and Seon-Hahn Kim

INDICATIONS/CONTRAINDICATIONS

Abdominoperineal resection (APR) has been a standard surgical treatment for rectal cancer since the first surgical case study was published by Miles in 1908. During the past few decades, sphincter-saving operations with colorectal or coloanal anastomosis (CAA) have replaced a large portion of APR because of the advancement of surgical instruments, including the anastomotic stapler, and neoadjuvant chemoradiation. Nevertheless, APR is still performed in at least 15–25% of patients with low rectal cancer. It is specifically used as treatment in patients with low-lying tumors involving the sphincter muscle, with poor sphincter function, or with a restrictive pelvis.

APR remains a challenging operation for treatment of low rectal cancer. Recently, robotic approach has been used for APR because the advanced technology of the robotic surgical system is effective for deep pelvic dissection. The da Vinci Surgical System (Intuitive Surgical System, Sunnyvale, CA) has the potential to overcome the potential limitations of laparoscopy by providing improved three-dimensional vision under the operator's control, effective countertraction with the EndoWrist motion, and tremor elimination. This robotic system has been actively used in specialties that work in narrow spaces, such as urologic, gynecologic, cardiac, and rectal surgery. In the field of rectal surgery, utilization of the robotic system has become higher over time in patients with very low rectal cancer, which requires either intersphincteric resection (ISR) or APR. A multicenter survey of 12 large medical centers in Korea in 2015 showed that robotic ISR comprised 3.7% of the total ISR procedures in 2007, and 42.4% in 2014. Similarly, robotic APR comprised 5.1% of the total APR procedures in 2007, and 12.2% in 2014. These results showed the increased dependency on the robotic method for both ISR and APR.

In principle, the indications and contraindications for the use of robotic APR are the same as those for open and laparoscopic APR. Patients with medical diseases unsuitable for treatment with laparoscopic surgery are also unacceptable for robotic surgery. In addition, patients with a small stature may not be appropriate for robotic surgery because the limited operative workspace cannot accommodate the robotic arms.

PREOPERATIVE PLANNING

All patients should be preoperatively evaluated by routine laboratory tests including tumor markers, digital rectal examination, total colonoscopy with biopsy, abdominopelvic computed tomography (CT), either an endorectal ultrasound or pelvic magnetic resonance imaging, and chest CT. Many patients are treated with 5–6 weeks of neoadjuvant chemoradiation (5,040 cGy in 28 fractions). Each patient is reevaluated 8–10 weeks later by final decision regarding sphincter preservation. The optimal stoma site is marked in the left lower quadrant (LLQ). Other steps in preoperative planning for robotic APR are similar to those used in open and laparoscopic APR.

SURGERY

Robotic APR is composed of three steps:

- Colonic phase—ligation of the mesenteric vessels and mobilization of the left colon
- Pelvic phase—pelvic dissection including total mesorectal excision (TME)

Perineal phase

p. 363

p. 364

There is relatively a little difference between the hybrid and fully robotic approach to APR because there is no mobilization of the splenic flexure and minimal mobilization of the left colon. This description is for a fully robotic procedure.

Operating Room Setup and Patient Positioning

The assistant is to the patient's right side and the scrub nurse is at the lower right side of the table (Fig. 37-1). The vision cart is located at the patient's feet. If a second monitor is prepared, it is set across from the assistant on the left side of the table. A sterile pocket for the assistant's instruments is located at the level of patient's right knee.

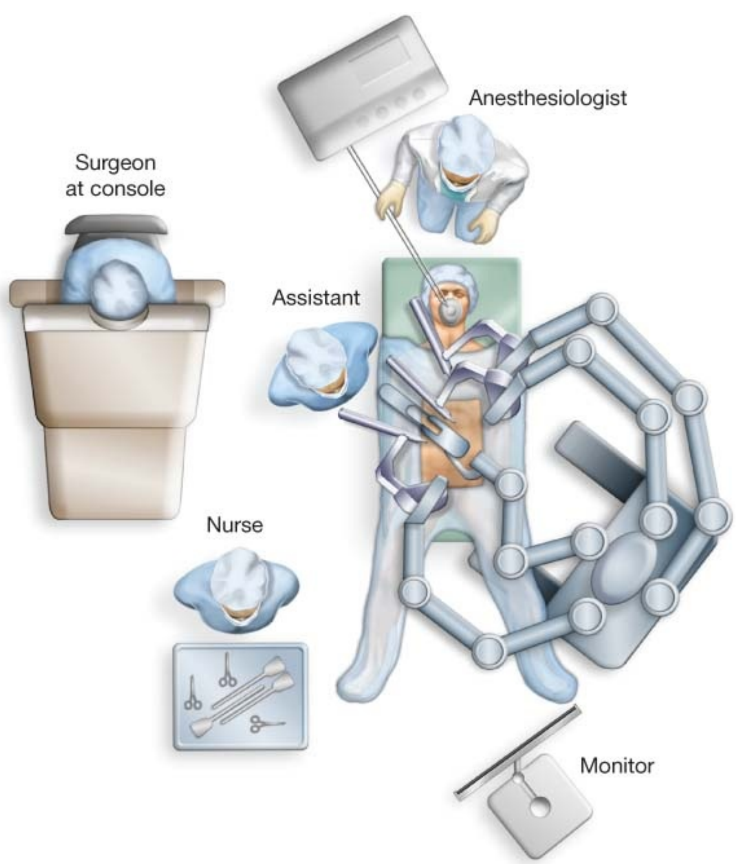


FIGURE 37-1 Operating room setup.

The patient is placed in a modified lithotomy position with legs in adjustable stirrups. The patient’s legs are abducted and slightly flexed at the knees and arms are tucked alongside the body to lessen the possibility of shoulder injury. A vacuum-mattress device secures and pads pressure points and bony prominences to avoid shifts during position changes. A urinary catheter is placed, and a body warmer and pneumatic compression devices are applied to prevent hypothermia and deep vein thrombosis. The patient is then placed in a Trendelenburg position with the right side down. The angle and steepness are adjustable during the initial exposure.

Port Placement and Docking

Port placement of a fully robotic APR is similar to that of a fully robotic low anterior resection. The location of the LLQ port is slightly medial because it is used as a stoma site (Fig. 37-2). All ports are placed under direct laparoscopic vision.

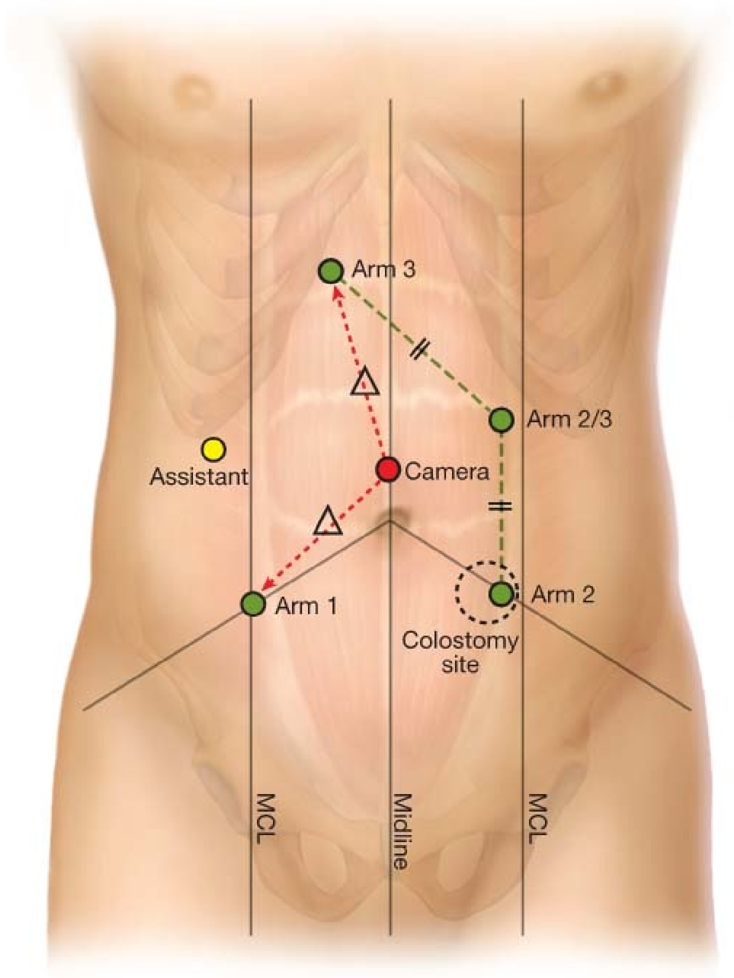


FIGURE 37-2 Port placement and docking. MCL, midclavicular line.

The 12-mm da Vinci camera port is placed 3–4 cm above the umbilicus.

The 8-mm da Vinci instrument arm 1 port is placed on the right spinoumbilical line at the crossing of the midclavicular line (MCL).

The 8-mm da Vinci instrument arm 3 port is placed *3 cm sub-xiphoid and* 2 cm medial to the right MCL.

The 8-mm da Vinci instrument arm 2 port is placed within the lateral border of the LLQ stoma site.

The 8-mm da Vinci instrument arm 2/3 port is placed 7–8 cm below the left costal margin, slightly medial to the left MCL.

The 5-mm assistant port is placed midway between the arms 1 and 3 ports for suction/irrigation, ligation, and retraction.

Note 1: Once the arm 3 port is placed, the location is better, because the distance from the camera port is longer (a minimum of 8 cm) and the angle between arm 3 (camera) and arm 1 ports is wider.

Note 2: Once the arm 2/3 port is placed, the location is determined to make symmetrical equilateral triangles with arm 3—camera—arm 2/3 ports and arm 2—camera—arm 2/3 ports to minimize external collisions.

During the colonic phase, the da Vinci instrument arms 1, 3, and 2/3 as 2 are used to dock the robot. During the pelvic phase, the da Vinci instrument arms 2/3 and 3 are undocked, and the 2 and 2/3 as 3 arms are used to re-dock the robot. A port on the right upper quadrant is used as a second assistant port for cephalad traction of the rectum.

After port placement and initial exposure, the patient cart is approached obliquely from the patient's left leg side toward the camera port (Fig. 37-3). The left stirrup might need to be adjusted and moved medially to allow space for the patient's cart column and arm 1. The angle for the patient cart roll up is defined by a straight line running from the camera port and crossing the anterior superior iliac spine. After the patient cart is positioned, docking of the robotic arms is completed by maximizing the space between the arms.

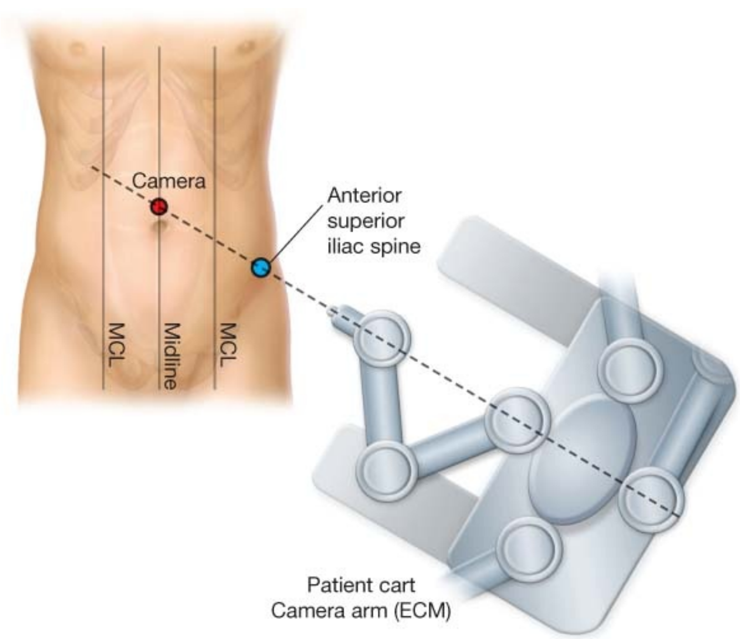


FIGURE 37-3 Correct roll-up angle for patient cart docking. ECM, endoscopic camera manipulator; MCL, midclavicular line.

Technique

Technique

The da Vinci instrument arm 1 port used for monopolar curved scissors represents the surgeon's right hand (the first arm), the arm 3 port for the Maryland bipolar forceps represents the left hand (the second arm), and the arm 2 port for the Cadiere forceps represents the second left hand (the third arm).

Abdominal Phase 1 (Colonic Phase): Vascular Control and Colonic Mobilization

After identification of the pulsatile inferior mesenteric artery (IMA), the peritoneum is incised and dissected superiorly along the right anterior border of the aorta to the root of the IMA under continuous ventral traction using Cadiere forceps. If the IMA root cannot be directly identified, the peritoneal incision is started at the level of the sacral promontory below the aortic bifurcation. The lymph nodes surrounding the root of the IMA are dissected while preserving the preaortic sympathetic neural plexus. After identifying the left ureter, two clips are placed on the exposed IMA using the EndoWrist Hem-o-Lok Large Clip Applier or a 5-mm laparoscopic clip applier through the assistant port, and the IMA is divided between the clips. The inferior mesenteric vein (IMV) is also transected in the same way. Although splenic flexure mobilization is not necessary in APR, dividing the IMV at the level of the inferior border of the pancreas is helpful to find an avascular plane for medial-to-lateral colonic dissection.

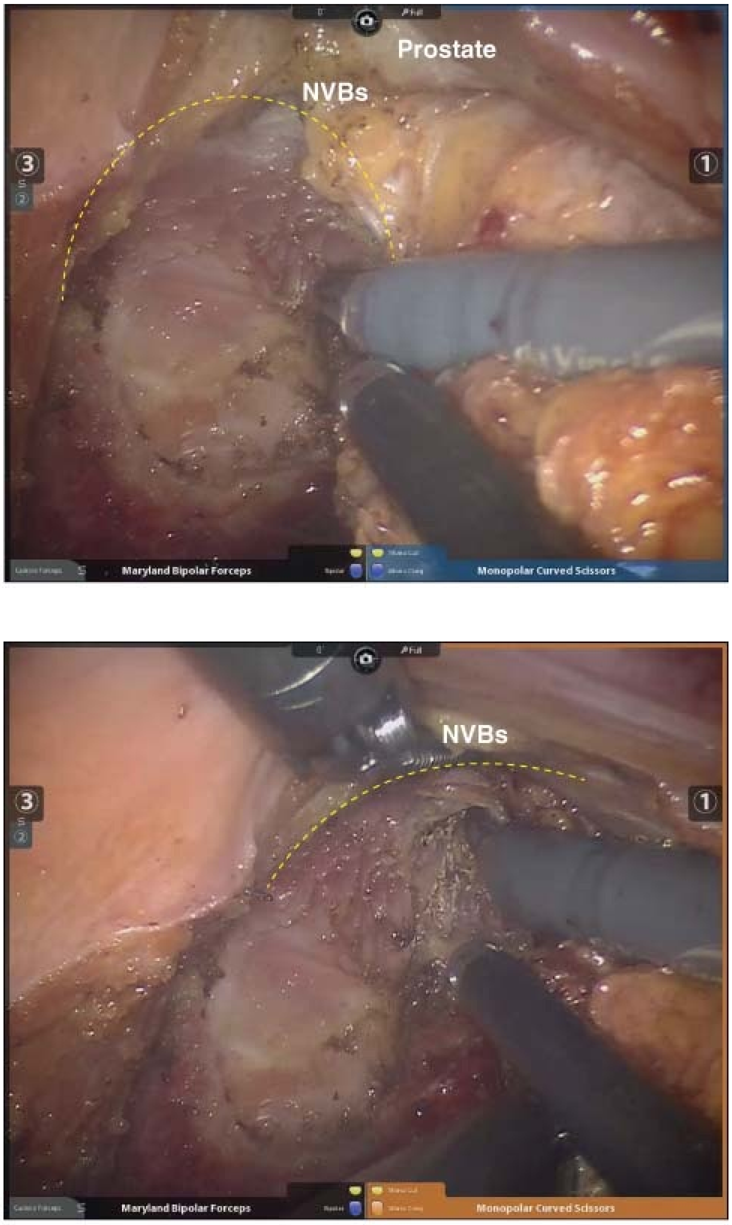
The left colon is mobilized in a medial-to-lateral manner below the level of Gerota's fascia to avoid injury to the gonadal vessels and the left ureter. The dissection is then laterally continued toward Toldt's line. During colonic mobilization, countertraction on the retroperitoneal tissues by the assistant facilitates safe and easy dissection along the avascular plane. While an assistant retracts the left colon caudally and medially, the white line of Toldt is incised and the lateral attachments of left colon are dissected to the previously performed medial dissection to completely mobilize the colon.

Abdominal Phase 2 (Pelvic Phase): Pelvic Dissection with Total Mesorectal Excision or Beyond Total Mesorectal Excision

After completion of the colonic phase, the da Vinci arms are re-docked as a pelvic setup. Rectal dissection begins at the level of the sacral promontory. The rectum is retracted cephalad and anteriorly out of the pelvis by an assistant's grasping retractor through the port in the right upper quadrant. In conventional APR, the posterior dissection is performed in an avascular presacral plane to the level of the pelvic floor following the principles of TME. The lateral attachments of the rectum are sharply dissected, preserving both the hypogastric nerves and the autonomic nerve plexus. Anteriorly, the rectovesical/rectovaginal fold of the peritoneum is incised to expose Denonvilliers' fascia or the rectovaginal septum, and the rectum is mobilized from the prostate/vagina. The third arm (da Vinci instrument arm 2) allows for retraction of the rectum anteriorly during the posterior rectal dissection and retraction of the bladder/vagina anteriorly during the anterior rectal dissection. The redundant rectum is retightened by a tie string at the level of the sacral promontory. If prolapse of the uterus or urinary bladder obstructs the visual field of the anterior dissection, it is helpful to secure an open view by anchoring the uterus or urinary bladder against the abdominal wall with a nylon suture thread. Once the rectal dissection is carried to the level of the pelvic floor, the TME is completed.

Unlike conventional APR, extralevator abdominoperineal resection (ELAPR) requires rectal dissection to be stopped just above the origin of the levator ani muscle, and the mesorectum should not be dissected off the levators. Then, a change in the patient's position from lithotomy to prone jackknife is often necessary to facilitate dissection of the coccyx, levators, and prostate in open or laparoscopic ELAPR. This position provides an excellent visualization of the neurovascular bundles (NVBs) attached to the seminal vesicles and the prostate.

In contrast robotic, ELAPR can be continued to dissect the pelvis transabdominally without a position change, still under super-exposure of the low pelvis. Pelvic dissection is performed down to the coccyx, which is posteriorly identified by direct palpation with either an assistant's laparoscopic instrument or a surgeon's robotic instrument. The levators are initially transected at their lateral sides then connected in the posterior midline, and the endopelvic fascia and iliococcygeal tendon are divided slightly distally to the coccyx tip. The circumferential divisions of the levator muscles are carried out partially or subtotally with at least 2 cm of the resection margin using both bipolar forceps and monopolar scissors until the lobular fat of the ischiorectal fossa is directly visualized (Fig. 37-4). Lateral transection of the levator muscles should not cross the line of origin from the obturator fascia. Maryland bipolar forceps are used to control bleeding from the levator muscle or the NVBs surrounding the seminal vesicles. The dissection is continued anterodistally to dissect the levators from the NVBs attached to the prostate. When coccygectomy is indicated at the same time, the coccyx can be excised in an en bloc manner without a position change (Fig. 37-5).


Prostate
NVBs
Maryland Bipolar Forceps
Monopolar Curved Scissors
A
NVBs
Maryland Bipolar Forceps
Monopolar Curved Scissors
B

C

D

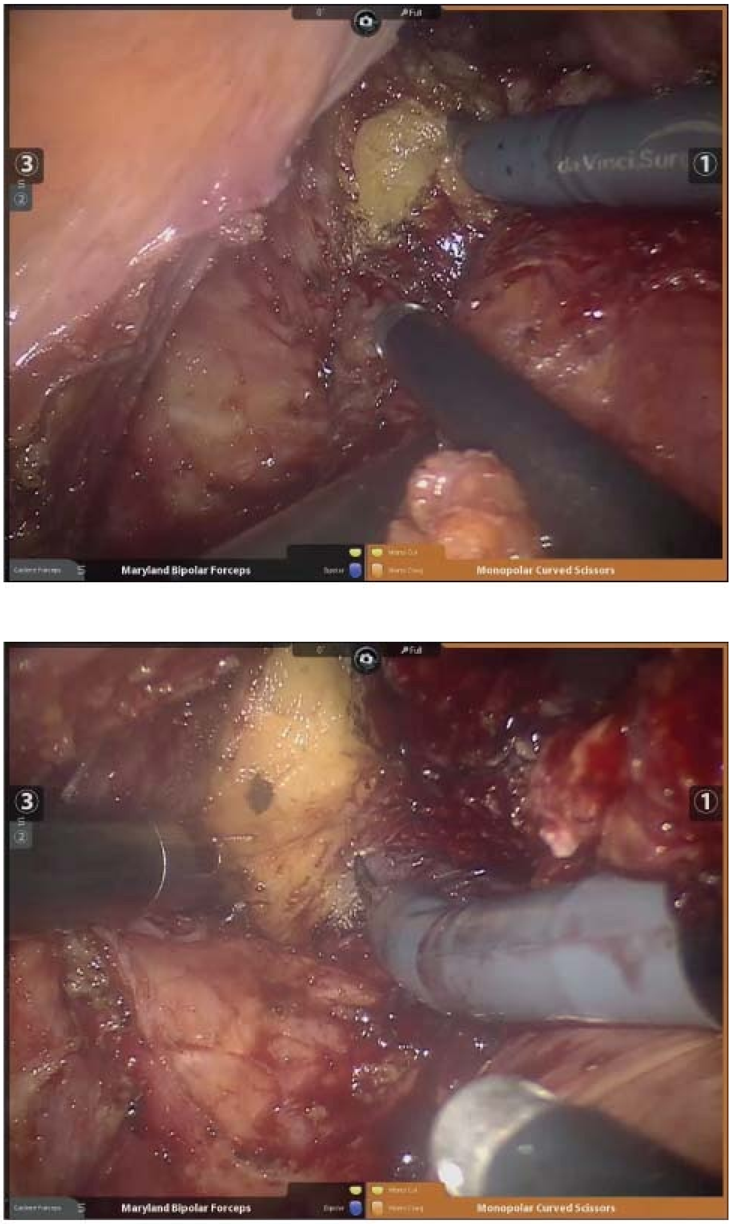
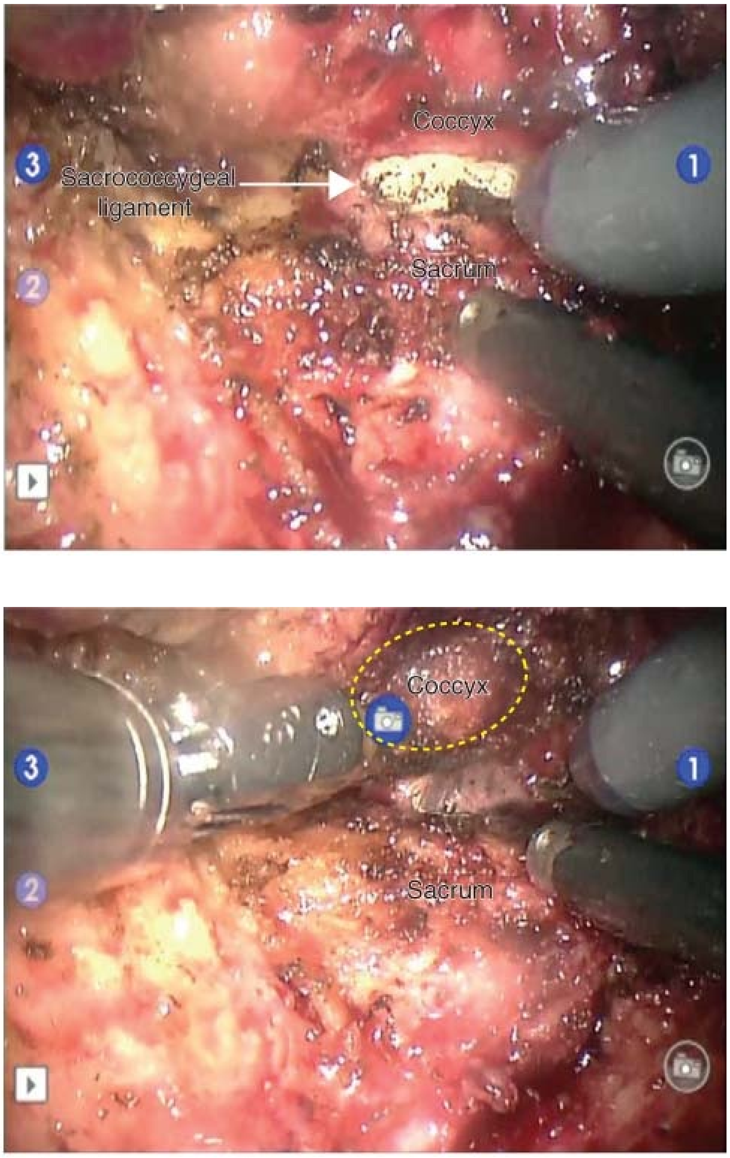


FIGURE 37-4 Anterodistal dissection of the rectum from the neurovascular bundles (NVBs) (A) following transection of the levator ani muscles (B) and exposure of the lobular fat of the ischiorectal fossa at the left anterolateral portion (C) and posterior portion (D).


Coccyx
3
Sacrococcygeal
ligament
1
Sacrum
2
Coccyx
3
1
2
Sacrum

A

B

C

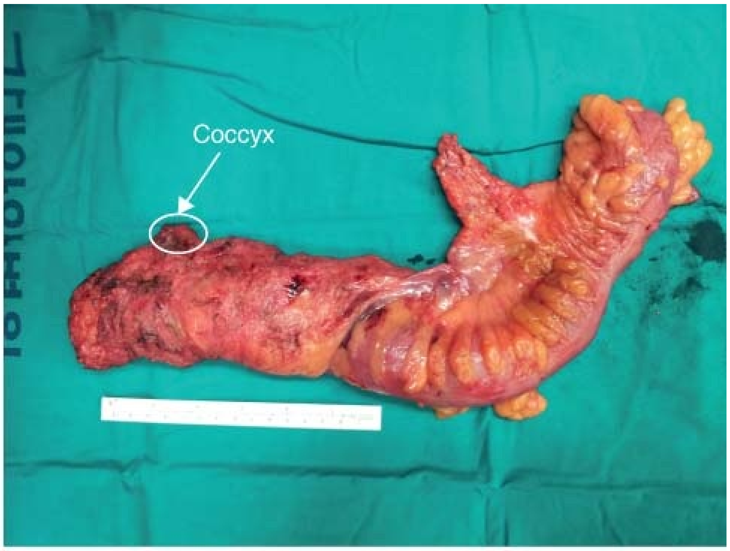


FIGURE 37-5 A case of en bloc coccygectomy. Transection of the sacrococcygeal ligament (A), division of the coccyx from the sacrum (B), and the resected specimen with attached coccyx (arrow) (C).

p. 367

p. 368

The mesocolonic vessels and fat tissues are trimmed at the level of the colon to be the stoma. Then, the descending colon is divided using monopolar curved scissors after tying both sides by tie strings. If a linear endostapler or robotic stapler (EndoWrist Stapler) is used to divide the descending colon, a 12-mm laparoscopic trocar or 13-mm robotic stapler cannula with a 13-8 mm reducer can be used as a port in the right lower quadrant (da Vinci instrument arm 1 port).

Perineal Phase

After undocking the robot arms, perineal dissection is performed in the lithotomy position. The anus is closed with a double purse string suture, and an elliptical incision is made around the anal skin from the perineal body to the coccyx. The fatty tissue of the ischiorectal fossa under the incision is then dissected to the levator ani muscle that had been previously excised during the pelvic phase with the help of the surgeon's fingers. The abdominal and perineal dissections are connected with the tip of the coccyx, and the anococcygeal ligament is incised just distal to the tip of the coccyx. All that remains is the ischiorectal fat that is easily divided to deliver the specimen because the levator muscles have been transected. The specimen is delivered posteriorly first, and anterior dissection is carried out under direct vision. The perineal wound is closed in a multilayered manner. A pelvic drain is placed laparoscopically and the divided colon end is brought through the skin. Finally, the abdominal incision is closed, and the end stoma is matured.

POSTOPERATIVE MANAGEMENT AND COMPLICATIONS

In the authors’ and editors’ institutions, an enhanced recovery after surgery program is employed for all patients following surgery. We do not use nasogastric tubes routinely and encourage early mobilization, and restrict the administration of fluids and opioids. The day after surgery, patients are started on a clear liquid intake and then advanced to a soft diet the following day. Antibiotics are used only on the operative day if the patients have no other infections. The urinary catheter is removed 1 or 2 days after surgery, and the pelvic drain is removed approximately 5 days after surgery. Before discharge, patients undergo education on colostomy management with the stoma nurse.

The most common complications of robotic APR, in particular in ELAPR, are perineal wound problems. Although the risk may be lower than with conventional ELAPR performing complete levator excision and coccygeal disarticulation, perineal wound issues are also important in robotic ELAPR. In particular, a perineal wound dehiscence or hernia can commonly occur in patients who underwent preoperative chemoradiotherapy. Perineal hernias following APR have a reported prevalence of up to 7% radiologically, with 0.2–0.6% requiring surgical intervention. An omental pedicle flap vascularized by the left gastroepiploic artery is created and placed in the pelvic cavity to reduce the hernias. Alternatively, a nonabsorbable composite mesh can be applied at the pelvic brim using intracorporeal interrupted sutures. A large skin defect is also an important perineal wound issue of this procedure. Several options for the source of the flap in a perineal reconstruction have been proposed, such as the rectus abdominis muscle (RAM), gracilis, gluteus, thigh, and latissimus muscle free flaps. Recently, a new technique using a transabdominal robotic approach has been introduced for both ELAPR and RAM, which allows for flap harvest without an open incision.

RESULTS

Several studies have reported that robotic APR has a lower rate of conversion to the open, intraoperative perforation, and circumferential margin (CRM) involvement. Marecik *et al.* and Kang *et al.* reported no intraoperative complications and no conversions with their initial robotic APR experiences. In addition, they reported good postoperative outcomes and all negative CRMs in their pathologic results. Kim *et al.* reported that robotic APR had a higher rate of subtotal excision of the levator muscles and negative CRMs than open APR. The mean number of retrieved lymph nodes was also greater in the robotic APR group. Based on a nationwide database analysis, Moghadamyeghaneh *et al.* reported that robotic APR has increased rapidly and that its conversion rate was lower than that of laparoscopic APR. Additionally, they found that the adjusted morbidity risk in robotic APR was similar to laparoscopic APR and lower than open APR. However, hospital charges for robotic APR were significantly higher than for a laparoscopic approach. In the authors' institution, we have performed 491 robotic rectal surgeries, including 29 robotic APR procedures between September 2006 and December 2015. Because ISR with CAA are predominantly performed, the number of APR procedures is very limited; meanwhile, 99 ISR with CAA procedures were performed during the same period. The mean age of patients who underwent robotic APR was 56.0 years and the sex ratio was similar. The mean distance of the tumor from the anal verge was 2.5 cm. Sixteen patients underwent preoperative radiotherapy. The mean operative time was 321.6 minutes and the mean estimated blood loss was 260.3 ml. Eight patients underwent a combined operation such as a pelvic lateral node dissection, hysterectomy, and sacrectomy. There was no intraoperative tumor perforation or conversion to the open approach. The mean number of retrieved lymph nodes was 23.7. All CRMs were negative for tumor. There were postoperative complications in eight patients (27.6%) including urinary retention, prolonged ileus, intra-abdominal abscess, wound infection, chyle ascites, and urethral injury. There were no postoperative mortalities.

CONCLUSIONS

Robotic APR is a technically and oncologically safe and effective procedure in patients with low rectal cancer. In particular, compared to conventional ELAPR, robotic ELAPR can reduce operative time, the size of the perineal skin defect, and the chance of long-term wound complications by allowing a tailored transabdominal resection of the levator muscles under super-exposure of the low pelvis, particularly for preserving the NVBs even without a position change. Although the high cost is still an issue, in the authors' opinion the robotic technique may be the best surgical option for low rectal cancer that minimizes surgeon stress.

RECOMMENDED REFERENCES AND READINGS

Aboian E, Winter DC, Metcalf DR, Wolff BG. Perineal hernia after proctectomy: prevalence, risks, and management. *Dis Colon Rectum* 2006;49:1564–8.

Bae SU, Saklani AP, Hur H, Min BS, Baik SH, Kim NK. Robotic interface for transabdominal division of the levators and pelvic floor reconstruction in abdominoperineal resection: a case report and technical description. *Int J Med Robot* 2014. doi:10.1002/rcs.1624.

Butt HZ, Salem MK, Vijaynagar B, Chaudhri S, Singh B. Perineal reconstruction after extralevator abdominoperineal excision (eLAPE): a systematic review. *Int J Colorectal Dis* 2013;28:1459–68.

Kang CY, Carmichael JC, Friesen J, Stamos MJ, Mills S, Pigazzi A. Robotic-assisted extralevator abdominoperineal resection in the lithotomy position: technique and early outcomes. *Am Surg* 2012;78:1033–7.

Kim JC, Kwak JY, Yoon YS, Park IJ, Kim CW. A comparison of the technical and oncologic validity between robot-assisted and conventional open abdominoperineal resection. *Int J Colorectal Dis* 2014;29:961–9.

Marecik SJ, Zawadzki M, Desouza AL, Park JJ, Abcarian H, Prasad LM. Robotic cylindrical abdominoperineal resection with transabdominal levator transection. *Dis Colon Rectum* 2011;54:1320–5.

Martijnse IS, Holman F, Nieuwenhuijzen GA, Rutten HJ, Nienhuijs SW. Perineal hernia repair after abdominoperineal rectal excision. *Dis Colon Rectum* 2012;55:90–5.

Melich G, Lim DR, Hur H, *et al.* Prevention of perineal hernia after laparoscopic and robotic abdominoperineal resection: review with illustrative case series of internal hernia through pelvic mesh. *Can J Surg* 2016;59:54–8.

Moghadamyeghaneh Z, Phelan M, Smith BR, Stamos MJ. Outcomes of Open, laparoscopic, and robotic abdominoperineal resections in patients with rectal cancer. *Dis Colon Rectum* 2015;58:1123–9.

Ng SS, Lee JF, Yiu RY, Li JC, Hon SS. Telerobotic-assisted laparoscopic abdominoperineal resection for low rectal cancer: report of the first case in Hong Kong and China with an updated literature review. *World J Gastroenterol* 2007;13:2514–8.

Singh P, Teng E, Cannon LM, Bello BL, Song DH, Umanskiy K. Dynamic article: tandem robotic technique of extralevator abdominoperineal excision and rectus abdominis muscle harvest for immediate closure of the pelvic floor defect. *Dis Colon Rectum* 2015;58:885–91.

Chapter 38

Extended Extralevator Abdominoperineal Resection

Torbjörn Holm

INDICATIONS

Extended extralevator abdominoperineal resection (ELAPE) may be indicated in low, advanced rectal cancer where a less extensive procedure is likely to be non-radical (R1/R2 resection). Below the insertion of the levator muscles, onto the obturator internus muscle, the mesorectum surrounding the rectum is reduced in size and subsequently disappears at the top of the sphincters. Below this level, the sphincter muscle forms the circumferential resection margin (CRM). A substantial proportion of patients with rectal cancer have tumors growing through the muscularis propria (T3/T4). With reduced volumes of tissue surrounding the bowel wall, even a limited extramural tumor growth in the lower rectum may threaten the CRM. The main purpose of ELAPE is to improve treatment results in low advanced tumors by reducing the risk of inadvertent bowel perforation (intraoperative perforation [IOP]) and tumor involvement of the CRM. This goal can be accomplished because the levator muscles are excised en bloc with the mesorectum to protect the most distal part of the bowel and thereby avoiding a “waist” on the specimen, which occurs when the pelvic dissection is united to the medial edges of the puborectal muscle. Thus, ELAPE may be indicated when preoperative magnetic resonance imaging (MRI) shows a low rectal cancer with threatened or involved CRM, including the distal mesorectum, levator or puborectal muscle, or external sphincter.

CONTRAINDICATIONS

ELAPE is not indicated in patients with less advanced tumors where an intersphincteric anterior resection (AR) or an intersphincteric abdominoperineal resection (APR) is feasible.

PREOPERATIVE PLANNING

It is crucial to perform a preoperative radiologic staging in all patients with rectal cancer and especially so in patients with low advanced tumors. A computed tomography scan of the chest and abdomen is standard to assess distant disease and an MRI of the pelvis is mandatory to locally stage the tumor. The information from MRI determines whether the patient requires neoadjuvant treatment and serves as a “roadmap to surgery” to plan the extent of the procedure.

All patients planned for an APR should be well informed about the extent of the procedure, the potential complications, and the possible late sequels, such as urogenital dysfunction and stoma problems.

A crucial part of the preoperative preparation and education is to have the patient meet a stoma nurse, well ahead of the operation, regarding stoma care. The stoma site should always be marked in advance by the stoma nurse, away from scars and skin folds, in an area that is easily seen by the patient.

Prophylaxis against deep venous thromboembolism (DVT) should be administered the evening before surgery and our routine is to give antibiotic prophylaxis orally in the morning before surgery, or intravenously within 30 minutes of the abdominal incision. The authors do not use mechanical bowel preparation for APR because no bowel anastomosis is constructed and bowel preparation is quite cumbersome for most patients. After administration of general anesthesia, a bladder catheter is inserted; the catheter facilitates identification of the urethra during the perineal phase of an extended extralevator APR. Our preference is to keep the catheter closed and to insert a suprapubic catheter once the abdomen is opened. The urethral catheter is removed after surgery, whereas the suprapubic catheter is kept in place postoperatively. This maneuver prevents the need for inserting a new urethral catheter in patients who cannot postoperatively void.

Patients are placed in a modified lithotomy position, with the buttocks at the edge of the table and legs placed into soft stirrups. A preoperative briefing is important to allow the surgeon to share the procedure plan with the entire operative team and to confirm the presence of appropriate instruments. The assistance of an experienced second surgeon is invaluable and strongly recommended.

Digital rectal examination confirms the degree of involvement of the anal sphincter or other organs and the distal edge of the tumor. In female patients, the vagina must also be examined to assess the relation of the tumor to the posterior vaginal wall. The abdomen and perineum, including the vagina in female vaginal wall. The abdomen and perineum, including the vagina in female patients, should be prepped.

SURGERY

The extended extralevator APR can best be described in three parts; the abdominal, the pelvic, and the perineal. The abdominal and the pelvic parts of the dissection can be done open or in a minimally invasive manner at the discretion of the individual surgeon.

The Abdominal Part of an Extended Extralevator Abdominoperineal Resection

With a few exceptions, the approach and the operative technique for the abdominal part of this procedure are identical to that used for total mesorectal excision (TME) and AR. The abdominal cavity is first explored to detect any metastatic disease or other unexpected pathology. The small bowel is then packed into the upper right abdomen, and the sigmoid colon is mobilized. It is usually necessary to mobilize a portion of the descending colon to allow the later construction of a tension-free end colostomy. However, a complete mobilization of the splenic flexure is usually unnecessary. The left ureter and gonadal vessels are identified and preserved by combining sharp and gentle blunt dissection to separate the retroperitoneal tissues from the left colonic mesentery. The sympathetic nerve plexus in front of the aorta is identified and the dissection continues in front of these nerves, just posterior to the inferior mesenteric artery (IMA). There is no consensus on where to divide the IMA. Some surgeons prefer a high ligation at the origin from the aorta and suggest that this maximizes the lymph node yield and may improve oncologic outcomes. Others have a preference for a low ligation just distal to the left ascending colic artery and argue that this ensures a better blood supply to the remaining left colon and may prevent nerve damage at the base of the IMA, resulting in less functional impairment. There is presently not enough evidence to state that one approach is better than the other. After ligation of the IMA or the superior rectal artery and the inferior mesenteric vein at the same level, the sigmoid mesentery is divided, including the marginal artery. The colon at the level of the proximal sigmoid colon is divided with a linear stapler to prevent any fecal contamination.

The Pelvic Part of an Extended Extralevator Abdominoperineal Resection

With restorative procedures in rectal cancer, the dissection continues down to the pelvic floor and puborectalis muscle, and the mesorectum is dissected off the levator muscles. In extended extralevator APR, it is crucial not to take the mobilization of the rectum and mesorectum as far down as the pelvic floor. Instead, the dissection should proceed down to the sacrococcygeal junction dorsally, just beyond the inferior hypogastric plexus anterolaterally, and anteriorly it should stop just below the seminal vesicles in men or the cervix uteri in women. By stopping the mobilization of the rectum and mesorectum at this level, the mesorectum is still attached to the levator muscles of the pelvic floor, which is a crucial feature of the extended extralevator APR. After completion of the dissection down to this level, the abdomen and pelvic cavity are rinsed, preferably with sterile water.

Omentoplasty

Bowel obstruction, because of entrapment of the small bowel in the pelvic cavity, can be prevented by omentoplasty to fill the pelvic cavity. We prefer to place a drain in the pelvic cavity.

The Perineal Part of an Extended Extralevator Abdominoperineal Resection

The perineal portion can be performed either with the patient in the lithotomy or prone-jackknife position. We prefer the prone position because of the excellent exposure of the operative field (Fig. 38-1). Some surgeons prefer the lithotomy position, mainly to avoid the time taken to change patient position.

FIGURE 38-1 The prone jackknife position is used for the perineal phase.

The perineal dissection starts with a double purse string closure of the anus to avoid any spillage of feces or tumor cells. After incision of the skin, the external sphincter is identified and the dissection is continued outside the sphincter up to the levator muscles on both sides. The levator muscles are followed up to the pelvic sidewall (obturator internus muscle) and the external sphincter and levator muscles are exposed around the circumference. The pelvis is now entered, either just below the tip of the coccyx or through the sacrococcygeal junction. At this stage, it is important to identify the mesorectum in order not to injure the mesorectal fascia. The levator muscles are divided on both sides and the division continues onto the prostate or vagina. The specimen is still attached to the anterior aspect of the levator muscles and to the prostate or posterior wall of the vagina.

The dissection in the anterior plane is the most difficult and potentially most dangerous part of the procedure because of the close relationship between the anterior rectal wall and the prostate or posterior vaginal wall. In addition, the neurovascular bundles derived from the inferior hypogastric plexus run anterolaterally on each side of the prostate or vagina and close to the rectum and can easily be damaged if they are not recognized at this stage of the operation (Fig. 38-2). The dissection along the anterior and lateral aspects of the lower rectum must therefore be meticulously performed and with great care. If the dissection is performed too close to the rectal wall, there is a risk of IOP or positive CRM. If the dissection is carried out too laterally, or too anteriorly, there is a risk of damage to the neurovascular bundles or to the prostate or vagina. In anteriorly located tumors, it may be necessary to include the posterior vaginal, the posterior prostate, and the neurovascular bundle on one side with the specimen, and sometimes even to sacrifice to be able to achieve a negative CRM. This extension of the procedure should be based on the preoperative MRI staging and digital examination, and the patient should be well informed about the consequences of bladder and/or sexual dysfunction.

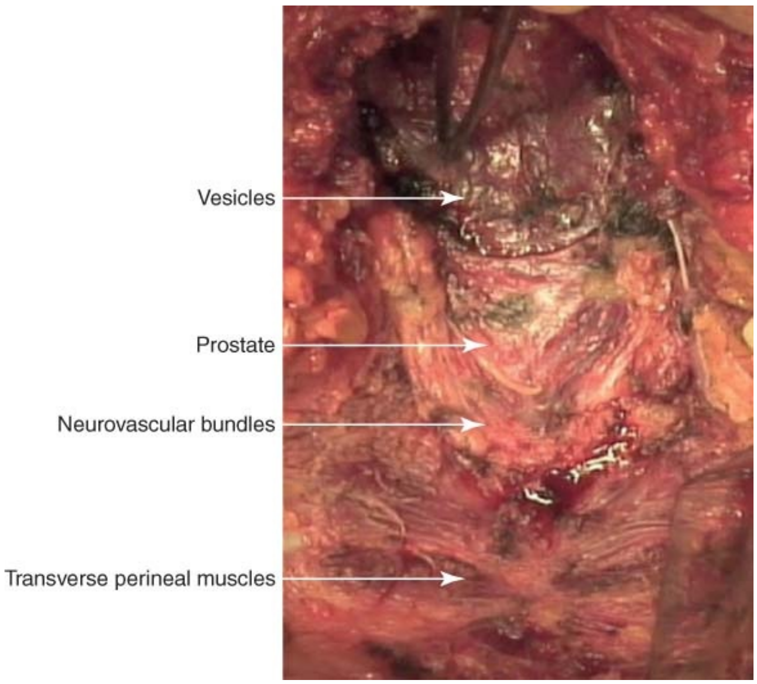


FIGURE 38-2 Patient in prone position. The arrows reveal the neurovascular bundles, hypogastric plexus, prostate and seminal vesicles.

The resulting excised specimen is “cylindrical,” usually without a waist, because the levator muscle is still attached to the mesorectum, forming a cuff around the rectal muscle tube (Fig. 38-3).

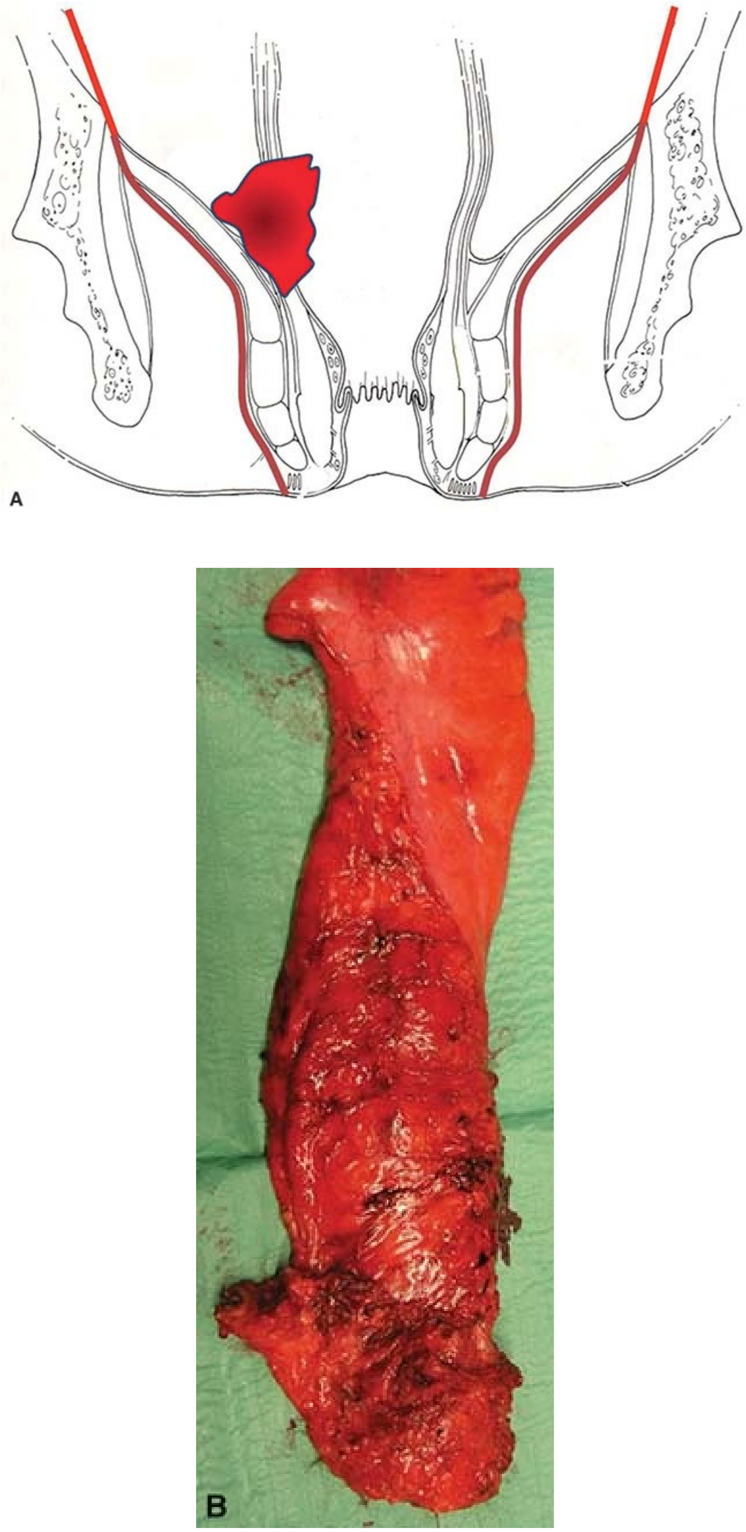


FIGURE 38-3 Dissection outside the external sphincter and levator muscles, without separating the mesorectum from the levators, creates a specimen

without a waist.

Extended Ischioanal Abdominoperineal Resection

In some patients, a locally advanced tumor may perforate the levator muscle and cause a fistula between the low rectum and the perianal skin. In these instances, an extralevator APR may not be sufficient to achieve a tumor-free CRM. An ischioanal APR is usually required to obtain an oncologically secure margin. The levator muscle must be removed covered with ischioanal fat to include the perianal fistula, which may contain tumor cells. The abdominal and pelvic part of the ischioanal APR is equivalent to the extralevator APR. Thus, the dissection stops just above the levator muscle, and leaves the mesorectum attached to the pelvic floor. When the abdominal and pelvic part of the procedure is completed, with closure of the abdominal wall and formation of a colostomy, the patient is turned into the prone-jackknife position.

The Perineal Dissection of an Extended Ischioanal Abdominoperineal Resection

After preparation of the skin of the perineum, lower sacrum, medial parts of the buttocks, and the vagina in women, the anus is closed with string to prevent seeding of bacteria and tumor cells. However, if the tumor is protruding through the anus or skin, it is better to make an appropriate incision in the skin, well away from any tumor or fistula opening and then close the skin with a running suture to seal the area (Fig. 38-4). The area accompanied by the skin incision in an ischioanal APR must provide a margin of at least 2–3 cm. The dissection should be directed laterally toward the ischial tuberosities and progress onto the fascia of the internal obturator muscle. Contrary to an extralevator APR, the dissection does not follow the external sphincter and levator muscle but is instead carried along the fascia of the internal obturator muscle. The dissection includes the entire fat compartment of the ischioanal space. This dissection can be unilaterally or bilaterally performed depending on the extent of tumor growth. The sacrococcygeal junction is incised and the pelvic cavity is entered in the same manner as with an extralevator APR. The levator muscles are divided along the fascia of the internal obturator muscle onto the prostate in men or the vagina in women. The specimen is divided through the posterior opening of the pelvic cavity. The anterior and lateral dissection along the prostate or vagina is then carried out as in an extralevator APR. The perineal dissection can be performed with the patient in the lithotomy or prone-jackknife position.

FIGURE 38-4 Locally advanced rectal cancer protruding through the anus. The line depicts the radial extent of the skin incision.

p. 374

p. 375

Pelvic Floor Reconstruction After Extended Extralevator or Ischioanal Abdominoperineal Resection

Perineal wound complications are among the major problems associated with the conventional type of APR, especially in patients who have received preoperative radiotherapy (RT). Wound problems have been reported in up to 50% of patients receiving preoperative RT after APR with primary wound closure. Infections and delayed healing are the most common complications. These problems may become even more frequent in patients who have received a combination of preoperative RT and an extralevator APR, with a more extensive excision of the pelvic floor.

Perineal hernia is a late complication after APR, and it is likely that the rate of this complication also increases with a more extensive removal of the pelvic floor. The incidence is variable in different reports but has been as high as 45% after laparoscopic ELAPE and primary closure of the perineum.

A variety of surgical alternatives to primary closure have been used to reconstruct the pelvic floor and to reduce the wound healing problems after APR. These procedures include different rotational musculocutaneous flaps, reconstruction with biological mesh, and omental pedicle flaps (omentoplasty).

reconstruction with biological mesh, and omental pedicle flaps (omentoplasty). In a systematic review of ELAPE including 27 series and 963 patients, the authors compared results after biomesh closures in 149 patients, musculocutaneous flap closures in 201 patients, and primary closures in 578 patients. Rates of minor and major wound complications and perineal hernias were analyzed. The authors found no significant differences regarding these outcomes in relation to biomesh, muscle flaps, or primary closure and concluded that: “Despite several techniques currently employed for perineal construction, it remains unclear to which is optimal.”

POSTOPERATIVE MANAGEMENT

The postoperative management of patients after ELAPE is not substantially different from that after any major colorectal procedure except for a few details. Patients should be encouraged to start oral intake and to mobilize early. Enhanced recovery programs (enhanced recovery after surgery [ERAS]) are recommended. Protracted antibiotic treatment after surgery is not indicated, but prophylaxis against DVT should be maintained for 1 month. Alertness for postoperative complications with daily patient assessment is mandatory and special attention must be paid to the perineal wound to detect infections early. It is important to show and teach the patient how to care for the permanent stoma early on. When the stoma has matured after a few weeks, the patient should also be offered instructions on how to irrigate, because this often improves the quality of life.

COMPLICATIONS

As with all major abdominal procedures, postoperative complications after ELAPE include but are not restricted to the following:

Ileus

Wound infections

Urinary tract and respiratory tract infections

Thromboembolism

Bleeding

Postoperative ileus and infections are common after colorectal surgery, but the risk can be substantially reduced by applying preoperative antibiotic prophylaxis and ERAS programs. Protracted DVT prophylaxis reduces the rate of early and late thromboembolism. The risk of postoperative bleeding should be kept extremely low with intraoperative hemostasis.

RESULTS

Since the first report on extended APR in 2007, the procedure has been called cylindrical APR and more recently extralevator abdominoperineal excision (ELAPE), a term which is currently used to describe the operation. The first attempt to compare the conventional type of APR with ELAPE was published in 2008 in which 128 surgical specimens from Leeds, United Kingdom and Stockholm, Sweden were assessed. The study showed that the "cylindrical technique" removed more tissue in the distal rectum and in all slices that contained tumor compared with the "standard" APR ($P < 0.0001$). Greater distance was observed from the muscularis propria or internal sphincter to the anterior, posterior, and lateral resection margins (all $P < 0.0001$). This finding was associated with a lower CRM involvement (14.8% vs. 40.6% $P = 0.013$) and IOP (3.7% vs. 22.8% $P = 0.0255$).

In 2011, Stelzner *et al.* published an overview of reports from a literature search that aimed to identify all articles reporting on APR after the introduction of TME. ELAPE was defined as operations that resected the levator ani muscle close to its origin at the pelvic sidewall. All other techniques were taken to be standard. Rates for perforation, CRM involvement, and local recurrence were compared. In all, 1,097 patients were pooled for statistical analysis in the ELAPE group and 4,147 patients in the standard group. The rate of IOP for ELAPE versus standard APR was 4.1% versus 10.4% (relative risk reduction 60.6%, $P = 0.004$) and the rate of CRM involvement 9.6% versus 15.4% (relative risk reduction 37.7%, $P = 0.022$). The local recurrence rate was 6.6% versus 11.9% (relative risk reduction 44.5%, $P < 0.001$) for the two groups. The authors concluded that extended techniques of APR results in superior oncologic outcomes as compared to standard techniques. Another review based on eight different studies pooled data on 949 patients and found reduced rates of IOP (RR, 0.34; 95% CI, 0.21–0.54; $P < 0.00001$), CRM involvement (RR, 0.44; 95% CI, 0.34–0.56; $P < 0.00001$), and local recurrence (RR, 0.32; 95% CI, 0.14–0.74; $P = 0.008$) and thus superior oncologic results after ELAPE than after conventional APR. There has been only one small randomized trial comparing ELAPE in 35 patients with conventional APR in 32 patients. In this trial, a positive CRM was found in 6% after ELAPE and in 28% after conventional APR, the corresponding figures for IOP were 6% and 16%, respectively. The local recurrence rate was also significantly lower in the ELAPE group.

Since then several studies have reported comparisons between conventional APR and ELAPE with conflicting results. The methodology and number of patients differ between the studies and the results are strikingly diverse. The rate of IOP varies between 0% and 8% for ELAPE and between 5% and 28% for conventional APR, the rate of CRM involvement varies between 0% and 20% for ELAPE and 3% and 50% for conventional APR, and the rate of perineal wound infections varies between 8% and 44% for ELAPE and between 11% and 39% for conventional APR. The significant diversity of reported results is interesting and it is also noteworthy that the results after conventional APR seem to improve over time. In 2010, West *et al.* reported IOP in 28%, positive CRM in 50%, and wound infection in 20% after conventional APR, whereas Prytz *et al.* in 2014 reported the corresponding figures of 11%, 6%, and 12% after conventional APR. The reported results after ELAPE have also been variable but with no obvious improvement over time.

To understand the diversity of results after APR, it is important to review the history of rectal cancer surgery. Results have gradually improved from the early attempts to operate through the perineal approach, via Miles procedure and later AR with anastomosis. The results after APR and AR were more similar before the TME era. The results improved with TME-based surgery, but more so after AR and low anterior resection (LAR) than after APR. The poorer results after APR were probably caused by a higher risk of IOP and positive CRM after APR as compared to AR.

The results after APR seemed to improve after the introduction of ELAPE, with significantly lower rates of perforations and involved margins. Early comparisons of ELAPE versus conventional APR appeared to favor ELAPE, but some later comparisons did not demonstrate any significant benefit for ELAPE albeit improved results after conventional APR. It is difficult to explain the diversity in the reports comparing ELAPE and conventional APR and maybe it is futile to judge one procedure against the other. As the editor-in-chief of *Colorectal Disease*, Mr. John Nicholls stated in 2013: “The adjective ‘standard’ began to be applied to APE, but it had no meaning because it was not possible to describe it anatomically.” Most likely, the APR procedure has changed over time. Several significant improvements have been made during the past decade, including increasing knowledge about the anatomy of the pelvis, pelvic floor, and perineum, based on published anatomic studies. The routine use of preoperative MRI for tumor staging, the increasing knowledge of the importance of precision surgery and high-quality specimens, and the tendency to specialization in rectal cancer surgery have all contributed to the improved results. Rectal cancer surgeons have probably, more or less consciously, changed their practice over time and now base their surgical approach on available preoperative radiologic staging. Awareness of the importance of avoiding perforations and involved margins has prompted most surgeons to use sharp, precise dissection under direct vision rather than blunt dissection, guided more by palpation than visualization. Thus, it is highly likely that “conventional” APR has gradually changed over time and that most surgeons operating on rectal cancer today base their resection on available MRI imaging and perform a more or less extensive ELAPE in low advanced rectal cancer. It has to be remembered that the external sphincter is integrally related to the levator muscle and thus removal of the external sphincter is, by definition, the initial part of an ELAPE, and all that is really at issue is the extent of levator removal.

CONCLUSIONS

Treatment results in rectal cancer have improved significantly during the recent two decades, but local control and survival after APR have not improved to the same degree as that seen after AR. The reasons for this are an increased risk of IOP and tumor-involved CRM after APR as compared to AR. The conventional synchronous combined APR has not been a standardized procedure and oncologic outcomes have varied considerably between different institutions and in different reports. With the new concept of extended ELAPE and ischioanal APR, the procedure is based on preoperative MRI and tailored to the individual patient with low locally advanced rectal cancer.

There are controversies related to the necessary extent of pelvic floor removal, the positioning of the patient, and the optimal method of reconstruction of the pelvic floor and perineum. Despite these issues, the key objective is to tailor the operation in relation to the patient and the tumor characteristics and to remove an intact specimen without perforation and with resection margins free from tumor cells, which leads to an improved local control and survival.

RECOMMENDED REFERENCES AND READINGS

Birbeck KF, Macklin CP, Tiffin NJ, *et al.* Rates of circumferential resection margin involvement vary between surgeons and predict outcomes in rectal cancer surgery. *Ann Surg* 2002;235(4):449–57.

Bullard KM, Trudel JL, Baxter NN, Rothenberger DA. Primary perineal wound closure after preoperative radiotherapy and abdominoperineal resection has a high incidence of wound failure. *Dis Colon Rectum* 2005;48(3):438–43.

Foster JD, Pathak S, Smart NJ, *et al.* Reconstruction of the perineum following extralevator abdominoperineal excision for carcinoma of the lower rectum: a systematic review. *Colorectal Dis* 2012;14(9):1052–9.

Holm T, Ljung A, Haggmark T, Jurell G, Lagergren J. Extended abdominoperineal resection with gluteus maximus flap reconstruction of the pelvic floor for rectal cancer. *Br J Surg* 2007;94(2):232–8.

Marr R, Birbeck K, Garvican J, *et al.* The modern abdominoperineal excision: the next challenge after total mesorectal excision. *Ann Surg* 2005;242(1):74–82.

Miles WE.A method of performing abdominoperineal excision for carcinoma of the rectum and of the terminal portion of the pelvic colon. *Lancet* 1908;2:1812–3.

Moran BJ, Holm T, Brannagan G, *et al.* The English National Low Rectal Cancer Development Programme (LOREC): key messages and future perspectives. *Colorectal Dis* 2014;16(3):173–8.

Palmer G, Anderin C, Martling A, Holm T. Local control and survival after ExtraLevator AbdominoPerineal Excision (ELAPE) for locally advanced or low rectal cancer. *Colorectal Dis* 2014;16(7):527–32.

Prytz M, Angenete E, Ekelund J, Haglind E. Extralevator abdominoperineal excision (ELAPE) for rectal cancer: short-term results from the Swedish Colorectal Cancer Registry. Selective use of ELAPE warranted. *Int J Colorectal Dis* 2014;29(8):981–7.

Shihab OC, Heald RJ, Rullier E, *et al.* Defining the surgical planes on MRI improves surgery for cancer of the low rectum. *Lancet Oncol* 2009;10(12):1207–11.

Stelzner S, Koehler C, Stelzer J, Sims A, Witzigmann H. Extended abdominoperineal excision vs. standard abdominoperineal excision in rectal cancer: a systematic overview. *Int J Colorectal Dis* 2011;26(10):1227–40.

West NP, Anderin C, Smith KJ, Holm T, Quirke P; European Extralevator Abdominoperineal Excision Study Group. Multicentre experience with extralevator abdominoperineal excision for low rectal cancer. *Br J Surg* 2010;97(4):588–99.

West NP, Finan PJ, Anderin C, Lindholm J, Holm T, Quirke P. Evidence of the oncologic superiority of cylindrical abdominoperineal excision for low rectal cancer. *J Clin Oncol* 2008;26(21):3517–22.

Chapter 39

Laparoscopic Total Mesorectal Excision

Antonio M. Lacy and Beatriz Martín-Pérez

INDICATIONS/CONTRAINDICATIONS

Total mesorectal excision (TME) is defined as the en bloc removal of the rectum and its entire mesentery as indicated for the oncologic treatment of rectal tumors. After removing the rectum and the mesorectum, the bowel continuity may be restored through an anastomosis and a temporary diverting ostomy may be indicated in cases of high-risk anastomosis.

Each patient with rectal cancer should be individually evaluated because the management of rectal cancer has become increasingly complex, from diverse technical options to combination with different neoadjuvant treatments. The technical plan for the resection is customized to stage, gender, age, body habitus, prior radiation history, and other variables. With these issues in mind, the technical choices for a radical resection are discussed subsequently.

At present, a surgeon has three major surgical curative options: local excision, sphincter-saving abdominal surgery, and abdominoperineal resections (APRs). High rectal tumors and mid rectal tumors will benefit from sphincter-sparing procedures in general terms, except when an anastomosis is contraindicated and a stoma is performed. Conversely, low rectal cancers would undergo APRs as described by Miles. Sphincter-sparing procedures for resection of mid and some distal rectal cancers have become increasingly prevalent, because their safety and efficacy have been established in lieu of APR. The advent of circular stapling devices is largely responsible for their increasing popularity and utilization. Body habitus, adequacy of the anal sphincter, encroachment of the tumor on the anal sphincters, and adequacy of the distal margin are all factors in determining the applicability of a sphincter-sparing operation. According to Rullier *et al.* (Fig. 39-1), APRs are indicated when the tumor invades the external sphincter (Table 39-1).

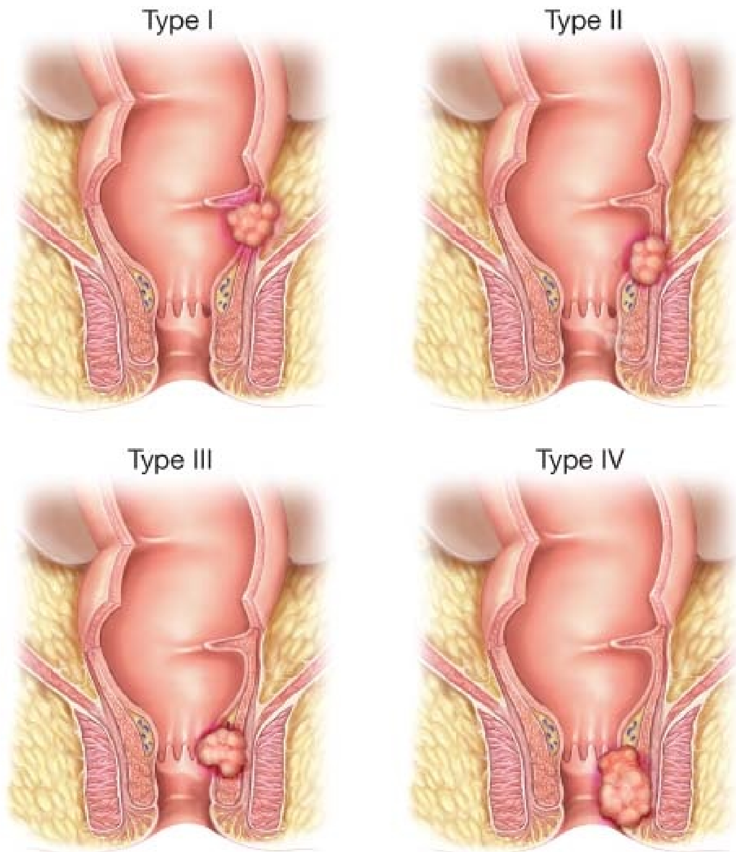


FIGURE 39-1 Standardization of low rectal cancer, according to Rullier. Type I: supra-anal; type II: juxta-anal; type III: intra-anal; type IV: transanal.

TABLE 39-1 Surgical Classification of Low Rectal Cancer According to Rullier's Classification

Classification	Definition	Surgical procedure
Type I	Supra-anal tumor >1 cm from anal ring	Coloanal anastomosis
Type II	Juxta-anal tumor <1 cm from anal ring	Partial intersphincteric resection
Type III	Intra-anal tumor Internal sphincter invasion	Total intersphincteric resection
Type IV	Transanal tumor External sphincter invasion A: levator ani muscles B: external sphincter	Abdominoperineal resection

C: levator ani and external sphincter

In summary:

Tumors in the high rectum may undergo a partial mesorectal excision (PME) with a high colorectal anastomosis.

Tumors in the mid rectum will be treated by TME with a low colorectal anastomosis.

Low tumors lying 1 cm above the anorectal ring will benefit from TME with a coloanal anastomosis.

Juxta-anal tumors lying in less than 1 cm from the anorectal ring will undergo TME with partial intersphincteric dissection.

Tumors invading the internal sphincter will be subjected to TME with total intersphincteric dissection.

Tumors invading the external sphincter will not be candidates for TME with a sphincter-preserving procedure, but for an APR.

Principles of Total Mesorectal Excision

Richard “Bill” Heald defined the concept of TME in 1982, establishing the principles of the modern era for rectal surgery. He proposed that the excision of all the tissue surrounding the rectum would improve the oncologic control of the rectal disease. Since his pioneering work, removing the mesorectum has been considered the gold standard in rectal cancer surgery.

The mesorectum is the layer composed of adipose and lymphovascular tissue covering the rectum. Thus, the mesorectum is found between the rectal wall and the visceral layer of the pelvic fascia, which will anteriorly continue as the Denonvilliers’ fascia in men and the rectovaginal septum in women. The mesorectum is developed mainly laterally and posteriorly rather than anteriorly, where it is a thinner layer of tissue, and extends distally up to 2–3 cm of the anorectal junction.

TME can be achieved either by a low anterior resection or during an APR. Regardless of the procedure performed, the entire mesorectum should be dissected sharply, including the mesorectum distal to the tumor, as an intact unit. Before the advent of the TME description, the visualization of the rectal dissection was limited to the pelvic anatomy characteristics and the mesorectum was excised mainly bluntly. Residual mesorectum was left behind because the circumference was routinely violated along undefined planes, leaving viable tumor burden within the pelvis, reflected by a higher recurrence rate in conventional surgery. In addition, a significant incidence of sexual and urinary dysfunction was described, related to the damage of the autonomic parasympathetic and sympathetic nerves by blunt dissection.

Thanks to the spread of the minimally invasive techniques, the mesorectum is sharply removed under direct visualization, following the same key principles described by Heald of autonomous innervation preservation while maintaining hemostasis, and avoiding mesorectal envelope violation. Lower anastomoses between 3and 6 cm from the anal verge are preferred to APR. Recent comparative studies between the open and the laparoscopic approaches show similar disease-free survival and overall survival.

Total Mesorectal Dissection Extent

Lymphatic Spread of Rectal Cancer

The importance of the mesorectum lies in the lymphatic extension from the rectum into the mesorectum, as it is a well-established prognosticator. Therefore, if the mesorectal envelope is removed en bloc, every path of spread of the tumor into the mesorectum will also be removed.

The extent of the rectal cancer resection remains controversial. On the basis of the spreading pathway described in several articles from the 20th century, the extension is mainly upward along the lymphatic course. However, tumors below the peritoneal reflection spread distally also by intra-and extramural routes. Summarizing, the spread will occur mainly as follows:

- Upwards, which is the main route of invasion along the lymphatic course, and justifies the en bloc excision of the mesorectal region containing the upper rectal pedicle.
- Downwards, up to 4 cm below the distal border of the tumor, translating into the average 5-cm distal margin for the mesorectum accepted traditionally, which is reduced to 2 cm for the lower rectal tumors for those well-differentiated according to recent studies.
- Laterally, reflected on the circumferential resection margin (CRM). If the lymphatic invasion threatens the circumferential margin, there is a higher chance of locoregional recurrence.

Distal Margins

Traditionally, a 5-cm distal margin was the minimum requirement for a safe surgery, because early surgeries demonstrated that the downward extension of the tumor reached up to 4 cm below the distal border of the tumor. More recent pathologic studies described that intramural extension occurs within 2 cm of the tumor, unless the tumor is poorly differentiated or widely metastatic. Extramural retrograde lymphatic dissemination is a poor prognostic factor even with more radical surgeries. Recent studies demonstrated no significant differences in survival or local recurrence when comparing distal rectal margins of <2, 2–2.9, and >3 cm. As a result, a 2-cm distal margin has become acceptable for resection of rectal carcinoma, although a 5-cm proximal margin is still recommended.

However, smaller distal margins, even 1 mm, may be acceptable to avoid APRs in patients who have received neoadjuvant chemoradiation.

Partial and total intersphincteric resections have been widely accepted. According to Rullier et al., juxta-anal tumors lying less than 1 cm from the anorectal ring are best treated by partial intersphincteric dissection, but those invading the internal sphincter will be subjected to TME with total intersphincteric dissection.

Radial Margins

On the basis of studies of Quirke et al., local recurrence is intimately related to a radial spread (Fig. 39-2). These studies demonstrated that approximately 90% of patients with positive radial margins would develop a local recurrence. A CRM <1 mm is an independent predictor of a poor outcome in patients whether they received neoadjuvant treatment or not. Patients with an R1 CRM have a risk of up to 26% for local recurrence at 5 years and an overall survival of 43%.

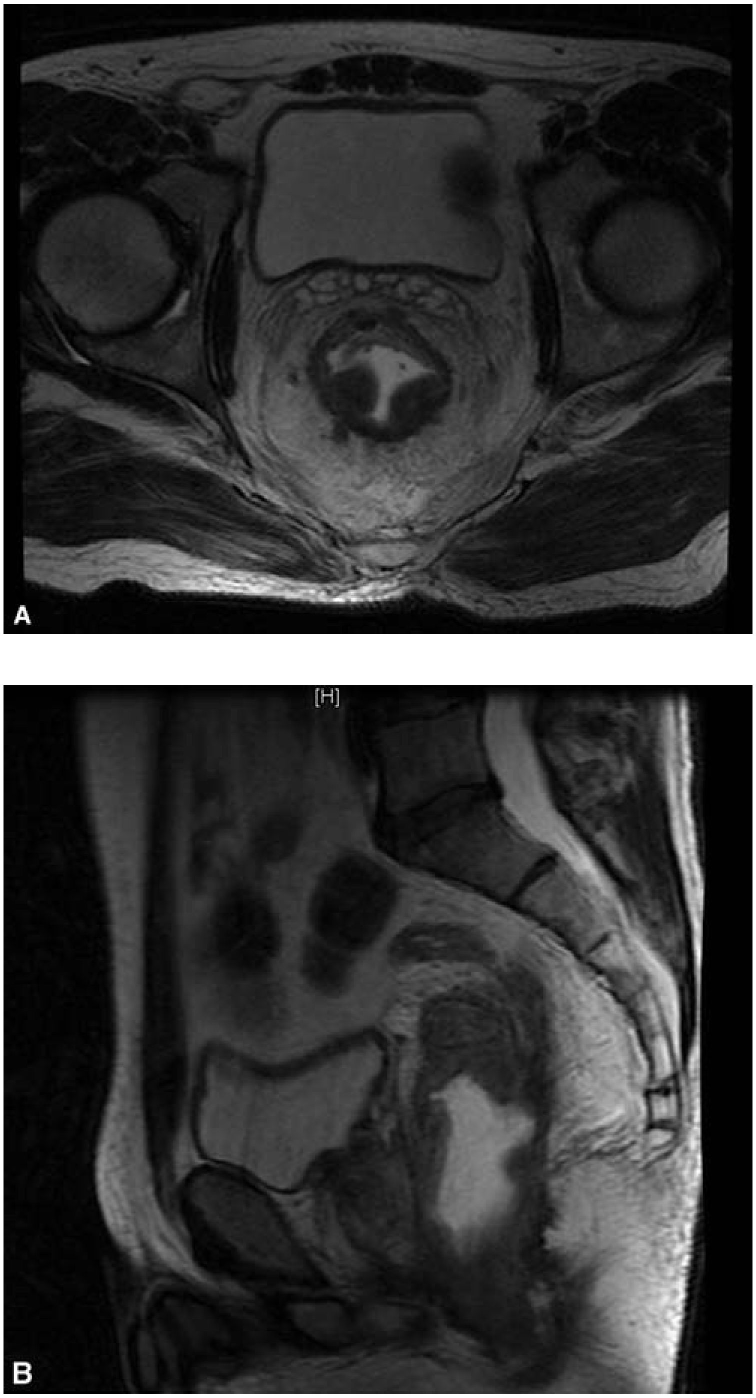


FIGURE 39-2 Magnetic resonance imaging for rectal cancer. Imaging is essential to determine the invasion of the tumor into the rectal wall. A. Axial view. B. Sagittal view.

Magnetic resonance imaging (MRI) has shown relatively high diagnostic accuracy for preoperative T staging and CRM assessment and should be reliable for clinical decision making. Endorectal ultrasound can provide additional assessment of CRM for mid or distal rectal lesions, increasing the accuracy of the staging when combined with MRI. Patients undergoing neoadjuvant treatment before surgery should be restaged. Accurate restaging of locally advanced rectal cancer by MRI, computed tomography (CT), and endoluminal ultrasound is still a challenge. Identifying a complete pathologic response by imaging is not completely accurate. It is difficult to predict the presence of metastatic lymph node disease. Further studies to correlate the radiologic findings and the final pathology results are required.

Lateral Lymph Node Dissection

Lateral lymph node dissection for low rectal cancers with suspected lateral lymph node metastasis is a routine practice in Japan. Prior studies have shown up to a 16.4% incidence of lateral lymph node involvement because of the lateral lymphatic drainage of the rectum from the lower rectum through the lateral ligaments ascending along the internal iliac arteries and inside the obturator spaces. However, even if the oncologic control may be improved, lateral dissection increases urinary and sexual dysfunction. Studies have compared local recurrences after lateral lymph node dissection (6.9%) versus radiation and TME treatment (5.8%). This questions the indication for extended lymph node dissection and the consequent morbidity, when neoadjuvant treatment can achieve similar oncologic outcomes. More comparative studies will need to address this issue to assess the benefit of the lateral lymph node dissection in patients without clinical disease along the pelvic sidewall or the iliacs.

Nerve Dissection

Nerve preservation is essential during TME to maintain optimal functional results after surgery. From the inferior mesenteric artery (IMA) pre-aortic plexus down to Denonvilliers' periprostatic plexus, dissection should be carefully performed to avoid nerve injuries. These complications during TME can occur at different levels and are well recognized:

During the dissection of the IMA close to this aorta, the pre-aortic plexus can be injured to cause retrograde ejaculation.

At the level of the sacral promontory, the presacral sympathetic plexus bifurcates to each side of the pelvis. The nerves should be left intact near the promontory to avoid retrograde ejaculation or bladder dysfunction.

The nervi erigentes (parasympathetic plexus) can be potentially damaged when dissecting the lateral stalks in the lower part of the mid rectum dissection, resulting in erectile dysfunction.

Mixed sympathetic and parasympathetic injury is encountered when dissecting under the sacral promontory into the lateral pelvic sidewall, outside of the lymphovascular bundle, lateral to the seminal vesicles in men and the cardinal ligaments in women, leading to erectile dysfunction and bladder dysfunction.

Dissection anterior to Denonvilliers' fascia can damage the periprostatic plexus, developing into erectile dysfunction and/or a neurogenic bladder.

Neoadjuvant Therapies

Associated with the oncologic improvement because of the advent of TME, adjuvant therapies including radiotherapy and chemotherapy have also been established to improve outcomes. Patients with node-positive disease benefited the most in terms of disease-free survival after neoadjuvant treatment. Accordingly, patients with Stage II and III disease should be considered for adjuvant therapy before TME surgery. Preoperative neoadjuvant treatment associated with TME has demonstrated in a randomized trial a significant decrease in the rate of local recurrence at 2 years without increasing complications. Conventional chemoradiation enhances pathologic response and improves local control in resectable Stage II and III rectal cancer when compared to short-term radiotherapy. There are contradictory results regarding the impact on the mid-or long-term disease-free survival results.

Short-course radiotherapy followed by immediate surgery is as effective as long-course radiotherapy with delayed surgery in terms of overall survival, disease-free survival, local recurrence, distant metastasis, sphincter preservation, R0 resection, and late toxicity. Long-course radiotherapy may increase the pathologic response rate at the expense of increasing acute toxicity.

In addition, those patients preoperatively treated with chemoradiation may achieve a complete clinical response according to MRI, CT, and/or endorectal ultrasound and clinically by rectoscopy. These patients may benefit from a "watch and wait" approach or from local resection as opposed to a radical surgery, with similar oncologic outcomes. The "watch and wait" approach is complete predicated on clinical and radiologic disappearance of the lesion. Close surveillance to detect any recurrence early on is required. If recurrence is detected, the patient can still undergo radical surgery without compromising the long-term oncologic results.

TECHNIQUES OF TOTAL MESORECTAL EXCISION

Preoperative Preparation

Full oral cathartic mechanical bowel preparation is advisable for rectal cancer surgery. Although it has not been demonstrated that full bowel preparation affects the clinical severity in case of an anastomotic leakage, the decrease in the bowel content makes the mobilization of the colon easier during laparoscopic surgery. In addition, oral antibiotics given with mechanical bowel preparation decrease surgical site infections and do not increase other risks.

Stoma sites should be preoperatively marked by a stomatherapist to try to avoid stoma-related complications.

Position

The patient is placed in the lithotomy position with the arms tucked and the chest secured, to be able to place the patient in the different tilt positions and avoid the patient sliding on the surgical bed. A bladder catheter is placed and the rectum is irrigated with a 1% iodine solution to clean the area.

Incision and Exploration

A Veress needle in the left upper quadrant or a Hassan technique can be used to access the abdomen. Two 12-mm trocars are placed at the umbilicus and at the right lower quadrant and two or three 5-mm trocars are placed in the right upper quadrant, epigastric (if splenic mobilization is indicated), and on the left lower quadrant. A 30-or 45-degree optic, or a 3D camera, can be inserted through umbilical port after a pneumoperitoneum is established.

The exploration of the abdomen and pelvis should be the first step after accessing the abdomen. Pathologic peritoneal implants would contraindicate a curative radical excision at this point. The uterus can be temporarily secured to the anterior abdominal wall with a stitch to facilitate exposure.

Blood Supply Control

The authors prefer a medial-to-lateral approach. If the length of the sigmoid and left colon is predicted not to be enough to perform a tension-free colorectal anastomosis, splenic flexure mobilization is required and therefore section of the inferior mesenteric vein (IMV) is required. The editors routinely mobilize the splenic flexure. The patient is placed in anti-Trendelenburg position and the small bowel is medially and inferiorly mobilized. The ligament of Treitz and lower border of the pancreas are the landmarks to be located. The IMV is tented up from the mesentery, creating an acute angle between the IMV on the superior side and the cava on the inferior side (*Rogie's quadrilateral*). The peritoneum is superficially incised parallel to the aorta at about 2–3 cm from the origin of the IMV, continuing the section toward the origin of the IMV. Either a hook cautery or a sealing device may be used for these steps. A retrocolic window is created from this peritoneal cut, toward the splenic flexure, above the anterior border of the pancreas through an avascular plane, leaving the colon superiorly and the pancreas inferior lateral and Gerota's fascia inferiorly. The IMV is skeletonized and ligated with clips, Hem-o-lock (Teleflex, NC), or sealing devices. Once the window has been created up to the spleen, the lesser sac is incised from medial to lateral. The epigastric trocar is very helpful for this step, to separate the gastroepiploic arcade from the lesser sac. The transverse colon is laterally mobilized up to the splenic flexure. The lateral attachments of the left colon can be addressed from this position or completed when mobilizing the left colon.

If the splenic flexure were not initially mobilized, the artery would be addressed as the first step (Fig. 39-3). The patient should be placed in a steep Trendelenburg position with the small bowel placed toward the right side. Gentle traction on the sigmoid colon toward the abdominal wall exposing the mesosigmoid enables exposing the *Bacon axilla*, formed among the IMA, the aorta's bifurcation, and the sigmoid colon (Fig. 39-4). Once localized, the peritoneum is superficially incised from the promontorium toward the root of the IMA, parallel to the aorta and its bifurcation. A retrosigmoid window is created between the IMA, the promontorium, and the sigmoid colon, through an avascular plane, where the gonadal vessels and the ureter should be left intact on the inferior side of the plane dissection. The IMA should be then skeletonized for a high ligation, to remove the proximal lymph nodes. If the splenic flexure has been mobilized, the IMA should be ligated below the branching of the left colic. Otherwise, the left colic can be preserved and the ligation of the IMA is performed distal to the left colic branching.

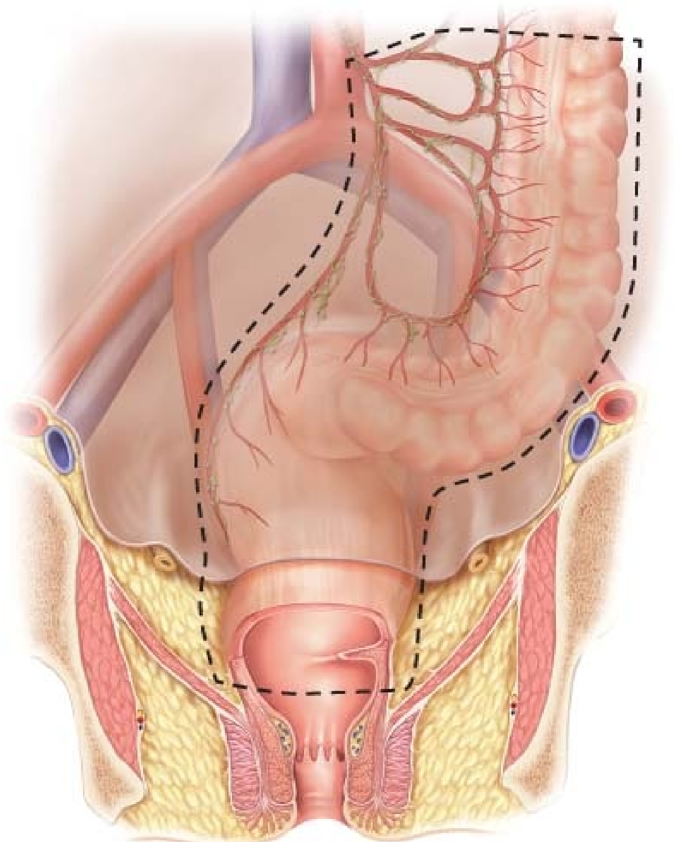


FIGURE 39-3 Vascular supply and bowel resection in total mesorectal excision. High ligation of the inferior mesenteric artery should be performed.

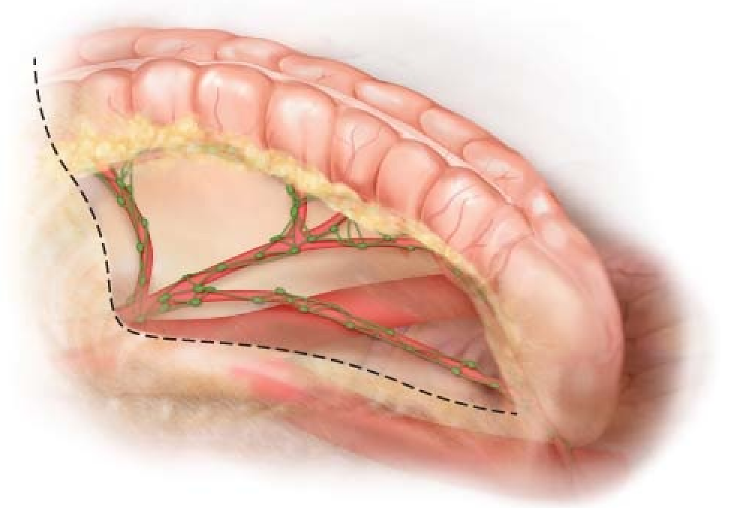


FIGURE 39-4 Exposure of the inferior mesenteric artery (IMA) during dissection. Gentle lateral traction over the sigmoid will expose the IMA, the mesosigmoid, the aorta, and the promontorium.

p. 383

---

p. 384

Mobilization

The dissection continues superiorly following the window created previously under the IMA, reaching out laterally to the abdominal wall. Once this plane has been developed, the sigmoid colon and left colon need to be mobilized. Some groups will leave gauze in the retrosigmoid window as a landmark when completing the lateral dissection and protecting the retroperitoneal structures. Medial traction of the sigmoid colon exposes the left pelvic brim where the dissection will continue toward the line of Toldt, connecting with the retrocolic window created previously. The gonadal vessels, ureter, and iliacs should already be reflected down toward the retroperitoneum. The previously placed gauze should serve as a guide for the dissection.

Once the left and sigmoid colon are mobilized, the pelvis is addressed. For a TME, the rectum must be fully mobilized down to the pelvic floor. The mesorectal fascia surrounding the mesorectal fat is kept as an intact unit down to the pelvic floor muscles.

Posterior dissection over the sacral promontory allows proper identification of the sympathetic nerve trunks. The dissection plane is immediately anterior and medial to the plexus, behind the superior hemorrhoidal artery. The nerves should be reflected toward the promontorium and the pelvic sidewall. The posterior mobilization continues down through the Waldeyer's fascia to the tip of the coccyx, then laterally and anteriorly along the mesorectal envelope, through the areolar tissue known as "angel's hair." In the mid rectal area along the lateral sidewalls, the lateral stalks are found. The middle rectal artery, if present, will be found in the lateral stalks. The parasympathetic nerves, which trace anteriorly toward the hypogastric plexus, are at risk of injury on the lateral wall at the level of the mid rectum.

The dissection progresses anteriorly, incising the peritoneal reflection. The anterior dissection is perhaps the most difficult. Denonvilliers' fascia should be included in the dissection for anterior tumors, posterior to the seminal vesicles and the prostate, avoiding any damage to the periprostatic plexus. However, it may be respected in posterior tumors to prevent possible nerve lesions. The rectovaginal septum is separated from the vagina after incising the pouch of Douglas. Careful dissection is made to avoid injuries to the vagina.

The dissection is continued distally along the mesorectal envelope down to the decided level of the transsection. The mesorectum should appear as a bilobulated structure, becoming thinner at the level of the pelvic floor where the mesorectal fat attenuates.

Transection of the Rectum

The assessment of the distal margin is crucial to achieve an adequate oncologic resection. Different methods have been used to determine the distance from the tumor to the distal level of resection.

- Visual assessment: the tumor can be localized by transabdominal retraction of the rectal wall. The tip of the laparoscopic instruments may be used as a guide, or a ruler may be introduced by a laparoscopic trocar.
- Digital examination: for a low tumor, a digital rectal examination is performed by the surgeon or the assistant, marking the level of the tumor and the adequate distance from the tumor.
- Anoscopy or rectoscopy: transanal visual examination of the tumor can more precisely guide the surgeon to locate the tumor and assess the distal margin.

Once the intended section level is marked, an articulated laparoscopic stapler is introduced through the 12-mm trocar on the right lower quadrant. Usually, a 45-mm cartridge will be fit into the pelvis with more than one cartridge usually necessary to accomplish the transection. If a 60-mm stapler can be placed in the pelvis, a single cartridge maybe enough. In case of low distal rectal tumors, this transection will be performed at or below the levator muscles.

Once the distal end of the rectum is transected, the specimen is extracted through an assistance incision and the proximal end is transected and prepared for the anastomosis. A Pfannenstiel incision is usually preferred for the specimen extraction. If available, indocyanine green (ICG) assessment is performed before the proximal transection of the specimen to ensure adequate vascularity. The ICG is intravenously injected (2–3 ml through central lines, 5 ml through peripheral lines, up to a maximum of 10 ml); and with the aid of a laparoscopic or open ICG camera, the vessels can be visualized, marking the adequate point of transection.

For end-to-end anastomosis, a purse string device may be used to tailor the proximal end of the anastomosis. This device allows the resection of the proximal end and creates a purse string. The purse string may also be manually performed with a running suture. The lumen of the proximal end is then cleaned with gauze and dilated if needed. The anvil will be placed into the proximal end and tied with the purse string sutures with a double knot, making sure that the edges of the mucosa are appropriately everted with the purse string ties.

A side-to-end colorectal anastomosis may be created especially if there are any size discrepancies between the anastomotic ends. The anvil is introduced through the colonic lumen and extracted approximately 4–5 cm away from the transection point on the antimesenteric surface. The anvil will be secured to the mucosa with a manual purse string. The colotomy at the end of the colon may be closed with a stapling device and optionally reinforced with stitches. If a J-pouch is created, an additional linear stapler is required to create a true common channel by folding the distal end of the colon on itself. J-pouches create a side-to-end anastomosis and require a pelvis wide enough to fit the pouch, as well as enough length to perform an adequate tension-free anastomosis; however, they seem to provide a better initial functional result for the patient.

The proximal end of the anastomosis is then returned to the abdominal cavity. The assistance incision may be permanently closed with the aid of a laparoscopic device that avoids loss of the pneumoperitoneum. The insufflation is reestablished and the rectal stump is visualized.

Anastomosis

The majority of anastomoses for cancers in the rectum are performed with the aid of circular staplers (29–33 mm) (Fig. 39-5). The stapler is transanally placed following the course of the sacrum and guided to the staple line under laparoscopic surveillance. The peritoneal reflection is usually lifted anteriorly for a better visualization of the pelvic cavity and the rectal stump. Once the tip of the stapler reaches the upper part of the rectal stump, the trocar protrudes through or immediately adjacent to the middle of the transverse staple line. The anvil of the proximal end is then coupled to the trocar, assuring that the mesocolon is straight. The vagina must be lifted up to avoid encroaching any tissue during the closure of the staplers. Tissue in the staplers from both proximal and distal ends must be assessed to detect any defects on the anastomosis.

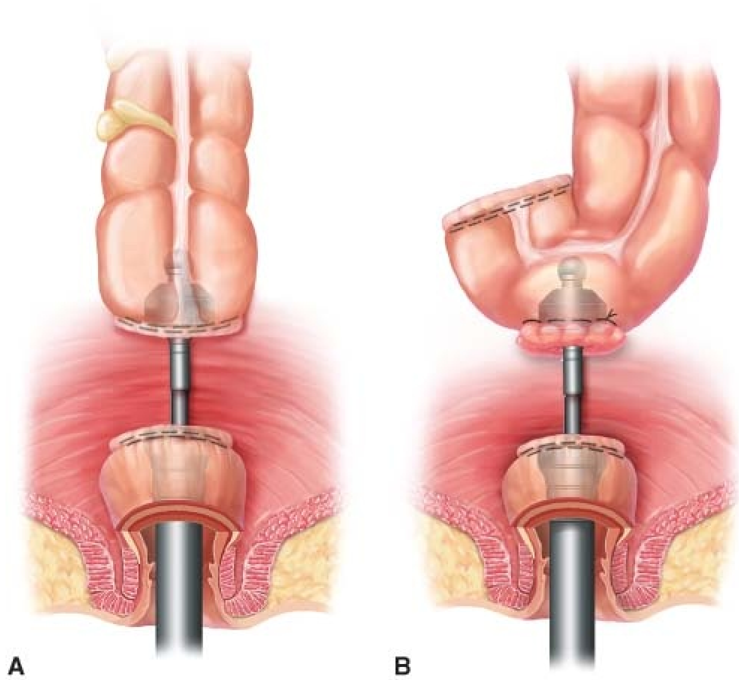


FIGURE 39-5 Type of colorectal anastomosis on a laparoscopic low anterior resection. A. End-to-end anastomosis. B. Colonic J-pouch.

The anastomosis may be tested with an air leak test, with a syringe, rectoscope, or colonoscope, and filling the pelvis with saline. If any bubbles are visible, a defect in anastomosis must be suspected and reinforcement stitches must be placed at the level of the defect. If performed with a rectoscope, colonoscope, or a laparoscopic camera, the anastomosis can also be checked visually to search for any bleeding or other complications. ICG perfusion assessment may be performed before and/or after anastomotic creation.

In cases where a coloanal anastomosis is planned, such as intersphincteric resections or in cases of inflammatory bowel diseases, a hand-sewn anastomosis is indicated to restore continuity, as explained in the chapter on “Intersphincteric Restorative Proctocolectomy for Malignant Disease.”

Partial Mesorectal Excision

Partial Mesorectal Excision

PME is a low anterior resection that involves dissection and anastomosis below the peritoneal reflection with ligation of the superior and middle hemorrhoidal arteries, but does not require of the mesorectal fat all the way to the pelvic floor muscles. This method is acceptable for high rectal or rectosigmoid junction tumors, because the anastomosis will be performed higher on the rectum. In this case, the distal point of transection is located approximately 5 cm distal to the tumor. The mesorectum is then transversely incised laterally and posteriorly, being careful not to perform an oblique dissection leaving potentially involved mesorectal tissue behind.

Assessment of Specimen Quality

The macroscopic quality of mesorectum after curative excision of rectal cancer is an important predictor of local and overall recurrences. The mesorectal grades may be of value in decisions regarding postoperative adjuvant therapy. According to Quirke's classification, the specimen may be described as follows (Fig. 39-6):

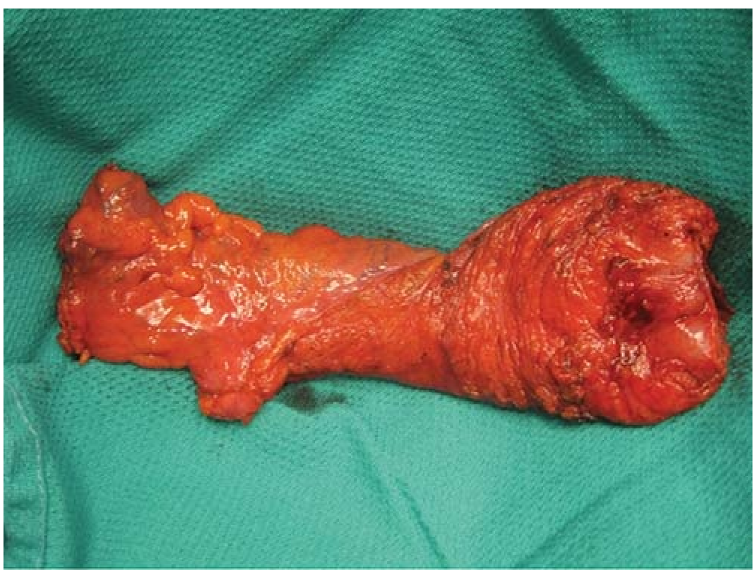


FIGURE 39-6 Mesorectal envelope after a laparoscopic low anterior resection.

Complete: the mesorectum is intact and smooth. There are no defects larger than 5 mm. There is no coning and the CRM is smooth and regular.

Nearly complete: moderate bulk, but irregular. The muscularis mucosa is not visible. There is a moderate coning and the CRM is irregular.

Incomplete: little bulk and irregular. The defects go down to the muscularis mucosa. The coning is moderate to marked and CRM is irregular.

Ostomy

Diversion is indicated following low or ultralow anastomosis and/or in other high-risk scenarios such as a previously radiated pelvis. A distal loop ileostomy is recommended, usually in the right lower quadrant.

The skin is exercised in a circular shape at the previously marked ostomy site. The subcutaneous tissues are dissected down to the fascia, which is divided in a vertical or cruciate manner. The muscle is split but not divided, and then the peritoneum is incised widely enough to let the bowel and its mesentery through. The bowel is exposed and, either manually or with laparoscopic assistance, the mesentery is visualized to ensure the correct positioning and avoid any twisting of the mesentery. The bowel is then transversely incised to leave the proximal and the distal loops open. The proximal side should be matured in a Brooke manner. The distal end can be secured flesh at the level of the stein.

Locally Advanced Rectal Tumors and Recurrence

In general, approximately 5% of patients will present with locally advanced lesions. Locally advanced rectal tumors and recurrence still benefit from a laparoscopic approach after the appropriate oncologic treatment. Shukla *et al.* confirmed faster recovery, although Yasui *et al.* described more complications following resection of T4 tumors. Extended resection of the cancer along with the tissue or organ to which it has adhered can still be performed safely through minimally invasive techniques. The organs that are usually involved with adhesions from colon or rectal cancer include the uterus, small bowel, urinary bladder, and abdominal wall.

Complications of Laparoscopic Total Mesorectal Excision

Both low anterior resection and APR with TME are associated with significant morbidity and mortality. Strictly, surgical complications include anastomotic leakage, wound infections, abscesses, pelvic hemorrhage, injuries to the bowel and genitourinary structures, small bowel obstruction, and strictures. Long-term complications are mainly urinary and sexual dysfunction, with rates as high as 50% and low anterior resection syndrome. Medical-related complications described are urinary tract infection, pneumonia, thromboembolism, renal failure, systemic sepsis, and cardiac events.

Injury to the presacral veins or the internal iliac vessels may cause serious bleeding during low anterior resection. Bleeding from the pelvic veins usually decreases or stops after the rectum is removed. Compression with a sponge, sterile thumbtacks or specially designed “occluder pins” may help because attempts at catuery coagulation or suturing may be detrimental. Rectus abdominus muscle flap may also be rotated down into the pelvis based on the inferior epigastric pedicle fixed by heavy sutures as the next resource. If these measures fail, pelvic packing is advised, scheduling a second look in 24–48 hours.

Injury to the genitourinary organs may occur during low anterior resection. In cases with large tumors or expected difficult dissection, such as recurrent Crohn’s disease, chronic diverticulitis, leaked pelvic anastomoses, and pelvic irradiation, preoperative placement of ureteral stents may be indicated. Ureters have to be carefully identified before ligation of the IMA, because the junction between the upper and the middle ureter may be injured at this level if not properly mobilized laterally before the ligation. Primary end-to-end repair over a stent would be indicated at this level. When the ureters cross over the bifurcation of the iliac artery, they are exposed to tangential injuries, because they may be adherent to the sigmoid colon. Primary repair or ureteral reimplantation may be required then, although many times these lesions go unnoticed. Lateral dissection of the stalks, anterolateral dissection between the lower rectum, pelvic sidewall, and bladder base, or dissection of the most cephalad position of the perineal phase can result in ureter injury at the ureterovesical junction. The ureter should be reimplanted if the injury is intraoperatively recognized.

p. 387

---

p. 388

Bladder injuries are often related to large rectosigmoid tumors or complicated diverticulitis. Defects are easily repaired in two layers, watching carefully not to occlude the ureteral orifices at the trigone. A Foley catheter should be left in place for 7–10 days. Before removal, imaging should be obtained to assess the healing of the injury. Those injuries detected postoperatively may require temporary fecal and urinary diversion.

The incidence of anastomotic leak varies widely from 3% up to over 20%. Greater operative duration, male sex, body mass index (BMI) >30 kg/m^2, tobacco use, chronic immunosuppressive medications, thrombocytosis (platelet count $>400\times10^9/l$), and urgent/emergency operations have been independently associated with anastomotic leak.

Treatment of a colorectal anastomotic leak depends greatly on the patient’s clinical condition. If the patient is septic or unstable, surgical revision of the anastomosis is indicated, through a minimally invasive approach. On the basis of the intraoperative findings, several options must be considered: proximal fecal diversion with a loop ileostomy or a loop colostomy; anastomotic takedown with creation of a terminal colostomy and closing the rectal stump; or lavage and drainage. Reinforcing the anastomosis is not usually recommended; although if performed, it is usually associated to a proximal diversion. Revision of the anastomosis may be transabdominally or transanally performed. If the patient is stable, the treatment may be conservative including radiologic drainage.

From the 40% wound infection rate before oral antibiotic preparation, the reported infection rate in the recent series ranges from 5% to 10%, and even lower following laparoscopy. Oral antibiotics combined with mechanic bowel preparation correlate with decreased risks of surgical site infections because they control the large bacterial content of the colon (10^{10} anaerobes and 10^{8} aerobes/g of stool). Risk factors for wound infection include male gender, BMI >30, current smoking, history of chronic obstructive pulmonary disease, American Society of Anesthesiologists III/IV, APR, stoma formation, open surgery (vs. laparoscopic), and operative time >217 minutes. Treatment of wound infections ranges from opening a portion of the skin incision over the area of maximal change to allow drainage, antibiotics, surgical debridement, vacuum-assisted wound closure, and wound healing by second intention.

Intra-abdominal abscesses become apparent from the fourth to the seventh day postoperative. Imaging demonstrating unexpectedly large pneumoperitoneum or contrast leakage adjacent to the staple line suggests an anastomotic leak. Antibiotic treatment after percutaneous drainage is a treatment option, with CT scan to monitor the evolution of the collection. Percutaneous drainage is successful in 65–90% of cases, depending on size, complexity, etiology, and microbial flora. Refractory abscesses may require surgical debridement as well as treatment of the infection source.

Anastomotic bleeding is frequent, from minor to severe in quantity. It is manifested by dark blood per rectum after surgery and although usually limited, may require transfusions or other intervention. Saline and 1:100,000 epinephrine washout can be carefully performed through a rectal tube. If bleeding persists or hypotension develops, endoscopy or surgery would be the next option. Transanal examination of the anastomosis under anesthesia may grant visualization of the bleeding site, which can be treated with cautery, injection of epinephrine, or endoscopic clips.

Routine intraoperative endoscopy or rectoscopy after the construction of coloanal or colorectal anastomoses may allow intraoperative rather than postoperative control of bleeding, because small bleeding points may be controlled with sutures. Cautery should be avoided because it may cause a burn injury that may lead to delayed leak.

Anastomotic chronic sinus or fistulae can develop from the bowel, the skin, vagina, male urethra, or form a chronic presacral abscess (presacral sinus). Conservative treatment is usually recommended, by bowel rest with total parenteral nutrition or with a low-residue diet if tolerated. Surgical treatment of the fistula would be indicated if the drainage of the fistula is high. If the fistula persists after 3–6 months, surgical definitive repair should be considered. The local treatment goal is to drain the cavity and heal by second intention, either by cauterizing the cavity wall, or sectioning it with a stapler, or placing a vacuumsponge device. More radical treatment may be required, by redoing the anastomosis, possibly with a diverting stoma.

Spontaneous closure of rectovaginal fistula is rare as the etiology may be an inadvertent inclusion of the vagina during the closure of the anastomotic stapler or a anastomotic leak finding a natural drainage through the vaginal cuff. Surgical repair options include local repair with advancement flaps, gracilis flaps, or a transabdominal approach to redo the anastomosis.

Anastomotic stricture may develop after an anastomotic leak or ischemia. It develops months to a year after surgery and it presents with progressive constipation, decreasing size of the stools, and difficulty evacuating. Malignancy should be excluded with a biopsy and imaging. Anastomoses of the distal third of the rectum are amenable to dilation, with more success if treated early. Higher anastomoses may be endoscopically treated, although ultimately surgery may be required.

Urinary dysfunction is one of the most common long-term complications, regardless of the operative approach. Dysfunction is common in the early postoperative period, and it usually resolves spontaneously. Persistent urinary retention results from partial denervation of the detrusor muscle causing partial paralysis. If necessary, a bladder catheter should be left in place until resolution; a small number of patients will require further intervention.

Sexual dysfunction related to nerve injury is a relatively frequent long-term complication after mesorectal excision. The most frequent sexual dysfunction is retrograde ejaculation, due to injury to the superior hypogastric (sympathetic) plexus during high ligation of the IMA or to the hypogastric nerves at the sacral promontory during mobilization of the upper mesorectum. Erectile dysfunction may result from lesions to the pelvic plexus during the lateral dissection or to the nervi erigentes or cavernous nerves while dissecting the anterior plane (abdominal or perineal phase) at the Denonvilliers’ fascia. Therefore, dissection of Denonvilliers’ is a matter of discussion. Some groups believe the fascia has to be included if the mesorectal excision to be complete, whereas others will only include Denonvilliers’ for anterior tumors to get a clear margin. Erectile dysfunction after proctectomy may respond to sildenafil. In female patients, the sexual dysfunction rate is lower than in male patients (10–20%) and may be reflected by dyspareunia and inability to produce vaginal lubrication and achieve orgasm.

Another complication after laparoscopic TME is small bowel obstruction. Early detection is crucial to prevent further evolution, and imaging may be able to define a transition point precisely.

Oncologic Results of Laparoscopic Total Mesorectal

Excision

Overall and disease-free survival for patients with rectal cancer has improved during the recent decade because of the improvements in surgical techniques and neoadjuvant and adjuvant treatment. Locoregional recurrence of rectal cancer has been reported as low as 3%, demonstrating non-inferiority with the open approach. However, when a patient develops a local recurrence, it is often not just a suture line recurrence, but a regional recurrence. The evaluation of these patients requires extensive imaging to identify features of the tumor that would make it unresectable. In appropriate settings, laparoscopy may be a reasonable option.

Overall, 10-year survival rates after major surgery for rectal cancer are similar between laparoscopy and open surgery (76.8% vs.70.6%, respectively). Similarly, disease-free survival is 69.1% following laparoscopic versus 67.7% in open surgery. The laparoscopic approach for TME is safe, oncologically sound, and offers the patient the advantages of the minimally invasive approach.

CONCLUSIONS

Laparoscopic TME is feasible, a safe technique, and oncologically sound. Careful dissection during the procedure can help prevent both early and late postoperative complications.

RECOMMENDED REFERENCES AND READINGS

Adamina M, Delaney CP. Laparoscopic total mesorectal excision for low rectal cancer. *Surg Endosc* 2011;25(8):2738–41. doi:10.1007/s00464-011-1626-0.

Allaix ME, Giraudo G, Ferrarese A, Arezzo A, Rebecchi F, Morino M. 10-year oncologic outcomes after laparoscopic or open total mesorectal excision for rectal cancer. *World J Surg* 2016;40(12):3052–62.

Chapman BC, Hosokawa P, Henderson W, *et al.* Impact of neoadjuvant chemoradiation on perioperative outcomes in patients with rectal cancer. *J Surg Oncol* 2017;115(8):1033–44. doi:10.1002/jso.24613.

de'Angelis N, Landi F, Vitali GC, *et al.* Multicentre propensity score-matched analysis of laparoscopic versus open surgery for T4 rectal cancer. *Surg Endosc* 2016;31(8):3106–21.

Fleshman J, Branda M, Sargent DJ, *et al.* Effect of laparoscopic-assisted resection vs open resection of stage II or III rectal cancer on pathologic outcomes: the ACOSOG Z6051 randomized clinical trial. *JAMA* 2015;314(13):1346–55. doi:10.1001/jama.2015.10529.

Habr-Gama A, Perez RO, Nadalin W, *et al.* Operative versus nonoperative treatment for stage 0 distal rectal cancer following chemoradiation therapy: long-term results. *Ann Surg* 2004;240(4):711–7; discussion 717–8.

Heald RJ, Husband EM, Ryall RD. The mesorectum in rectal cancer surgery—the clue to pelvic recurrence? Br J Surg 1982:613–6.

Kang CY, Halabi WJ, Chaudhry OO, *et al.* A nationwide analysis of laparoscopy in high-risk colorectal surgery patients. World *J Surg* 2016;17(2):382–91. doi:10.1007/s00268-016-3839-9.

Martínez-Pérez A, Carra MC, Brunetti F, de'Angelis N. Pathologic outcomes of laparoscopic vs open mesorectal excision for rectal cancer: a systematic review and meta-analysis. *JAMA Surg* 2017:e165665. doi:10.1001/jamasurg.2016.5665.

Park JS, Huh JW, Park YA, *et al.* A circumferential resection margin of 1 mm is a negative prognostic factor in rectal cancer patients with and without neoadjuvant chemoradiotherapy. *Dis Colon Rectum* 2014;57(8):933–40. doi:10.1097/DCR.0000000000000171.

Quirke P, Durdey P, Dixon MF, Williams NS. Local recurrence of rectal adenocarcinoma due to inadequate surgical resection. Histopathological study of lateral tumour spread and surgical excision. *Lancet* 1986;2(8514):996–9.

Ratto C, Ricci R, Rossi C, Morelli U, Vecchio FM, Doglietto GB. Mesorectal microfoci adversely affect the prognosis of patients with rectal cancer. *Dis Colon Rectum* 2002;45(6):733–42; discussion 742–3.

Rullier E, Denost Q, Vendrely V, Rullier A, Laurent C. Low rectal cancer: classification and standardization of surgery. *Dis Colon Rectum* 2013;56(5):560–7. doi:10.1097/DCR.0b013e31827c4a8c.

Takahashi T, Ueno M, Azekura K, Ohta H. Lateral node dissection and total mesorectal excision for rectal cancer. *Dis Colon Rectum* 2000;43(10 Suppl):S59–68.

Williams NS, Dixon MF, Johnston D. Reappraisal of the 5 centimetre rule of distal excision for carcinoma of the rectum: a study of distal intramural spread and of patients' survival. *Br J Surg* 1983;70(3):150–4.

PART VIII

PELVIC EXENTERATION

Chapter 40

Anterior, Posterior, and Total Pelvic Exenteration

Seth I. Felder and Martin R. Weiser

INDICATIONS/CONTRAINDICATIONS

Pelvic exenteration is a radical approach to resecting pelvic disease, generally involving the rectum and pelvic viscera. The goal is a margin-negative resection often requiring en bloc removal of the rectum with the bladder, lower ureters, uterus, fallopian tubes, and either ovaries or seminal vesicles and prostate. Extirpation may include lateral pelvic lymph nodes; internal iliac vessels; nerves; pelvic peritoneum; and portions of the bony pelvis, muscles, and ligaments. Multivisceral or extended exenterative rectal resections offer the best chance of curing locally advanced primary rectal cancers and locally recurrent disease confined to the pelvis. The distorted tissue planes, aggressive biology, and prior irradiation increase the risk and technical difficulty of these operations, necessitating meticulous surgical planning. Despite the technical challenges associated with pelvic exenterative operations, the rates of operative mortality and morbidity have sharply declined in recent years because of improvements in patient selection, advances in the quality of imaging, and emphasis on multidisciplinary perioperative care. Although better oncologic outcomes are now anticipated, the magnitude of resection obligates the surgeon to carefully consider the effects of the expected morbidity on the patient’s quality of life. Once a patient has committed to undergoing pelvic exenteration, achieving a microscopic negative (R0) resection margin becomes the surgeon’s primary objective. An R0 resection margin remains the most important prognostic factor for long-term survival in patients with locally advanced primary and recurrent rectal cancers.

Indications

Locally Advanced Primary Rectal Cancer

For the nearly 15% of rectal cancers adherent to adjacent pelvic viscera, neoadjuvant therapy and multivisceral resection are required. In contrast to many other solid tumors, large locally advanced primary rectal tumors are not necessarily indicative of concurrent distant disease. Curative resection is necessarily indicative of concurrent distant disease. Curative resection is therefore potentially attainable. Because malignant infiltration cannot be clearly differentiated from inflammatory adhesions on surgical exploration, aggressive resection of adherent organs is often necessary. Many studies have shown that if negative margins are achieved, en bloc resection of the anatomic structures invaded by the tumor can lead to long-term survival approaching 60% at 5 years after surgery. In contrast, the prognosis for locally advanced primary rectal cancer left untreated is poor, with median survival being less than 1 year and the 5-year survival rate being less than 5%.

Recurrent Rectal Cancer

After a curative rectal cancer resection, 3–30% of patients experience local recurrence. In the absence of surgical intervention, the mean survival for such patients is 7 months. Although metastatic disease subsequently develops in up to 70% of patients with recurrent rectal cancer, up to 50% of patients die with local disease only. Approximately 20% of patients with recurrent pelvic disease are amenable to a repeat radical resection, which improves 5-year survival to 18–46%. The majority of local recurrences are detected within 48 months of the primary surgery. Radiation and chemotherapy may partially alleviate symptoms; but with medical therapy alone, patient survival is less than 5% at 5 years. Pelvic exenteration remains the only form of treatment that is potentially curative and, in some select instances, effectively palliative for recurrent rectal cancer.

Metastasectomy/Palliative Surgery

The benefit of pelvic exenteration for patients with metastatic disease remains unclear. Metastatic disease does not necessarily disqualify a patient from operative consideration. In a highly select group of patients with limited and resectable visceral metastases, pelvic exenteration has produced acceptable outcomes, with survival beyond 5 years. Selective use of exenteration may also be reasonable for palliation in patients with unmanageable perineal wounds, disabling pain, bleeding, obstruction, and recurrent infections, even if resection of the disease is incomplete.

Contraindications

Patients with significant comorbidities and poor performance status such as American Society of Anesthesiology IV–V are rarely candidates for the extensive surgery required. Likewise, exenteration should not be performed in patients for whom complete resection is not possible or patients for whom surgical morbidity is likely to be excessive. Other contraindications for exenteration include the following:

- Invasion of the sciatic notch or sciatic pain with sciatic nerve involvement
- S1 or S2 bony or neural involvement
- Extensive peritoneal involvement
- Unresectable extrapelvic metastases including para-aortic lymphadenopathy
- Multifocal local recurrence and multiple threatened margins or circumferential pelvic sidewall involvement
- Bilateral ureteral obstruction

Traditionally, peritoneal carcinomatosis, high sacral involvement, encasement of the external iliac vessels, invasion of the sciatic notch, bilateral ureteral obstruction with bilateral hydronephrosis, and the presence of gross lower limb edema have been considered absolute contraindications to curative pelvic exenteration. The categorization of many of these conditions as contraindications has recently been reevaluated and challenged, particularly at expert high-volume centers, where several of the traditionally absolute contraindications are now considered relative.

PREOPERATIVE PLANNING

Before the operation, the surgeon must carefully evaluate the clinical symptoms, the extent of local and distant disease, the patient’s fitness for major surgery, and the patient’s cognitive awareness of the rehabilitative process. It is crucial that patients with multifocal distant metastases not undergo such a potentially morbid treatment. Recurrent disease should be verified usually by computed tomography (CT)-guided biopsy before an operation of such magnitude is undertaken. Many efforts have been made to identify factors associated with complete resection, which could aid surgeons in selecting patients who are truly suitable for exenteration. Because a spectrum of opinions regarding suitability for exenteration exists, a consensus survey of experienced surgeons has been conducted. Among 58 clinical criteria for patients with recurrent rectal cancer, “history of pain” and “pelvic bone pain” were among the highest ranked variables associated with an anticipated negative effect on the surgical outcome.

Physical Examination

Although many surgeons consider modern imaging modalities to be the most effective means of tumor staging, a thorough physical examination, including detailed digital rectal and vaginal examinations, remains essential. Physical examination can provide an experienced surgeon with valuable information on the tumor’s extent and its fixation to adjacent organs and/or the bony pelvis. In some cases, adequate examination may need to be performed under anesthesia. A thorough pelvic examination is usually the simplest, most direct method of determining whether sphincter-sparing surgery is feasible or multivisceral resection or exenteration is necessary. To exclude synchronous primary tumors, a complete colonoscopy should also be performed.

Radiologic Imaging

Contrast-enhanced CT is the most frequently used imaging modality for assessing a tumor’s extent and/or the presence of metastatic disease. CT can provide an approximate idea of tumor size, but it does not always accurately differentiate tumor margins from the surrounding viscera. A more accurate indication of pelvic involvement and of the potential need for multivisceral resection can be obtained with magnetic resonance imaging (MRI). Several comparative studies have demonstrated the superiority of MRI in predicting extrapelvic visceral involvement in both primary and recurrent diseases. A negative predictive value of 93–100% for invasion into critical structures has negative predictive value of 93–100% for invasion into critical structures has been reported for MRI. However, treatment-related fibrosis has been shown to result in overstaging, particularly for recurrent tumors along the pelvic sidewall.

MRI remains the most valuable tool for delineating the extent of tumor involvement in the four main pelvic compartments: anterior, axial/central, posterior, and lateral sidewall. Tumor involvement of central and anterior structures, with the potential exception of bone involvement, indicates a high likelihood of obtaining negative margins. Lateral pelvic sidewall disease identified on preoperative imaging, however, portends a worse surgical outcome and represents the most common site for a positive margin because of the anatomic constraints of the bony pelvis. For this reason, intraoperative radiation to the pelvic sidewall soft tissue, ureters, iliac vessels, sciatic nerve, piriformis muscle, and pelvic bones may need to be considered. Even with pelvic sidewall involvement, recent series have reported R0 resection rates approaching 53%, with overall survival as high as 69% at 19 months, although these operations often required vessel reconstruction with bony and ligamentous resections.

Fluorodeoxyglucose positron emission tomography can image tumor metabolic activity and provide useful information regarding the presence of metastatic disease. This technology can be a valuable tool in detecting pelvic recurrence, with potential advantages over CT or MRI in differentiating fibrosis from viable tumor. Nonetheless, false-positive interpretations of physiologic fluorodeoxyglucose uptake in displaced pelvic organs, such as bladder, seminal vesicles, uterus, and small-bowel loops, as well as radiation-induced inflammation, reduce its specificity.

Neoadjuvant Therapy

The single most important factor in curing rectal cancer is complete excision of the tumor with negative margins, thus achieving an R0 resection. In primary rectal cancer, preoperative chemoradiation has been shown to prevent local recurrence more effectively than postoperative therapy, without necessarily extending overall survival. Although radiotherapy and chemotherapy may allow for palliation and symptom control, prolonging survival by 10–17 months, surgical resection remains the only curative option. A significant benefit of preoperative chemoradiotherapy is its potential to downsize the tumor, which may facilitate complete resection of locally advanced disease. Indeed, neoadjuvant chemoradiation has become standard practice in treating most locally advanced rectal cancers.

In efforts to enhance the likelihood of complete resection of advanced rectal cancer, the intensity and sequence of preoperative therapy have been actively studied, and recommendations continue to evolve. One such strategy for potentially improving R0 resection rates is induction chemotherapy followed by standard chemoradiation. Chua *et al.* conducted a phase II study of 105 poor risk patients with rectal cancer treated with induction capecitabine–oxaliplatin before receiving standard chemoradiation. Poor risk was defined according to MRI findings as (a) tumor extending to within 1 mm of, or beyond, the mesorectal fascia; (b) T3 low-lying tumor at or below the levators; (c) tumor extending 5 mm or more into the perirectal fat; and (d) T4 tumor. Of the 97 patients in the study, 93 eventually underwent complete negative-margin resections. The EXPERT-C phase II study, which included 165 patients with “high-risk” rectal cancers defined on the basis of MRI findings, treated with four cycles of induction chemotherapy, reported a similar, 96% R0 resection rate.

For patients with pelvic recurrence who have not previously received radiation, preoperative chemoradiotherapy should be strongly considered. Reirradiation is also a consideration in patients with recurrent disease. In a multicenter study, Valentini *et al.* reported an 8.5% rate of complete pathologic response and a 29% rate of downstaging following reirradiation. Because robust clinical data on long-term normal tissue recovery and radiation tolerance doses are sparse, reirradiation is controversial, although it has been shown to have acceptable risks of toxicity. Considering the available evidence, reirradiation should be prescribed on a case-specific basis.

Additional Studies

Preoperative evaluation, including physical examination and imaging, will determine the need for any additional studies such as pelvic ultrasound, cystoscopy, or dedicated sacral bone evaluation. Cystoscopy may be necessary before surgery, or it may be intraoperatively performed. Temporary ureteral catheters should be used liberally, especially in cases of recurrent disease. A positron emission tomography scan may identify distant metastatic disease and prevent unnecessary operation with no benefit to the patient and delay systemic chemotherapy.

SURGERY

The expertise of the surgical team should be broad and include specialists in colorectal, urologic, gynecologic, orthopedic, neurologic, and plastic reconstructive surgery. The surgical objective is to achieve complete en bloc resection of the tumor and viscera with negative margins while preserving as much healthy anatomy as possible. Although defining total pelvic exenteration is relatively straightforward, partial exenteration describes a more heterogeneous group of procedures. Total pelvic exenteration is the removal of the rectum with or without sphincter preservation, genitourinary viscera, reproductive organs, regional lymph nodes, and pelvic peritoneum. Anterior pelvic exenteration is defined as the removal of the rectum and genitourinary organs including the bladder, lower ureter(s), prostate, seminal vesicles, uterus, vagina, and cervix. Posterior pelvic exenteration is defined as en bloc resection of the rectum with or without reproductive organs, with bladder preservation. Sacropelvic exenteration is used when the rectal tumor invades or is broadly adherent to the sacrum or the coccyx and requires removal of the bony pelvis.

Preoperative Regimen

Patients who undergo pelvic surgery of such magnitude are at a high risk of major cardiac, respiratory, thrombotic, and wound complications. Medical evaluation to assess surgical risk and optimally treat comorbidity is important. A recent study reported that a dedicated “prehabilitation” program has been beneficial in reducing perioperative risks.

Patients undergo mechanical cathartic bowel preparation and oral antibiotic preparation on the day before surgery. Ureteral stents can be preoperatively placed to help identify and protect the ureters. Parenteral antibiotics are delivered in the operating room along with preoperative deep vein thrombosis prophylaxis. The patient is placed in the lithotomy position, giving the surgeon anterior access to the pelvis and the perineum. Surgery will be performed in one or two stages, depending on the extent of resection, with the potential need to move the patient into the prone position.

Resection

The surgeon first examines the abdomen and evaluates for any hepatic, peritoneal, or retroperitoneal disease, because detection would likely dictate a management change (Figs. 40-1 to 40-4). It is helpful to identify stable landmarks, including the proximal ureters, the distal aorta, and common iliac vessels, before committing to the deeper pelvic dissection. If dense fibrosis is encountered near the promontory, the iliac veins will be at especially high risk for injury. The most common vein injured in difficult pelvic dissections is the left common iliac vein, because it is typically immobile and fragile and courses from right to left across the midline with little protective tissue overlying it. Apart from the left common iliac vein, other major risk zones for severe bleeding are the retroprostatic or retrovaginal vessels, presacral venous plexus, and pelvic sidewalls.

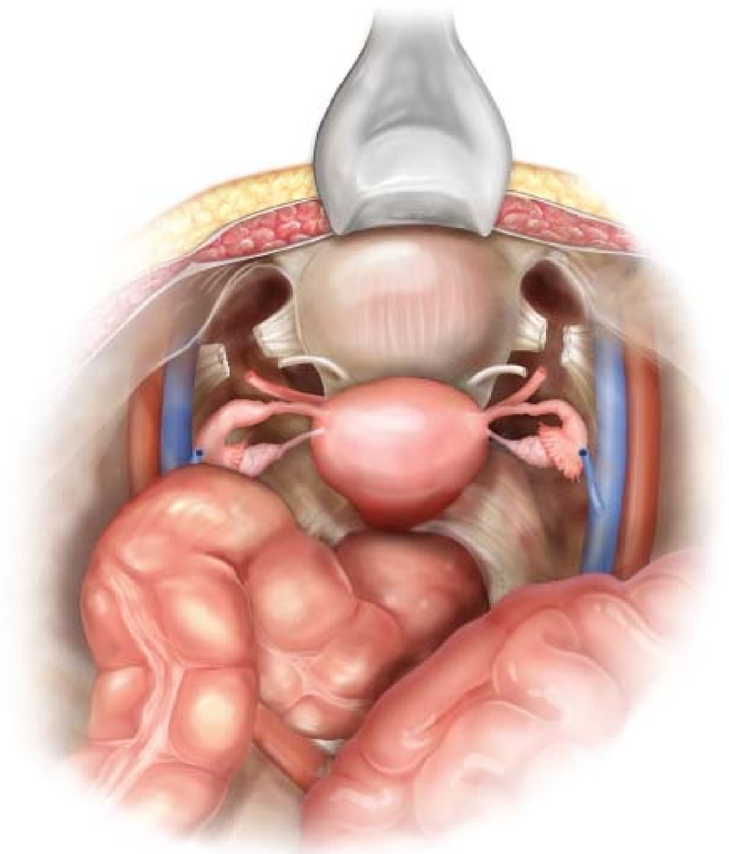


FIGURE 40-1 In total pelvic exenteration, the lateral dissection begins on the common and external iliac vessels, which are lateral to the parietal layer of the endopelvic fascia. The internal iliac artery and vein are clamped, cut, and tied distal at their origin. The ureter is cut in the pelvis with care to preserve ureter length for reconstruction.

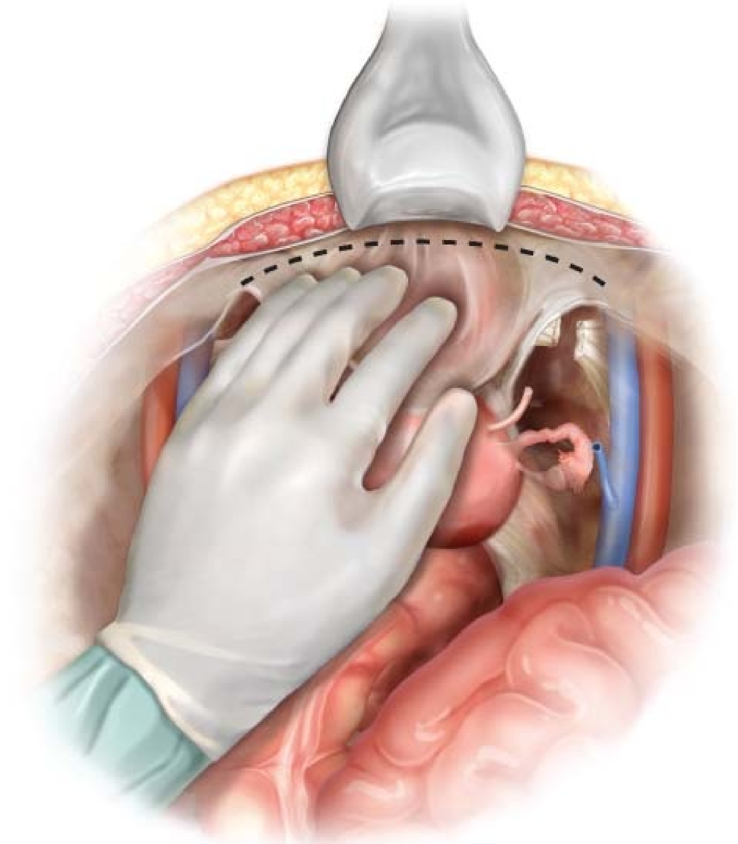


FIGURE 40-2 The surgeon may perform the dissection of the bladder before or after the posterior dissection of the pelvic organs. The bladder is dissected from the symphysis and pubic rami with dissection in the space of Retzius. The bladder is freed by dividing the lateral peritoneal attachments.

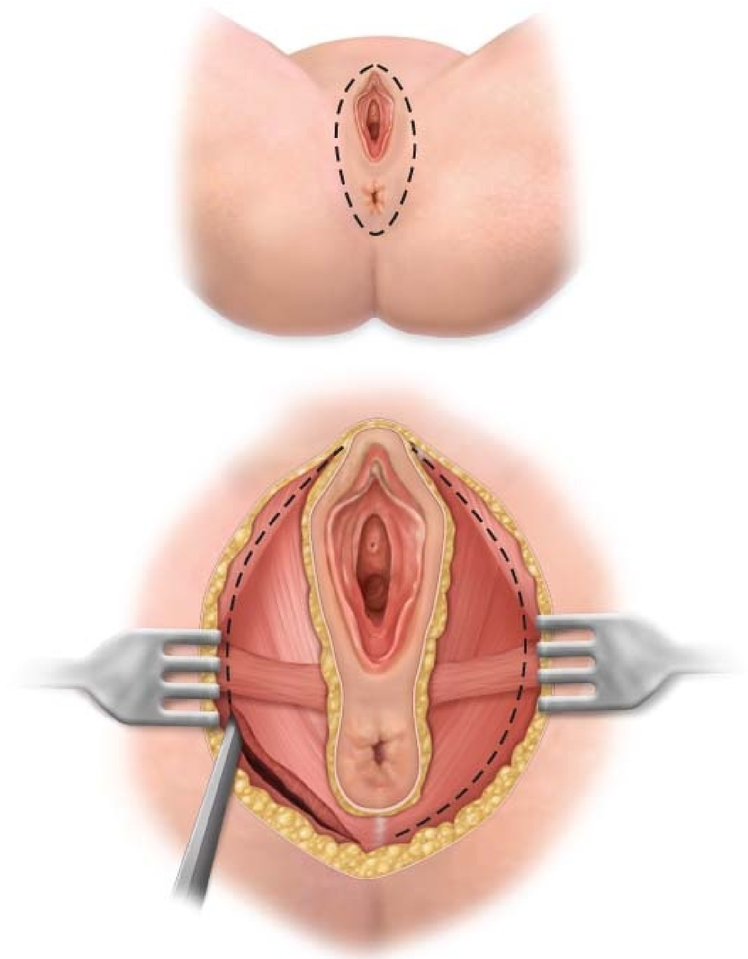


FIGURE 40-3 Perineal dissection is required for total pelvic exenteration that includes the intralevator organs (anal canal, labia majora, urethra). An elliptical incision is created from the tip of the coccyx to the pubic symphysis. In men, the incision ends at the bulb of the penis, with the urethra previously divided in the pelvis. The pelvic floor attachments are divided widely, freeing the urethra, vagina, and rectum.

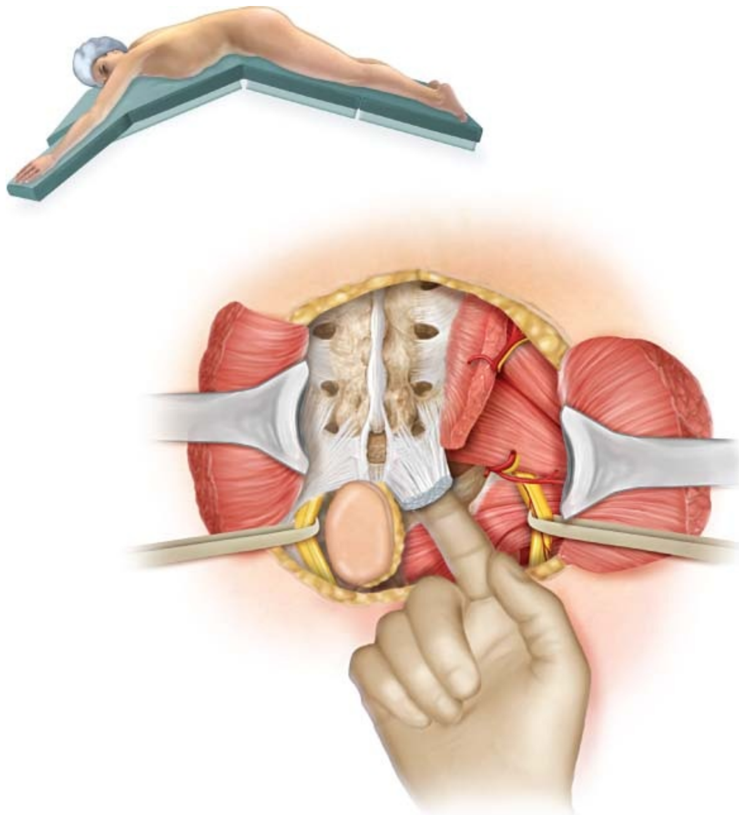


FIGURE 40-4 Following anterior dissection, the patient is placed prone for the sacral resection. A posterior sacral incision is made with excision of the anus. Flaps are raised to the lateral extent of the sacrum. The gluteus maximus and medius muscles are dissected from their sacral origins, and the sciatic nerve is located by retracting the gluteus maximus and underlying piriformis muscle superiorly at the lateral aspect of the midsacrum. The nerve is superficial to the obturator internus muscle and courses inferolaterally between the ischial tuberosity and greater trochanter. The sacrotuberous and sacrospinous ligaments are incised at their attachments to the ischial tuberosity and ischial spine. A finger is inserted anteriorly from the medial aspect of the sciatic nerve. This facilitates dissection beneath the piriformis muscle and through the underlying endopelvic fascia. This exposure directs the sacral ostectomy and ensures adequate tumor clearance.

Lateral dissection begins on the common and external iliac vessels, which are located lateral to the parietal layers of the endopelvic fascia. The medial border of the external iliac vein provides entry onto the medial aspect of psoas major muscle, which, in turn, is the medial border of the obturator internus muscle, which represents the key dissection point for a lateral pelvic sidewall dissection. The obturator internus can be partially removed if it is involved by the tumor

The obturator internus can be partially removed if it is involved by the tumor, sacrificing the obturator nerve if necessary. The internal iliac artery and vein can be ligated as required. At this point, dissection exposes the lumbosacral trunk, with further caudal dissection exposing the piriformis and splanchnic nerve roots.

If bladder resection is planned, the space of Retzius is dissected, separating the bladder from the symphysis and pubic rami in the retropubic space down toward the levator plate anteriorly. The vesicular veins that drain the bladder into the internal iliac veins should be ligated carefully, because they are easily torn and difficult to control. Dissection continues until the urethra is encountered and then transected. The anterior levator muscle is resected off the pubic bone and the obturator internus muscle to the ischial spine laterally. If the tumor involves the anterior compartment, then the obturator internus is completely resected.

Posterior exenteration is similar to total exenteration. However, rather than dissection proceeding anterior to the bladder in the retropubic space, the peritoneum is incised over the bladder, and the bladder is dissected sharply off the anterior surface of either the cervix and vagina or the prostate down to or depending on the level of the tumor beyond the levator ani muscle. Distally, the ureters must be dissected free from the anterior parametria in women, over the ureteral tunnel running along the uterine artery.

Sacropelvic Resection

When the sacrum is involved, the only curative option is an en bloc resection of the sacrum and surrounding structures. Tumors that invade the sacrum have been shown to have a poorer but still acceptable prognosis. The operation is typically a two-part procedure: an abdominal phase and then a prone phase for completion of the sacrectomy. Because dissection of the sacrum is more extensive, mobilization of vessels including the aorta, vena cava, and the iliac arteries and veins is often necessary. Dissection commences at the aortic bifurcation, with aortic and common iliac node dissection and vascular control. For sacral resections above the fourth sacral body, the internal iliac artery branches are ligated distal to the takeoff of the superior gluteal arteries. This method ensures preservation of blood flow to the gluteal region, which might later be used for reconstructive flaps.

If an anterior–posterior approach is anticipated, a thick piece of silastic mesh can be placed between the sacrum and the vessels and soft tissue structures of the bladder, uterus, and rectum, as described by Dozois and colleagues, thus the bladder, uterus, and rectum, as described by Dozois and colleagues, thus protecting against injury during the prone stage when blind osteotomies are performed. The proximal extent of the tumor is then identified, and the appropriate level above the upper extent of the tumor is marked on the sacrum with a K-wire or osteotome on the anterior cortex of the sacrum. This marking is used for the identification of the level of sacrectomy in the prone position by radiologic intraoperative localization.

With the patient in the prone position, a dorsal longitudinal incision is made, starting at the level of L5 down to and around the anal canal. The gluteus maximus and gluteus minimus muscles are dissected from the sacrum, and flaps are bilaterally raised to the lateral extent of the sacrum. The sciatic nerve is located by retracting the gluteus maximus and underlying piriformis muscle superiorly at the lateral aspect of the midsacrum. The nerve is superficial to the obturator internus muscle and courses inferolaterally between the ischial tuberosity and greater trochanter. The sacrotuberous and sacrospinous ligaments are transected at the ischial tuberosity and ischial spine, respectively, facilitating access to the pelvic floor musculature and the infra-piriformis opening. Medial to the infra-piriformis and sciatic nerve, a finger can be inserted anteriorly into the presacral space to identify the level of resection. This maneuver facilitates dissection beneath the piriformis muscle and through the underlying endopelvic fascia. This exposure directs the sacral transection, ensuring adequate tumor clearance. Sacral nerve roots are sacrificed below the level of bone resection. Occasionally, they can be preserved, if uninvolved with tumor, thus saving lower extremity functioning. Ultimately, the distal sacrum, lateral pelvic walls, and rectum are delivered en bloc through the perineal wound.

High spinal resections can result in spinal instability requiring reconstruction. Colibaseanu and colleagues have reported findings for a small series of patients undergoing extended sacral resection with subsequent spinopelvic stabilization. Although almost all patients had R0 resections, most patients experienced substantial morbidity, with nearly half of the patients developing chronic pain and needing ambulatory assistance.

Reconstruction

Following exenteration, bowel, bladder, vaginal, and perineal defects require reconstruction. The goals of reconstruction include optimizing healing, preventing perineal sepsis, and, in some patients, restoring function. In most cases, a rectal anastomosis is not possible, and a permanent colostomy is created. The surgeon then confronts a large irradiated pelvic “dead space” susceptible to abscess formation and wound-healing complications. A variety of techniques have been utilized in efforts to close or obliterate the noncollapsible dead space: biologic mesh, pedicled omental flaps, and myocutaneous flaps. Patients with biologic mesh, pedicled omental flaps, and myocutaneous flaps. Patients with locally advanced and recurrent rectal cancers, particularly patients who have undergone reirradiation, are typically considered a higher risk group and are more likely to obtain a benefit from a flap closure rather than a primary closure.

In a series of 70 patients, Hultman and colleagues found the incidence of pelvic complications, including abscesses, hernias, bowel obstructions, and fistulas, to be significantly lower in the group that underwent an omental-flap closure than in the primary-closure group (21% vs. 61%). In a study comparing closure with a vertical rectus abdominus myocutaneous flap and primary closure for pelvic and perineal reconstruction, Chokshi and colleagues found no significant difference between the groups. The use of myocutaneous flaps did not significantly decrease the rate of perineal wound complications, such as dehiscence or wound infection, which contrasts with other reports.

If a cystectomy is performed, the ureters are carefully transected in the pelvis to preserve ureteric length for reconstruction. The options for urinary diversion include the traditional ileal conduit or an orthotopic bladder substitution. Urologists have developed multiple options of urinary diversion. However, reconstruction may be difficult in an irradiated and reoperated pelvis that may contain dense adhesions or when an irradiated small bowel is not suitable for use as a conduit or reservoir.

Intraoperative Radiation Therapy

The primary goal of radiation therapy is to optimize the dose delivered to a tumor relative to the dose delivered to normal adjacent tissues. A dose of intraoperative radiation therapy (IORT) is biologically equivalent to two to three times the fractionated external radiation dose. IORT, which allows delivery of radiation to the tumor bed while shielding normal tissue, is used when minimal gross disease remains or microscopic positive margins are suspected in the resection field. Two alternative but complementary IORT techniques are available: intraoperative electron radiation, which uses a linear accelerator to deliver electron particles, and high-dose-rate brachytherapy, which delivers an iridium seed (^{192}Ir) via afterloading catheters to the target tissue. With either technique, normal tissues can be moved aside simultaneously or physically shielded. In addition, because the tumor can be visualized intraoperatively, it is possible to more accurately define areas at risk for tumor involvement.

The data on IORT are limited to small series with conflicting findings, making conclusions difficult. In the largest series to date, investigators at the Mayo Clinic examined outcomes in 304 patients undergoing resection of recurrent rectal cancer. IORT was performed in 33% of the 138 patients with an R0 resection and in 52% of the 166 patients with R1 and R2 resections. In this series, local control and survival in patients who received IORT for microscopically positive margins were similar to those in patients with R0 resections.

In a study conducted at Memorial Sloan Kettering Cancer Center, high-dose-rate intraoperative brachytherapy in 74 patients (21 of whom had R1 resections) yielded 5-year local control, distant disease-free, local disease-free, and overall survival rates of 39%, 39%, 23%, and 23%, respectively. Patients with negative margins of resection were reported to have a similar 5-year local control rate of 43%, compared with 26% in patients with microscopically positive margins. A negative microscopic margin and the use of intraoperative brachytherapy proved to be significant predictors of longer overall survival. However, a French multi-institutional phase III randomized study of IORT for rectal cancer in 142 patients obtained contradictory results, with no statistically significant difference in overall survival (69.8% vs.74.8%; $P = 0.3$) or disease-free survival (63.7% vs.63.1%; $P = 0.8$) between IORT and non-IORT patients.

POSTOPERATIVE MANAGEMENT

Most patients require close postoperative monitoring after a pelvic exenteration. The majority of patients will have had fecal diversion, making the return of bowel function easily measurable. Depending on the type of exenteration, the patient may have an additional urinary conduit stoma, which similarly allows for accurate urine measurement and guidance of postoperative volume status. If the bladder and ureters are preserved, the bladder catheter should remain in place for several days, because of the significant risk for urinary retention. Reconstructed perineal wounds deserve close attention in view of the relatively high incidence of healing problems. It is preferable for the patient not to lie or sit directly on the dependent perineal wound but rather to distribute weight on the lateral aspects and learn a sit-to-stand maneuver. Postoperative care requires frequent side-to-side turning and regular flap observations. Physical and occupational therapists often play a central role in the rehabilitation process following exenteration, particularly when a more proximal sacral resection is performed.

COMPLICATIONS

Most recent studies of exenteration have reported acceptable perioperative mortality but significant morbidity, including surgical site infection, sepsis related to the noncollapsible empty pelvis, and complications from urinary diversion. These findings highlight the importance of patient selection for preventing unnecessary morbidity in patients considered to have a low likelihood of deriving a survival benefit from pelvic exenteration. A recent systematic review of 19 series on pelvic exenteration for rectal cancer reported a 2.2% median perioperative mortality rate and a median complication rate of 57% (range, 37–100%). No difference in morbidity between patients operated on for locally advanced primary rectal cancer and those operated on for locally recurrent rectal cancer was identified. The most common postoperative complications were superficial site infections, pelvic abscesses, and urinary leaks or infections.

Sacrectomy carries a significant burden of morbidity, with increased rates reported in patients after high-level sacrectomy. Moriya and colleagues reported sacral wound dehiscence in 51% of the 48 patients studied. Similar findings were obtained by Bhangu and colleagues, who found S1/S2 sacrectomy complication rates to be higher than those for S3 and S4/S5 sacrectomies (60% vs. 27% and 29%, respectively).

RESULTS

The literature on pelvic exenteration outcomes for rectal cancer remains limited to retrospective analyses of relatively small series. Achieving an R0 resection is consistently the most significant and reliable prognostic factor for long-term survival in patients with locally advanced primary or recurrent rectal cancer. Other factors shown to influence outcomes, although to a somewhat lesser extent, include the disease-free interval in recurrent rectal cancers (with an interval of <1 year) being indicative of poor prognosis. In addition, other variables include anatomic location of disease within the pelvis with central, as opposed to lateral, recurrences being more amenable to resection with negative margins, pelvic pain before resection, and nodal involvement.

In a recent systematic review of 15 series by Yang et al., the rate of local recurrence following pelvic exenteration for locally advanced primary and recurrent rectal cancers combined ranged from 4.8% to 61% (median, 22%). Resection margins were negative (R0) for 539 of 715 patients (median for the 15 studies, 73%; range, 42–100%) and microscopically or macroscopically positive in 176 patients (median for the 15 studies, 26%; range, 0–58%).

The shorter survival for recurrent than for primary locally advanced primary rectal cancer is most likely the result of interrupted tissue planes, altered anatomy, and more aggressive biology, because pelvic exenterations for recurrent rectal cancer are associated with higher rates of resection margin positivity. In their review of 17 studies, Yang *et al.* reported that the 5-year survival rate for patients with locally advanced primary rectal cancer ranged from 31% to 77% (median for 17 studies, 52%), with median survival duration ranging from 14 to 93 months (median for 10 studies, 36 months). The 5-year local control rate for locally advanced primary rectal cancer ranged from 65% to 89% in three studies. Median survival for patients who had R0 resections ranged from 23 to 53 months (median, 35 months), whereas for those who had R1 and R2 resections, median survival ranged from 6 to 32 months (median, 16 months).

In a recent series of 174 patients who underwent pelvic exenteration for locally advanced primary rectal cancer, Radwan *et al.* reported that 90% of the patients had R0 resections and 121-month median survival, compared to 24 months for patients who had incomplete resections. No patient in the series underwent a sacrectomy. Mortality at 30 days was 1.1%. Overall morbidity was 32%, mostly from perineal reconstructive complications, with 16% of the patients requiring an additional operation (Table 40-1).

TABLE 40-1 Outcomes After Pelvic Exenteration for Locally Advanced Rectal C

Study	n	% Patients				Median survival (mo)		
		Sacrectomy	R0	R1	R2	R0	R1	R2
Primary cancer								
Nielsen et al. (2011)	50	10	66	34	0	NR		
Bhangu et al. (2014)	55	15	91	5	4	NR		
Radwan et al. (2015)	174	0	87	13	0	121	24	
Recurrent cancer								
Salo et al. (1999)	103	16	69	13	18	42	32	27
Hahnloser et al. (2003)	304	NR	45	9	46	44.4	30	22.8
Bhangu et al. (2014)	45	49	62	27	11	NR		
Moriya et al. (2004)	57	100	84	16†		51	14.5†	

*Estimated from a Kaplan–Meier curve.

†For R1 and R2 resections combined.

‡Three-year overall survival. Three-year disease-free survival was 76% for primary cancer and 57% for recurrent cancer.

**Disease-specific survival.

NR, not reported.

Five-year survival for patients with locally recurrent rectal cancer ranges from 0% to 37% (median, 18%), as reported by Yang *et al.* for 13 studies, with median survival ranging from 8 to 38 months (median, 24 months). Salo and colleagues completed a 10-year retrospective analysis of 103 patients with resectable locally recurrent rectal cancer who underwent curative-intent pelvic exenteration at Memorial Sloan Kettering Cancer Center from 1986 to 1995. An R0 resection was possible in 69% of the patients, resulting in a median survival of 42 months, compared to 32 and 27 months for the 13 patients with an R1 resection and 19 patients with an R2 resection, respectively (Table 40-1). Five-year survival for the R0 resection patients was 35%, compared to 23% and 9% for the R1 and R2 resection patients, respectively. Sixteen percent of the patients underwent a sacrectomy at various levels. Complications requiring hospitalization or additional surgery occurred in 24% of the patients.

In the Mayo Clinic series, 45% of 304 patients with resectable disease had negative resection margins, and 9% and 46% had R1 and R2 exenterations, respectively. The 5-year survival rate in patients who underwent an R0 resection was significantly higher than in patients with positive margins (37% and 16%, respectively). In the MD Anderson Cancer Center series, 77% of 85 patients who underwent resection for recurrent rectal cancer had negative margins. The 5-year rate of disease-free survival was 52%, and multivariate regression analysis revealed that an R1 resection was associated with a lower 5-year rate of disease-free survival (21%).

Seven studies in the systematic review by Yang *et al.* included extended exenteration with sacrectomy. In two of the studies, Wells *et al.* and Melton *et al.* found that patients with a recurrent tumor adherent to the sacrum who underwent an en bloc sacrectomy with an R0 margin had relatively longer overall survival and disease-free survival, although at the cost of significant morbidity. Dozois *et al.* obtained similar results, with median survival of 31 months in patients who underwent a high S1/S2 sacrectomy with clear margins. In a study of 240 pelvic exenteration patients, an R0 margin was achieved in 36 (73%) of the 49 patients who underwent a sacrectomy for recurrent rectal cancer. R0 resections were associated with significantly longer disease-free survival (median, 45 months) than R1 and R2 resections (median, 19 and 8 months, respectively) ($P = 0.045$). The overall complication rate was 74% (43% major and 67% minor), with no 30-day mortality. Postoperative neurologic deficits, where the sciatic nerve was not purposely excised, occurred in 25 patients and were significantly more frequent in high (≥S2/S3 disk) sacrectomy patients (39%) than in low (≤S3) sacrectomy patients (19%) ($P = 0.04$).

Quality of Life

As a result of improved survival following pelvic exenteration for rectal cancer, a greater proportion of patients are anticipated to present postoperatively with a range of physical and psychological issues. Health-related quality-of-life considerations are therefore integral to their long-term care. Current literature provides inadequate insight into quality-of-life outcomes, given the long lag time between treatment and assessment, the use of inappropriate disease-specific measures to assess different populations of interest, and the retrospective nature of the available data adding significant selection biases. Functional and psychological outcomes have yet to be rigorously studied.

Palliative Outcomes

Given that pelvic exenteration is associated with extended hospital recovery, high complication rates, prolonged rehabilitation, and potential disfigurement, both patients and physicians should weigh the costs of a curative resection versus nonsurgical palliation. Fecal diversion, nephrostomy insertion, and ureteral stents can all be selectively employed when radical surgery is deemed inappropriate. Reirradiation has been shown to yield good symptomatic effects, with alleviation of pain and reduction in rectal bleeding in the majority of patients. Palliative pelvic reoperative surgery may be necessary in some patients to relieve pain, treat necrotic abscesses, relieve bowel obstruction, or treat fistulas that significantly impact the quality of life.

CONCLUSIONS

Pelvic exenteration is a radical operation associated with high morbidity. Surgical salvage is considered appropriate in the curative setting as well as in very select cases for palliation. Careful patient selection guided by high-resolution imaging and careful physical examination is critical. A multidisciplinary approach including a team of various surgical specialists (colorectal, gynecologic, orthopedic, urologic, reconstructive, and vascular surgeons), radiation and medical oncologists, physical and occupational therapists, psychologists, enterostomal nurses, and dieticians optimizes perioperative planning, surgery, and postoperative management. Patients need to be psychologically prepared for extensive resections, prolonged hospital stays, and morbidity. Even with neoadjuvant therapy and complementary use of IORT, a complete R0 resection remains the most important determinant of long-term survival.

Although pelvic exenteration was mainly a palliative procedure in the past, it now represents a potentially curative treatment option for patients with advanced primary rectal cancer. When integrated into multimodality treatment, pelvic exenteration is associated with 5-year survival rates of up to 60% and acceptable morbidity. Because of the complexity of pelvic exenteration, optimal outcomes are more likely at specialty referral centers that have sufficient experience and adequate multidisciplinary resources.

ACKNOWLEDGMENT

We gratefully acknowledge the editorial assistance of Arthur Gelmis.

RECOMMENDED REFERENCES AND READINGS

Bedrosian I, Giacco G, Pederson L, *et al.* Outcome after curative resection for locally recurrent rectal cancer. *Dis Colon Rectum* 2006;49:175–82.

Bhangu A, Ali SM, Brown G,Nicholls RJ, Tekkis P. Indications and outcome of pelvic exenteration for locally advanced primary and recurrent rectal cancer. *Ann Surg* 2014;259:315–22.

Boostrom SY, Dozois EJ. Recurrent pelvic surgery. *Surg Clin North Am* 2013;93:199–215.

Chew M-H, Brown WE, Masya LB,Harrison JD, Myers E, Solomon MJ. Clinical, MRI, and PET-CT criteria used by surgeons to determine suitability for pelvic exenteration surgery for recurrent rectal cancers: a Delphi study. *Dis Colon Rectum* 2013;56:717–25.

Colibaseanu DT, Dozois EJ, Mathis KL, *et al.* Extended sacropelvic resection for locally recurrent rectal cancer: can it be done safely and with good oncologic outcomes? *Dis Colon Rectum* 2014;57:47–55.

Dozois EJ, Privitera A, Holubar SD, *et al.* High sacrectomy for locally recurrent rectal cancer: can long-term survival be achieved? *J Surg Oncol* 2011;103:105–9.

Hahnloser D, Nelson H, Gunderson LL, *et al.* Curative potential of multimodality therapy for locally recurrent rectal cancer. *Ann Surg* 2003;237:502–8.

Harji DP, Griffiths B, Velikova G, Sagar PM, Brown J. Systematic review of health-related quality of life in patients undergoing pelvic exenteration. *Eur J Surg Oncol* 2016;42:1132–45.

Jimenez RE, Shoup M, Cohen AM, Paty PB, Guillem J, Wong WD. Contemporary outcomes of total pelvic exenteration in the treatment of colorectal cancer. *Dis Colon Rectum* 2003;46:1619–25.

Melton GB, Paty PB, Boland PJ, *et al.* Sacral resection for recurrent rectal cancer: analysis of morbidity and treatment results. *Dis Colon Rectum* 2006;49:1099–107.

Miles WK, Chang DW, Kroll SS, *et al.* Reconstruction of large sacral defects following total sacrectomy. *Plast Reconstr Surg* 2000;105:2387–94.

Milne T, Solomon MJ, Lee P, *et al.* Sacral resection with pelvic exenteration for advanced primary and recurrent pelvic cancer: a single-institution experience of 100 sacrectomies. *Dis Colon Rectum* 2014;57:1153–61.

Moriya Y, Akasu T, Fujita S, Yamamoto S. Total pelvic exenteration with distal sacrectomy for fixed recurrent rectal cancer in the pelvis. *Dis Colon Rectum* 2004;47:2047–54.

Nielsen MB, Rasmussen PC, Lindegaard JC, Laurberg S. A 10-year experience of total pelvic exenteration for primary advanced and locally recurrent rectal cancer based on a prospective database. *Colorectal Dis* 2012;14:1076–83.

Radwan RW, Jones HG, Rawat N, et al; Swansea Pelvic Oncology Group. Determinants of survival following pelvic exenteration for primary rectal cancer. *Br J Surg* 2015;102:1278–84.

Salo JC, Paty PB, Guillem J,Minsky BD, Harrison LB, Cohen AM. Surgical salvage of recurrent rectal carcinoma after curative resection: a 10-year experience. *Ann Surg Oncol* 1999;6:171–7.

van der Meij W, Rombouts AJ, Rütten H, Bremers AJ, de Wilt JH. Treatment of locally recurrent rectal carcinoma in previously (chemo)irradiated patients: a review. *Dis Colon Rectum* 2016;59:148–56.

Wells BJ, Stotland P, Ko MA, *et al.* Results of an aggressive approach to resection of locally recurrent rectal cancer. *Ann Surg Oncol* 2007;14:390–5.

Wiig JN, Poulsen JP, Larsen S,Braendengen M, Waehre H, Giercksky KE. Total pelvic exenteration with preoperative irradiation for advanced primary and recurrent rectal cancer. *Eur J Surg* 2002;168:42–8.

Yang TX, Morris DL, Chua TC. Pelvic exenteration for rectal cancer: a systematic review. *Dis Colon Rectum* 2013;56:519–31.

You YN, Habiba H, Chang GJ, Rodriguez-bigas MA, Skibber JM. Prognostic value of quality of life and pain in patients with locally recurrent rectal cancer. *Ann Surg Oncol* 2011;18:989–96.

Chapter 41

Lateral Lymph Node Dissection for Rectal Carcinoma

Petr V. Tsarkov and Inna Tulina

INTRODUCTION/OBJECTIVES

Recent progress in rectal cancer staging, development of surgical procedures including total mesorectal excision (TME) and nerve-sparing TME, and advances in neo-and adjuvant therapy (such as chemotherapy and radiotherapy [RT]) have dramatically reduced locoregional recurrence, but unfortunately still have not eliminated it. Local recurrences are likely to be the result of one of the following reasons—missed microscopic involvement of circular resection margin, rare involvement of distal mesorectum beyond the “5-cm” barrier, lateral spread to pelvic lymph nodes beyond the mesorectum, and possibly seeding of the pelvis during surgical dissection.

Early anatomic study by Gerota in 1895 initially described the presence of lateral lymphatic flow in the rectum. In 1925 Villemin and later in 1950 Blair *et al.* using dye injection described lymphatic pathways in the pelvis. They suggested that lymphatic drainage from the rectum follows three main routes: the upper route is along the superior rectal artery, the middle route is along the middle rectal arteries and goes to the obturator spaces, and the lower route is along the inferior rectal arteries leading to the iliac basins. The lymphatic drainage to the lateral compartment was suggested to have an important role for low rectal cancers located at or below peritoneal reflection. The clear connection between the lymphatics of the mesorectum below peritoneal reflection and lateral pelvic spaces was also recently demonstrated.

Biological behavior of primary rectal cancer is characterized by relatively slow growth and being localized for a long time compared to other gastrointestinal malignancies. This behavior determines the concept of extended lymph node dissection. Lymph node metastases first occur along the well-described lymphatic channels and follow a well-defined pattern. Lateral lymphatics in the pelvis consist of channels from pelvic organs such as bladder, genital organs, and rectum. Lymphatic spread from anteriorly located organs goes to the more proximal part of internal iliac vessels, whereas lateral lymphatics of the rectum drain into the distal part of internal iliac vessels close to the root of the internal pudendal artery. Lymphatic vessels that extend laterally from the rectum are relatively small, but it does not reduce their importance in the lymphatic spread in rectal cancer. When reviewing series of patients who developed local recurrence after radical TME, lateral pelvic wall involvement is found in 20–80% of them. Thus, lateral lymph nodes (LLNs) can be a potential site of locoregional recurrence even in the absence of circumferential margin involvement.

According to Japanese concepts based on early anatomic studies of Senba and Kuru, the rectal muscle tube is surrounded by three fat-tissue “spaces.” The first space corresponds to the mesorectum that is enveloped by rectal fascia propria. Two hypogastric nerves (HNs) and the pelvic plexuses (PPs) are attached to both posterolateral sides of the mesorectum. Adjacent to the nerves lie the right and left second fat-tissue spaces. Lateral borders are the internal iliac vessels and their visceral branches. The left and right third spaces are located lateral to the internal iliac vessels in both obturator fossae. Since being established as a standard in Japanese colorectal surgery, this three-space dissection around the rectum is considered essential to achieve complete pelvic lymph node dissection in all three areas.

The Japanese system of grading lymph node involvement is different from the tumor, node and metastasis system and is based on the metastatic lymph node location in the abovementioned spaces and the distance from the primary tumor rather than on the total number of involved lymph nodes. According to the Japanese classification of rectal cancer, N1 (pararectal) lymph nodes are located inside the mesorectal fascia envelope up to the origin of the superior rectal artery. The mesorectal fascia represents a distinct anatomic barrier toward direct cancer spread to extramesorectal lymphatics, and thus the major route for lymphatic spread is upward along the superior rectal artery. Upward N2 (intermediate) lymph nodes lie within the vascular pedicle between the last sigmoid artery (SA) and left colic artery (LCA). Lateral N2 lymph nodes are located outside the mesorectal fascia between HN and PP and internal iliac arteries (IIAs) and their branches. N3 (main or apical) lymph nodes in the upward direction are found around the trunk of the inferior mesenteric artery (IMA) above the origin of the LCA. The N3 lymph nodes in the lateral direction are located along the common iliac vessels and in the obturator space. Subsequent classification of lymph node dissection in rectal cancer is based on the grades of removed lymph nodes. Thus, D1 lymph node dissection is aimed at removing N1 lymph nodes, D2 lymph node dissection encompasses N2 lymph nodes, and D3 lymph node dissection—N3 lymph nodes. In this way, TME can be represented as a D1/D2 lymph node dissection based on the level of upward lymphatic resection, and D3 lymph node dissection involves resection of lymph nodes around the IMA trunk and internal iliac and obturator lymph nodes, which is often called the extended aortopelvic lymph node dissection or lateral pelvic lymph node dissection or lateral lymph node dissection (LLD).

Unlike the Eastern world, D3 lymph node dissection for rectal cancer is uncommon in Western countries because of the belief in the negligible incidence of LLN involvement and the possibility of RT to prevent and cure LLN metastases. In Eastern series, the rate of pathologically proven metastatic mesorectal and lateral pelvic lymph nodes in low rectal cancer patients may be as high as 39% even after the completion of neoadjuvant RT. The Japanese Society for Cancer of the Colon and Rectum has presented the data from the Japanese registry, which showed that among 2,916 patients with rectal cancer, LLN involvement was present in 20.1% of patients who underwent prophylactic LLD because of low location of the tumor (below the peritoneal reflection) and/or cancer invasion through the muscularis propria. Among the patients who had involved mesorectal lymph nodes, the incidence of LLN involvement was 27%. In the review of neoadjuvant chemoradiotherapy (CRT) and TME surgical treatment of 366 patients with rectal cancer, Kim *et al.* have reported that LLN metastasis is the major cause of locoregional recurrence.

The Western data on the incidence of LLN involvement and lateral pelvic recurrence is scarce. Recent data from Oxford, United Kingdom, suggest that in low rectal cancer, magnetic resonance imaging (MRI) can identify enlarged lymph nodes in lateral pelvic compartments in 85% of patients and LLNs with malignant features were found in 10% of patients. All of these patients underwent TME and 69% had preoperative CRT; the overall 5-year local recurrence rate was 18.7% and 5-year lateral LLR was 11.8%. Our group performed a single-center randomized controlled trial that compared patients with very low rectal cancer (below 3 cm) who underwent standard abdominoperineal excision (APE) with patients who underwent APE combined with prophylactic LLD. This study demonstrated that the incidence of local recurrence was significantly lower with LLD than with only APE—13.8% versus 20.7%, respectively.

Despite all modern trends of neoadjuvant CRT and TME, locoregional recurrence attests to the need for more intense surgical research and/or technical improvements.

INDICATIONS

The indications for LLD are still controversial even among Japanese surgeons.

Previously, the concept of “prophylactic” LLD was widely adopted, but now a more “selective” approach is gaining its place. Current guidelines for the treatment of colorectal cancer by the Japanese Society for the Cancer of the Colon and Rectum recommend LLD for rectal cancers with lower border below peritoneal reflection that invade beyond the muscularis propria. Thus, prophylactic LLD is considered before treatment irrespective of evaluation of LLN status to try to reduce the risk of intrapelvic recurrences by a half and improve 5-year survival by 8–9%. The progress in diagnostic tools, especially in pelvic MRI, enables us to better stage not only the primary tumor but also the lymph node involvement. The possibility of detecting suspicious LLNs helps stratify patients to those who really need LLD and those who can probably avoid this procedure. This “selective” approach toward LLD is becoming more popular nowadays.

Predictive risk factors for LLN involvement include the following:

Tumor location below the level of peritoneal reflection, and the lower the tumor the higher the incidence of lateral node metastasis. Takahashi *et al.* have demonstrated that in patients with rectal tumors above the peritoneal reflection, the incidence of LLN involvement is 1.7%, whereas for the tumors below peritoneal reflection this rate is 16.7% ($P<0.001$), with maximum of 36.8% for tumors located just above the dentate line.

Depth of tumor invasion—through bowel wall (T3) and infiltrating fascia propria of the rectum and adjacent organs (T4). The highest incidence of positive LLNs of 10.0–27.2% has been demonstrated for tumors invading mesorectal fat (T3) and 27.3–31.0% for cancer involving adjacent organs and structures (T4). Multivariable analysis performed by Sugihara and colleagues revealed that tumors below peritoneal reflection as well as female sex, tumor size of >4 cm and T3/4 stage were significantly associated with an increased incidence of positive LLNs.

Tumor histologic grade—moderately and poorly differentiated adenocarcinomas have higher chances of metastases to LLNs.

Positive mesorectal lymph nodes—several studies including the national Japanese registry have shown that presence of positive lymph nodes in mesorectal fat is an important predictive factor of LLN involvement.

Enlarged LLN on pelvic computed tomography (CT)/MRI—diameter of LLN ≥8 mm; however, among these patients, up to 50% can still be node negative after CRT. It was shown that in patients who undergo CRT to determine the indications for LLD, it is more appropriate to measure the initial size of LLN irrespective of its possible regression because of CRT. However, if the LLN does not disappear after CRT but persists, this feature is another strong indication to perform selective LLD.

PREOPERATIVE PLANNING

Preoperative planning includes a thorough physical examination. Enlarged inguinal lymph nodes should be noted. Physical examination, including digital rectal examination, vaginal inspection, and regional lymph node assessment, may help assess the possible risk of LLN involvement. Rigid proctoscopy is performed to assess the accurate distance from the lower border of the tumor to the anal verge and/or dentate line. Colonoscopy is required to identify any synchronous lesions. However, barium or Gastrografin enema is helpful in cases with severe tumor stenosis. Although some authors do not suggest chest CT as a routine diagnostic tool, all of our patients undergo chest CT to exclude pulmonary metastasis. A routine examination list includes an abdominal ultrasound (US) or an abdominal CT scan with intravenous contrast. In patients with nonobstructing cancer, a rectal US is performed to stage the lesion. A phased-array MRI obtained by a colorectal-surgery-oriented radiologist is a vital part of the multidisciplinary approach to the treatment. MRI identification of mesorectal and LLN >5 mm with irregular borders, mixed magnetic resonance signal intensity, or both is considered as highly suspicious for tumor involvement. LLN location, number, and their relation to any neighboring anatomic structures should be clearly noted.

SURGICAL TECHNIQUE—OPEN LATERAL LYMPH NODE DISSECTION

Positioning

The patient is positioned in the modified Lloyd–Davies position. Safe positioning of the patient's bony prominent part is very important; padding of neurovascular bundles is performed to prevent damage. The surgeon is initially positioned on the left side of the patient, the first assistant is positioned on the right side, and the second assistant is positioned between the patient's legs. During surgery, the surgeon can change sides several times as needed. After induction of anesthesia, an additional digital rectal examination is performed to verify the tumor location, height, mobility, and the involvement of any other organs.

Laparotomy and Exposure

A laparotomy is performed through a lower midline incision; great care is taken not to damage the bladder, which is usually dissected and retracted to the left because the 2 cm above pubic bone is quite important to optimize adequate visualization of the lower pelvis. After the midline laparotomy and intra-abdominal inspection, a wound retracting system is installed. The surgeon retracts the small bowel, right colon, omentum, and proximal left colon under the blades of the retractor to open the sigmoid colon and its mesentery. The optimal view should include the duodenum as an upper border, aorta and vena cava on the right side with the white line of Toldt on the left side.

Open Para-aortic D3 Lymph Node Dissection

We perform routine para-aortic lymphadenectomy for T3/4 rectal, sigmoid, and left colon cancers with the suspicious lymph nodes on preoperative diagnosis. The vascular pedicle containing IMA and fat tissue around it is approached in a lateral-to-medial direction. The sigmoid colon is lifted up and the avascular space behind it is entered. Applying traction and countertraction the posterior surface of the sigmoid mesocolon is released gently from the underlying Toldt's and prerenal fascia, left ureter, gonadal vessels, and hypogastric plexus and nerve. The root of the IMA is reached from behind and peritoneum incision is made medial to the root of the IMA to connect the planes. The surgeon inserts the left index finger through the medial peritoneal incision and lifts up the IMA root with a hook, thus protecting underlying preaortic nerve plexus and other vital structures from injury while dissecting at the IMA root. The medial peritoneal incision is extended up to the duodenum and curved to follow the duodenum lower border. The latter is gently retracted cranially and carefully dissected. Next, the preaortic fascia is opened and fat tissue surrounding the IMA root is cleared off between the left and right splanchnic lumbar nerves leaving the latter intact. It is preferable to use Harmonic scalpel (Ethicon Endo-Surgery, Inc., Cincinnati, OH) to reduce nerve damage at this step. The preaortic fat and the fat around the root of IMA that contains apical lymph nodes is cleared off the aorta and the IMA surface and dissected downward. Using scissors or Harmonic scalpel the IMA is freed circumferentially from the paravasal fat all way down to the origin of the LCA, sigmoid arteries (SAs), and superior rectal arteries (Fig. 41-1). The mobilized preaortic and paravasal fat is posteriorly retracted. This method of vessel “skeletizing” enables performing extended para-aortic lymph node dissection together with precise isolation and separate dissection of IMA branches without excessive colon resection. To perform D3 lymph node dissection in upward direction, the space between the IMA and LCA should be cleared out and the fat with apical lymph nodes removed. The IMA can be divided either at the root or below the LCA depending on the length of the sigmoid colon and the possibility of using it for colorectal anastomosis. The inferior mesenteric vein is divided at the same level as IMA. Any type of vessel ligation technique can be used, including advanced bipolar device or an ultrasonic scalpel with advanced hemostasis technology.

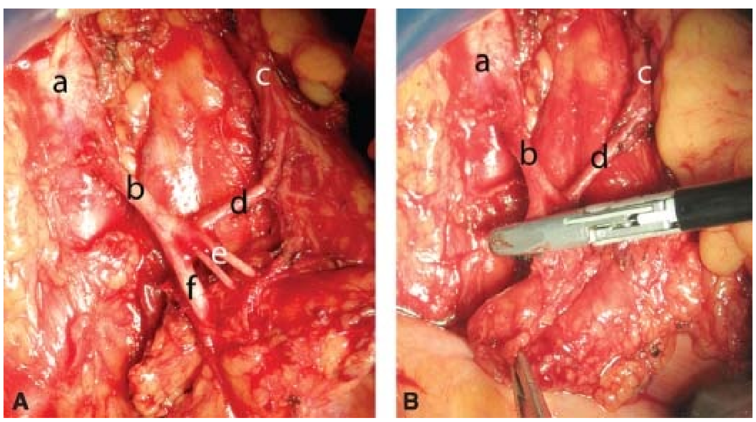


FIGURE 41-1 Para-aortic lymph node dissection. A. Skeletonized IMA; B. Division of IMA. a, aorta; b, IMA; c, IMV; d, LCA; e, sigmoid arteries; f, superior rectal artery. IMA, inferior mesenteric artery; inferior mesenteric vein; LCA, left colic artery.

Further mobilization of the sigmoid colon, colon division, and rectal mobilization fully correspond to the principles of nerve-sparing TME described in several other chapters.

Open D3 Lateral Lymph Node Dissection

LLD can be performed either en bloc with the mesorectum if there is direct tumor invasion outside mesorectal fascia or as a separate maneuver after the rectum has been removed. The concept of LLD is removing of fatty and connective tissue outside the PP, around the internal iliac and common iliac vessels, and in the obturator cavity. The results of nerve-preserving LLD are the skeletonized iliac vessels and their branches, and preservation of obturator nerve (ON) and pelvic autonomic nerves (ON and PP).

The lateral pelvic area is classified into four regions: common iliac (N2 lymph nodes), internal iliac (N2 lymph nodes—"second" space), obturator (N3 lymph nodes—third space), and external iliac, according to the Japanese classification. The common iliac lymph nodes are rarely dissected because the frequency of metastasis in this area is low. Before the start of LLD, the ureter and gonadal vessels from the corresponding side of the pelvis are medially retracted and fixed with vessel loop to achieve good exposure. The following structures are the anatomic landmarks for LLD:

Lateral border—external iliac artery

Medial border—PP

Cranial border—bifurcation of common iliac artery

Caudal border—levator ani muscles and Alcock (pudendal) canal

Dorsal border— sciatic nerve

Three ways to enter and clear the obturator (third) space can be used.

The first approach is medial-to-lateral along the internal iliac vessels. The second method is paravesical, and the third technique is the lateral-to-medial approach that was developed by our group. We feel that this approach allows better visualization and manipulation in the obturator space. The surgeon stands on the side opposite to that of the dissection. The paravesical space is entered and the peritoneal dissection is extended to the external iliac vessels. The peritoneum across the external iliac artery is opened, the underlying vessels are freed (Fig. 41-2), and gently retracted medially with a vessel loop. Medial retraction of the iliac vessels helps access the caudal part of the obturator fossa, which is reached with difficulty by a conventional approach. The fat tissue is removed from the middle part of the obturator fossa between the external iliac vessels medially and psoas muscle laterally (Fig. 41-3). The external iliac vessels are pulled back to the lateral side of the obturator fossa and the fat removal is completed.

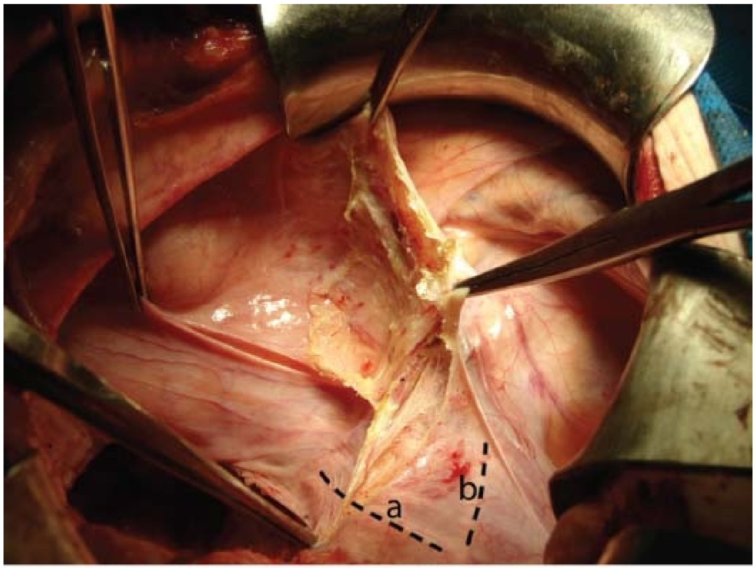


FIGURE 41-2 Right-side lateral lymph node dissection (LLD) with external iliac artery retracted medially. Peritoneal incision along external iliac artery. a, right ureter; b, right external iliac artery.

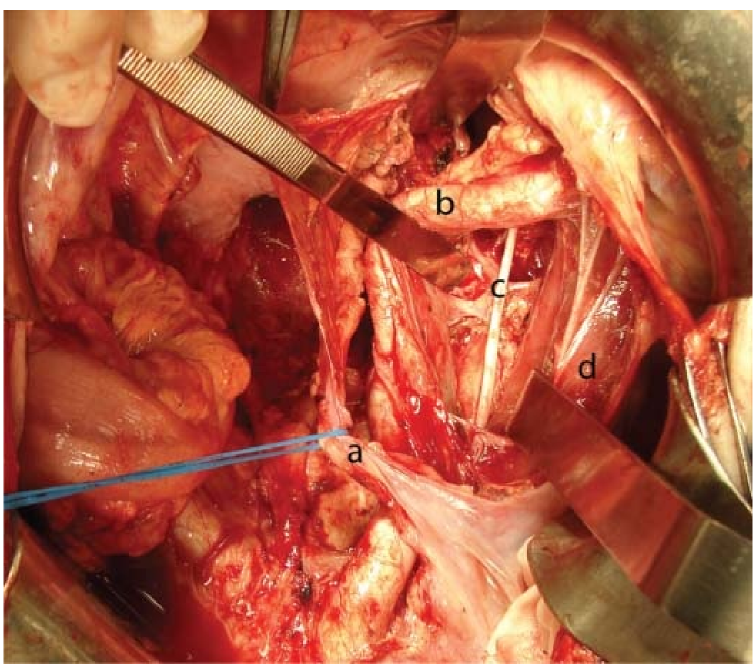


FIGURE 41-3 Right-side lateral lymph node dissection (LLD) with external iliac artery retracted

medially. Further developing of the obturator space. a, right ureter; b, right external iliac artery; c, branch of right femoral nerve; d, fat in right obturator space.

After the obturator fossa (third space) is cleared out, lymph nodes from the second space are removed. To perform this maneuver, the HN and PP are gently drawn medially and fat tissue attached to their lateral border is peeled away down to the level of the PP and sacral nerves. The complex of the visceral internal iliac branches forms the lateral border of the second space. In case of advanced disease, some of the vascular or nervous structures can be removed en bloc with the dissected fat tissue. In routine cases, a nerve-sparing LLD is performed (Fig. 41-4). Great care is taken to preserve major nerves branches.

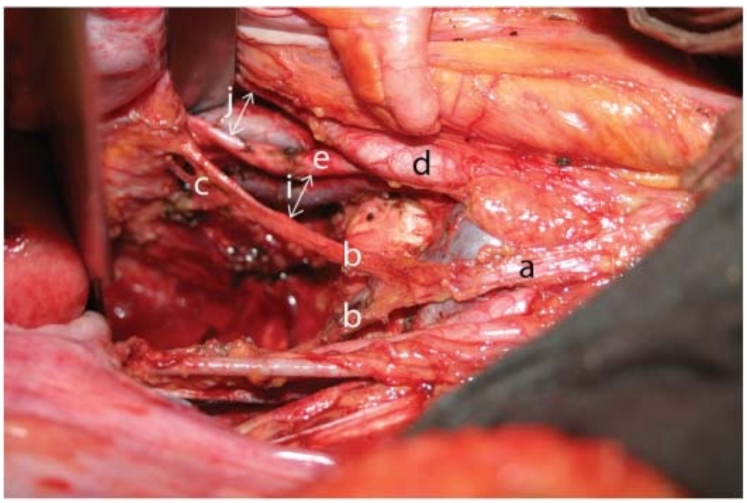


FIGURE 41-4 Nerve-sparing right-side LLD. a, hypogastric plexus; b, hypogastric nerves; c, right pelvic plexus; d, right common iliac artery; e, right internal iliac artery; i, second space (between pelvic plexus and internal iliac artery); j, third space (between internal and external iliac arteries). LLD, lateral lymph node dissection.

SURGICAL TECHNIQUE—LAPAROSCOPIC LATERAL LYMPH NODE DISSECTION

Positioning, Port Placement, and Exposure

The patient is placed in modified lithotomy position with the table in deep Trendelenburg (20–25 degrees), with the surgeon standing opposite to the LLD and the side slightly turned down. The surgeon and camera are located on the side opposite to the LLD. The camera port is located near the umbilicus. The first working 12-mm troacar is located in the right iliac region 2–3 cm medial to the iliac spine. Another working 5-mm troacar is placed between the umbilicus and the first working troacar but above the line connecting them, so that it is almost at the level of the umbilicus but to the right. At the right side of the patient, the same positions are used to place the third and fourth 5-mm working ports. In patients with high body mass index, an additional suprapubic 5-mm troacar can be helpful.

Laparoscopic D3 Para-aortic Lymph Node Dissection

The laparoscopic technique almost fully repeats the open procedure except that the medial-to-lateral approach is utilized. The root of the IMA is approached from the medial side, and as in the open technique all the fat tissue around the IMA trunk is cleared and the IMA branches are skeletonized before vessel division.

Laparoscopic D3 Lateral Lymph Node Dissection

Analogous to the open approach, it is easier to perform LLD after the rectum has been already removed from the pelvis. However, the rectum can be kept in the abdominal cavity until the LLD has been completed to allow subsequent synchronous removal of all of the specimens through a Pfannenstiel or perineal incision.

It is essential to identify external and internal iliac vessels before dissection. The fat and lymphatic tissue from the obturator fossa (third space) is dissected followed by the mobilization of tissue between internal iliac vessels and PP (second space). The peritoneum is incised lateral to the ureter following the line between external and internal iliac vessels downward to the internal iliac ring and the ureter is medially retracted. The seminal duct in men and the round ligament of uterus in women are preserved and caudally retracted. The medial border of the external iliac artery is visualized, and the assistant gently pushes it laterally with a soft grasper creating countertraction. Meanwhile, the surgeon gently grasps the fat and lymphatic tissue below the external iliac vessels, and retracts it gently downward to facilitate dissection from the external iliac artery and vein. The fat and lymphatic tissue is dissected further downward, while the assistant gently retracts the external iliac vein. The lateral border of the obturator fossa is formed by the internal obturator muscle right beneath external iliac vein. The fat and lymphatic tissue is further peeled away from the internal obturator muscle, while the assistant continues to gently laterally reflect the external iliac vessels (Fig. 41-5).

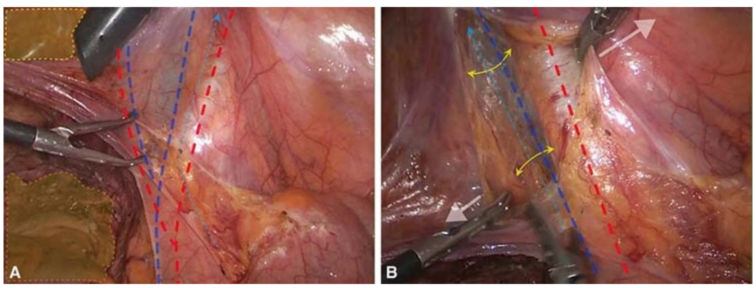


FIGURE 41-5 Right-side laparoscopic LLD. Peritoneum incision. A. Red dotted line—projection of right common iliac artery bifurcation, blue dotted line—projection of common iliac vein bifurcation; light blue dotted arrow—projection of peritoneum incision. B. Red dotted line—external iliac artery, blue dotted line—external iliac vein, light blue dotted arrow—dissection line, white arrow—the direction of assistant countertraction. LLD, lateral lymph node dissection.

The fat and lymphatic tissue is gently peeled away from the bifurcation of the common iliac vessels and right there the ON can be visualized. The nerve crosses the obturator fossa toward the obturator canal, and while removing the fat and lymphatic tissue from the obturator fossa it should be preserved. When the ON is fully released, it is gently moved laterally (Fig. 41-6), after which the fat and lymphatic tissue of the obturator fossa is dissected from the bottom, where the thin obturator artery and vein and also the anterior branches of internal iliac vessels can be found (Fig. 41-7A). Careful dissection can spare these structures. In case of injury, it is usually relatively easy to ligate them with an ultrasonic device to avoid major bleeding. Sometimes posterior branches of internal iliac vessels (especially gluteal veins) can be found, which are usually more difficult to control bleeding. If they are divided, they tend to retract beneath the parietal fascia. The fat tissue is dissected in medial and in caudal direction toward the Alcock's canal, through which the pudendal vessels and nerve leave the pelvic cavity. Finally, the block of fat tissue is dissected from the lateral bladder wall (Fig. 41-7B), taken out from the obturator fossa, and kept in a plastic bag in the pelvic or abdominal cavity until the whole specimen is removed. The obturator fossa (third space) LLD dissection is complete (Fig. 41-8A). To remove the fat and lymphatic tissue from the second space, the ureter is moved laterally and the dissection is continued along the medial border of the IIA. The right ON and right PP are moved medially and the fat tissue between IIA and ON and PP is dissected and taken out (Fig. 41-8B). Both specimens are taken out together with the resected rectum specimen through Pfannenstiel incision.

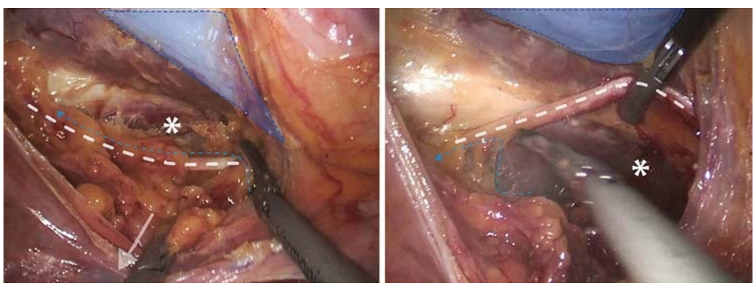


FIGURE 41-6 Obturator nerve dissection. White dotted line—obturator nerve, blue shade—external iliac vein, light blue dotted line—plane of dissection, white asterisk—internal obturator muscle; white arrow—the direction of traction.

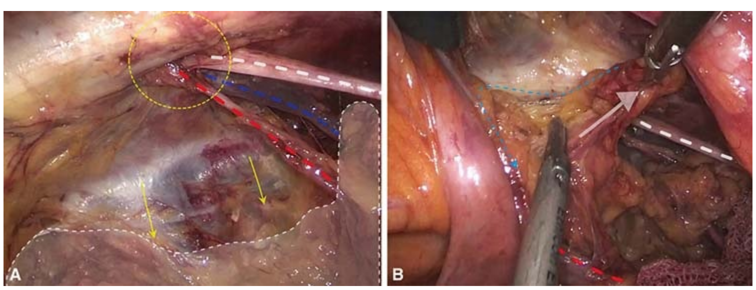


FIGURE 41-7 Dissection in the caudal part of obturator fossa. A. White dotted line—obturator nerve; blue dotted line—obturator vein; red dotted line—obturator artery; yellow dotted circle—obturator canal; white shade—mobilized fat tissue of obturator fossa. B. White dotted line—obturator nerve; red dotted line—superior vesical artery; light blue dotted line—dissection line; white arrow—the direction of traction.

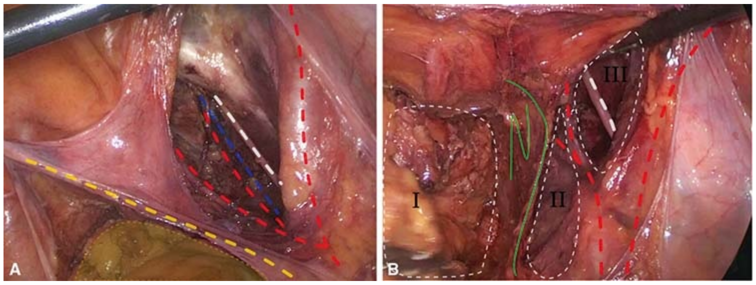


FIGURE 41-8 The final view after right-side LLD is complete. A. White dotted line—obturator nerve; blue dotted line—obturator vein; red dotted line—bifurcation of common iliac artery into external and internal iliac arteries, the latter gives rise to obturator artery; yellow dotted line—left ureter. B. I, the space after mesorectum removal; II, second space cleared out; III, third space cleared out; red dotted lines—external and internal iliac arteries; white dotted line—obturator nerve, green line—hypogastric nerve and pelvic plexus. LLD, lateral lymph node dissection.

LLD is a time-consuming procedure, which requires 20–30 minutes for each side even when performed by a high-volume rectal cancer surgeon. It can require several hours in complex cases or when undertaken by a low-volume colorectal surgeon in the beginning of the learning curve. If required, a contralateral LLD is performed in the same manner as a mirrored technique, resulting in bilateral lymph node dissection.

After LLD is complete, a Blake drain is placed in the obturator fossa on each side and fixed to the skin of the corresponding iliac region of the abdominal wall. A pelvic drain is also placed after the colorectal anastomosis is performed. We routinely perform stapled colorectal anastomosis with a diverting loop colostomy.

POSTOPERATIVE MANAGEMENT

Extensive dissection of lymphatic tissue and the cavity within the pelvis often leads to lymphorrhea of up to 500 ml/day from each side of the LLD, but the amount gradually reduces usually within 2 weeks. It is essential to control and maintain adequate drainage from obturator spaces, to monitor vital signs and blood counts, perform pelvic US or CT scan if needed to detect fluid collections in the pelvis and to try to prevent infectious complications and lymphoceles. Maintaining a high-protein diet as well as peanut oil consumption may make the exudate more viscous and help diminish lymphorrhea. In rare cases, a lymphocele demands percutaneous or transvaginal US-guided drainage. Drains from LLD areas are discharged once the output is <100 ml/day. An additional control US study is performed after the drains are removed.

The control of urinary function is another important part of postoperative management. In case of increased postvoiding residual urine volume (more than 200 ml) or patient inability to void spontaneously after bladder catheter is removed, pharmacologic or electrostimulating therapy is attempted to restore bladder function. If these measures fail to rectify the problem, trocar epicystotomy is performed.

COMPLICATIONS

Efforts to improve survival by utilizing more radical lymphatic excision have been accompanied by increased morbidity. Early reports of LLD indicated that additional pelvic dissection demanded longer operative time, caused additional blood loss and pelvic nervous system injury. But further refinement of pelvic dissection based on anatomic clarification and the development of nerve-preserving techniques helped significantly reduce genitourinary complications of LLD.

The results of the first detailed meticulous nerve-sparing LLD were presented by Moriya *et al.* who described three types of nerve-preserving surgery: total autonomic nerve preservation, preservation of pelvic nerves, and partial pelvic nerve preservation. Improving skills in nerve-sparing LLD not only helped in maintaining urination in 84% of patients but also reduced operative time to 334 minutes and blood loss to 935 ml. Further investigation led to a new national concept of nerve-preserving rectal cancer surgery in Japan. Pelvic autonomic nerve preservation is classified into four types based on the works of Hojo et al., Moriya et al., Sugihara et al., and Takahashi *et al.* complete preservation of autonomic nerves, preservation of autonomic nerves on one side, resection of hypogastric plexus, and resection of hypogastric plexus with unilateral PP preservation. As demonstrated by Morita et al., the extent of genitourinary dysfunction is directly related to the volume of nerve system preservation. Both total and unilateral preservation of the pelvic nervous system maintains urinary function, whereas subtotal pelvic nerve resection inevitably leads to functional impairment. Sexual function is preserved in 80% of patients with total or unilateral nerve-sparing surgery, whereas resection of the hypogastric plexus results in erectile dysfunction in 45% and most patients with subtotal nervous system resection never regain sexual function.

Recent data from multicenter experience of nerve-preserving LLD in Japan demonstrate that although TME + LLD takes longer operating time and leads to higher blood loss than TME alone, still the rate of postoperative complications is the same and long-term urinary and sexual function is not impaired by the extensive lymph node dissection.

RESULTS

The Western experience with aortopelvic lymph node dissection began in the late 1940s and early 1950s, when initial works of Gilchrist and David, Waugh and Kirklin, and Pfeifer and Miller revealed that lymph node involvement in patients with rectal cancer below the peritoneal reflection was a significant predictor of poorer survival. The first results of extended abdominoperineal resection with regional lymphatic removal were published by Deddish, Sauer, and Bacon, Bacon et al., and Sterns and Deddish. Although these works lack detailed depiction of the extent of LLD, they are likely to have been limited to internal iliac lymph node removal. These papers reported the incidence of LLN metastasis of 16–30% and a slight survival improvement in patients who underwent extensive surgery. The difference in 5-year survival was more evident in the subgroups of patients with Dukes' C lower rectal cancer (40% and 23% for extended and standard surgery, respectively). Still the authors emphasized high morbidity rates following extensive surgery including intraoperative hemorrhage, bladder dysfunction, and prolonged hospitalization, thus making the benefit of LLD questionable.

On the basis of these reports, Western surgeons abandoned further research of extensive LLD, until the published results from the Memorial Sloan-Kettering Cancer Center demonstrated a significant survival advantage for patients with Dukes' C rectal cancer who underwent en bloc LLD as compared to standard resections. Still no influence on local control was achieved in this series. The authors performed limited pelvic lymphadenectomy (removing only the internal iliac nodes, no obturator space clearance, and no nerve-preserving techniques) in 192 out of 412 patients with rectal cancer and demonstrated 5-year survival rates of 63.8% and 54.3% for extended and standard operations, respectively. Among numerous factors involved in regression analysis, pelvic lymphadenectomy and distance from the anal verge demonstrated the strongest association with survival. The disappointing experience of iliac lymph node dissection for rectal cancer in St. Mark's Hospital showed no improvement in crude 5-year survival and even worse survival in patients after extended surgery for Dukes' C rectal cancer compared to standard operation. Another American paper from the University of Chicago revealed the benefit of LLD in decreasing LLR from 16.4% to 9.4%, although it was not statistically significant, and no influence on survival was reported.

Meanwhile, the extensive Japanese experience with LLD was more promising. The technique of meticulous lymph node dissection in three "spaces" (perirectal fat, tissue along PP and obturator fossa fat) was established and (perirectal fat, tissue along PP and obturator fossa fat) was established and practiced long before the first Japanese reports appeared in English language literature. The National Cancer Center Hospital presented the results of LLD in 423 patients operated on from 1969 to 1980. The incidence of LLN metastasis in lower advanced rectal cancer group was 23% and these patients had the worst survival rate (16 of 17 patients died within 5 years of follow-up). A subsequent report from the same institution suggested that extended LLD was superior to standard LLD in terms of both 5-year disease-free survival (75.8% and 67.4%, respectively) and LLR (12% and 17%, respectively).

The initial large studies that addressed the effectiveness of LLD in the Japanese population demonstrated evident correlation—the more distal the tumor, the higher the risk of LLN involvement; specifically, rates were 0.6–10.5% for tumors located above 6 cm from the dentate line and 29.6–42.0% for those lesions at the level of dentate line. The study by Takahashi *et al.* also suggested that LLD may be of extreme benefit for patients with isolated lateral node metastases without affected mesorectal lymph nodes who demonstrate 5-year overall survival of 75% compared to 32% in patients with positive both lateral and mesorectal lymph nodes.

The question still remains whether prophylactic LLD performed when there is no clinical lateral node metastasis can prevent local recurrence and/or improve survival. The only large multicenter randomized controlled trial that comes from Japan demonstrates that even without preoperative RT LLD can reduce the LLR but with a marginal effect on survival. This study included the patients with stage II–III rectal cancer below peritoneal reflection and the LLR was 13% for TME alone and 7% for TME + LLD. The Dutch TME trial demonstrated almost the same results: LLR for short-course RT and TME was 6% and 12% for TME alone. These results indicated that LLD can be almost as effective as preoperative radiation in preventing local relapse. However, the survival rate in the Japanese population was remarkably higher (92.6% for TME + LLD and 90.2% for TME alone) than in the Dutch population (64.2% for RT + TME and 63.5% for TME alone). Although the incidence of local recurrence is comparable between studies, in the Dutch trial the most frequent recurrence site was the central pelvis and in the Japanese study—the lateral pelvis. This suggests that the incidence of lateral pelvic lymph node metastasis might be different between East and West populations. Thus, at present there is no definitive conclusion about the effectiveness of LLD compared to preoperative CRT for patients with low-risk low rectal cancer.

Preoperative CRT is indicated for low rectal cancer in many national guidelines. Preoperative CRT does not fully eradicate LLN metastasis in patients with clinically suspicious LLNs because 30–40% of these patients still have pathologically proven LLN invasion after LLD. In these circumstances, LLD should be considered if there are suspicious LLN before and especially after CRT, because this procedure can macroscopically eradicate LLN metastasis and reduce local recurrence. The early small retrospective series from the University of Tokyo Hospital and Komagome Hospital demonstrated that there was no significant difference between the patients who had CRT + TME and those who significant difference between the patients who had CRT + TME and those who had TME+LLD. This finding suggests that LLD can be an alternative to CRT for patients with low rectal cancer without LLN involvement.

Another question is whether LLN involvement represents stage IV disease or advanced locoregional disease. In a retrospective analysis of more than 10,000 Japanese patients with low rectal cancer, it was demonstrated that the prognosis of patients with LLN metastases who underwent LLD (thus LLN metastases were surgically removed) was comparable to patients who had only mesorectal lymph node metastases and was even better than in patients who had stage IV disease. The united report from two major oncologic centers in Japan showed that for T3/4 low rectal cancer with pathologically proven LLN metastases LLD allows to achieve 45–53% overall survival, which demonstrates that LLN involvement is considered to be advanced locoregional disease instead of metastatic disease, which can only be cured by extensive LLD.

The possibilities of modern diagnostic tools made it possible to reveal enlarged and suspicious LLN before start of treatment. It opened the opportunity to better select patients for extensive treatment—either CRT or LLD or both. The recent report from the University of Tokyo Hospital suggests that a cut-off value of 8 mm on CT or MRI performed before CRT can be effectively used to choose the patients for selective LLD. In this group, the patients who had preoperative CRT and LLD for suspicious LLNs (larger than 8 mm) had 0% of LLR and overall survival comparable to patients who did not have enlarged LLNs and thus did not undergo LLD after CRT.

Our experience with LLD suggests that it requires an additional profound knowledge of lower pelvis anatomy with skills in extended dissection. The procedure has an obvious learning curve, and is clearly considered a complex pelvic surgery case. An additional problem is dissection in the deep fatty pelvis often encountered in the Caucasian population, which is associated with an increased operative time and blood loss. Our approach of LLD with medial retraction of external iliac vessels provides beneficial visualization of LLN, thus decreasing risk of trauma to the surrounding structures with an increased superior LLD. Nerve-sparing LLD in patients with no direct tumor invasion is a valuable and important surgical approach that provides superior functional results and quality of life. Our experience showed that LLD is associated with 20% increase in 3-year overall survival and an 8% increase in 5-year overall survival without a decrease in distant metastasis. However, a more selective approach and combination of CRT and LLD should be tested not only in Eastern but also in Western populations to demonstrate the exact place of this surgical technology.

CONCLUSIONS

LLN dissection for rectal carcinoma is a technically demanding and controversial surgical procedure. However, it is also a feasible and safe tool, which should be included in the skills set of a rectal cancer surgeon. Our experience has shown that it might give some benefits in terms of local recurrence and survival to patients, although at the cost of increased operative time, blood loss, and overall morbidity.

RECOMMENDED REFERENCES AND READINGS

Akiyoshi T, Matsueda K, Hiratsuka M, *et al.* Indications for lateral pelvic lymph node dissection based on magnetic resonance imaging before and after preoperative chemoradiotherapy in patients with advanced Low-Rectal Cancer. *Ann Surg Oncol* 2015;22(Suppl 3):614–20.

Akiyoshi T, Watanabe T, Miyata S, Kotake K, Muto T; Sugihara K; Japanese Society for Cancer of the Colon and Rectum. Results of a Japanese nationwide multi-institutional study on lateral pelvic lymph node metastasis in low rectal cancer: is it regional or distant disease? *Ann Surg* 2012;255:1129–34.

Bacon HE, Dirbas F, Myers TB, Ponce De Leon F. Extensive lymphad enectomy and high ligation of the inferior mesenteric artery for carcinoma of the left colon and rectum. *Dis Colon Rectum* 1958;1:457–64; discussion 64–5.

Blair JB, Holyoke EA, Best RR. A note on the lymphatics of the middle and lower rectum and anus. *Anat Rec* 1950;108:635–44.

Boyle KM, Sagar PM, Chalmers AG, Sebag-Montefiore D, Cairns A, Eardley I. Surgery for locally recurrent rectal cancer. *Dis Colon Rectum* 2005;48:929–37.

Colquhoun P, Wexner SD, Cohen A. Adjuvant therapy is valuable in the treatment of rectal cancer despite total mesorectal excision. *J Surg Oncol* 2003;83:133–9.

Deddish MR. Abdominopelvic lymphnode dissection in cancer of the rectum and distal colon. *Cancer* 1951;4:1364–6.

Enker WE, Pilipshen SJ, Heilweil ML, *et al.* En bloc pelvic lymphadenectomy and sphincter preservation in the surgical management of rectal cancer. *Ann Surg* 1986;203:426–33.

Fujita S, Akasu T, Mizusawa J, *et al.* Postoperative morbidity and mortality after mesorectal excision with and without LLN dissection for clinical stage II or stage III lower rectal cancer (JCOG0212): results from a multicentre, randomised controlled, noninferiority trial. *Lancet Oncol* 2012;13:616–21.

Fujita S, Mizusawa J, Kanemitsu Y, *et al.* Mesorectal excision with or without lateral lymph node dissection for clinical stage II/III lower rectal cancer (JCOG0212): amulticenter, randomized controlled, noninferiority trial. *Ann Surg* 2017;266:201–7.

Gerota D. Die lymphgefasse des rectums und des anus. *Arch Anat Physiolog* 1895:240.

Gilchrist D, David D. Prognosis of carcinoma of the bowel. *Surg Gynecol Obstet* 1948;86:359–71.

Glass RE, Ritchie JK, Thompson HR, Mann CV. The results of surgical treatment of cancer of the rectum by radical resection and extended abdomino-iliac lymphadenectomy. *Br J Surg* 1985;72:599–601.

Heriot AG, Byrne CM, Lee P, *et al.* Extended radical resection: the choice for locally recurrent rectal cancer. *Dis Colon Rectum* 2008;51:284–91.

Hojo K, Koyama Y, Moriya Y. Lymphatic spread and its prognostic value in patients with rectal cancer. *Am J Surg* 1982;144:350–4.

Hojo K, Vernava AMIII, Sugihara K, Katumata K. Preservation of urine voiding and sexual function after rectal cancer surgery. *Dis Colon Rectum* 1991;34:532–9.

Ishihara S, Kawai K, Tanaka T, *et al.* Oncological outcomes of lateral pelvic lymph node metastasis in rectal cancer treated with preoperative chemoradiotherapy. *Dis Colon Rectum* 2017;60:469–76.

Japanese Society for Cancer of the Colon. *Japanese Classification of Colorectal Carcinoma* 2nd ed. Tokyo:

Kanehara & Co., LTD, 2009:90.
Kanemitsu Y, Komori K, Shida D, *et al.* Potential impact of lateral lymph node dissection (LLND) for low rectal cancer on prognoses and local control: a comparison of 2 high-volume centers in Japan that employ different policies concerning LLND. *Surgery* 2017;162(2):303–14.

Kim TH, Jeong SY, Choi DH, *et al.* Lateral lymph node metastasis is a major cause of locoregional recurrence in rectal cancer treated with preoperative chemoradiotherapy and curative resection. *Ann Surg Oncol* 2008;15:729–37.
Kuru M. Cancer of the rectum [in Japanese]. *J Jpn Surg Soc* 1940;41:832–77.
Kusters M, Beets GL, van de Velde CJ, *et al.* A comparison between the treatment of low rectal cancer in Japan and the Netherlands, focusing on the patterns of local recurrence. *Ann Surg* 2009;249:229–35.
Kusters M, Slater A, Muirhead R, *et al.* What to do with lateral nodal disease in low locally advanced rectal cancer? A call for further reflection and research. *Dis Colon Rectum* 2017;60:577–85.
Kusters M, Wallner C, Lange MM, *et al.* Origin of presacral local recurrence after rectal cancer treatment. *Br J Surg* 2010;97:1582–7.
Michelassi F, Block GE, Vannucci L, Montag A, Chappell R. A 5-to 21-year follow-up and analysis of 250 patients with rectal adenocarcinoma. *Ann Surg* 1988;208:379–89.
Mori T, Takahashi K, Yasuno M. Radical resection with autonomic nerve preservation and lymph node dissection techniques in lower rectal cancer surgery and its results: the impact of lateral lymph node dissection. *Langenbecks Arch Surg* 1998;383:409–15.
Morita T, Murata A, Koyama M, Totsuka E, Sasaki M. Current status of autonomic nerve-preserving surgery for mid and lower rectal cancers: Japanese experience with lateral node dissection. *Dis Colon Rectum* 2003;46(Suppl 10):78–87; discussion S-8.
Moriya Y, Hojo K, Sawada T, Koyama Y. Significance of lateral node dissection for advanced rectal carcinoma at or below the peritoneal reflection. *Dis Colon Rectum* 1989;32:307–15.
Moriya Y, Sugihara K, Akasu T, Fujita S. Nerve-sparing surgery with lateral node dissection for advanced lower rectal cancer. *Eur J Cancer* 1995;31A:1229–32.
Nagawa H, Muto T, Sunouchi K, *et al.* Randomized, controlled trial of lateral node dissection vs. nerve-preserving resection in patients with rectal cancer after preoperative radiotherapy. *Dis Colon Rectum* 2001;44:1274–80.
Oh HK, Kang SB, Lee SM, *et al.* Neoadjuvant chemoradiotherapy affects the indications for lateral pelvic node dissection in mid/low rectal cancer with clinically suspected lateral node involvement: a multicenter retrospective cohort study. *Ann Surg Oncol* 2014;21:2280–7.
Peeters KC, Marijnen CA, Nagtegaal ID, *et al.* The TME trial after a median follow-up of 6 years: increased local control but no survival benefit in irradiated patients with resectable rectal carcinoma. *Ann Surg* 2007;246:693–701.
Pfeiffer DB, Miller DB. Cancer of the rectum; five and ten year follow-up study of cases of cancer below the peritoneal reflection. *Surg Gynecol Obstet* 1950;91:319–22.
Saito S, Fujita S, Mizusawa J, *et al.* Male sexual dysfunction after rectal cancer surgery: results of a randomized trial comparing mesorectal excision with and without lateral lymph node dissection for patients with lower rectal cancer: Japan Clinical Oncology Group Study JCOG0212. *Eur J Surg Oncol*

2016;42:1851–8.
Sauer I, Bacon HE. A new approach for excision of carcinoma of the lower portion of the rectum and anal canal. *Surg Gynecol Obstet* 1952;95:229–42.
Senba Y. An anatomical study of lymphatic system of the rectum [in Japanese]. *J Hukuoka Med Coil* 1927;20:1213–68.
Stearns MW Jr, Deddish MR. Five-year results of abdominopelvic lymph node dissection for carcinoma of the rectum. *Dis Colon Rectum* 1959;2:169–72.
Sugihara K, Kobayashi H, Kato T, *et al.* Indication and benefit of pelvic sidewall dissection for rectal cancer. *Dis Colon Rectum* 2006;49:1663–72.
Sugihara K, Moriya Y, Akasu T, Fujita S. Pelvic autonomic nerve preservation for patients with rectal carcinoma. Oncologic and functional outcome. *Cancer* 1996;78:1871–80.
Takahashi T, Ueno M, Azekura K, Ohta H. Lateral node dissection and total mesorectal excision for rectal cancer. *Dis Colon Rectum* 2000;43(Suppl 10):59–68.
Tsarkov P, Troitskiy A, Sekacheva M, Mudrov N. 3 and 5 year survival in patients with low rectal cancer after extended lateral lymphadenectomy vs total mesorectum excision. *Colorectal Dis* 2007;9(Suppl 3):1.
Ueno M, Oya M, Azekura K, Yamaguchi T, Muto T. Incidence and prognostic significance of lateral lymph node metastasis in patients with advanced low rectal cancer. *Br J Surg* 2005;92:756–63.
Villemin F, Huard P, Montagne M. Recherches anatomiques sur les lympatiques gu rectum et de l’anus. *Rev Chir* 1925;63:39–80.
Vorob’ev GI, Odariuk TS, Tsar’kov PV, Eropkin PV. Aortoiliopelvic lymphadenectomy in surgical treatment of rectal cancer [in Russian]. *Khirurgiia (Mosk)* 1998:4–8.
Watanabe T, Itabashi M, Shimada Y, *et al.* Japanese society for cancer of the colon and rectum (JSCCR) guidelines 2014 for treatment of colorectal cancer. *Int J Clin Oncol* 2015;20:207–39.
Watanabe T, Tsurita G, Muto T, *et al.* Extended lymphadenectomy and preoperative radiotherapy for lower rectal cancers. *Surgery* 2002;132:27–33.
Waugh JM, Kirklin JW. The importance of the level of the lesion in the prognosis and treatment of carcinoma of the rectum and low sigmoid colon. *Ann Surg* 1949;129:22–33.
Yasutomi M. Advances in rectal cancer surgery in Japan. *Dis Colon Rectum* 1997;40(Suppl 10):74–9.

Chapter 42

Ileal Conduit Construction After Exenteration (Bricker Conduit)

Yuxiang Wen and Scott R. Steele

INDICATIONS/CONTRAINDICATIONS

Each year approximately 40,000 new cases of rectal cancer are diagnosed in the United States, comprising nearly 30% of all colorectal malignancies. Locally advanced rectal cancer may often require an extensive pelvic operation. Despite the increase in sphincter-sparing operations, the abdominoperineal resection (APR) remains the operation of choice for many low-lying rectal cancers, certain recurrent rectal cancers, as salvage therapy for anal cancers, as well as advanced gynecologic and genitourinary malignancies. For tumors that involve adjacent organs requiring multivisceral resection, pelvic exenteration is performed to achieve negative margins in accordance with standard oncologic principles. With exenteration, en bloc resection of the bladder, urethra, and rectum is performed along with the prostate in men, and uterus, ovaries, fallopian tubes, and vagina in women—all to various degrees depending on the individual tumor extent. Although the procedure involves formation of a permanent colostomy for the gastrointestinal (GI) tract, restoration of the genitourinary system requires reconstruction of a new bladder. The ileal conduit is one type of non-continent urinary diversion procedure that was first described by Seiffert in 1935, and subsequently popularized since the 1950s by Bricker and Wallace. Although having certain nuances, it is a relatively straightforward and reproducible technique that has been the most commonly used urinary diversion method after pelvic exenteration for several years. This operation encompasses isolating a loop of distal ileum to create the neo-bladder, attaching the ureters, and restoration of the GI continuity through an ileal-ileal, ileocolic, or ileorectal anastomosis.

Contraindications to the use of an ileal conduit include chronic problems associated with the intestine to include small bowel Crohn’s disease and other inflammatory conditions. It is also contraindicated in patients with renal impairment secondary to long-term obstruction or chronic renal failure. For select patients who require urinary diversion, an alternative to ileal conduit includes an orthotopic bladder substitution.

PREOPERATIVE PLANNING

As with other major operations, a thorough overall assessment of the patient's cardiac, pulmonary, renal, and hepatic function is necessary before surgery. Depending on the risk stratification, appropriate referral for further testing and treatment should be performed. Several surgical risk calculators are available, such as the American College of Surgeon's National Surgery Quality Improvement Program Surgical Risk Calculator (http://riskcalculator.facs.org), and these are valuable to aid in estimating outcomes and in preoperative counseling.

The authors' and editors' preference is to use a complete mechanical bowel preparation with polyethylene glycol along with oral antibiotics (neomycin and erythromycin) to try to help reduce the incidence of postoperative ileus, wound infections, and digestive anastomotic dehiscence, as well as clearing the ileal conduit of stool. In addition, we invoke an enhanced recovery pathway for appropriate patients, although almost all patients are able to receive at least some portion. Although enhanced recovery protocols may include anywhere from 8 to 26 different components, almost all begin with detailed patient education on expectations and outcomes in the outpatient setting before pursuing optimal perioperative techniques, early enteral nutrition, and early mobilization. Initially described by Professor Henrik Kehlet in the setting of open abdominal surgery, the impact of this "fast track" protocol in the setting of a minimally invasive/laparoscopic approach has also demonstrated improved outcomes, even in patients undergoing ileal conduit procedures.

p. 415

---

p. 416

The stoma site(s) are marked by an enterostomal therapist before the operation, and stoma therapists play a critical role in education and management in stoma-related issues. Risks and benefits, as well as quality-of-life expectations of living and managing an ileal conduit should be explicitly explained to the patient.

TECHNICAL TIPS

After exenteration and clearance of margins, it is time for construction of the ileal conduit for urinary diversion.

Mobilization and preparation of ureters

First, it is important to recognize the most common place to identify the ureters—crossing the bifurcation of the common iliac vessels. Either a lateral or a medial approach may be used during this portion of the procedure to help identify the structures, and the sacral promontory serves as another landmark to help orientation. Obviously, this step should have been completed before any major vascular ligation or extensive dissection/division during the exenteration portion of the operation (Fig. 42-1). After identification of the course of the bilateral ureters, dissection of the ureters is performed distally with care. The blood supply to the ureter comes in from medially and laterally; therefore, during the mobilization, periureteral soft tissue should be kept with the ureter to preserve the blood supply. Preserving length is another crucial aspect of this step of the procedure, and transection of the ureters should be performed as close to the bladder as possible. We prefer to “tag” the ureters using sutures on the distal end to help identify and retract them at this stage. In addition, medium clips are placed at the distal end to avoid continual spillage of urine and to allow dilatation while the ileal conduit is harvested and prepared.

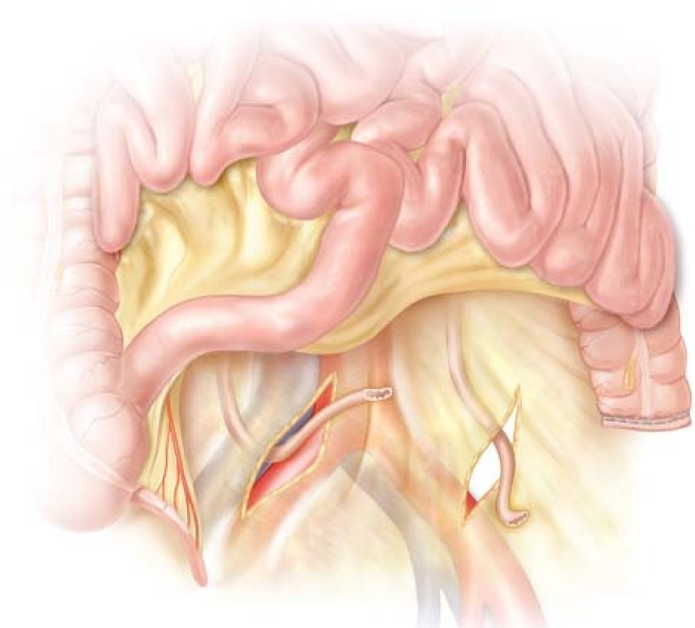


FIGURE 42-1 Isolation of the ureters. The left ureter generally requires a more proximally extended isolation.

Preparing the ileal segment for the conduit

Identification of the appropriate segment of the terminal ileum is the next step. If patients have had previous pelvic radiation or prior inflammation/stricture, it is imperative that a segment of unaffected ileum is selected. As stated earlier, Crohn's disease normally is a contraindication to the use of an ileal conduit. The length of the ileal segment should be adapted to the individual patient's body habitus, especially for obese patients where a longer segment is typically required to reach through a thick abdominal wall. To avoid metabolic disturbances related to mineral and fat-soluble vitamin absorption, at least 15 cm of terminal ileum should be preserved; therefore, an ileal segment of 12–18 cm in length, leaving an additional adjacent segment proximal to the ileocecal valve is chosen. Gentle traction and manipulation are necessary to avoid any tension or stretch on the conduit.

p. 416

---

p. 417

The mesentery to this section of bowel is trans-illuminated to identify an avascular plane for incision. The selected segment of mesentery is then carefully incised with the help of Kelly clamps and 3-0 ties, or harmonic devices. Care should be taken to avoid injury to any of the major feeding vessels to maintain adequate blood supply to the ileal conduit and surrounding bowel. The mesentery around the bowl with tagged sutures should be delicately dissected to allow placement of GIA stapler or clamps. The bowel is divided, and the distal end of the conduit (which will be exteriorized later) is tagged with a long suture to maintain orientation (Fig. 42-2A). Restoration of the GI continuity is completed by anastomosing the proximal and distal ends of ileum using either staplers or sutures in an end-to-end or (preferably) side-to-side manner (Fig. 42-2B). The senior author prefers to reinforce the staple line with interrupted 3-0 Vicryl sutures in a Lembert manner. The mesenteric window may be closed with running or interrupted dissolvable sutures. This is theoretically to prevent internal hernia development; however, it is important to avoid creating a smaller hole that could more readily induce strangulation or to ligate the blood supply to that segment of the bowel.

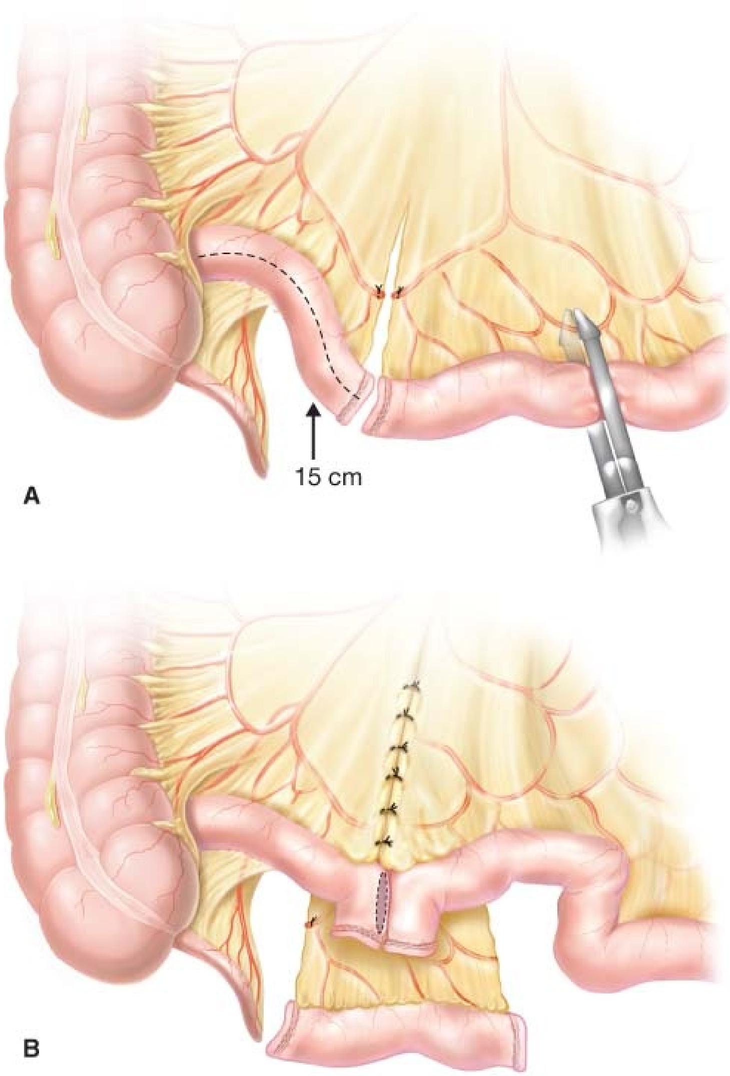


FIGURE 42-2 Illeal conduit harvest. A. An ileal segment 15 cm proximal to the ileocecal valve is isolated. B. It is then placed caudally to the anastomosis of the small bowel.

Ureteral anastomosis: The new ileal conduit is brought underneath the ileal-ileal anastomosis (Fig. 42-2B). Sterile towels are placed around the ileal conduit. Iodine-soaked sponges may be used to clean the bowel lumen of the conduit. At this point, the next step is either stoma formation or ileoureteral anastomosis. However, because ureteral stents are generally inserted to prevent strictures, we prefer to perform the anastomosis first so that the stent passage is easier. In isolated urologic cases, because there is only cystectomy without colon resection, creation of stoma first would provide more optimal localization and orientation for ileoureteral anastomosis as well as the passage of the left ureter through sigmoid mesentery. However, after pelvic exenteration for colorectal cancer, there is already excision of mesocolon and mesorectum and inferior mesenteric artery ligation. Therefore, there is no need for passage of the left ureter through the sigmoid mesentery, which makes this portion of the procedure easier.

Ileoureteral anastomosis—Bricker versus Wallace

Similar to other anastomoses, the major principles in performing a satisfactory ileal-ureteral anastomosis include preservation of adequate blood supply to distal ureters, avoidance of any tension on the anastomosis, and avoidance of any kinking or twisting of the ileal conduit or ureters. In general, the different techniques used to perform the ileoureteral anastomosis include the Lu Duc, Bricker, and Wallace. The anti-refluxing technique proposed by Lu Duc and colleagues is often used in patients with underlying decreased renal function, although not the sole indication. In addition, there is no solid evidence of whether or not it is effective in achieving this end. Furthermore, this technique precludes the use of loopogram study for assessment of upper genitourinary tract after conduit formation. Hence, the end-to-side Bricker technique and end-to-end Wallace technique remain the most common techniques.

The selection between Bricker versus Wallace depends, in part, on ureteral length and body habitus. When there is length disparity in the ureters, such as in obese patients, the Bricker technique is often preferred. In addition, there are some concerns regarding the use of the Bricker conduit in patients with bladder cancer because the potential for an increased risk of malignancy exists across the same epithelium, although this is a relative contraindication and controversial. Another consideration includes using a hand-sewn anastomosis in the Wallace conduit, which is felt to reduce formation of stones along the staple line. Despite these differences, the current literature has proved that both techniques are safe and reliable without significant difference in stricture rates.

Bricker anastomosis: In a Bricker anastomosis (Fig. 42-3), the proximal end of the ileal conduit is stapled. The ureter ends are spatulated and anastomosed separately to the conduit, with a refluxing technique along the anti-mesenteric side of the conduit. In the refluxing technique (Fig. 42-4), the ureter is brought directly through the bowel wall. This is more widely used than the anti-refluxing technique, in part due to lower stricture rates. In the anti-refluxing technique, the ureters are implanted through the bowel wall and introduced into the reservoir lumen, with the in-lumen length:transmural window ratio of ~5:1. When intraluminal pressure increases, the bowel wall acts like a valve and closes off the ureter. However, such an anti-refluxing technique is not supported with solid evidence.

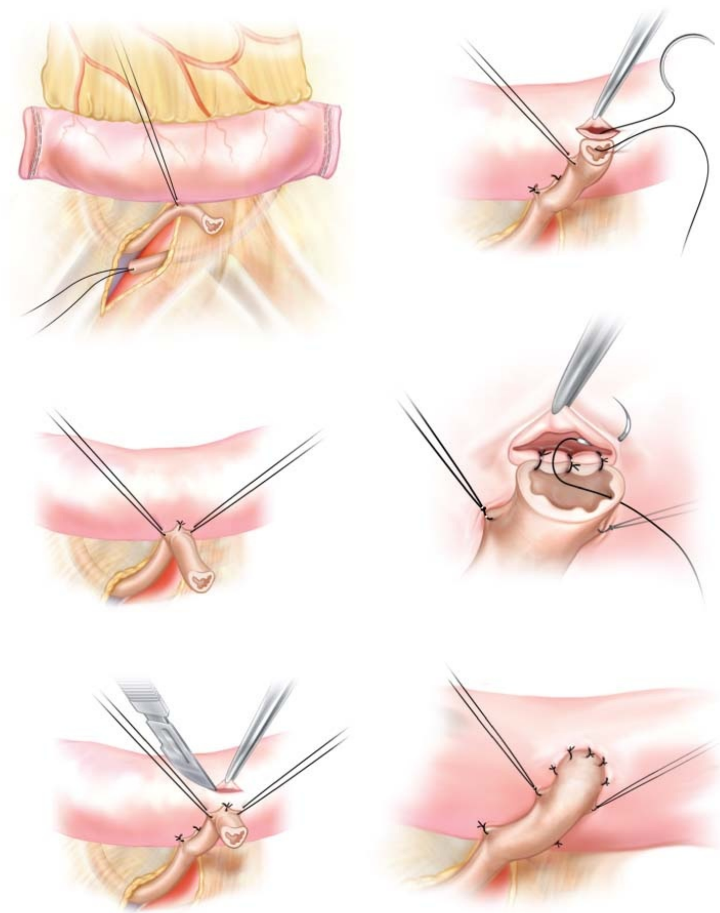


FIGURE 42-3 A Bricker anastomosis.

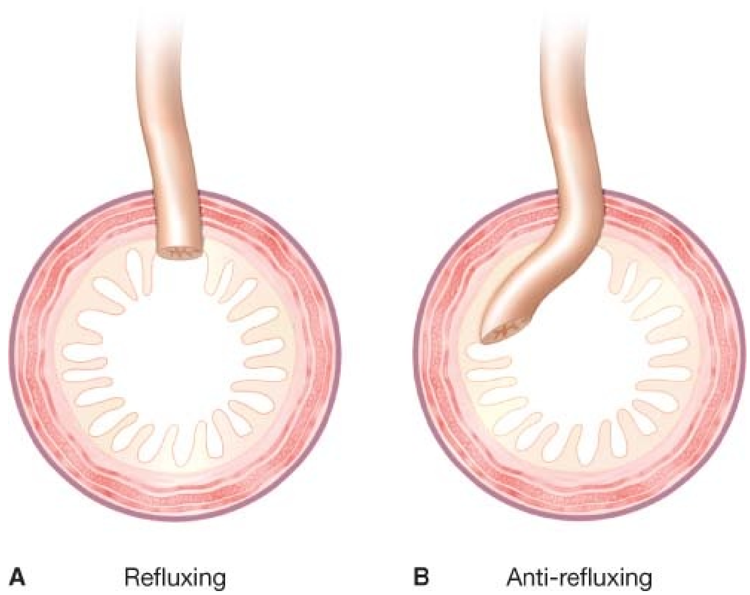
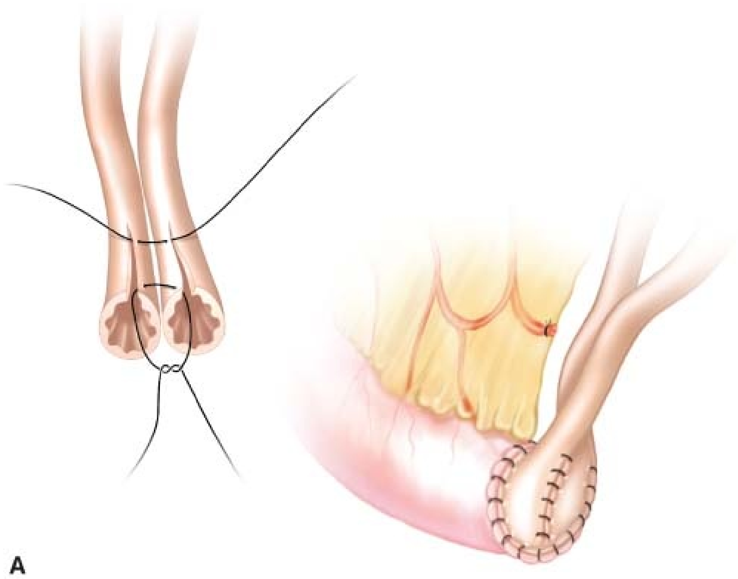
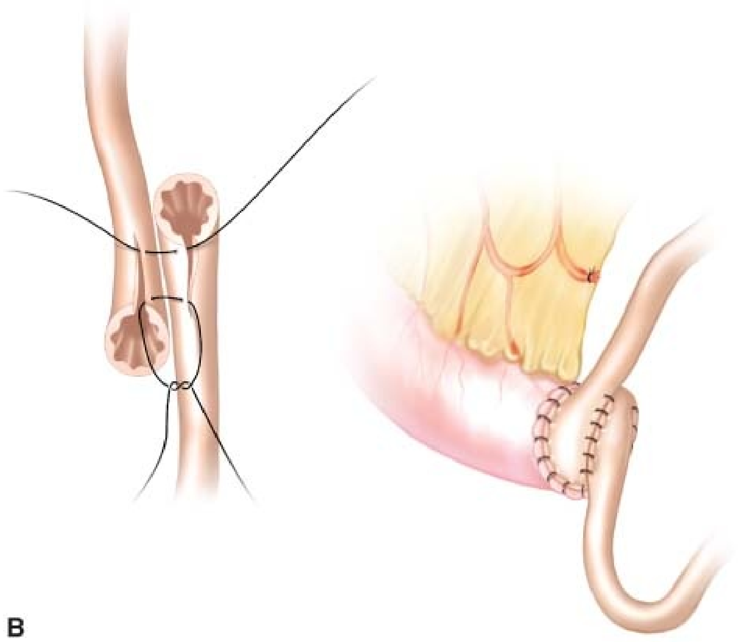


FIGURE 42-4 (A) Refluxing and (B) anti-refluxing technique.

Wallace anastomosis: There are two types of Wallace anastomosis (Fig. 42-5A and B). Wallace I involves a head-to-head anastomosis, whereas a Wallace II anastomosis is oriented head-to-tail. In the Wallace anastomosis, spatulating cuts are made in both ureters, and in such a way that the combined ureteral lumen is increased. In patients who have undergone pelvic radiation, where stricture might be of a concern, the Wallace anastomosis is preferred over the Bricker.



A



B

FIGURE 42-5 Wallace anastomosis. A. Wallace I B. Wallace II.

p. 418

p. 419

In addition, the ideal choice of location for either anastomosis on the ileal conduit should be as close to the mesentery as possible to maintain good blood supply (Fig. 42-6).

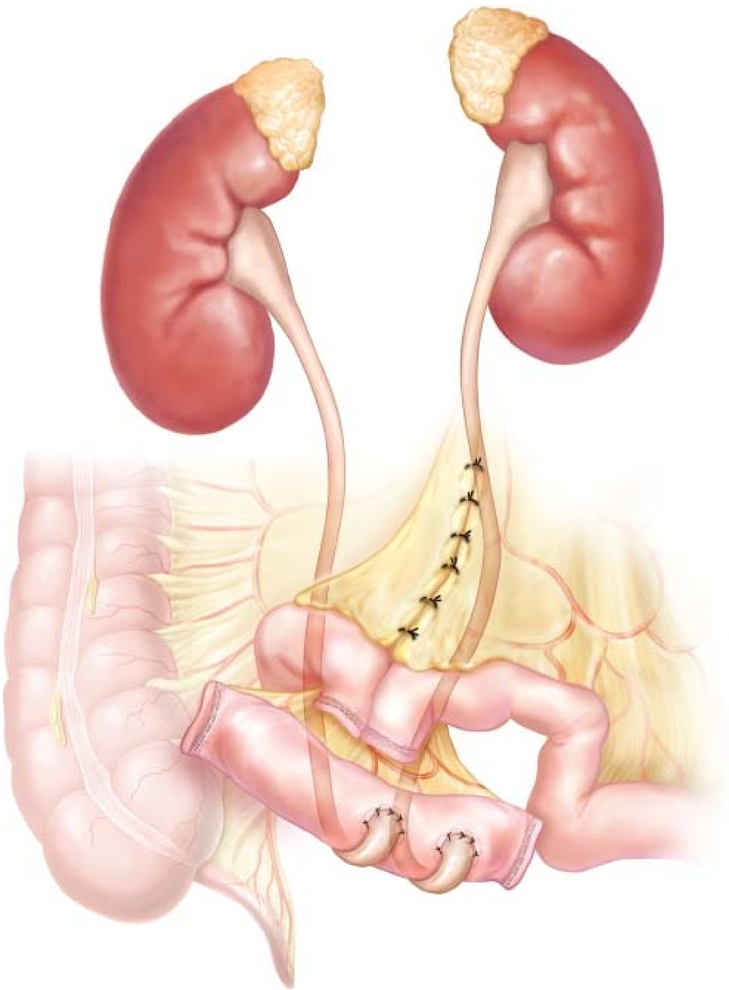


FIGURE 42-6 Completed anastomosis of the ureters to the limb of small intestine.

Ureteral stents of appropriately selected size are inserted and drawn through the distal end of the conduit to the skin. Fixation sutures can be secured to ileal mucosa and ureters. Finally, the integrity of the ileoureteral anastomosis is examined using saline solution, gently injecting into the distal end of the conduit. Any leakage should be repaired intraoperatively. Jackson-Pratt drains are placed adjacent to the ileoureteral anastomosis and maintained for the first few operative days.

Stoma formation and maturation

It is the authors' preference to ensure that patients undergoing this procedure are evaluated preoperatively by an enterostomal therapist. This allows not only for ideal skin marking for the stoma site but also an opportunity to become more educated about living with and caring for an ostomy. When constructing the actual stoma, a 3-cm-diameter skin incision is made at the previously marked stoma site. We prefer to excise the subcutaneous tissue to the level of the anterior rectus fascia. Following a cruciate incision, blunt dissection through the rectus muscle is carried down all the way to the posterior fascia, which is then opened. It is important to ensure there is enough tunnel space for the passage of ileal conduit without causing any ischemia and further stenosis or retraction. This must be balanced with avoiding too large a trephine that might lead to stoma prolapse and/or parastomal hernia development. The distal portion of the ileal conduit is brought through the window of the abdominal wall and pulled to the skin until the end is 2–3 cm above the skin surface (Fig. 42-7). The ileal end is secured to the rectus fascia with 3-0 Vicryl sutures at 3, 6, 9, and 12 o'clock positions. The stoma is matured in a standard "Brooke" manner using absorbable sutures through the mucosal edge of the bowel, the bowel serosa adjacent to the skin, and subcutaneous tissue at the skin edge (Fig. 42-8). In this manner, the stoma is everted. Ureteral stents are secured with a suture to the protruding edge of the stoma, and a Foley catheter may be placed in the ileal conduit for extra drainage.

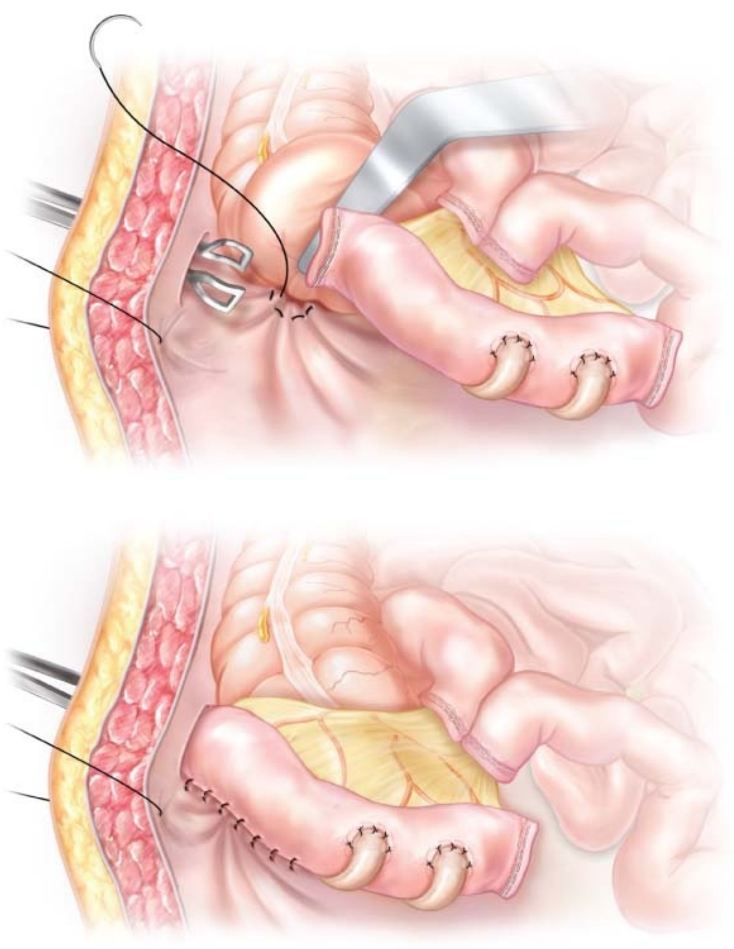


FIGURE 42-7 Bringing the ileal conduit through the abdominal wall.

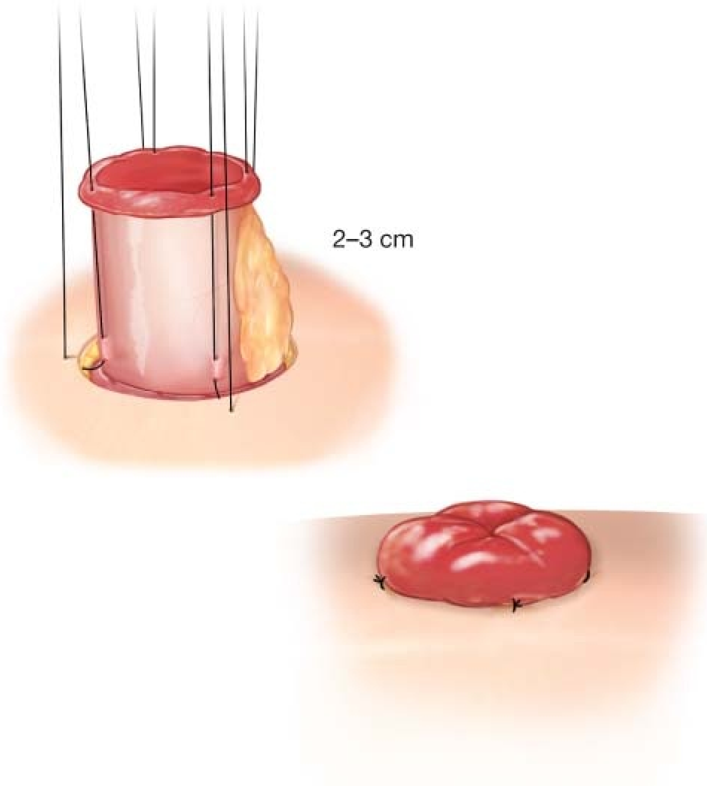
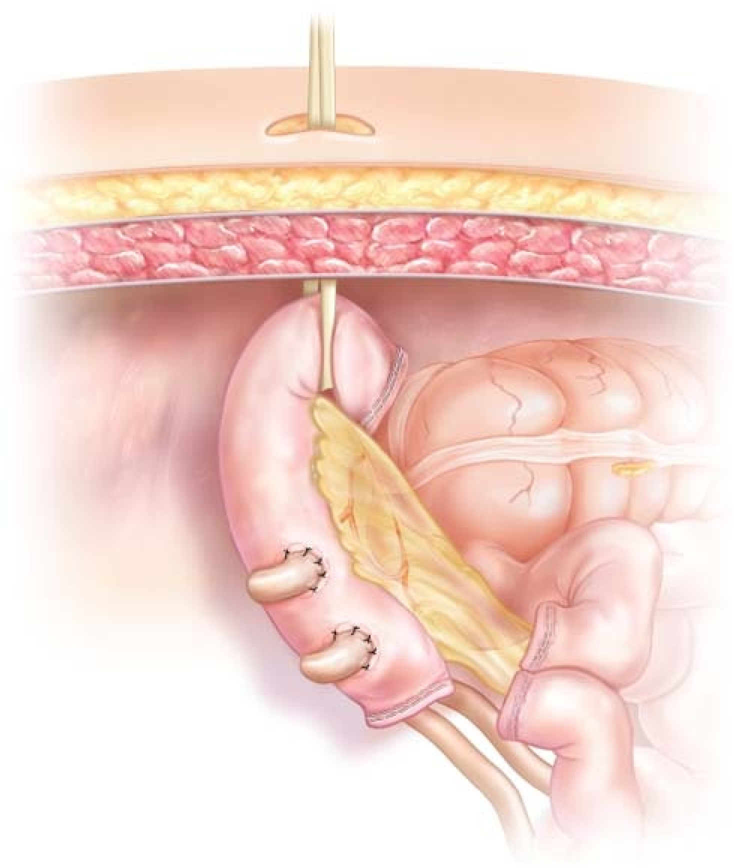


FIGURE 42-8 Eversion and maturation of the ileal conduit opening.

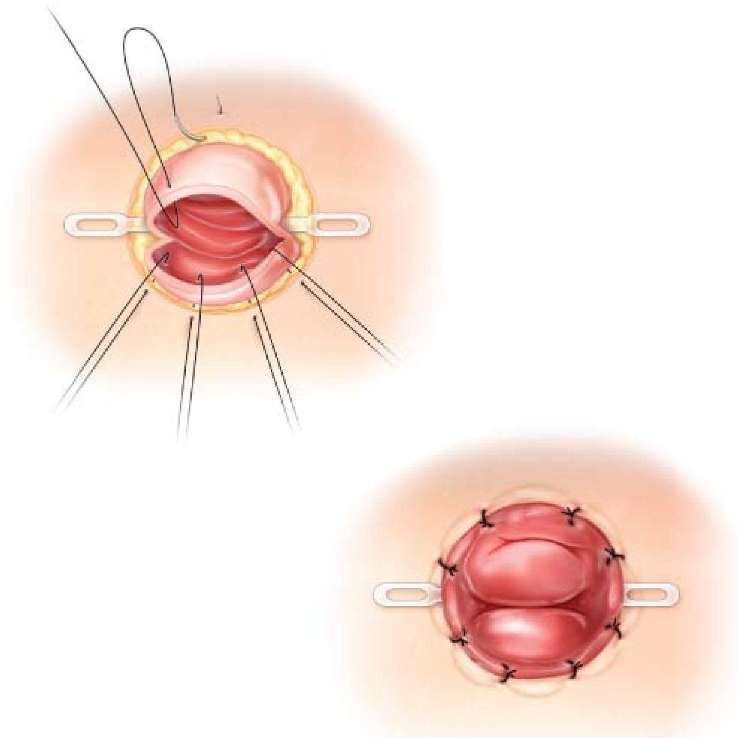
PEARLS AND PITFALLS

The optimal location of the ileal stoma is the right abdominal quadrant between the umbilicus and the anterior–superior iliac spine. A location too close to the iliac spine or the umbilicus may result in frequent detachment of the stoma device and persistent urinary leakage.

In obese patients or those with a short mesentery, directly pulling the distal end of the conduit through the thick abdominal wall might jeopardize the mesenteric flow and cause ischemia, in which case a Turnbull loop stoma may be considered (Figs. 42-9 and 42-10).



A



B

FIGURE 42-9 A. End-loop stoma formation B. Maturation of the End-loop stoma.

FIGURE 42-10 Cross sectional view of the end-loop stoma.

Outcomes

Short-Term Outcomes (<90 Days)

Ureteroileal Anastomotic Leakage

Anastomotic leakage is one of the most dreadful complications. It is commonly secondary to technical errors including tension at the anastomotic site, inadequate vascular supply, or kinking of the ureters (Fig. 42-11). There is no difference in leak rate between stapled versus sutured anastomosis. Fortunately, in many cases, conservative management is successful in the stable patient with adequate drainage. Ensuring adequate nutritional supplementation, utilizing transcutaneous drainage, and invoking appropriate medical management (i.e., antibiotics) of any infectious or septic signs are crucial to avoiding a return to the operating room for revision. This must be balanced with chronic leakage that increases an inflammatory response and may result in an anastomotic stricture.

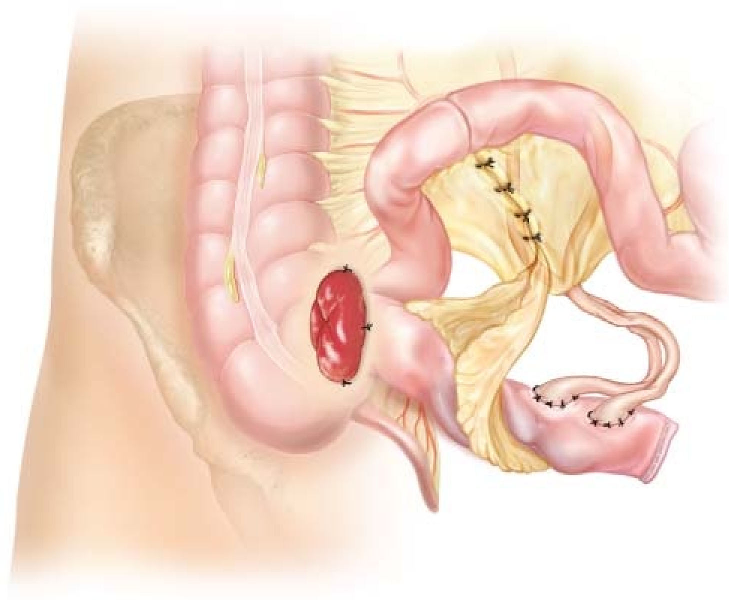


FIGURE 42-11 The mesenteric pedicle is twisted, causing severe ischemic damages to the ileal conduit.

Early Stomal Complications

Early stomal complications are not common and mostly involve stomal necrosis and bleeding. Bleeding is typically easily controlled with gentle pressure with packing or placement of suture at bedside. Necrosis is usually due to poor vascular supply and necessitates operative intervention.

p. 422

p. 423

Paralytic Ileus and Small Bowel Obstruction and Internal Hernia

The most important determinant of hospital stay is paralytic ileus. Preoperative bowel preparation, pain medication, surgical technique, and postoperative ambulation are all contributors to ileus. The development of a small bowel obstruction should increase the suspicion for an internal hernia of the small bowel either through the mesenteric defect or around the stoma and needs to be investigated (Fig. 42-12).

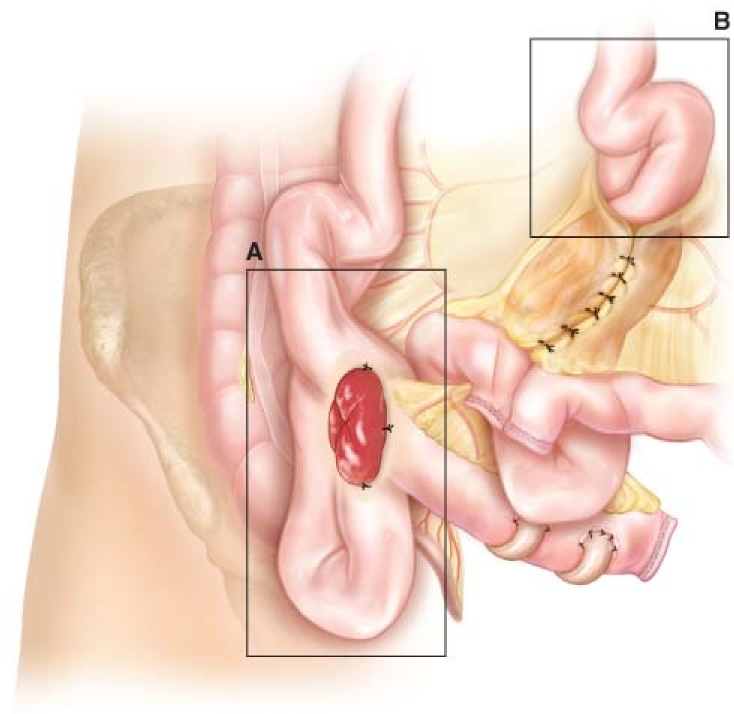


FIGURE 42-12 (A) Internal transmesentery ileal hernia and (B) internal ileal hernia through the conduit and the peritoneum of the abdominal lateral wall.

Long-Term Outcomes (>90 Days)

Ureteroileal Anastomotic Strictures

Anastomotic stricture at the ureteral-ileal anastomosis is typically benign and reported to occur in ~1–6% of cases in a recent meta-analysis. There is no significant difference in the incidence of stricture between the Wallace versus Bricker conduits. Strictures usually develop within 2 years of surgery. Luckily, endoscopic and percutaneous techniques are often successful in dilating the stenosis. Chronic, dense, fibrotic strictures typically respond poorly to conservative management and surgical revision is necessary for repair.

Renal Complications

Renal impairment may be secondary to chronic and long-term obstruction. However, it is important to recognize that deterioration may occur in the absence of obstruction or repeated infections. Upper urinary tract deterioration has been reported in up to 35% of patients at 5-year follow-up. Other renal problems include kidney stones and urinary tract infections. Risks for the development of kidney stones include infection, hyperchloremic acidosis, and high residual conduit volumes. Urinary tract infections should raise suspicion for anatomic changes including stoma stenosis or ureteroenteric stricture.

Late Stomal Complications

In the long term, stoma-related complications are relatively common, occurring in up to 15–65% of patients. The most frequent skin disorders include contact dermatitis, pressure ulcers, and fungal infections. Enterostomal therapists play a critical role in pre-and postoperative patient education, because effective communication has proved to be essential in both the prevention and management of these complications.

Stoma prolapse, stenosis, retraction, and parastomal hernia are reported in up to 31% of cases. Parastomal hernia alone has also been reported to occur in 10–15% of patients, although asymptomatic hernia may be much more common. Obesity, poor nutrition, and steroid use are all risk factors for the development of parastomal hernias. Asymptomatic hernias can often be managed conservatively; however, if the patient develops pain, obstruction, or bleeding, an operation is often necessary. Stoma prolapse is present in ~1.5–8% of procedures and is associated with impaired vascularization to the ileum combined with chronic infection. A prolapse belt is usually helpful in managing it conservatively. Finally, stomal stenosis is reported to be present in ~2.5–8.5% of cases at a median of 10 years after surgery. Simple dilation is useful for stenosis at the skin level.

Metabolic Complications

Hyperchloremic, hypokalemic metabolic acidosis is the most common metabolic complication following an ileal conduit. The mechanism is due to the increased ammonium absorption via the sodium receptors in addition to absorption of chloride in exchange for bicarbonate. Treatment with oral potassium citrate is generally tolerable and effective.

CONCLUSION

The use of urinary diversion conduits is a mainstay for patients with advanced pelvic disease processes that require extensive resections and cannot reestablish continuity. The Bricker conduit has withstood the test of time, and continues to be a mainstay in this setting. By adhering to several technical principles, the Bricker conduit can allow a great functional outcome with minimal morbidity.

RECOMMENDED REFERENCES AND READINGS

Bricker EM. Bladder substitution after pelvic evisceration. *J Urol* 2002;167(2):1140–5.

Colombo R, Naspro R. Ileal conduit as the standard for urinary diversion after radical cystectomy for bladder cancer. *Eur Urol Suppl* 2010;9(10):736–44.

Davis NF, Burke JP, McDermott T, *et al.* Bricker versus Wallace anastomosis: a meta-analysis of ureteroenteric stricture rates after ileal conduit urinary diversion. *Can Urol Assoc J* 2015;9(5–6):284–90.

Evangelidis A, Lee EK, Karellas ME, *et al.* Evaluation of ureterointestinal anastomosis: Wallace vs Bricker. *J Urol* 2006;175(5):1755–8.

Farnham SB, Cookson MS. Surgical complications of urinary diversion. *World J Urol* 2004;22(3):157–67.

Fazio VW, Church JM, Wu JS. *Atlas of Intestinal Stomas*. Vol. 850. New York, NY: Springer Science & Business Media, 2012.

Graham SD, Keane TE, Glenn JF, eds. *Glenn's Urologic Surgery*. Philadelphia, PA: Lippincott Williams & Wilkins, 2010.

Gudjónsson S, Davidsson T, Månsson W. Incontinent urinary diversion. *BJU Int* 2008;102(9b):1320–5.

Guzman-Valdivia G, Guerrero TS, Laurrabaquio HV. Parastomal hernia-repair using mesh and an open technique. *World J Surg* 2008;32:465–70.

Herlufsen P, Olsen AG, Carlsen B, *et al.* Study of peristomal skin disorders in patients with permanent stomas. *Br J Nurs* 2006;15:854–62.

Kouba E, Sands M, Lentz A, Wallen E, Pruthi RS. A comparison of the Bricker versus Wallace ureteroileal anastomosis in patients undergoing urinary diversion for bladder cancer. *J Urol* 2007;178(3):945–9.

Kouba E, Sands M, Lenz A, Wallen E, Pruthi RS. Incidence and risk factors of stomal complications in patients undergoing cystectomy with ileal conduit urinary diversion for bladder cancer. *J Urol* 2007;178:950–95.

Lawrentschuk N, Colombo R, Hakenberg OW, *et al.* Prevention and management of complications following radical cystectomy for bladder cancer. *Eur Urol* 2010;57(6):983–1001.

Le Duc A, Camey M, Teillac P. An original antireflux ureteroileal implantation technique: long-term followup. *J Urol* 1987;137(6):1156–8.

Maffezzini M, Campodonico F, Canepa G, Gerbi G, Parodi D. Current perioperative management of radical cystectomy with intestinal urinary reconstruction for muscle-invasive bladder cancer and reduction of the incidence of postoperative ileus. *Surg Oncol* 2008;17:41–8.

Magnusson B, Carlen B, Bak-Jensen E, Willen R, Mansson W. Ileal conduit stenosis—an enigma. *Scand J Urol Nephrol* 1996;30:193–7.

Martins LT, Serrano JLC. Introducing a peristomal skin assessment tool. The Ostomy Skin Tool. *World Counc Therapists J* 2008;28 Suppl:S8–13.

Rolstad BS, Erwin-Toth PL. Peristomal skin complications: prevention and management. *Ostomy Wound Manage* 2004;50:68–77.

Szymanski KM, St-Cyr D, Alam T, Kassouf W. External stoma and peristomal complications following radical cystectomy and ileal conduit diversion: a systematic review. *Ostomy Wound Manage* 2010;56:28–35.

Tabibi A, Simforoosh N, Basiri A, Ezzatnejad M, Abdi H, Farrokhi F. Bowel preparation versus no preparation before ileal urinary diversion. *Urology* 2007;70:654–8.
Wallace DM. Uretero-ileostomy. *Br J Urol* 1970;42(5):529–34.

Chapter 43

Posterior Sacrectomy and Reconstruction with Alloderm

Aaron J. Quyn and Peter M. Sagar

INDICATIONS AND CONTRAINDICATIONS

The ongoing evolution of surgical techniques for “higher and wider” multivisceral resections has been driven by surgeons seeking the ultimate goal of R0 resection, which is now considered the key parameter when deciding what constitutes “resectable” disease with curative intent. Essentially, the indications revolve around the ability to obtain clear resection margins.

Pelvic exenteration (PE) still remains a surgical challenge associated with high mortality and significant morbidity, especially when associated with partial or complete sacral resection. Such extensive radical surgery aims to completely resect all malignant disease to achieve an R0 resection (i.e., a clear resection margin) and resection is the most important predictor of long-term survival in patients undergoing curative surgery for recurrent rectal cancer. To accomplish this, complete or partial removal of all of the pelvic viscera, vessels, muscles, ligaments, and part of the pelvic bone (ileum, ischium, pubic rami, sacrum, or coccyx) may be required. High sacral bone involvement remains controversial and, although en bloc high sacrectomy has been shown to be safe and oncologically feasible in several specialist centers (Table 43-1), concerns remain about pelvic instability and the need for subsequent reconstruction, as well as postoperative neurologic deficits associated with sacrifice of sacral nerve roots. Nonsurgical treatments such as radiotherapy and chemotherapy provide only temporary relief of symptoms in most cases, with continual disease progression resulting in pain, bleeding, and intestinal and urinary fistulae and obstruction. Oftentimes, patients develop a painful, malodorous, fungating mass before death.

TABLE 43-1 Outcomes After Sacrectomy

	Median age (y)	Sacrectomy	R1	R2	Mortality	Median LOS (d)

	n		High	Low	R0				
Moriya et al. (2004)	57	55	9	48	48	9	0	2	35
Melton et al. (2006)	29	60	0	29	18	10	1	1	18
Sagar et al. (2009)	40	59	13	27	20	19	1	1	14
Dozois et al. (2011)	9	63	9	0	9	0	0	0	22
Bhangu et al. (2012)	22	61	5	17	15	7	0	0	15
Milne et al. (2014)	49	59	20	29	36	11	2	0	37
Fawaz et al. (2014)	19	62	13	0	19	0	0	1	20
Uehara et al. (2015)	35	66	6	26	27	8	0	0	46

DFS, disease-free survival; LOS, length of stay; OS, overall survival.

p. 425

p. 426

Aggressive surgical techniques in the form of a composite abdominosacral resection allows for the en bloc resection of tumor, sacrum, and pelvic floor musculature. This operation offers the potential of symptomatic relief, prolongation of life, and cure. The procedures are technically demanding and there is a price in terms of significant morbidity and mortality. As noted, completeness of resection (no microscopic disease evident at resection margins = R0) is a major factor that significantly influences outcome.

The planned resection margins and malignant indications for radical exenteration can guide the decision to proceed, but the anatomic limitations of the pelvis as well as quality of life implications and patient choice are all important for informed consent. An understanding of outcomes both with and without exenteration including long-term survival data, operative morbidity and mortality, length of hospital stay, and time for rehabilitation as well as quality of life all need to be discussed in detail. Hospital stays average often close to 3 weeks, with recovery taking 3–6 months before a stable quality of life is achieved.

There is ongoing discussion with regard to the absolute and relative contraindications for resection but we would advise against posterior sacrectomy in the following situations:

- Likely to result in an R2 resection
- Multifocal extra-pelvic disease unless curative metastasectomy is available
- Significant extension through the greater sciatic notch

Multiple areas of peritoneal seedlings
Poor performance status

PREOPERATIVE PLANNING

A comprehensive evaluation of the patient and tumor is performed. All patients undergo a full clinical assessment to ascertain their fitness for major pelvic surgery. Eligibility for resection of the tumor is dependent on the exclusion of unresectable metastatic disease outside the pelvis by computed tomography (CT) of the thorax and abdomen with positron emission tomography (PET) and where an R0 (complete) resection of the pelvic tumor was considered technically feasible by magnetic resonance imaging (MRI) criteria. However, consideration should also be given for patients with metastatic disease and/or where an R1 resection is likely if the patient would benefit from palliative resection such as a malignant vaginal fistula.

MRI (Figs. 43-1 and 43-2) is used to assess tumor size and location, the direction of invasion, involvement of the pelvic sidewall, and any extension to adjacent viscera. Radiologic assessment of the magnetic resonance (MR) scans should report the following:

Tumor clearance or involvement of the sidewalls of the pelvis and depth of invasion.

Tumor contiguity with piriformis, obturator internus, or both. This is suggestive, but not diagnostic, of invasion.

Direct invasion of the muscle as evidenced by signal change or expansion of the muscle.

Encasement of vessels can be defined as involvement of greater than 180 degrees. Encasement of the internal iliac vessels and/or the ureter would not necessarily preclude resection because these structures can be resected en bloc with the tumor.

Extent of sacral involvement, extension to or above the lumbosacral junction, and extent of posterior invasion beyond the bony margins of the sacrum.

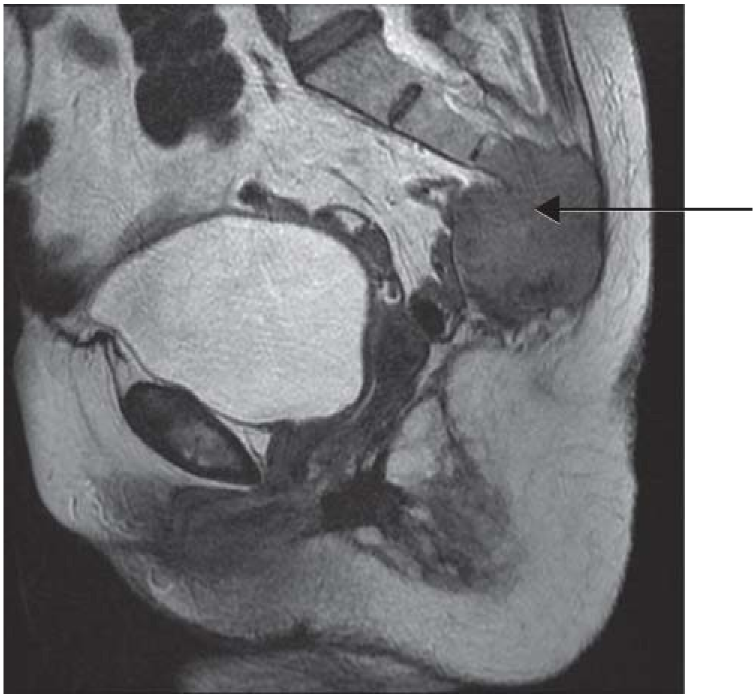


FIGURE 43-1 Recurrent rectal cancer after abdominoperineal excision of the rectum with invasion of the sacrum below the S2/3 interface. Arrow, points to the recurrent rectal cancer.

FIGURE 43-2 A recurrence at a colorectal anastomosis with secondary involvement of the distal sacrum.

Review of the location, relationship to the left and right sidewalls and sciatic notch, and encasement of the vessels is combined to give prediction of R status. This information should be taken from the immediate preoperative scans (rather than dated scans, e.g., before long-course chemoradiotherapy).

A dedicated radiologist, experienced in the imaging of recurrent rectal cancer, should review all MR and PET-CT images. Patients should undergo a guided biopsy to confirm malignancy before surgery.

Patients with locally recurrent rectal cancer who are radiotherapy naive after their initial treatment of the primary rectal tumor should receive long-course preoperative chemoradiation, for example, a total of 45 G over 5 weeks with intravenous 5-fluorouracil during the first and fifth week (days 1–5 and 29–33) of radiotherapy. Patients are then restaged preoperatively by clinical examination, CT abdomen and thorax, and MRI pelvis before resection. Surgery usually follows 6–10 weeks after the completion of any neoadjuvant therapy.

Surgery

In summary, preoperative evaluation should include the following:

- CT/PET-CT to exclude distant disease
- MRI of the pelvic tumor ideally with reconstructed images

Multidisciplinary review of the case

Preoperative long-course chemoradiotherapy (assuming the patient is radiotherapy naive)

Reimage post chemoradiotherapy

Preoperative anesthetic assessment
Full counseling of the patient and involvement with family members

SURGERY

Positioning

PE always involves an abdominal approach, usually with a perineal completion phase that can be done in lithotomy or prone with high sacrectomies. The anterior, axial, and lateral compartments are best done through an abdominal combined with a perineal lithotomy approach. Posterior resection of the sacrum from S4 down and including the sacrospinous ligaments allows radical excision of posterior pelvic floor that is approached from the abdominal side and is often better visualized than prone. Involvement of S3 and above by nature of the sacroiliac joint attachment requires a prone approach unless only the anterior cortex of the midline bones of L5 and upper sacrum are necessary, which can be done abdominally. Lateral higher sacrum and full vertebral excision of S2 and S3 requires the posterior prone approach. Abdominosacral exenteration requires lateral pelvic dissection that includes the ligation and transection of the internal pelvic vasculature and the exposure of the pelvic nerves and bones. This aspect is discussed in detail in Chapter 41.

Technique: Partial Anterior Sacrectomy

In patients in whom there is minimal but definite invasion of the cortex of the sacrum (as evidenced by MRI), it may be appropriate to excise the anterior table of the sacrum leaving the bulk of the sacrum intact. This is particularly useful in cases where the cortex of S1 and/or S2 is potentially involved but the morbidity of a total sacral resection is considered too high. In such cases, the anterior body of the sacrum and the anterior foramina are removed. An osteotome is used to incise the cortex above the level of presumed involvement starting in the midline and extending laterally. After the cortex has been breached, Kerrison rongeurs are used to develop the plane behind the involved bone and the dissection extended laterally to the lateral anterior foramina. The dura and nerve roots are preserved in this operation.

Technique: Posterior Sacrectomy

The sacrectomy is performed in the prone position especially if the recurrence is above S4. A partial anterior sacrectomy can be performed (L5-S3) or a distal sacrectomy (S3 or distally) can be transabdominally performed. Central (axial) and low posterior tumors require wide excision of the entire posterior levator floor from the level of the ischial spine laterally to the junction of S3-S4 vertebra floor from the level of the ischial spine laterally to the junction of S3-S4 vertebra medially. These tumors may require excision of the lower piriformis muscle and sacral nerves laterally if the mass extends to the lateral compartment. Once these structures have been disconnected laterally, the junction of S3 and S4 is exposed using diathermy to transect the longitudinal ligaments and the midline muscles. The sacrum is then transabdominally transacted, using an osteotome. The lumbosacral trunk and upper sacral nerve trunks on the piriformis are preserved if they are not abutting or involved with the tumor. The perineal surgeon will dissect posterior to the coccyx and sacrum up to the level of S3 before bone transaction. The anterior perineal plane is then connected to the posterolateral plane by combined abdominal and perineal dissection. The specimen is removed through the perineal wound.

For high sacrectomies, the patient is placed in the prone jackknife position for the sacrectomy after the abdominal component is completed. Completion of the transabdominopelvic component includes vessel loops secured around the lumbosacral and S1 nerve roots, the placement of a sterile pack in the pelvis above the plane of sacral resection to protect small bowel loops as the saw enters the pelvis, insertion of a pelvic drain, closure of the abdominal wound, and maturation of the colostomy and conduit.

The level of the sacral planned transaction is marked before closure utilizing a sacral pin. This allows lateral radiologic confirmation of the level of transaction of the sacrum before commencing transaction of the sacrum. Transabdominal completion of the anterior dissection can greatly facilitate the prone dissection.

A midline sacral incision is made. It is distally extended to encompass the perianal skin. Alternatively, the sacral incision can be joined with the previous perineal incision created during the abdominal lithotomy dissection. Diathermy dissection is performed onto the median crest of the sacrum. The gluteus maximus muscles are detached from the sacrum bilaterally and mobilized laterally. Any skin compromised by tumor, previous biopsy sampling, radiation-induced change, or prior surgery should also be excised with the specimen. This excision exposes the posterior and lateral sacrococcygeal ligaments inferiorly and the posterior sacroiliac and sacrotuberous ligaments laterally. The sacrospinous ligament lies deep to the sacrotuberous ligaments. All ligaments are divided to free the lateral borders of the sacrum. When the sacrospinous ligament is divided, the piriformis muscle will be exposed. The sacral nerve roots and the sciatic nerve lie deep to the piriformis muscle. Staying close to the lateral borders of the sacrum avoids injury to these nerves.

The level of sacrectomy is estimated by lateral x-ray and correlated with the sacral pin inserted during the transabdominal dissection. The aim of the surgery is to resect the sacrum with the pin in situ to ensure clear sacral margin. After determination of the sacrectomy level, the median crest is resected to expose the dura mater. The cauda equina and occasionally the lower canal is identified and ligated with a heavy tie and transected distally. The sacrectomy is then completed with a bone scalpel or oscillating saw. The sacrum is retracted to expose the pelvic cavity. The sterile pack will become evident. The vessel loops should be intact.

should be intact.

The sacrotuberous ligament is detached from the ischial tuberosity, and the coccygeal muscles are cut. The sacrospinous ligament is detached by an osteotomy cut across the base of the ischial spine. After this maneuver, the sacrum is free and can be dorsally lifted out of the wound. Sacral nerve roots are divided as they exit the sacrum, protecting the sciatic nerves from injury. The entire sacrum along with the neoplasm is then excised en bloc. After total sacrectomy, a spinopelvic reconstruction is required.

Technique: Stabilization After High Sacrectomy

High sacral resections will compromise the integrity of the spinopelvic support and will require some form of instrumental reconstruction. Resections above the level of the S1 neural foramina require spinopelvic stabilization to avoid collapse of the remaining sacrum. Posterior spinopelvic fusion is made between the lower lumbar spine and the remaining pelvis. If the resection has been made through the lumbosacral junction, then spinopelvic continuity has been severed and reconstruction by means of dual fibula grafts and instrumentation between the lower lumbar spine and the remaining spine is required.

Technique: Vertebral Body Stabilization

Occasionally, patients may present with isolated sacral metastasis involving S1 alone. In such cases, it is possible to avoid a major sacral resection and instead excise the involved sacral bone and provide support at the defect with an expandable metal cage.

The proximal margin of the tumor is marked both at the lumbosacral junction and caudally at the S1/2 disc space using the cautery. Discectomy is commenced using an ultrasonic aspirator followed by osteotomy of S1 vertebra body (Fig. 43-3). Anterior dissection toward the lateral sacrum is performed with care to protect the previously slung internal iliac vessels and their tributaries. The ultrasonic aspirator allows for protection of both the dura and the nerve roots. The vertebral end plates of the recipient vertebrae are then prepared for implant insertion with an expandable cage device (Fig. 43-4). The cage consists of one central core and two end plates, with small holes made around the device for the purpose of bone fusion. The length of the sacral gap to be bridged is measured using a caliper. Once the appropriate implant size has been determined, the matching end plates are attached to the central core. Angled end plates that match the anatomy of the vertebral end plates are selected. The expandable cage is then implanted into the cavity followed by expansion of the device to ensure proper fit. The position of the implant is confirmed radiologically (Fig. 43-5) and the end plates are secured to the receiving end plates with two sets of screws.

Finally, bone grafts are placed around the implant to provide extra stability.

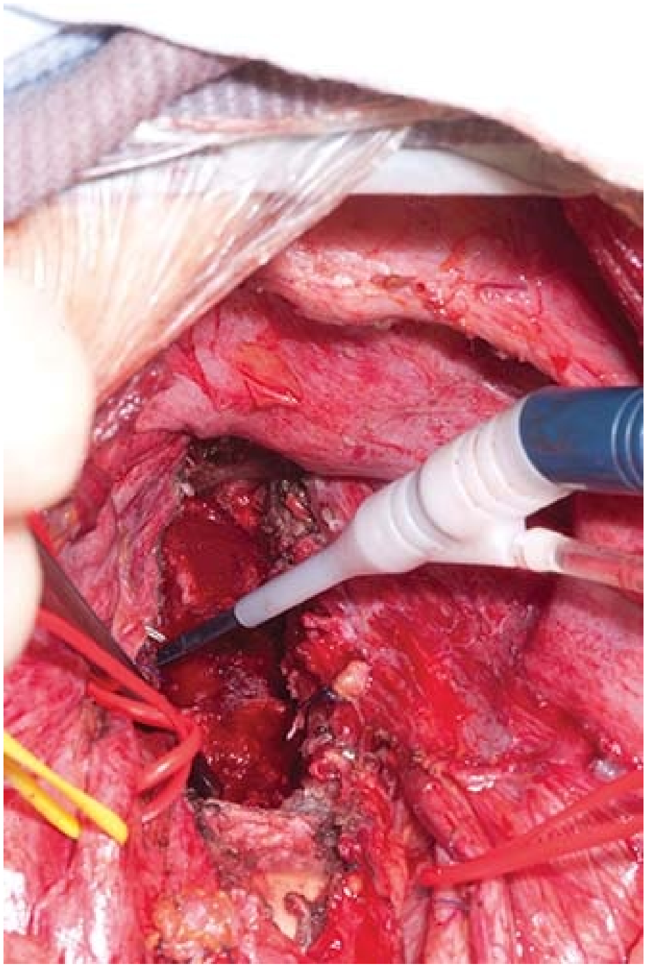


FIGURE 43-3 Corpectomy using the Sonopet (Stryker, Kalamazoo, MI) (S) ultrasonic aspirator.

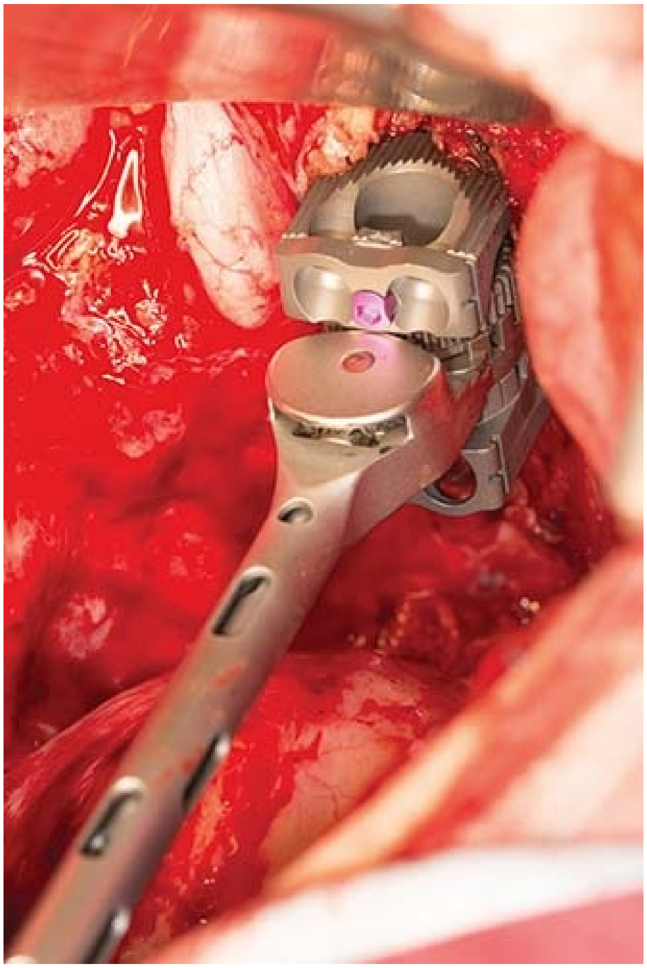


FIGURE 43-4 Placement of the Fortify (Globus Medical Inc, Audubon, PA) expandable corpectomy implant that consists of a central core and two modular endplates.

FIGURE 43-5 Postoperative computed tomography showing well-aligned fixation of implant with adjacent bone graft.

Technique: Closure of the Perineal Wound

Perineal Reconstruction

A major challenge of pelvic reconstructive surgery is restoring support for intra-abdominal organs. Failure to do so has been reported to result in such sequelae as perineal hernias, pelvic organ prolapse, and even perineal evisceration. Most pelvic and perineal defects following cancer resection can be repaired with local tissue rearrangement and/or tissue flaps, without the use of prosthetic mesh. The use of well-vascularized tissue flaps in such settings has been demonstrated to dramatically reduce the complication rate because they facilitate healing. It is the author’s preference to close these defects primarily where possible and avoid the morbidity associated with flap reconstructions.

Perineal Reconstruction with Flaps

Inferior Gluteal Artery Perforator Flaps

The inferior gluteal artery perforator flap allows the transfer of skin and fat but is muscle sparing and provides a good option for perineal reconstruction. The flaps are fasciocutaneous perforator flaps and are designed in a V-Y manner. The lower border is in the crease of the buttock with the lateral extension lying medial to the greater trochanter. The flaps are raised along a subfascial plane working from lateral to medial because this allows the identification of the perforating vessels that pass through the muscle into the flap. Once mobilized, the flaps are advanced medially into the pelvis and the buried part of the flap is de-epithelialized and secured to the remaining pelvic outlet. Vaginal reconstruction may be performed with the medial edges of the flap sutured to the lateral edges of the vagina after excision of the posterior wall of the vagina or using both flaps without de-epithelialization and rotating internally and then laterally to create a neo-vagina.

Vertical Rectus Abdominus Myocutaneous Flap

The vertical rectus abdominus myocutaneous flap is often preferred for pelvic reconstruction because it is a composite myocutaneous flap consisting of three layers: skin, subcutaneous fat, and muscle. It is durable.

The flap is designed around the required skin island and this is elevated along with the rectus abdominus muscle. After dissection of the posterior, medial, and lateral portions of the rectus sheath, the anterior portion of the sheath is left intact to prevent damage to the vascular perforators. The harvested flap is rotated 180 degrees on the inferior epigastric vessel pedicle and passed into the pelvis taking care not to kink or place tension on the pedicle. The dead space within the pelvis can be further reduced by means of an omental pedicle.

Reconstruction with Mesh

Implantable mesh materials have been used to address several inherent aspects of pelvic floor reconstruction including prevention of abdominal and pelvic organ prolapse, pelvic floor resuspension after oncologic resection and augmentation of bladder function. The implantable materials used are principally constrained by three factors: the durability of repair, tissue biocompatibility, and material-related complications. Historically, surgical repairs of the pelvic floor have included synthetic absorbable and nonabsorbable mesh materials. The use of nonabsorbable synthetic meshes has been reported to yield effective, long-lasting surgical repairs in the pelvis. Unfortunately, permanent synthetic materials are prone to infection, extrusion, adhesions, and foreign body reactions. The use of absorbable synthetic materials results in limited durability of the repair because the tissue plane remaining after their resorption is not sufficiently strong.

Tissue conductive bioprosthetic mesh materials provide a good alternative to prosthetic mesh in these situations because of their excellent mechanical properties, improved ability to become incorporated into surrounding tissue, and the potentially lower incidence and severity of complications. These materials are processed to remove host cells but preserve the native three-dimensional biological tissue matrix, thereby preserving its tissue conductivity (ability to incorporate into recipient wounds with cellular incorporation and revascularization). Studies are required, however, to evaluate differences in outcome between the various bioprosthetic mesh materials and to better elucidate the indications and contraindications for their use.

POSTOPERATIVE MANAGEMENT

Patients are usually managed on a high-dependency unit for 48 hours after surgery. Good nursing care is required to ensure pressure areas are protected and in particular to avoid excessive pressure on the perineal wound/flap. Early mobilization is encouraged along with the use of enhanced recovery protocols. CT imaging (± MRI) is carried out at postoperative day 7 in patients after high sacrectomy to assess the stabilization of the support.

COMPLICATIONS

Complications after posterior sacrectomy include the following:

- Perineal wound infection, breakdown, and dehiscence. Tissue viability needs to be assessed, and vacuum-assisted closure is often useful.
- Urinary complications include retention and infection.
- Inadvertent damage to adjacent organs including ureteric injury may be reduced by routine use of ureteric stents.
- Damage to sciatic nerve is uncommon.

RESULTS

Oncologic outcomes for reported series of sacrectomy for rectal cancer recurrence are shown in Table 43-1.

CONCLUSIONS

Conclusions are follows:

Posterior sacrectomy is indicated for patients with sacral involvement of primary rectal cancer or recurrent rectal cancer using a multidisciplinary team approach.

High sacrectomy, above the S2/3 interface can be a challenging procedure.

Surgeons should aim to achieve an R0 resection.

Patients need to be aware of the potential for complications.

RECOMMENDED REFERENCES AND READINGS

Bhangu A, Brown G, Akmal M, Tekkis P. Outcome of abdominosacral resection for locally advanced primary and recurrent rectal cancer. *Br J Surg* 2012;99:1453–61.

Boyle KM, Sagar PM, Chalmers AG, Sebag-Montefiore D, Cairns A, Eardley I. Surgery for locally recurrent rectal cancer. *Dis Colon Rectum* 2005;48:929–37.

Colibaseanu DT, Dozois EJ, Mathis KL, *et al.* Extended sacropelvic resection for locally recurrent rectal cancer: can it be done safely and with good oncologic outcomes? *Dis Colon Rectum* 2014;57:47–55.

Dozois EJ, Privitera A, Holubar SD, *et al.* High sacrectomy for locally recurrent rectal cancer: can long-term survival be achieved? *J Surg Oncol* 2011;103:105–9.

Evans MD, Harji D, Sagar PM, *et al.* Partial anterior sacrectomy with nerve preservation to treat locally advanced rectal cancer. *Colorectal Dis* 2013;15:e336–9.

Fawaz K, Smith MJ, Moises C, Smith AJ, Yee AJ. Single-stage anterior high sacrectomy for locally recurrent rectal cancer. *Spine (Phila Pa 1976)* 2014;39:443–52.

Hainsworth A, Al Akash M, Roblin P, Mohanna P, Ross D, George ML. Perineal reconstruction after abdominoperineal excision using inferior gluteal artery perforator flaps. *Br J Surg* 2012;99:584–8.

Harji DP, Griffiths B, McArthur DR, Sagar PM. Surgery for recurrent rectal cancer: higher and wider? *Colorectal Dis* 15:139–45.

Melton GB, Paty PB, Boland PJ, *et al.* Sacral resection for recurrent rectal cancer: analysis of morbidity and treatment results. *Dis Colon Rectum* 2006;49:1099–107.

Milne T, Solomon MJ, Lee P, *et al.* Sacral resection with pelvic exenteration for advanced primary and recurrent pelvic cancer: a single-institution experience of 100 sacrectomies. *Dis Colon Rectum* 2014;57:1153–61.

Moriya Y, Akasu T, Fujita S, Yamamoto S. Total pelvic exenteration with distal sacrectomy for fixed recurrent rectal cancer in the pelvis. *Dis Colon Rectum* 2004;47:2047–53; discussion 53-4.

Quyn AJ, Solomon MJ, Lee PM, Badgery-Parker T, Masya LM, Young JM. Palliative pelvic exenteration: clinical outcomes and quality of life. *Dis Colon Rectum* 59:1005–10.

Sagar PM, Gonsalves S, Heath RM, Phillips N, Chalmers AG. Composite abdominosacral resection for recurrent rectal cancer. *Br J Surg* 2009;96:191–6.

Uehara K, Ito Z, Yoshino Y, *et al.* Aggressive surgical treatment with bony pelvic resection for locally recurrent rectal cancer. *Eur J Surg Oncol* 2015;41:413–20.

Wang K, Lee D, Timothy J, Sagar PM. Vertebral body replacement with expandable cage following S1 sacrectomy for recurrent rectal cancer. *Dis Colon Rectum* (in press).

Warren OJ, Solomon MJ. R0 resection, not surgical technique, is the key consideration in pelvic exenteration surgery. *Tech Coloproctol* 2015;19:117–8.

Wells BJ, Stotland P, Ko MA, *et al.* Results of an aggressive approach to resection of locally recurrent

rectal cancer. *Ann Surg Oncol* 2007;14:390–5.
Yamada K, Ishizawa T, Niwa K, Chuman Y, Aikou T. Pelvic exenteration and sacral resection for locally advanced primary and recurrent rectal cancer. *Dis Colon Rectum* 2002;45:1078–84.

PART IX

COLOSTOMY

Chapter 44

Open Colostomy

Linda Ferrari and Alessandro Fichera

INDICATIONS

Despite advances in medical therapy and surgical techniques, temporary or permanent fecal diversion with a colostomy is still frequently indicated.

The majority of elective colostomies are laparoscopically performed. However, open surgery may be indicated in the following circumstances: when dense adhesions preclude proper exploration of the abdominal cavity; in the presence of a large mass causing lack of intra-abdominal domain; severe comorbid conditions as a contraindication to pneumoperitoneum; or large bowel obstruction.

The leading malignant indications for elective permanent colostomy include very distal advanced rectal cancer; anal cancer, persistent or recurrent; advanced rectal cancer invading adjacent structures, requiring abdominoperineal en bloc resection to achieve adequate oncologic margins; cancers with direct invasion of the elevator muscles and patients with severe fecal incontinence undergoing ablative rectal surgery.

The leading benign indications for elective permanent colostomy are Crohn’s disease, diverticular disease, and radiation proctitis. In severe fistulizing perianal Crohn’s disease, refractory to medical management, fecal diversion may maximize the chances of healing the perianal disease. Recent evidence suggests that this strategy may not be as effective as previously thought. In extreme cases, especially if associated with stricturing or incontinence, a proctectomy with creation of an end colostomy is the only definitive option.

A sigmoid resection with colostomy and Hartman’s pouch may be appropriate for patients with Hinchey III–IV diverticulitis, too unstable to tolerate a definitive operation with anastomosis. An anastomosis may subsequently be performed once the patient is medically optimized.

In the acute phase, radiation proctitis may present with bleeding, which can be severe, requiring local endoscopic treatment or temporary fecal diversion. In the chronic phase, complicated by stricture, a proctectomy with end colostomy is the only option for these patients.

Colostomies are often created for distal large bowel obstruction due to neoplasia or benign stricture, or to protect a distal rectal anastomosis. In the latter case, the authors prefer to use an ileostomy. When there is colonic obstruction, if the ileocecal valve is competent, ileostomy may not be appropriate.

Preoperative planning and patient education are critical steps when preparing a patient for elective colostomy creation. Preoperative siting by a Wound and Ostomy Certified Nurse (WOCN) before an elective procedure identifies the ideal placement of the stoma either temporary or permanent. Furthermore, it improves patient outcomes and satisfaction, reduces the risk of possible future complications, and should be considered mandatory.

PREOPERATIVE PLANNING

Patient Education

Preoperative education is a critical component of elective colostomy planning. Properly educated patients experience a shorter hospital stay and fewer postoperative complications. Knowledge of what to expect can alleviate fears and anxiety associated with surgery and help the patient understand the adjustments needed to live a normal life with a permanent colostomy.

Ideally, the patient should meet with the surgical team, including a WOCN provider, several days before elective colostomy surgery. At that time physical and psychological implications, as well as the patient's available support system, should be reviewed. The WOCN provider should meet with the patient at the preoperative visit, during the postoperative recovery and for long-term follow-up in case of a permanent diversion. In an emergency, if at all possible, stoma marking should still be preoperatively performed by a WOCN provider followed by postoperative education evaluation, and assistance.

Colostomy Siting

Proper siting of the colostomy is a critical aspect of the preoperative planning that has shown to decrease long-term complications and improve patient satisfaction. Stoma marking should be performed by a WOCN provider in all patients undergoing elective temporary and, even more so, permanent fecal diversion.

In 2014, recommendations from the World Council of Enterostomal Therapists stated that preoperative education should include explanation of the surgical procedure, stoma site marking, and planning of postoperative management. In terms of siting they stated: "The ideal stoma site is located below the umbilicus, within the rectus muscle, away from the scars, creases, bony prominence, umbilicus, and belt line, on the summit of the infraumbilical fold, and visible to the patient." The patient should be evaluated both standing and seated. The site should be within the rectus abdominus, because lateral placement will predispose to parastomal hernia. In general, the stoma should be sited above the belt line; however, in some patients with a relatively high belt line, placing the stoma above it may not be feasible or practical.

Additional considerations include body habitus and abdominal scars. In thin patients who may have lost weight due to illness, the stoma should be positioned taking into consideration anticipated weight gain. Patients with loose, mobile skin due to weight loss over a firm abdomen, create additional difficulty because the skin mark may descend significantly when the patient is standing, creating tension on the colostomy. In obese patients, the rectus muscles are hard to identify, because of the thick abdominal wall. In these patients, the stoma is often placed in the upper quadrants (Fig. 44-1) where the abdominal wall is usually thinner, thus facilitating the creation of the tract in a location that is more accessible and visible to the patient. This also prevents tension on the colostomy due to descent of the pannus when the patient is standing (Fig. 44-2).

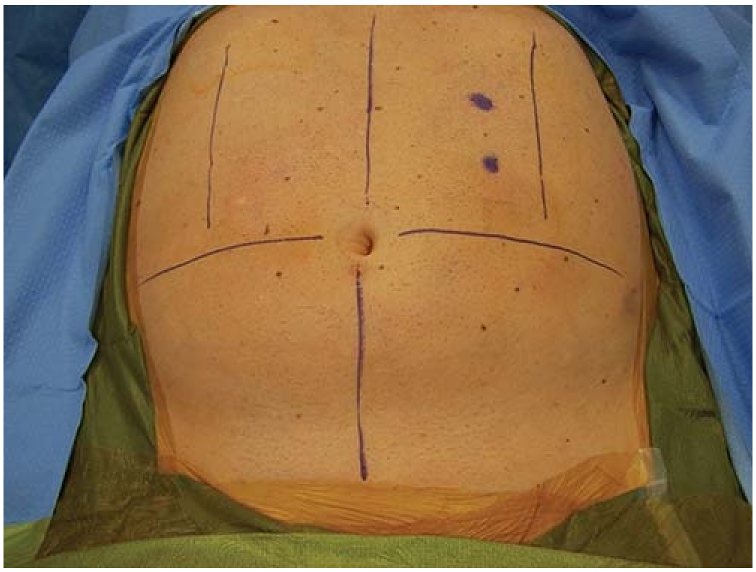


FIGURE 44-1 Obese man undergoing open permanent end colostomy for a distal sigmoid malignant obstruction due to a large mass, requiring an open approach. The stoma is placed in the upper quadrants.

FIGURE 44-2 Marking for a transverse colostomy in an obese patient. The stoma will be placed in the upper quadrant were the abdominal wall is thinner and the stoma will be visible to the patient.

Lastly, abdominal scars may create additional folds and potential for weakness of the abdominal wall, predisposing the patient to parastomal herniation.

p. 434

p. 435

Bowel Preparation

The evidence to support the use of mechanical bowel preparation (MBP) remains controversial and perhaps poorly understood. It is accepted that MBP alone should not be offered for right colon resection and perhaps not even for left colectomies. However, data on colon resection from the National Surgical Quality Improvement Program clearly shows that MBP with oral antibiotics reduces the rate of surgical site infection by 50% over MBP alone or MBP with intravenous (IV) antibiotics, without increasing the risk of anastomotic leak, postoperative ileus, or *Clostridium difficile* infections. On the basis of this evidence and our own institutional experience, it is the authors’ and editors’ practice to use MBP with oral and IV antibiotics for all colectomy patients.

SURGICAL TECHNIQUE

End Colostomy

An end colostomy is usually performed after an abdominoperineal resection, pelvic exenteration, or a Hartmann's procedure, and the stoma is usually placed in the left lower quadrant. Patients are usually in the low lithotomy position for the ablative portion of the procedure. Tension on the stoma should be avoided, especially in patients with a thick abdominal wall, and, in selected cases, it may be necessary to mobilize the splenic flexure. The colostomy, as previously discussed, should be placed through the rectus abdominus to decrease the risk of parastomal herniation. A WOCN provider should have preoperatively marked the site.

In our practice, a disk of skin at the previously marked site is sharply excised. With the electrocautery, dissection is carried down through the subcutaneous tissue down to the anterior rectus sheath. If the patient is obese, the adipose tissue leading to the fascia is excised. Hemostasis is meticulously obtained. We typically use a vertical incision on the rectus sheath. The rectus muscles are not divided, but rather split between two retractors to expose the posterior sheath where a second vertical incision is placed. A gauze pad is placed under the abdominal wall to protect the bowel while the second incision with electrocautery is performed. After the opening is created, it is sized on the basis of the patient's body habitus, the size of the colon, and the mobilized intestine available. We do not use a standard two-fingerbreadth trephine aperture diameter as a reference, but rather use clinical judgment based on the specific clinical scenario. Once again, tension should be avoided at all cost to decrease the risk of retraction, mucocutaneous separation, ischemia, and stenosis.

An atraumatic clamp is inserted through the ostomy aperture into the abdomen, after which the colon is gently delivered through the abdominal wall with a combination of pushing and pulling until enough intestine is delivered. Clinical judgment is used to determine the amount of intestine based on body habitus, vascularization of the stump, and mobilization. The mesentery should be properly situated and correct orientation should be checked before proceeding with the abdominal wall closure to avoid twisting leading to obstruction and ischemia.

The abdominal wall and the skin are then closed in the standard manner and the incisions are protected with towels. We prefer the Brooke technique with 3/0 chromic catgut, taking a full-thickness bite of the cut edge of the colon, a seromuscular bite 2–3 cm proximal, and finally an intradermal bite. We place these sutures in the four quadrants with one or two additional simple sutures in between them (Fig. 44-3).

FIGURE 44-3 End colostomy.

p. 435

p. 436

Loop Colostomy

Loop colostomy is a simple, fast, and relatively easy procedure typically used for temporary fecal diversion and in emergency settings. It is usually performed on the sigmoid or transverse colon in patients with obstructive distal disease requiring temporary fecal diversion for decompression and medical optimization and in emergency settings when the patient is not a candidate for definitive surgery. Although the choice of the segment of the colon to be utilized is left to the surgeon's clinical judgment and expertise, it should also take into consideration several factors: the indications for the diversion; the definitive surgery planned; the likelihood of such a procedure to take place; and the patient medical conditions at the time of surgery and body habitus.

A transverse loop colostomy is a faster and less invasive operation and should be reserved for critically ill patients. A limited incision is placed left of the midline in the epigastrium and extended through the subcutaneous tissue to the anterior rectus sheath that is opened longitudinally; the rectus muscles are retracted and the posterior sheath and peritoneum are opened. The transverse colon is cleared of the omentum and a small window is created in the mesocolon to allow placement of a colostomy bridge or a rubber catheter. The colon is elevated through the incision in the abdominal wall. The colostomy bridge or catheter is fixed to the skin to prevent retraction, slightly compressing the distal limb on the patient's left side. The authors prefer a red rubber catheter that, in their experience, is less traumatic to the bowel and the surrounding skin. When maturing the stoma, we place three 3/0 chromic sutures on the proximal limb with one or two simple sutures in between using the previously described Brooke technique. The distal limb is matured flush to the skin and slightly compressed by the red rubber catheter to prevent fecal spillage, but still maintaining a lumen for distal decompression as needed (Fig. 44-4).

FIGURE 44-4 Loop colostomy.

When dealing with patients with a thick abdominal wall or a short mesentery, it is sometimes not feasible to deliver enough colon for a tension-free loop stoma. A potential option in these cases is an end-loop colostomy. The colon is divided using a stapling device, with the mesentery basically intact. Both ends are delivered through the abdominal wall, but only the proximal lumen is matured. The distal colon can be left in the subcutaneous tissue or the antimesenteric edge matured as a mucous fistula. By not delivering both loops completely through the abdominal wall, tension on the colon mesentery is reduced. This type of stoma will function as an end stoma, with the advantage of not requiring a full laparotomy to reverse it.

POSTOPERATIVE MANAGEMENT

The ability to care for the stoma and acceptance of permanent diversions are fundamental steps toward the rehabilitation of patients with a colostomy. Postoperative patient education has become more challenging recently because of the reduced length of hospital stay, which limits the time available to provide the necessary information. For this reason the majority of the education is performed at the time of the preoperative visit, which is the most important in our practice. Patients should leave the hospital able to independently care for the stoma, with dietary and nutritional instructions, adequate support, and scheduled follow-up appointments with a WOCN provider.

COMPLICATIONS

Both early and late complications are associated with colostomy creation and management.

Early complications are usually the result of poor planning, technical issues, and challenging body habitus.

The most common early problem is difficulty obtaining adequate sealing of the appliance. This issue is sometimes just the result of the patient “learning curve,” a problem that will be solved with time; but often the stoma is in a crease (Fig. 44-5) or near a scar, and this precludes or limits the duration of the seal. The expertise of a WOCN provider is critical in these cases.

FIGURE 44-5 Stoma located in a crease, making it difficult to see and to pouch.

Necrosis of the stoma is a serious early complication (Fig. 44-6). The colon is not adequately perfused, resulting in loss of mucosa or even the full thickness of the colon wall. The lack of perfusion or ischemia is often caused by tension on the bowel and its blood supply or excessive dissection of the mesentery. It is often associated with obesity. When noted at surgery, efforts should be made to release the tension and revise the stoma. Necrosis, ischemia, and tension will start a cascade of long-term complications that will result in stenosis and/or retraction.

FIGURE 44-6 Necrotic stoma.

Stomal stenosis (Fig. 44-7) results from acute mucosal ischemia that did not lead to extensive loss of the full thickness of the bowel wall or from chronic ischemia. Stenosis can occur at the skin or fascia level. As healing occurs, formation of granulation tissue around the stoma constricts the lumen. Often, a formal revision of the previous site or relocation of the stoma is needed. Minor skin-level stenosis can be treated with local procedures.

FIGURE 44-7 Stenotic end colostomy.

Retraction is usually caused by excessive intra-abdominal adhesions or scar formation; foreshortened mesentery, or high body mass index, all resulting in inadequate mobilization. Retraction is seen more often in our practice in morbidly obese patients (Fig. 44-8). In these cases, obtaining adequate sealing of the appliance becomes an issue that in extreme cases requires stomal revision. In our experience, local procedures for retraction are not successful because they do not release the tension on the bowel, which can only be performed via a standard laparotomy.

FIGURE 44-8 Retracted stoma.

Stoma prolapse is the telescoping of the intestine through the stoma; it is seen more commonly in loop colostomy, with the distal limb being predominantly involved (Fig. 44-9). The more proximally along the colon the stoma is constructed, the higher the likelihood of a prolapse. Predisposing factors include increased intra-abdominal pressure, large stoma opening in the abdominal wall, and transverse loop colostomy. Depending on the severity, acuity, and reducibility of the prolapse, different treatment options can be offered. They include simple local revision, conversion to an end loop, and closure of the stoma if feasible.

FIGURE 44-9 Loop colostomy prolapse.

Parastomal hernia is a common long-term complication of permanent colostomy (Fig. 44-10). It is defined as an enlarged defect in the abdominal wall with protrusion of the intestine. The defect could have been created too large at surgery, especially in emergency cases with edematous bowel, or it has enlarged over time. The majority of cases are initially asymptomatic, but over time they can cause significant pain and obstruction due to incarceration and even physical disfiguration with loss of abdominal domain. For asymptomatic patients, conservative management options include flexible pouching system, hernia support belt, spandex garments, and dietary modification with increased fluid intake to prevent constipation. Surgical repair should be offered when conservative management fails and the patient becomes symptomatic. The types of surgical repair depend on the size of the hernia, the possibility of closure of the stoma, the patient comorbidities, body habitus, and history of previous repairs or relocation of the stoma. These repairs described and discussed elsewhere in this textbook.

FIGURE 44-10 Large parastomal hernia.

CONCLUSIONS

In all elective settings, preoperative planning and patient education are critical steps to reduce the risk of long-term complications and improve patient satisfaction. The surgeon should work closely with the WOCN provider. Long-term follow-up of permanent diversion is mandatory for early detection of complications.

RECOMMENDED REFERENCES AND READINGS

Aycock J, Fichera A, Colwell JC, Song DH. Parastomal hernia repair with acellular dermal matrix. *J Wound Ostomy Continence Nurs* 2007;34(5):521–3.

Colwell JC, Fichera A. Care of the obese patient with an ostomy. *J Wound Ostomy Continence Nurs* 2005;32(6):378–83; quiz 384–5.

Morris MS, Graham LA, Chu DI, Cannon JA, Hawn MT. Oral antibiotic bowel preparation significantly reduces surgical site infection rates and readmission rates in elective colorectal surgery. *Ann Surg* 2015;261(6):1034–40. doi:10.1097/SLA.0000000000001125.

Chapter 45

Laparoscopic Colostomy

H. David Vargas

INTRODUCTION

Fecal diversion or intestinal stoma creation may be indicated for a variety of pathologic conditions and may be temporary or permanent. Stomas can be performed as the primary procedure or as an alternative to anastomosis following resection. Stomas may be either elective or emergent. Temporary stomas generally imply that definitive treatment of the underlying presenting pathologic condition ultimately can be treated with curative intent. Colostomy creation offers advantages over ileostomy, including decreased fluid losses and more formed, less frequent evacuations, and are necessary in particular when patients suffer from distal obstruction of the large intestine. End colostomies generally are smaller, easier to pouch, and arguably better permanent stomas than loop colostomies, especially given the tendency of the latter to prolapse.

Laparoscopic technique compared to open colon surgery offers patients decreased wound size, less pain, shorter hospitalization, and quicker return to regular activities; and these advantages remain true particularly in the case of laparoscopic stoma creation. The following discussion pertains to laparoscopic colostomy creation for fecal diversion and does not address colonic resection with stoma creation. Although colostomies can be performed in any segment, either the left colon or the transverse colon is most commonly employed and laparoscopic colostomy generally involves the left colon or sigmoid colon.

INDICATIONS FOR LAPAROSCOPIC COLOSTOMY CREATION

Key Concepts

A variety of pathologic conditions exist requiring consideration of fecal diversion, and procedures may be elective or urgent in nature.

Colostomy creation may be temporary if the underlying condition can be definitively treated and the type of stoma—loop or end colostomy—should be performed after due consideration of prognosis.

Distal bowel obstruction requires venting (loop colostomy or colostomy with mucous fistula) of the defunctionalized segment to prevent closed-loop obstruction.

Colostomy creation for fecal diversion is offered to patients for a range of clinical situations and a variety of diseases. Obstruction of the colon can occur as a result of neoplasms of the colon or rectum or because of other pelvic and abdominal malignancies. Complex fistulas such as rectovaginal or rectourethral fistulas or severe fistula-in-ano disease may require diversion. Traumatic injury to the anorectum, pelvic sepsis, or perineal soft-tissue infections may necessitate colostomy. Functional conditions such as fecal incontinence, intractable constipation, or decubitus ulcer may require palliative colostomy creation. Radiation proctitis with severe intractable bleeding or pain is another somewhat uncommon but described indication for colostomy creation. Depending on the anticipated future treatment of the underlying condition, colostomies may be permanent or temporary. Fecal diversion in the case of distal obstruction requires a loop colostomy or a divided end-loop colostomy with venting mucous fistula to avoid a closed-loop obstruction of the defunctionalized limb. Reports describing laparoscopic stoma creation for fecal diversion were described as one of the earliest ideal applications of minimally invasive surgery for colon rectal surgery.

CONTRAINDICATIONS TO LAPAROSCOPIC COLOSTOMY

Key Concepts

Laparoscopic colostomy construction is rarely contraindicated.

Complete large bowel obstruction is best managed using open surgical technique.

Anticipate the difficult stoma creation—marked abdominal wall thickness, shortened mesentery, inflammation and distorted anatomy, multiple adhesions, multiple non-midline incisions—and be aware of one's surgical experience and technical limitations.

Absolute contraindications against the use of the laparoscopic technique are rare. Hemodynamic instability represents such a situation because the pneumoperitoneum may exacerbate hypotension because of its effect on the cardiovascular system. Complete or high-grade large bowel obstruction with a competent ileocecal valve leads to a tensely distended bowel. This setting should be considered a contraindication for laparoscopic colostomy because massive dilation of the colon may lead to loss of domain and compromised videoscopic view of the peritoneal cavity. Moreover, marked elongation of the colon due to obstruction may confound accurate colonic segment identification; lastly, and most importantly, tense distension of the bowel leads to marked thinning of the wall, making manipulation of the bowel with miniaturized end effectors hazardous with increased risk of perforation—a catastrophe in the setting of a massively distended and obstructed colon. In the author's opinion, high-grade large bowel obstruction with massive distension is best managed by laparotomy and open surgical technique, with the initial step being controlled decompression of the massively distended bowel. Unfortunately, other limitations notwithstanding, reliable means of laparoscopic decompression and avoidance of contamination remains a critical limitation of the existing minimally invasive technique and therefore is not advisable.

Identification of the patient at risk for a challenging stoma remains paramount when considering a minimally invasive approach because these situations represent relative contraindication and can impact open surgery as well. Thick, foreshortened mesentery and/or increased abdominal wall thickness cause central difficulty in bringing the colon to the skin. Similarly, patients with inflammatory bowel disease, mesenteric desmoid tumors, history of mesenteric or peritoneal abscess, or prior radiation therapy also may suffer from short mesenteric length making exteriorization difficult. Patients having undergone mesenteric length making exteriorization difficult. Patients having undergone prior resection present unique challenges given prior mobilization and mesenteric division. All of these situations increase the risk of a more complex operation, both from a technical standpoint as well as from the point of operative decision making. A surgeon must be cognizant of own clinical experience as well as the skill level when considering the application of laparoscopic technique for colostomy creation because the platform employed—minimally invasive or open—must always enable and not hinder the surgeon’s ability to create a well-formed, functioning stoma.

PREOPERATIVE PLANNING

Key Concepts

- Stoma education and marking
- Bowel preparation if possible, including oral and intravenous (IV) antibiotics
- Clear strategy: loop, divided loop stoma (Prasad-type stoma), or end colostomy but adaptable when necessary
- Identify the patient at high risk for difficult stoma creation: increased obesity, prior radiation therapy, inflammatory bowel disease, prior intestinal/colonic resection

In the elective setting, one cannot overemphasize the importance of preoperative consultation with an enterostomal specialist for education and marking. The role of such an interaction remains critical to patient preparation. The anticipation of life with a stoma, even if temporary, understandably causes fear and anxiety; the ability of a patient to discuss concerns before surgery eases this transition and reduces such feelings.

Proper stoma marking also cannot be overstated. Preoperative consultation with an enterostomal therapist helps ensure that the stoma is optimally located, improving stoma pouching and reducing occasions of leakage. Lastly, preoperative counseling provides the initial interaction for a long-term relationship benefiting the ostomate.

Ideally, bowel preparation should be performed before elective colostomy creation. Although laparoscopic surgery generally offers the benefit of reduced wound infection, the author and editors prefer bowel preparation to include both mechanical cathartic cleansing and oral and IV antibiotics.

p. 442

---

p. 443

One of the key concepts for preparation before surgery includes *surgeon preparation*. Again, it is imperative that a surgeon considers patient factors placing them at risk for a challenging stoma. The obese patient represents the most common such situation, given the rates of severe obesity observed in Western industrialized countries. Stoma marking must take into account abdominal skin creases resulting from the panniculus, increased thickness inferior to the umbilicus with a thinner abdominal wall often present cephalad to this landmark, and one must anticipate movement of the panniculus and abdominal wall upon standing. An experienced enterostomal therapist again provides critical assistance regarding optimal stoma siting in the obese patient.

In addition, when considering the obese patient, one must anticipate intraoperative challenges. Surgeon preparation should include specific strategies for the type of stoma (loop, end loop, divided loop, or end colostomy) to be created, as well as preparation for issues related to adequate bowel and mesenteric mobilization, accurate vessel and mesenteric division, and ensuring mesenteric mobilization, accurate vessel and mesenteric division, and ensuring adequacy of length for exteriorization. In the obese patient, one must strongly consider the use of the descending colon as opposed to the sigmoid colon. This requires specific steps related to (1) mesenteric division to include high ligation of the inferior mesenteric artery, division of the ascending left colic artery and proximal ligation of the inferior mesenteric vein; (2) full splenic flexure mobilization with complete dissection from the retroperitoneum and inferior border of the pancreas back to the ligament of Treitz; and (3) lastly, one must anticipate the challenge of mobilizing the omentum from the transverse colon and splenic flexure. When utilizing the descending colon as the conduit for colostomy, the arterial blood supply is provided by the marginal artery of Drummond; and one can resect and tailor the mesentery medial to this vessel, resulting in a narrowed and trim descending colon containing the marginal artery that is close to and parallels the medial edge of the bowel. This trim profile assists greatly in reducing the volume of tissue to be exteriorized through a thick abdominal wall. Amputation of appendices epiploica also can reduce the volume of tissue, facilitating exteriorization. Wound protectors used at the stoma site, with lubricating gel, can ease passage of the bowel through the aperture. A last consideration for stoma creation in the obese patient should include mention of abdominal wall contouring or formal panniculectomy. This should be considered an option of last resort.

A surgeon must take into account his or her own experience and skill set when contemplating a minimally invasive approach to colostomy creation in the patient at high risk for a challenging repair. The operative platform for creating a colostomy must enable the surgeon to reliably and precisely perform each operative step. The obese patient clearly benefits from small incisions offered by a laparoscopic approach. However, this patient group imposes considerable technical challenge to such an approach whether it is related to obtaining adequate exposure, accurate vessel identification and mesenteric division, or contending with a large omentum. One must always remember that the highest priority remains creation of a well-vascularized, adequately mobilized portion of bowel that can be exteriorized through an appropriately sized aperture in good position on the abdominal wall, exteriorized above the skin and everted for pouching. A laparoscopic colostomy that is poorly constructed and is at high risk for complication, reoperation, and revision should be condemned if a better stoma would have been provided by an open technique.

SURGERY

Patient Positioning

Supine or lithotomy: Consider the need to access the perineum for examination purposes, treatment of pathology, or access for endoscopy when choosing supine or lithotomy position.

Instrumentation

Thirty-degree laparoscope, 5-mm; alternatively 10-mm laparoscope depending on surgeon preference

Three ports—one 12-mm port, two 5-mm ports; if 10-mm laparoscope used, then two 12-mm ports and one 5-mm port

- Camera port—5 or 10 mm, at superior aspect of umbilicus
- 12-mm port at stoma site—access for retracting grasper and stapling instrument (bowel and vascular cartridges)
- 5 mm in right lower quadrant—access for dissecting instrument

Stoma rod if loop colostomy

Stoma appliance

SURGERY (TECHNIQUE)

End Colostomy or Loop Colostomy

Key Points

Adequate length of bowel and mesentery is needed to exit aperture and facilitate everted stoma.

Maintain orientation of the bowel and mesentery keeping in mind that the fanlike sigmoid mesentery projects radially from medial to lateral.

Develop consistent strategy to ensure correct end of bowel matured as end stoma.

The procedure is performed under general anesthesia, with the patient in the supine position. IV antibiotics are administered and a nasogastric tube and a bladder catheter are inserted. Alternatively, lithotomy position in padded Yellofin stirrups (Allen Medical, Acton, MA) can be employed and offers the surgeon the ability to access the perineum if examination under anesthesia is indicated and necessary. In addition, access to the perineum also allows for sigmoidoscopy if one anticipates this maneuver. However, supine positioning is satisfactory if these considerations are not expected to be issues.

The patient must be secured to the operating room (OR) table for expected changes in position of the OR table—anticipated degrees of Trendelenburg positioning and table tilting. The author prefers the use of the nonslip, “pink pad” patient positioning system, although simple taping of the patient’s chest to the OR table (3-inch-wide silk tape across the chest and around the table) proves effective and inexpensive; the editors favor bean bags. The patient’s right arm is tucked. OR setup is illustrated in Figures 45-1 and 45-2. The surgeon and camera holder/assistant stand to the right side of the table viewing a monitor directly opposite on the left side of the patient (Fig. 45-2).

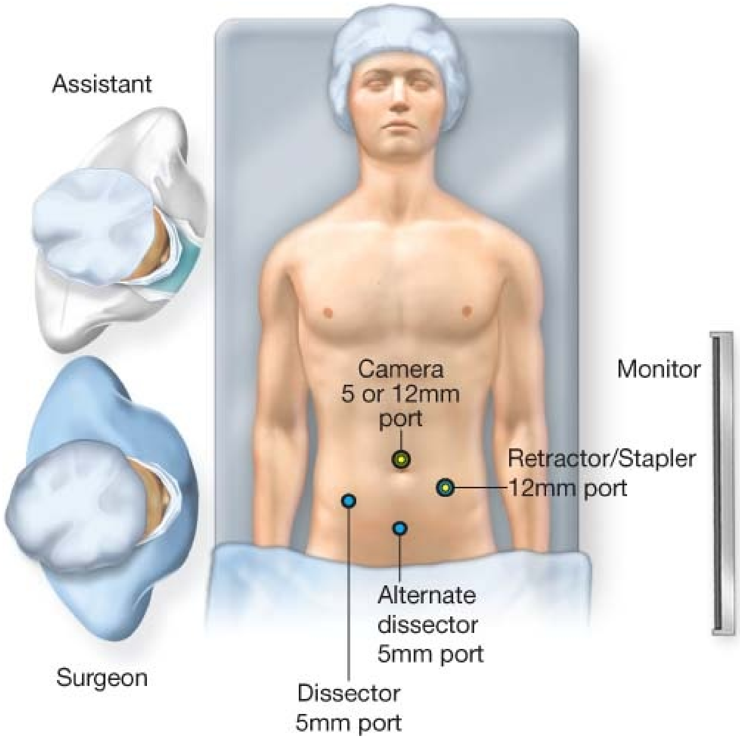


FIGURE 45-1 Port placement.

FIGURE 45-2 Surgeon with assistant camera holder standing on right side, monitor opposite on left side.

Ports and Laparoscopic Camera

Generally, the procedure is performed using three ports, one 5-mm port and two

12-mm ports (Fig. 45-1). Open umbilical port insertion is performed at the superior aspect of the umbilicus (creating some distance from the anticipated port at the stoma site on the left side of the abdomen), 12 mm in size accommodating a 10-mm 30-degree laparoscope. This configuration provides the best image for educational purposes; 5-mm laparoscopes may also provide excellent images if available. Pneumoperitoneum is achieved by insufflation of CO_2 gas and videoscopic exploration of the peritoneal cavity is performed. At the premarked stoma site, a 12-mm port is inserted and then a 5-mm port is inserted under laparoscopic guidance into the right lower quadrant. The OR table is then placed in Trendelenburg position and the table is rotated to the right facilitating exposure of the left side of the abdominal cavity and retraction of the small bowel out of the pelvis and left lower quadrant; gravity by patient positioning usually serves to keep the bowel out of the way. A grasper is inserted in the 12-mm port to medially retract the sigmoid colon. Scissors with cautery is then used to sharply mobilize the sigmoid and descending colon lateral to medial level of the splenic flexure with preservation of the gonadal vessels and left ureter (Fig. 45-3). The mid-sigmoid colon is usually employed for colostomy creation. To determine adequate length, the bowel is grasped and retracted to the abdominal wall at the stoma site (into the 12-mm port wound) under laparoscopic visualization while releasing pneumoperitoneum. If deemed adequate, divide the bowel using a 60-mm stapler and the same stapler is used to divide the mesentery with vascular load ensuring radial orientation perpendicular to the bowel axis (Figs. 45-4 and 45-5). One must preserve the blood supply of the end of the bowel to be matured as stoma as well as the defunctionalized end of sigmoid. It is critical that after bowel and mesenteric division that the proper end of the bowel is grasped to be exteriorized and matured as the functional colostomy end with avoidance of any twisting of the mesentery. Marking the proximal end to be exteriorized can be performed to assist in this. The stoma aperture is then created. The disk of skin excised at the premarked stoma site, and small handheld retractors expose the subcutaneous fat and anterior fascia, which are incised with cautery superiorly and then inferiorly in a longitudinal manner using the plastic 12-mm trocar levered (Fig. 45-6) against the abdominal wall to assist in this process while protecting the viscera. The rectus muscle can then be divided longitudinally exposing the posterior rectus sheath and peritoneum, which again are divided over the levered plastic trocar. Pneumoperitoneum is relieved upon entry and the aperture enlarged to two fingerbreadths, enabling exteriorization of the end of the proximal bowel (Figs. 45-7 and 45-8). During creation of the aperture, one must control the grasper without twisting of the end of colon. The proximal end is exteriorized (Fig. 45-9).

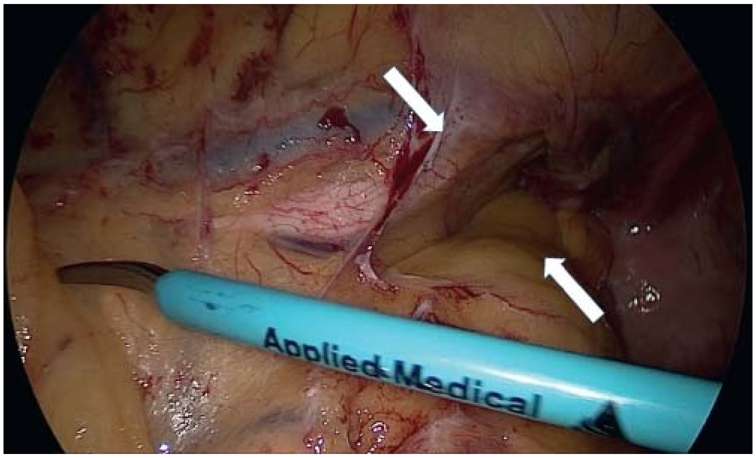


FIGURE 45-3 Mobilizing left colon sharp dissection lateral to medial, and identifying the ureter and gonadal vessels. White arrows, identify edges of peritoneum.

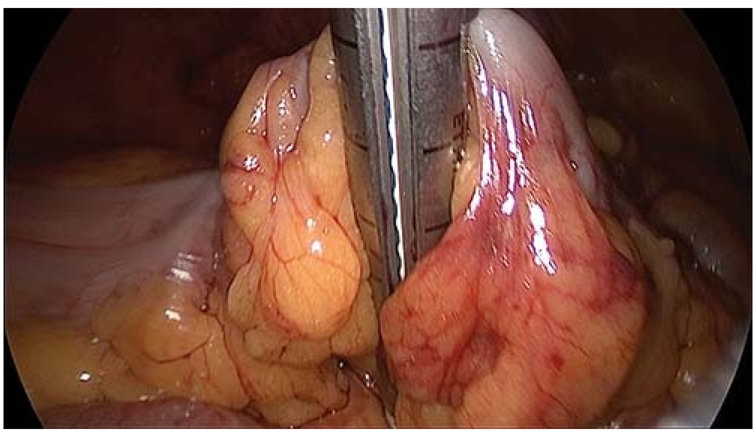


FIGURE 45-4 Assessing reach, then dividing the bowel.

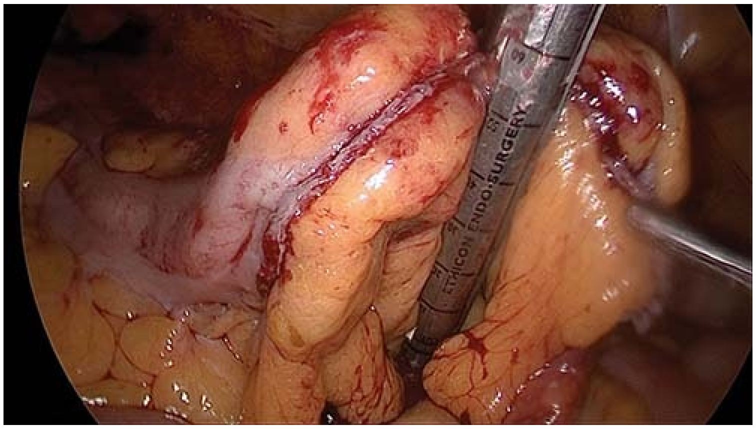


FIGURE 45-5 Dividing the mesentery.

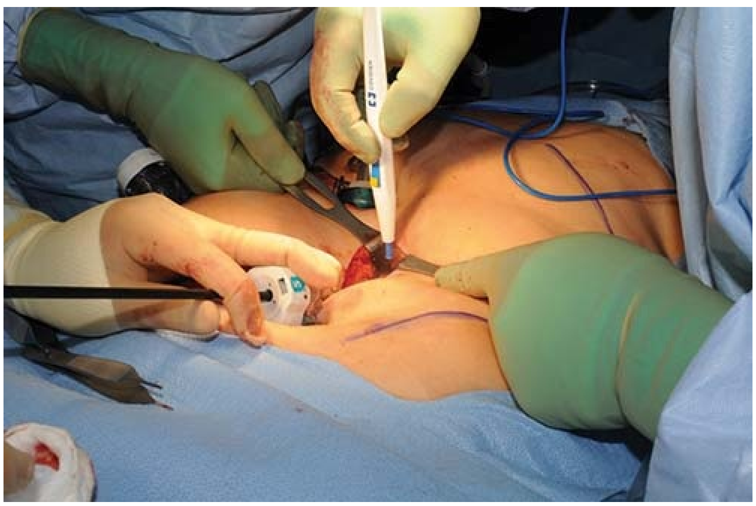


FIGURE 45-6 Creating stoma aperture—dividing fascia over plastic port, which is levered.

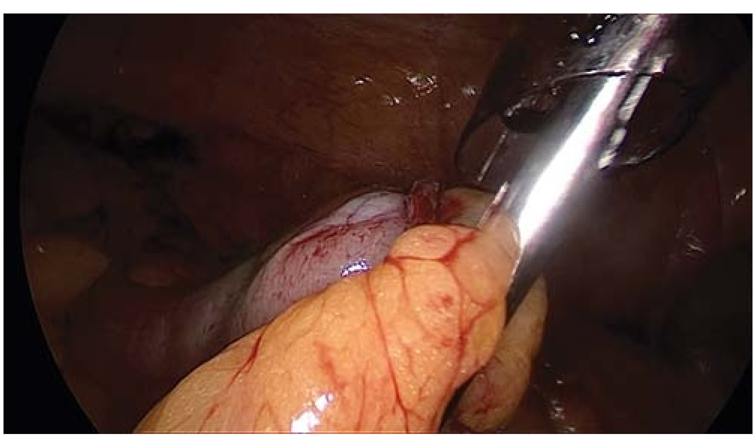


FIGURE 45-7 Grasping the end and relieving pneumoperitoneum.

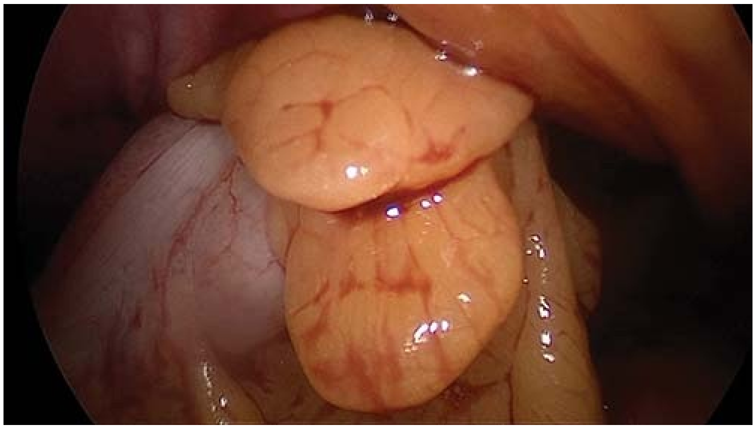


FIGURE 45-8 The bowel is delivered through aperture.

FIGURE 45-9 Exteriorization of the end of the left colon.

p. 444

---

p. 445

One can then re-insufflate the abdomen and laparoscopically visually inspect the mesentery and the bowel end exteriorized to ensure proper orientation (Fig. 45-10). This step is critical and represents a distinct advantage of this technique when compared with single-port laparoscopic colostomy. If one has any problems with maintaining pneumoperitoneum to accomplish visual confirmation of orientation, a penetrating towel clamp can pinch the aperture snugly around the end of the exteriorized bowel to prevent loss of CO_2 gas. A laparotomy sponge in the stoma aperture alongside of the bowel before placing the towel clamp will help close the aperture.

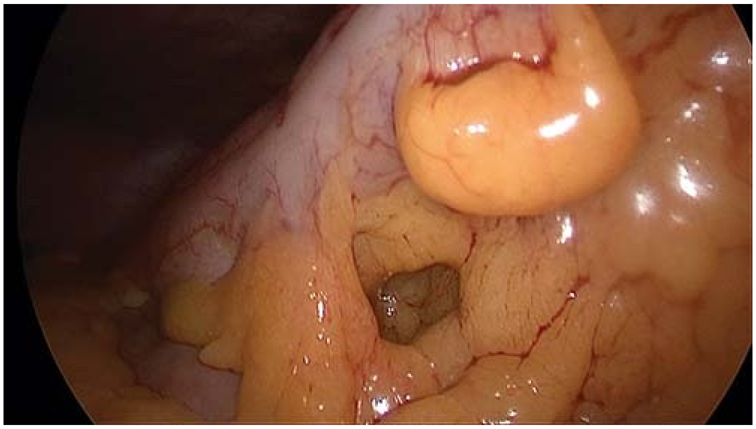


FIGURE 45-10 Assessing the bowel and mesentery to confirm absence of twisting.

p. 445

p. 446

After determining proper orientation of the bowel and mesentery, pneumoperitoneum is released and the end of bowel is then matured as a Brooke-type everted stoma (Figs. 45-11 and 45-12). The end of the colon should reach 2–3 cm above the skin for eversion of the stoma. Keeping in mind the anatomy of the mesentery, the end of the bowel should be delivered above the skin most easily with the mesenteric aspect of the bowel facing medially. The ports are removed and any 12-mm defects closed and the skin approximated.

FIGURE 45-11 Everted end colostomy.

FIGURE 45-12 Completed stoma.

p. 446

p. 447

If the tip of the distal limb requires decompression as a mucous fistula, this goal can be accomplished by grasping the anti-mesenteric tip of the staple line of the distal end of the bowel and delivering the tip above the skin at the inferior aspect of the aperture. A divided Prasad loop stoma is thus created. The tip of the staples can be excised and the tip matured flush to the skin at the inferior aspect of the aperture and also sutured superiorly to the caudal edge of the everted, proximal colostomy.

There are certainly occasions where markedly redundant sigmoid colon in a thin patient could be a situation where colonic and mesenteric division may be accomplished without difficulty. However, considering the rate of obesity in the United States and other Western industrialized nations, the likelihood of such an ideal situation should not be considered a common scenario; and technically, intracorporeal division will be a more reliable and precise method avoiding any struggle to perform steps extracorporeally in a tiny wound.

If a loop colostomy is preferred, no stapling occurs; thus, loop stomas are easier to perform than are end stomas. Arguments against a loop colostomy include the larger size and requisite larger aperture and the tendency of the distal limb to prolapse. Loop stomas may be easier to close when diversion no longer is needed, adding to their preferability; but if this is a strong consideration, one should perform an end-loop-type colostomy. In the case of distal obstruction, a loop stoma obviates the issue of distal decompression and avoidance of a closed loop. If a loop colostomy is preferred, one must ensure that the aperture is large enough to accommodate the larger specimen exteriorized. Care must also be taken to properly orient the mesentery. Re-insufflation and visual confirmation of bowel and mesenteric orientation again can be performed.

Single-Port Laparoscopic Colostomy

Single-port colectomy was first described by Remzi *et al.* The technique involves one small incision and a special wound port through which insertion of all laparoscopic instruments occurs. The spectrum of colorectal operations has been reported, including colostomy creation. The benefit to patients is the avoidance of the additional ports and the potential for wound complications. Both end and loop colostomies can be accomplished with the single-port technique. Without question, the technique offers unique ergonomic challenges, is physically and mentally more demanding than traditional multiport laparoscopic technique even for experienced laparoscopic surgeons, and requires specific planning and preparation.

Indications and Contraindications

The technique is similar to laparoscopic colostomy. Again, surgeons must identify (1) high-risk patients for a difficult colostomy creation and (2) their own personal experience and skill set and the increased technical challenge of the single-port technique when factoring into the decision-making process for or against the appropriateness of a single-port approach to laparoscopic colostomy creation.

Patient Preparation

The process is similar to that of multiport laparoscopic colostomy described, including stoma marking, bowel preparation, and oral and IV antibiotics.

Patient Positioning

The position used is supine or lithotomy, although the lithotomy position may be advantageous allowing the surgeon to stand between the patient legs and view a monitor at the head of the patient. The assistant usually stands on the left side of the patient (Fig. 45-13).

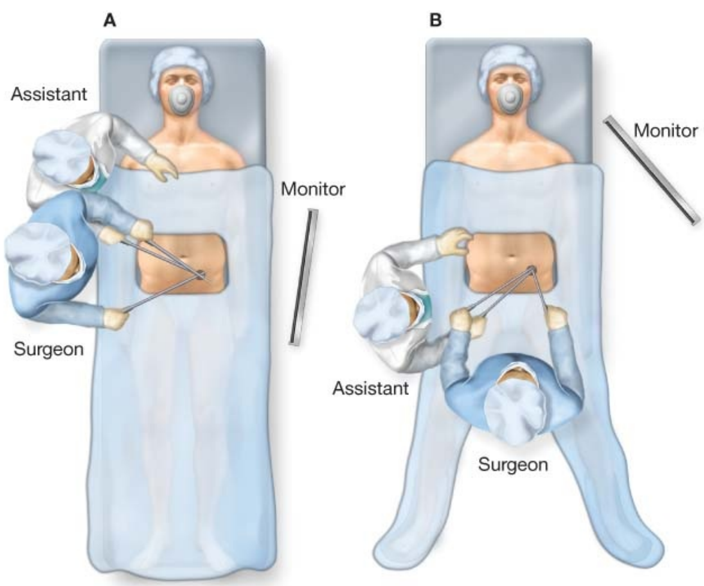


FIGURE 45-13 Options for personnel positioning.

Instrumentation

Single-port access device

Five-mm laparoscope, 30 degree

Angled light cord adapter that keeps the laparoscopic light cord in line with longitudinal axis of the laparoscope, maximizing space for freedom of hand movement externally

Standard and bariatric length instruments—staggered length improves movement of surgeon and assistant hands externally

Locking grasper, scissors with cautery

Stapler—60 mm, bowel and vascular cartridges

Stoma rod if loop stoma planned

Stoma appliance

Operative Technique

The technique usually involves skin excision at the premarked stoma site. There remains a small risk that the planned aperture site may not be suitable and thus abandoned and a separate stoma wound created (two stoma wounds), which may be cosmetically undesirable. This should be considered a rare occurrence if patient selection and appropriate stoma marking occurs.

Following skin excision, the subcutaneous and fascial layers are opened vertically using retractors for exposure, and the rectus muscle then is split bluntly exposing the posterior sheath. Fixation sutures of 0 Vicryl suture on a UR 6 needle are placed on either side of the planned longitudinal incision of the posterior sheath and peritoneum. These sutures assist in elevating the fascia and peritoneum away from the viscera as well as facilitate single-port device insertion. The posterior sheath is incised and the aperture should easily accommodate two normal-sized fingers. The port device is inserted.

After pneumoperitoneum is achieved in standard manner, a 5-mm laparoscope is introduced. Owing to the limitations of the small fascial defect through which all instruments must pass, there are advantages to the use of a 5-mm lens. Laparoscopic exploration ensues and the OR table is then placed in Trendelenburg position and rotated to the right. Graspers are inserted and the small bowel maneuvered out of the pelvis and left side of the abdomen. The operative dissection proceeds in identical manner as described using the multiport laparoscopic technique.

It must be emphasized that the single-port technique imposes substantial ergonomic challenges upon the operating surgeon and assistant. Generally, three instruments are inserted into the port including the laparoscope. There is competition for space externally between three hands, light and camera cords, and instrument manipulation; and degrees of movement of end effectors internally are limited by the competition for hand space externally. Varying the lengths of two of the three instruments allows one to “stagger” the position of one’s hands, reducing competition for the limited working space externally. In addition, the single-port technique limits instrument triangulation and degrees of movement internally. Three instruments often must move in concert. Some triangulation internally can be achieved by crossing one’s hands externally.

If an end stoma is desired, it is especially important to have a consistent method for identification of the proximal and distal ends of the bowel. Visual confirmation will not be available once the bowel is exteriorized through the aperture. Carefully marking the bowel with superficial thermal burn marks (one burn proximal, three burns distally, or by marking with an ink marker tip are acceptable means for this purpose). Exteriorization of the bowel first involves removing the single-port device. When delivering the end of the bowel through the abdominal wall, as previously mentioned it is critical to avoid twisting of the bowel and/or the mesentery.

POSTOPERATIVE MANAGEMENT AND COMPLICATIONS

Key Concepts

Early feeding

Early mobilization

Postoperative stoma education and post-hospitalization stoma support services

If successfully performed, patients undergoing laparoscopic colostomy generally tolerate feeding and rapid return of bowel function. Pain medication requirements also tend to quickly transition to oral routes of administration. Ambulation should be expected immediately after surgery. The length of hospitalization is often limited by the availability for postoperative teaching and patient preparation for stoma care at home. Postoperative assistance at home may facilitate this transition of care. Risks of major complications following laparoscopic colostomy remain rare but include bleeding, infection, and stoma-related complications. Bleeding can occur from mobilization or mesenteric division, port side bleeding, or stomal bleeding. The risk is low and bleeding requiring operative intervention should be considered unusual. Wound infection at port incisions also is unusual. Early stoma-related complications include ischemia, retraction, stenosis, parastomal hernia, or bleeding; generally these are rare, but may require operative revision depending on the severity and impact on stoma function and pouching.

RESULTS

In general, the literature regarding laparoscopic colostomy includes single-institution, retrospective studies reporting on the safety and feasibility and early postoperative outcomes. The studies tend to be small and noncomparative, and therefore, the statements regarding the potential benefits of a minimally invasive approach to colostomy creation generally cannot be concluded. Most reports tend to include both ileostomies and colostomies, given the small numbers of such procedures for fecal diversion alone (no resection). The case series indicates that this approach is safe with rare major complications, and associated with minimal risk of wound infection and short length of hospital stay.

A recent study by Ivatury *et al.* queried the National Surgical Quality Improvement Program dataset and used propensity matching to compare laparoscopic colostomy to open colostomy. Contrary to experience with colectomy, operative time for laparoscopic colostomy was not increased when compared to open colostomy. Less wound infection and decreased length of hospital stay were seen in the laparoscopic colostomy group. There was no difference in mortality between the two groups. Limitations aside, the findings of the report certainly are consistent with case series previously published and with the author's own anecdotal experience. Laparoscopic colostomy offers benefits of reduced wound infections and decreased length of hospitalization.

No studies that compare cost between open and standard laparoscopic colostomy exist. The clinical benefit to patients by avoidance of major laparotomy to create a colostomy, however, remains compelling, and evidence—limitations notwithstanding—now has been put forth indicating outcomes of reduced wound infection and reduced length of hospital stay. Unfortunately, no comparative studies demonstrate any clinical superiority over multiport or standard laparoscopic colostomy creation. The single-port colostomy technique reduces the number of port sites and potential associated wound complications. The price differential of a single-port access device compared to three standard laparoscopic ports immediately raises concerns in this era of health care cost containment. The single wound at the stoma site arguably provides improved cosmesis but imposes increased technical demands and limits a surgeon's ability to perform visual confirmation of the bowel and mesentery because it passes into the abdominal wall aperture when compared with standard laparoscopic colostomy. It remains speculative at this time that the single-port technique will offer an appreciable or distinct advantage over the standard laparoscopic colostomy technique.

CONCLUSIONS

In summary, laparoscopic colostomy creation represents a simple and highly practical technique for fecal diversion, enabling surgeons to perform under direct vision all aspects of colostomy creation without a laparotomy wound. In the appropriate patient and setting, this technique offers advantages of reduced wound infection and decreased length of hospital stay when compared to open colostomy creation, and thus offers benefits to patients suffering from serious conditions requiring fecal diversion for palliation or as a first step toward definitive treatment. The single-port variation of laparoscopic colostomy offers further reduction of surgical wounds, but it is unclear if patients will experience improved clinical outcomes to justify additional expense and technical differences of the technique when compared to standard laparoscopic colostomy.

RECOMMENDED REFERENCES AND READINGS

Aytac E, Stocchi L, Williams R, Remzi FH. Single-port laparoscopic fecal diversion: more than cosmetic benefits? *Surg Laparosc Endosc Percutan Tech* 2014;24:e133–6.

Gorgun E, Gezen FC, Aytac E, Stocchi L, Costedio MM, Remzi FH. Laparoscopic versus open fecal diversion: does laparoscopic offer better outcomes in short term? *Tech Coloproctol* 2015;19:294–300.

Hellinger MD, Haddad AA. Minimally invasive stomas. *Clin Colon Rectal Surg* 2008;21:53–61.

Ivatury SJ, Rosenzweig IC, Holubar SD. Short-term outcomes after open and laparoscopic colostomy creation. *Dis Colon Rectum* 2016;59:543–50.

Lange V, Meyer G, Schardey HM, Schildberg FW. Laparoscopic creation of a loop colostomy. *J Laparoendosc Surg* 1991;1:307–12.

Ludwig KA, Milsom JW, Garcia-Ruiz A, Fazio VW. Laparoscopic techniques for fecal diversion. *Dis Colon Rectum* 1996;39:285–8.

McGee M, Cataldo P. Intestinal stoma. In: Steel SR, Hull TL, Read TE, Sacclaraides TJ, Senagore AJ, Whitlow CB, eds. *The ASCRS Textbook of Colon Rectal Surgery*. 3rd ed. Switzerland: Springer, 2015:971–1014.

Nguyen HM, Causey MW, Steele SR, Maykel JA. Single-port laparoscopic diverting sigmoid colostomy. *Dis Colon Rectum* 2011;54:1585–8.

Remzi FH, Kirat HT, Geisler DP. Laparoscopic single-port colectomy for sigmoid cancer. *Tech Coloproctol* 2010;14:253–5.

Strong SA. The difficult stoma: challenges and strategies. *Clin Colon Rectal Surg* 2016;29:152–9.

PART X

ILEOSTOMY

Chapter 46

Laparoscopic Ileostomy

Bradford Sklow and William J. Peche Jr

INDICATIONS AND CONTRAINDICATIONS

Laparoscopic ileostomy for fecal diversion is minimally invasive and can be accomplished with minimal morbidity. The laparoscopic approach offers the advantages of decreased pain, smaller incisions, quicker return of bowel function, and shorter hospital stay. Most of the time a diverting loop ileostomy is constructed, but an end ileostomy can also be easily performed using the laparoscopic approach. The indications for performing a laparoscopic ileostomy for fecal diversion include fecal incontinence, rectovaginal fistula, perianal Crohn’s disease, obstructing unresectable colon cancer, and anastomotic leak. There are no absolute contraindications to performing a laparoscopic ileostomy, even in patients who are considered high risk or who have had previous abdominal surgery.

PREOPERATIVE PLANNING

The patient should meet with an enterostomal therapy (ET) nurse to be marked with a permanent marker on the abdomen at the site for the planned ileostomy to ensure proper stoma location. Any questions can be answered and concerns addressed during that visit with an ET nurse. Preoperatively meeting with an ET nurse has been shown to reduce postoperative complications and problems with stomas, especially ileostomies.

SURGERY

The patient is positioned in the supine position on the operating room table. A beanbag or pink memory foam pad can be safely used to help carefully secure the patient to the table. Preoperative antibiotics are administered within 1 hour of skin incision. The site of the planned ileostomy is scratched with a small needle because the marker ink can be wiped off during the prep of the skin. The operating surgeon stands on the left side of the table and a 5-mm trocar is placed superior to the umbilicus after pneumoperitoneum is established using a Veress needle. A 5-mm, 30-degree laparoscope is inserted through the supraumbilical port. Alternatively, a 10-mm trocar can be placed using a direct Hasson technique above the umbilicus. Placement of the camera port midway between the umbilicus and the xiphoid may facilitate visualization of the stoma site and facilitate any necessary dissection under it. A10-mm, 30-degree laparoscope is used (Fig. 46-1). An additional 5-mm port is placed on the left side of the abdomen two fingerbreadths medial and superior the left iliac crest (Fig. 46-1). An optional third 5-mm port can be placed through the planned ileostomy site on the right side of the abdomen (Fig. 46-2). Alternative port configurations include the single supraumbilical camera port and a 10-mm port through the ileostomy site. Mobilization of the terminal ileum may be facilitated by releasing the lateral attachments along the pelvic brim up to the right paracolic gutter. The site of a diverting loop ileostomy is chosen approximately 25–40 cm proximal to the ileocecal valve and grasped with an atraumatic bowel grasper (Fig. 46-3). The ileum is oriented with the grasper so as not to twist the loop of ileum. The preselected stoma site on the right side of the abdomen is prepared by making a 2-cm-diameter skin opening. The rectus muscle is bluntly opened to allow 1½–2 fingers to pass with a muscle-splitting technique. The loop of ileum is delivered through the rectus muscle above the level of the skin (Fig. 46-4). A stoma rod may or may not be required to suspend the loop depending on the body habitus of the patient. The abdomen is then re-insufflated and the loop of ileum is visualized going into the stoma site to ensure that the ileostomy was not twisted during delivery through the abdominal wall. The distal limb is placed inferiorly and the functioning limb is placed superiorly. At this point, the ileum can be divided using an open surgical linear cutter to create a divided end-loop stoma and the distal end tucked back into the abdomen below the fascia. This has the advantage of being completely diverting. The laparoscopic ports are removed, and the port site incisions are closed with absorbable, subdermal sutures. A sterile dressing or skin adhesive is applied before maturing the ileostomy. If a loop ileostomy is performed, an incision is made 80% around the circumference of the ileum. The proximal limb of the ileum will be everted as the functioning limb (Fig. 46-5). The proximal aspect of the stoma is Brooked above the level of the skin to the dermis with 3-0 absorbable sutures and the distal end is sutured flush to the dermis of the skin, gathering the bowel wall to a small portion of the circumference of the skin opening at the most inferior part of the stoma site (Figs. 46-6 and 46-7). A stoma appliance is subsequently applied. The editors' preference is to place the camera port in the midline midway between the umbilicus and the xiphoid. The stoma can often be created through the right iliac fossa stoma site without any additional ports. The exception is if terminal ileal mobilization and/or adhesiolysis are necessary then an additional 20-mm left lower quadrant port can be placed as the authors suggest.

FIGURE 46-1 Laparoscopic port placement. Hassan trocar is shown at the umbilicus.

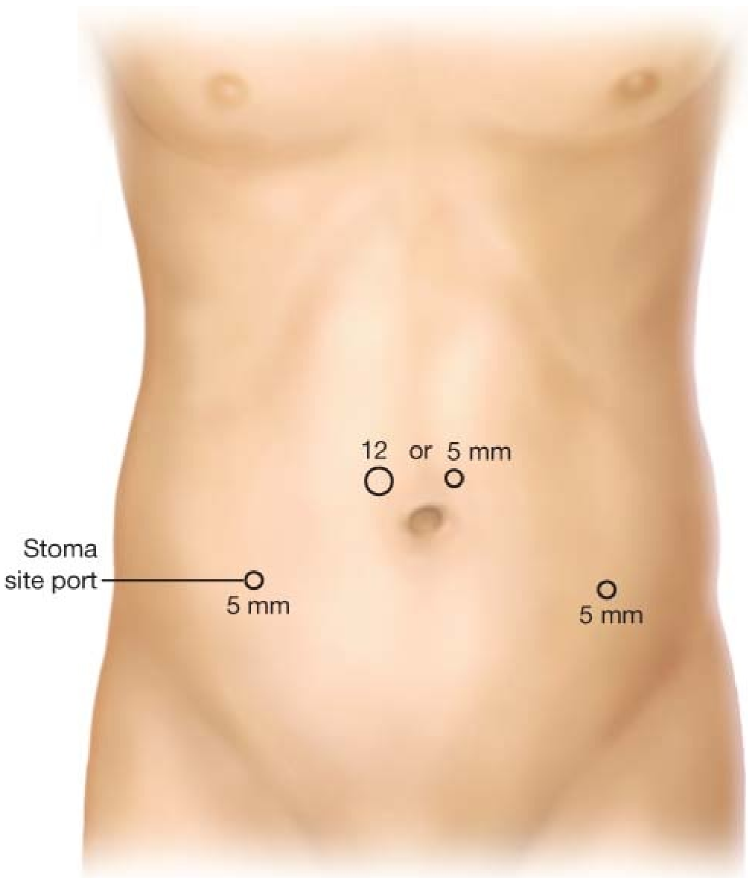


FIGURE 46-2 Port placement with optional 5-mm port through the planned stoma site.

p. 452

p. 453

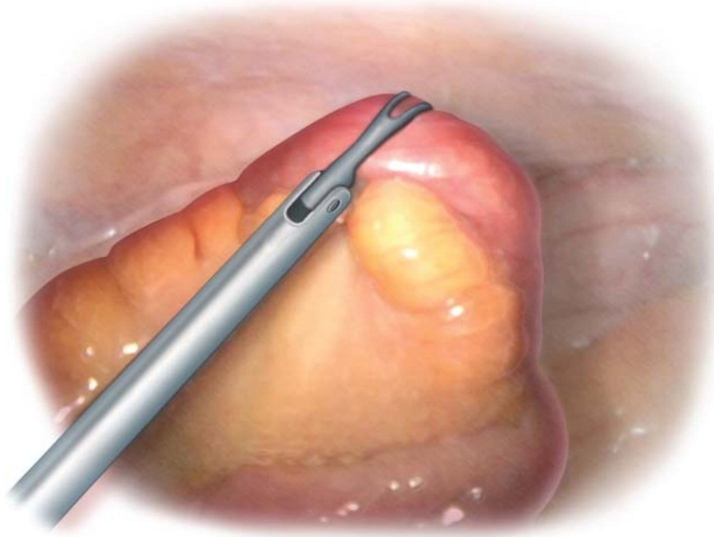


FIGURE 46-3 Loop of ileum is delivered up to the abdominal wall.

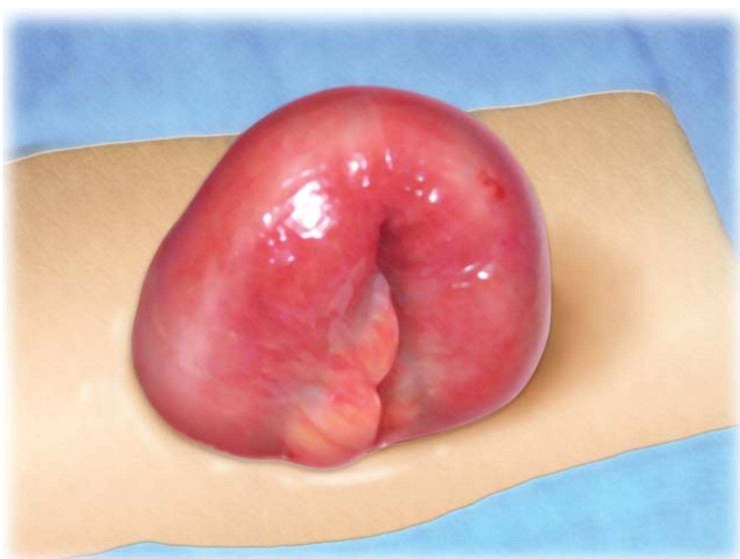


FIGURE 46-4 Loop of ileum before opening and maturing the stoma.

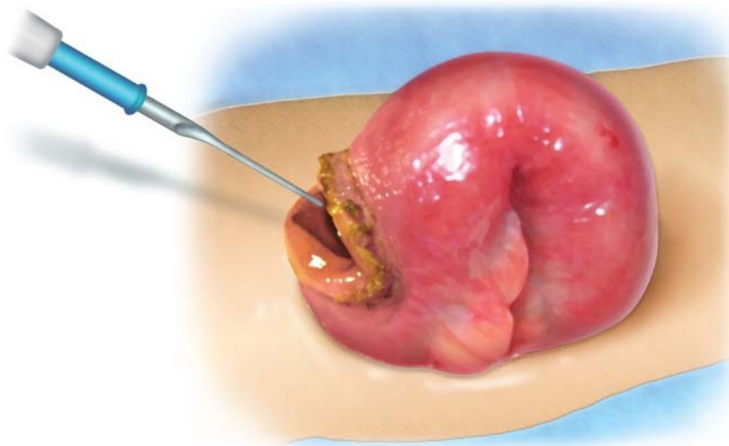


FIGURE 46-5 The incision is made in the ileum close to the distal end.

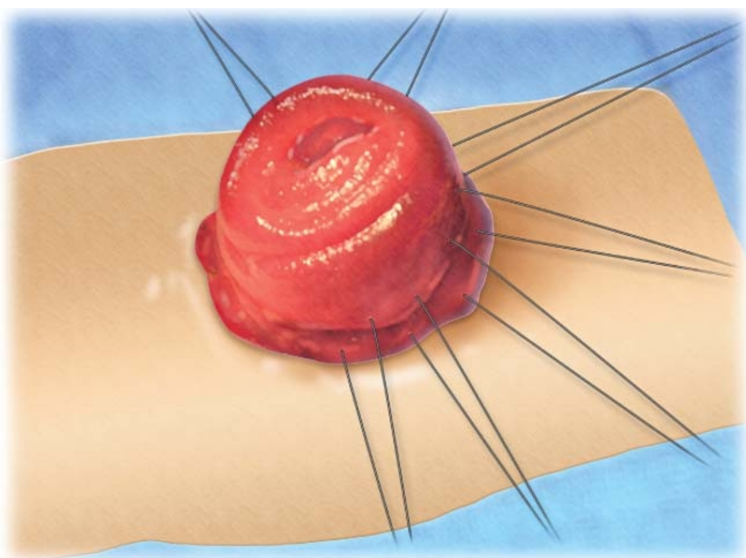


FIGURE 46-6 Maturing the ileostomy using absorbable sutures.

FIGURE 46-7 Brooke ileostomy ready for stoma appliance.

POSTOPERATIVE MANAGEMENT

After creation of a laparoscopic loop or end ileostomy, diet can be advanced as tolerated. Return of bowel function usually occurs within 24–48 hours. Once bowel function has resumed, the ileostomy output may be high initially. Patients must consume an adequate amount of fluids to keep up with the stoma output and avoid dehydration. Electrolyte abnormalities are common, and patients with high-output ileostomies should have their electrolytes checked. Output should be less than 1,200 ml/day before discharge. If the stoma output remains high, there are various medications that can help reduce the effluent. Fiber supplementation, loperamide or diphenoxylate, tincture of opium, and codeine are helpful. If a patient still has high output despite the use of antidiarrheal medications, he or she may need to be discharged on intravenous (IV) fluids. Over a period of weeks, the ileostomy output will decrease to between 500 and 800 ml/day. If a stoma rod was used for a loop ileostomy, it can be removed on postoperative day 3–5. Peristomal skin care is paramount in the postoperative period. Proteolytic enzymes and the high alkaline content of the stoma effluent are responsible for significant skin irritation. Care of the patient should involve close cooperation between the surgeon and enterostomal therapist. Stoma care teaching by an enterostomal therapist is helpful in educating patients on the care of their ileostomy, and patient education is paramount in avoiding readmissions or visits to the emergency room for dehydration.

COMPLICATIONS

The laparoscopic approach lends itself to all of the complications associated with laparoscopy in general. The most common access injury is small bowel injury from trocar or Veress needle insertion (0.13%). Extra care must be taken to avoid the complication of twisting the ileostomy. Tactile sensation and visualization are reduced with the laparoscopic approach and an instrument can overgrasp or release without warning. The incidence of complications rates for ileostomy formation is variable, ranging from 24% to 69%. The largest study by Park *et al.* reported a complication rate of 34% in 1,616 patients with both ileostomies and colostomies performed at Cook County Hospital over a 20-year period. This study also demonstrated the highest complication rate of 75% in loop ileostomies. Arumugam *et al.* performed a prospective study demonstrating that body mass index, diabetes, and emergency surgery were associated with complications on multivariate regression analysis.

Complications are generally classified as being early or late. Early complications include peristomal dermatitis, dehydration, necrosis/ischemia, retraction, and infection. The most common complication is peristomal dermatitis or irritation and has a reported incidence of 15–42%. Placing the ileostomy in the proper location along with adequate skin care in conjunction with an ET nurse will help minimize this complication. Dehydration combined with electrolyte abnormalities is also very common following construction of a new ileostomy and up to 20% of patients require either hospital readmission or IV fluids as an outpatient. A small percentage of patients may require IV fluid supplementation at home following creation of a new ileostomy.

Peristomal infections and abscess are uncommon, with a reported incidence of 2–15%. An abscess must be surgically drained at the mucocutaneous junction or outside the border of the stoma appliance. The subsequent development of a fistula is not uncommon; and if persistent, it often requires new stoma formation.

Late complications include parastomal hernia, bowel obstruction, stenosis, nephrolithiasis, and stomal prolapse. The incidence of paraileostomy hernia ranges from 1.8% to 28.3% for end ileostomy and 0–6.2% for loop ileostomy. Risk factors for parastomal hernia include obesity, poor nutrition, steroid therapy, wound infection, and chronic cough. Parastomal hernias are often asymptomatic and should be managed conservatively. Pain, difficulty with fitting the stoma appliance, bowel obstruction, strangulation, and perforation are indications for repair of the hernia. The results of parastomal hernia repair are disappointing, with high recurrence rates. Options include primary suture repair, repair with prosthetic or biologic mesh, and stoma relocation.

RESULTS

Laparoscopic ileostomy is safe, with low conversion rates. In one of the largest series in which 53 laparoscopic loop ileostomy procedures were retrospectively reviewed, there were no conversions. The average duration of the surgery was 47 minutes and there were no early complications reported. Other series have included laparoscopic end and loop colostomies and ileostomies with conversion rates between 2.4% and 15.6% and early complications related to the operation of 6–9.5%. These studies all concluded that laparoscopic stoma creation is safe and effective.

CONCLUSIONS

Ileostomy construction is well suited for the laparoscopic approach with low conversion rates and short operative times.

Preoperative appointment with an ET nurse is important for proper ileostomy location selection and to minimize postoperative complications.

The majority of postoperative complications are stoma related and not due to the laparoscopic technique itself.

RECOMMENDED REFERENCES AND READINGS

Arumugam PJ, Bevan L, Macdonald L, *et al.* A prospective audit of stoma: analysis of risk factors and complications and their management. *Colorectal Dis* 2003;5(1):49–52.

Bass EM, Pino AD, Tan A, Pearl RK, Orsay CP, Abcarian H. Does preoperative stoma making and education by the enterostomal therapist affect outcome? *Dis Colon Rectum* 1997;40(4):440–2.

Duchesne JC, Wang YZ, Weintraub SL, Hunt JP. Stoma complications: a multivariated analysis. *Am Surg* 2002;68(11):961–6.

Edwards DP, Leppington-Clarke A, Sexton R, Heald RJ, Moran BJ. Stoma related complications are more frequent after transverse colostomy than loop ileostomy: a prospective randomized clinical trial. *Br J Surg* 2001;88:360–3.

Feinberg SM, McLeod RS, Cohen Z. Complication of loop ileostomy. *Am J Surg* 1987;153(1):102–7.

Hellman J, Lago CP. Dermatologic complications in colostomy and ileostomy patients. *Int J Dermatol* 1990;29(2):129–33.

Joh YG, Kim SH, Hahn KY, Stulberg J, Chung CS, Lee DK. Anastomotic leakage after laparoscopic proctectomy can be managed by a minimally invasive approach. *Dis Colon Rectum* 2009;52(1):91–6.

Leslie D. The parastomal hernia. *Surg Clin North Am* 1984;64:407–15.

Londono-Schimmer EE, Leong AP, Phillips RK. Life table analysis of stomal complications following colostomy. *Dis Colon Rectum* 1994;37(9):916–20.

Marks JH, Kawun UB, Hamdan W, Marks G. Redefining contraindications to laparoscopic colorectal resection for high-risk patients. *Surg Endosc* 2008;22(8):1899–904.

Nagle D, Pare T, Keenan E, Marcet K, Tizio S, Poylin V. Ileostomy pathway virtually eliminates readmissions for dehydration in new ostomates. *Dis Colon Rectum* 2012;55(12):1266–72.

Ng KH, Ng DC, Cheung HY, *et al.* Obstructive complications of laparoscopically created defunctioning ileostomy. *Dis Colon Rectum* 2008;51:1664–8.

Offodile AC, Lee SW, Yoo J, *et al.* Does prior abdominal surgery influence conversion rates and outcomes of laparoscopic right colectomy in patients with neoplasia? *Dis Colon Rectum* 2008;51(11):1669–74.

Oliveira L, Reissman P, Nogueras J, Wexner SD. Laparoscopic creation of stomas. *Surg Endosc* 1997;11(1):19–23.

Park JJ, Del Pino A, Orsay CP, *et al.* Stoma complications: the Cook County experience. *Dis Colon Rectum* 1999;42(12):1575–80.

Pearl RK, Prasad ML, Orsay CP, *et al.* Early complications from intestinal stomas. *Arch Surg* 1985;120(10):1145–7.

Pearl RK. Parastomal hernias. *World J Surg* 1989;13:569–72.

Robertson I, Leung D, Hughes D, *et al.* Prospective analysis of stoma-related complications. *Colorectal Dis* 2005;7:279–85.

Rullier E, Le Toux N, Laurent C, Garrelon JL, Parneix M, Saric J. Loop ileostomy versus loop colostomy for defunctioning low anastomosis during rectal cancer surgery. *World J Surg* 2001;25:274–8.

Schwandner O, Schiedeck T, Bruch H. Stoma creation for fecal diversion: is the laparoscopic technique appropriate? *Int J Colorectal Dis* 1998;13(5–6):251–5.

Shabbir J, Britton DC. Stoma complications: a literature overview. *Colorectal Dis* 2010;12:958–64. [Epub ahead of print].

Shellito PC. Complications of abdominal stoma surgery. *Dis Colon Rectum* 1998;41:1562–72.

Swain B, Ellis N. Laparoscopic-assisted loop ileostomy an acceptable option for temporary fecal diversion after anorectal surgery. *Dis Colon Rectum* 2002;45(5):705–7.

Thalheimmer A, Bueter M, Kortuem M, Thiede A, Meyer D. Morbidity of temporary loop ileostomy in patients with colorectal cancer. *Dis Colon Rectum* 2006;49(7):1011–7.

Van der Voort M, Heijnsdijk EA, Gouma DJ. Bowel injury as a complication of laparoscopy. *Br J Surg* 2004;91:1253–8.

Williams JG, Etherington R, Hayward MW, Hughes LE. Paraileostomy hernia: a clinical and radiological study. *Br J Surg* 1990;77:1355–7.

Chapter 47

Continent Ileostomy
David W. Dietz

INTRODUCTION

Complete removal of the colon and rectum is sometimes the only treatment option for patients with complicated or medically refractory inflammatory bowel disease (IBD) or certain hereditary colorectal cancer syndromes. Fortunately, patients undergoing total proctocolectomy (TPC) today are almost always able to maintain intestinal continuity with preservation of an anatomic route for defecation through creation of an ileal pouch-anal anastomosis (IPAA). Before the description of the restorative proctocolectomy (IPAA) by Parks and Nicholls in 1978, however, this was not the case. Patients in that era had an end ileostomy as the only option and the inconvenience and stigma attached to the ileostomy often made patients reluctant to consent to needed surgery. Appreciating the difficulties that such patients often encountered, Professor Nils Kock of the University of Gothenburg in Sweden first described a “continent ileostomy” (CI) in 1969. The advantages of the CI over an end ileostomy stemmed from an intussuscepted valve that allowed for creation of a flush stoma that did not require the patient to wear an external appliance to collect intestinal waste. A number of colorectal surgery centers around the world adopted the CI and began to gain experience with the procedure. However, the advent of the IPAA 10 years later, along with the difficulties and complications encountered during the early experience with CI surgery, led to a marked and rapid decrease in its popularity. As time passed, fewer and fewer centers offered CI as an option for patients wishing to avoid a conventional end ileostomy and today only a handful of surgeons familiar with the procedure can be found in practice. Despite this, however, the procedure still plays an important role in the surgical management of certain highly selected patients.

INDICATIONS/CONTRAINDICATIONS

Today, IPAA is the gold standard procedure for the surgical treatment of patients with ulcerative colitis (UC), but CI still remains an option in certain specific situations in patients with UC and in very highly selected patients with Crohn's colitis. In an unpublished series of 423 patients undergoing CI surgery at the Cleveland Clinic, the final diagnosis was UC in 74%, indeterminate colitis in 5%, and Crohn's colitis in 10%. Familial adenomatous polyposis (FAP) accounted for the remainder.

There are four common indications for CI surgery, mostly in patients with IBD. These indications are discussed in detail here.

Patients who are referred for redo-IPAA after failure of their index IPAA and are found not to be candidates (approximately 15% of patients).

Patients who are taken to the operating room for IPAA in whom pouch-anal anastomosis cannot be achieved because of inadequate mesenteric length (approximately 5%).

Patients who require TPC but have contraindications (e.g., fecal incontinence, very low rectal cancer, anal canal disease) to pouch-anal anastomosis (approximately 10%).

Patients with an existing conventional ileostomy who find it unacceptable because of severe pouching problems or interference with sex life, athletics, or occupation (approximately 60%).

Failed Ileal Pouch-Anal Anastomosis

Failure of an IPAA is defined as excision of the ileal pouch with closure of the anal canal, permanent fecal diversion with a proximal loop ileostomy, or having an unreversed diverting ileostomy. The long-term risk of IPAA failure varies between 3% and 28% and is influenced by characteristics of the patient population. Pelvic sepsis complicating surgery and a diagnosis of Crohn's disease (CD) are strongly associated with pouch failure.

Patients with a failed IPAA are often candidates for redo-IPAA and good results can be obtained. In 502 patients undergoing an IPAA reconstruction, the overall success rate was reported as 80%. Despite this high percentage of success, some patients who are referred for redo-IPAA are not candidates for that procedure. Factors such as sphincter dysfunction and extensive pelvic that procedure. Factors such as sphincter dysfunction and extensive pelvic fibrosis due to peripouch sepsis are contraindications to redo-IPAA, because bowel function and quality of life can be anticipated to be extremely poor. Some of these patients, however, can be offered a CI if it is felt that they will not do well with a conventional end ileostomy. In 64 patients with a failed IPAA, 25% had the existing J-pouch converted into the CI pouch, whereas 75% required excision of the existing pelvic J-pouch with creation of a de novo CI pouch. The length of the remaining bowel is often an issue in these patients, because the previously constructed pelvic pouch may comprise 15% of their existing bowel length. Because a CI requires approximately 55–60 cm of bowel for construction, a patient who undergoes excision of a failed pelvic pouch with creation of a new CI may lose up to one-third of the functional bowel length, because the absorptive capacity of the CI pouch is largely unknown. It is critical to consider and discuss with the patient the “worst case scenario” of subsequent failure of the CI that requires pouch excision. This would potentially leave the patient with only 200 cm of small bowel proximal to an end ileostomy, a bowel length that most would consider on the borderline of short-bowel syndrome.

Technical or Patient-Related Factors that Preclude Ileal Pouch-Anal Anastomosis After Total Proctocolectomy

Occasionally, patients are taken to the operating room for restorative proctocolectomy but the surgeon finds that it is not possible to create an IPAA because of inadequate small bowel mesenteric length. Patients requiring TPC may also be poor candidates for IPAA because of preexisting problems such as poor sphincter function, low rectal cancer complicating chronic colitis, or anal canal/perineal CD. In these situations and when preoperative discussion has been held and consent obtained, a CI can be constructed at the same operation. However, in the former case, especially if not anticipated and discussed before surgery, it is best to construct a conventional end ileostomy. Consent can then be obtained from the patient after surgery and the conventional ileostomy can be converted to a CI 6–12 months later.

Existing Conventional Ileostomy Unacceptable

The largest groups of patients undergoing CI surgery nowadays are those who present with an existing conventional end ileostomy. These patients seek a CI for a variety of reasons, but the common denominator is that they feel their existing ileostomy adversely affects their quality of life. Common concerns relate to the effect of the ileostomy on sex life and limitations on physical activity, especially in young athletes. A small group of patients have skin conditions such as psoriasis or allergic dermatitis related to the stoma appliance. These patients have great difficulty in maintaining a seal and suffer from frequent and embarrassing leakage. In addition, the need for frequent pouch changes, sometimes several daily, can be financially prohibitive. Patients seeking CI for these reasons should be counseled extensively. The risks of CI surgery, both short-and long-term, must be balanced against the patient’s expectations and the likely benefits.

Contraindications to Continent Ileostomy Creation

Existing short-bowel syndrome, or risk of short-bowel syndrome if the CI were to fail and pouch excision was required

Obesity

Unfavorable anatomy

Small bowel CD

Intra-abdominal desmoid disease in patients with FAP

There are several situations where CI creation is ill-advised. Patients with existing short-bowel syndrome, or those who would be at risk of short-bowel syndrome should the CI fail and require excision, are not candidates for the procedure. As discussed, the latter determination requires considerable judgment by the surgeon who must calculate the risk of CI failure in the individual patient, estimate or measure the length of existing small bowel, and predict the outcome if the patient lost an additional 55–60 cm of small bowel vis-a-vis pouch excision. Obesity, both truncal and visceral, may be considered as contraindications to CI creation. Obese patients have been found to be at increased risk of valve slippage, and a large pannus as well as a thick small bowel mesentery create technical difficulties with construction of both the intussuscepted nipple valve and its exit conduit. Patients with small bowel CD have been found to be at higher risk for CI failure, with failure rates of 20%, 35%, and 50% at 5, 10, and 20 years, respectively (unpublished data). Intra-abdominal desmoid disease, which complicates the course of approximately 10–15% of patients with FAP, can also preclude creation of a CI.

PREOPERATIVE PLANNING

The steps that should be taken to prepare a patient for CI surgery may vary, depending on the indication for surgery. Common to each is the preoperative marking of the patient by either the surgeon or enterostomal therapy nurse. Continent ileostomies are usually sited lower in the abdomen than a conventional end ileostomy, typically at the level of the anterior superior iliac spine and just above the pubic hairline, but still within the confines of the rectus abdominus muscle (Fig. 47-1). The reasons for this relate to the fact that the CI pouch usually resides in the lowest aspect of the right lower quadrant or in the pelvis, the abdominal wall may be less thick at this site, and that cosmesis is improved. In patients being considered for conversion of a failed IPAA to a CI, the health, size, and suitability of the existing ileal J-pouch should be assessed. Significant mucosal disease (pouchitis or CD) precludes use of the existing pouch and is likely a contraindication to formation of even a de novo CI. Extremely small or large ileal pouches may need to be either augmented or reduced in size during conversion to a CI and CI surgeons must possess sufficient experience and creativity to deal with these issues when they arise.

FIGURE 47-1 A. Continent ileostomy patient. The stoma is typically located in the lowermost aspect of the right abdomen. B. Patient performing catheter intubation of the continent ileostomy.

SURGERY

Evolution of the Continent Ileostomy

After its first description by Koch in 1969, the technique for CI creation has undergone a number of modifications. Kock's initial description of the CI did not include an intussuscepted nipple valve. The primitive design was a U-shaped pouch constructed from the distal small bowel with a long efferent limb pulled through an opening in the abdominal wall within the confines of the rectus abdominis muscle and terminating in a skin-level stoma. The rectus abdominis muscle was intended to act as a sphincter-type mechanism around the efferent limb to provide continence. Unfortunately, this design provided continence only in a small minority of patients. Kock's initial, albeit unsuccessful, modification to overcome the problem of incontinence was to create an antiperistaltic efferent limb. It was not until 1973 that he described intussusception of the efferent limb to create the characteristic nipple valve that is the hallmark of most modern continent ileostomies. This modification was successful in providing continence to a majority of patients, but it also set the stage for the most common complication of the modern CI which is valve slippage.

During the past 30 years, a number of new methods have been developed in an attempt to reduce the rate of valve slippage, which has been reported in as many as 30% of CI patients. Kock attempted to address this problem through modifications of his technique that involved splitting and de-fatting of the valve mesentery, suture fixation and serosal scarring, partial rotation of the valve, and finally stapled fixation with the use of a fascial strip or Marlex mesh (Bard, Warwick, RI). Kock's largest published series of 314 patients showed a steady reduction in valve complications and slippage with the evolution of his technique. Others have made similar modifications to the procedure, mostly aimed at fixation of the valve by chemical or physical means. Fibrosis between the two intussuscepted layers has been promoted by traumatizing the serosa of the efferent limb using an orthopedic rasp, deep diathermy scarring of the serosa, interposing synthetic mesh between the valve layers, and by chemical means with substances such as formalin, silver nitrate, talc, and even asbestos. Staple fixation of the valve, both to itself and the pouch sidewall, was first described by Fazio and Tjandra in 1992, and this method remains the author's primary means of valve stabilization today. Although these modifications have undoubtedly reduced the incidence of valve slippage, they have also increased the risk of other complications such as valve or pouch fistulas.

More radical attempts at altering the basic design of the CI have also been

More radical attempts at altering the basic design of the CI have also been undertaken in an attempt to decrease the risk of valve slippage. The most common of these is the Barnett continent ileostomy reservoir, or BCIR. The initial form of the BCIR was described by Spencer and Barnett in 1979 and relied on an isoperistaltic intussuscepted valve for continence. However, valve slippage continued to occur and the "living intestinal collar" that is the distinguishing feature of the modern BCIR was added in 1986 in an attempt to buttress the mesenteric side of the valve where slippage is felt to first develop.

Regardless of the technique of CI construction, valve slippage remains the "Achilles' heel" of the operation. In an attempt to eliminate the problem of valve slippage altogether, Kaiser and Beart have developed a "valveless" CI. This design, known as the "T-pouch", was initially described by Stein for urinary diversion after cystectomy. Although valve slippage is inherently avoided, analysis of the designers' first 10 years of experience with the technique still found a reoperation rate of greater than 50%.

Current Technique

The CI operation can be divided into four stages: construction of the S-pouch, creation of the intussuscepted nipple valve, valve fixation, and siting of the pouch with stoma maturation. In the case of de novo CI creation, the entire pouch is constructed from the distal-most 60 cm of small bowel. In the first stage, an S-pouch is fashioned from three 12-to 15-cm limbs of ileum (Fig. 47-2). These limbs are first approximated with a serosal layer of interrupted or continuous 3-0 absorbable suture leaving an efferent limb of approximately 20 cm that will ultimately become the intussuscepted nipple valve. The exact length of the efferent limb is derived from doubling the desired length of the valve (6–7 cm) and adding the thickness of the abdominal wall through which the exit conduit will pass. An antimesenteric enterotomy is then created along the three limbs of the S-pouch and the back wall of the pouch is constructed with a running full-thickness 3-0 absorbable suture (Fig. 47-3). A 6-to 7-cm valve is then fashioned by intussuscepting the efferent limb into the pouch and fixing it to itself with two firings of a non-cutting 55-mm linear stapler placed along either edge of the valve mesentery (Fig. 47-4). Care must be taken to not include the mesentery in the staple lines because a hematoma or valve ischemia could result. If the efferent limb that will be used for valve construction has a bulky mesentery, it should be stripped of peritoneum and fat, taking care not to damage the underlying blood vessels. This "de-fatting" maneuver will make it easier to intussuscept the efferent limb to create the valve and promote fibrosis between the valve layers to inhibit slippage. The anterior wall of the S-pouch is then closed with either a running or interrupted 3-0 absorbable seromuscular suture(s). Suture closure of the anterior pouch wall is initiated at the apex of the pouch and each stitch includes the mucosa and submucosa of the antimesenteric aspect of the valve. This is important for fixation of the valve to the pouch wall, a maneuver that helps to minimize the risk of valve slippage. When the suture line reaches the tip of the valve, a third firing of the non-cutting 55-mm linear stapler is applied along this suture line to further reinforce the suture fixation of the valve to the pouch wall (Fig. 47-5). Stitches are then transitioned to only include the pouch wall and the suture line is completed. “Fundoplication” stitches of a 3-0 nonabsorbable suture are then placed between the apex of the pouch and the exit conduit to further stabilize the valve. Pouch suture line integrity and continence of the valve are tested by intubating the pouch with a 30 French catheter, filling the pouch to capacity with saline and air, and then withdrawing the catheter (Fig. 47-6). The pouch is then situated within the pelvis or lower abdominal cavity and the exit conduit is brought through the abdominal wall after creating a stoma aperture at the previously marked site. The apex of the pouch is then fixed to the underside of the abdominal wall with several 3-0 nonabsorbable sutures (Fig. 47-7), and the stoma is matured flush with the skin (Fig. 47-8). The stoma is again intubated with the catheter; the location of its tip is confirmed within the pouch (Fig. 47-9); and the catheter is secured to the skin to prevent it from becoming dislodged in the postoperative period (Fig. 47-10). The pelvis is drained, and the abdomen is then closed.

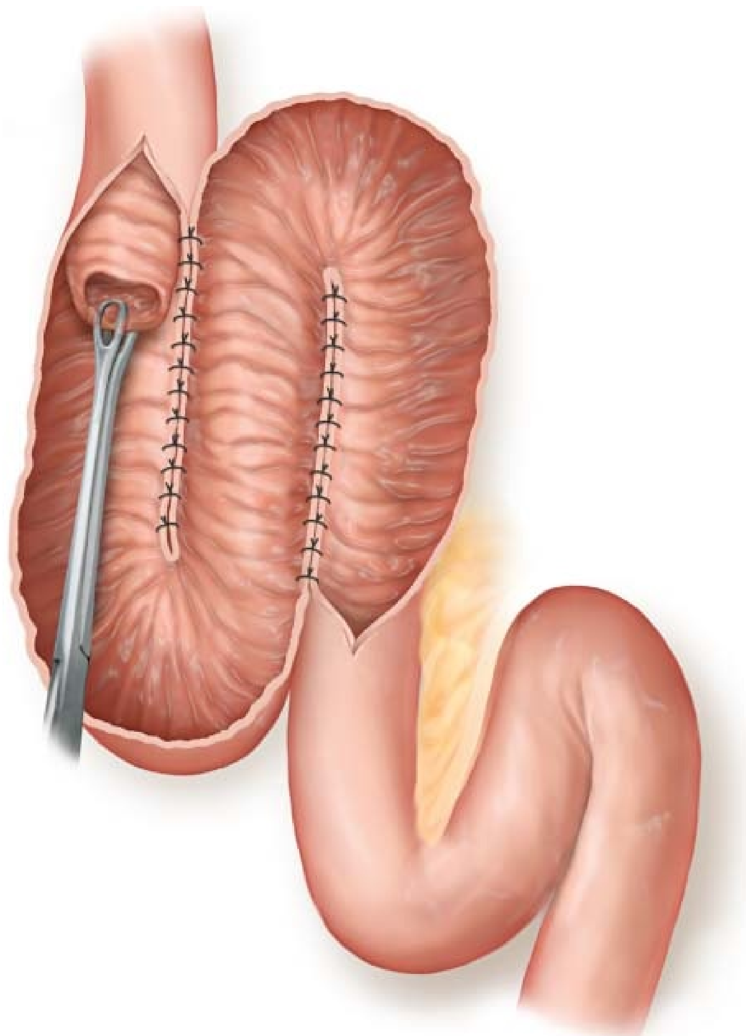


FIGURE 47-2 S-pouch configuration for continent ileostomy formation as favored by author.

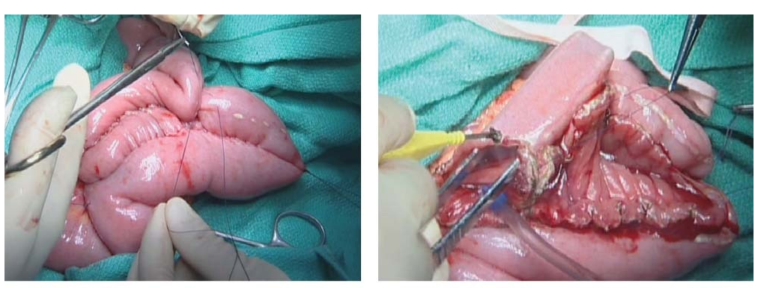


FIGURE 47-3 A. Aligning the three limbs of the S-pouch. B. Opening the aligned loops on the antimesenteric border.

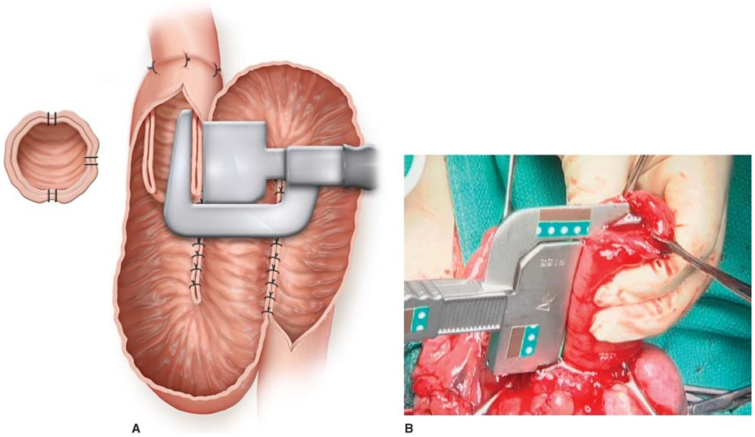


FIGURE 47-4 A. Stabilization of the nipple valve using three to four applications of a stapler. B. Intraoperative image of the TX stapler used to stabilize the nipple valve.

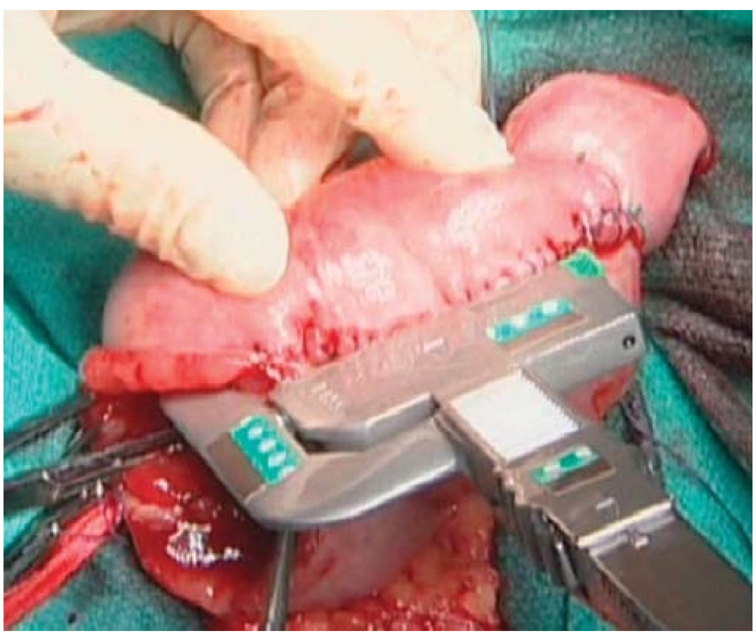


FIGURE 47-5 Application of PI 55 stapler over the anterior portion of the nipple valve that has already been stabilized with sutures to anterior portion of pouch.

FIGURE 47-6 Testing pouch capacity plus valve integrity.

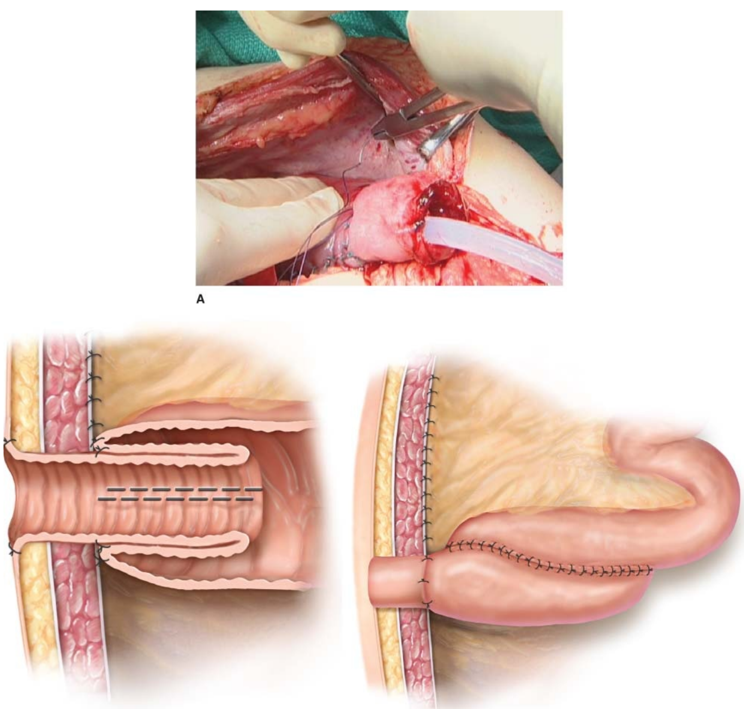


FIGURE 47-7 A. Anchoring the fundus of the pouch lateral to the stoma opening. B. Anchoring fundus of pouch and closure of parastomal space.

FIGURE 47-8 Exit conduit is sutured flush with the stoma opening.

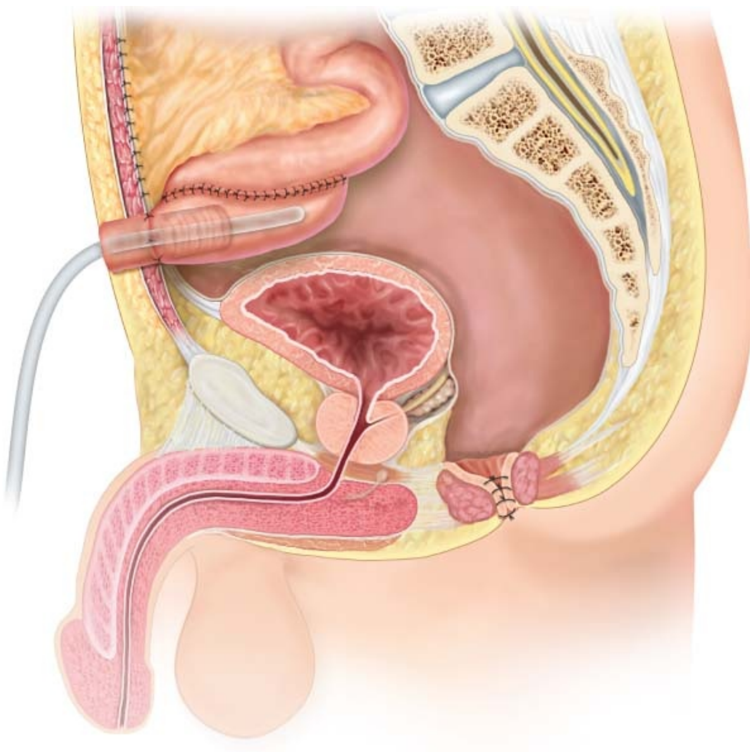


FIGURE 47-9 Drainage tube must pass easily and without excessive angulations into the pouch.

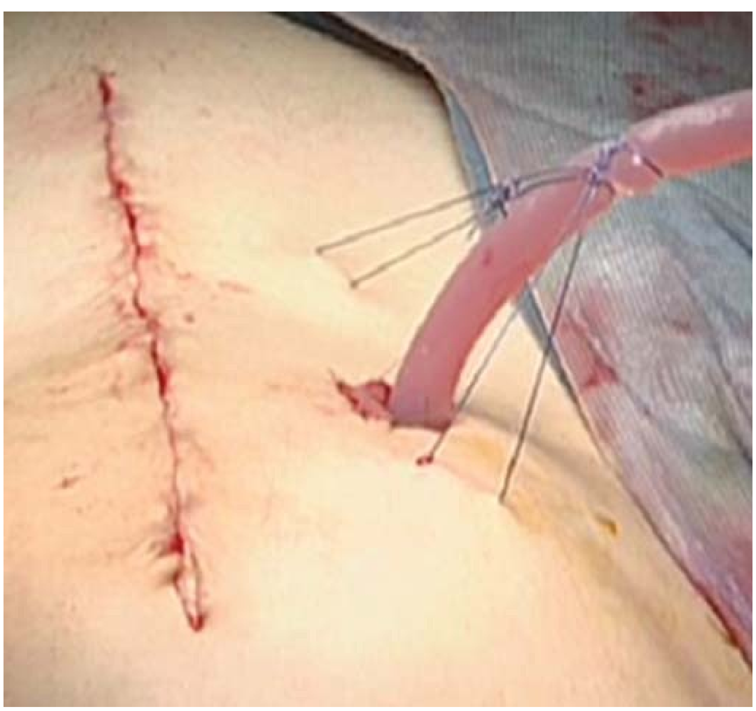


FIGURE 47-10 Tripod sutures secure the draining tube.

POSTOPERATIVE MANAGEMENT

During the in-hospital phase of postoperative management, the assistance of a skilled enterostomal therapy nurse experienced in the care of CI patients is vital. The catheter is irrigated with 30 ml of normal saline every 2 hours until intestinal function returns. If the catheter is found to be occluded, it can usually be successfully cleared by further irrigation and/or gentle adjustment of the catheter's position within the pouch. The patient is instructed in the care of the catheter in preparation for discharge and is usually able to be sent home on postoperative day 5–7 on a soft, low-fiber diet.

The catheter is left in place for 4 weeks after surgery to keep the pouch continuously drained, using frequent small-volume irrigations by the patient to ensure patency. The first outpatient visit occurs 1 month after surgery, at which time the CI is tested for continence and capacity. The patient is seen by the enterostomal therapy nurse during this visit and is instructed in the proper method of pouch intubation. Intermittent catheterization begins at 2-hourly intervals, with a gradual reduction in the frequency of intubation over the ensuing weeks. The author prefers the routine follow-up to be scheduled at 3 months from the discharge day and at yearly intervals thereafter. Pouchoscopy is performed at those visits to assess the valve for signs of slippage (Fig. 47-3). Over the first 6–12 months, the capacity of the pouch will gradually expand to a volume of approximately 800 ml. A "mature" CI requires intubation approximately 4–6 times/day and most patients can sleep through the night.

COMPLICATIONS

Early postoperative complications are common after CI surgery, a fact that has likely restricted its widespread use. However, the procedure is relatively safe, with reported mortality rates that are similar to restorative proctocolectomy. Complications occurring within the first 30 days of surgery include wound infections, staple line bleeding, suture lines leaks and enterocutaneous fistulas, and valve necrosis. The latter problem is exceedingly rare but would likely require pouch excision with immediate conversion to a conventional ileostomy. In select cases, the valve only could be excised, the resulting pouchotomy closed, and a proximal diverting loop ileostomy created. This measure would allow for the possibility of eventual pouch salvage, with creation of a new valve from the afferent limb of the pouch 6–12 months later. Enterocutaneous fistulas after CI surgery often close spontaneously if the pouch is kept to prolonged continuous drainage. These patients are usually managed with total parenteral nutrition and nothing by mouth until healing occurs. Staple line bleeding is managed conservatively with supportive care and transfusion of blood products and coagulation factors as needed. The pouch should be frequently irrigated to remove clots. If bleeding fails to cease, then endoscopic management is undertaken. An endoscopist experienced with the anatomy of the CI is best suited to deal with this difficult situation.

RESULTS

Continent Ileostomy Durability

Long-term outcomes following CI surgery have been reported in several large series, with the authors generally concluding that while reoperations are common, the majority of patients can be maintained with a well-functioning CI for many years. Valve-related problems including valve slippage, fistula, and prolapse are the common issues requiring revision surgery, whereas other more mundane problems such as pouchitis and bacterial overgrowth are managed medically. Parastomal hernias frequently occur, and, contrary to those arising around conventional stomas, should be repaired when discovered because they contribute to the mechanism of valve slippage. Skin-level strictures of the stoma are also common and can be treated by careful local revision to excise the stenotic distal-most aspect and re-mature the stoma, thus avoiding a laparotomy.

As previously stated, valve slippage is the “Achilles’ heel” of CI, and is responsible for the majority of reoperations in CI patients. The first sign of a slipped valve is usually difficulty with intubation of the pouch. This occurs due to the angulation of the exit conduit that results as a portion of the intussuscepted valve slips and moves into the subcutaneous space. The patient may also notice mild prolapse of the stoma at this time. If valve slippage progresses, incontinence to gas and stool will follow because the intrapouch segment of valve is no longer adequate to close with rising pouch pressures. Patients may first notice incontinence in the morning when pouch pressures are highest after a night’s sleep without intubation. In a series of 330 patients undergoing CI surgery from 1975 to 2001, the overall reoperation rate was 70%. This rate is similar to reports from other high-volume experiences. However, after a median follow-up of 11 years, 10-and 20-year pouch survival rates were 87% and 77%, respectively, and the median length of pouch survival was 27 years. Maintenance of a functioning pouch came at the cost of an average of 2.9 reoperations per patient with a median revision-free interval of only 14 months. This data suggests that when patients develop a slipped valve, they are likely to have problems with recurrent valve slippage over the lifetime of their pouch. Patients’ whose valve does not slip within the first several years of CI creation are likely to remain without the need for reoperation.

Development of a fistula involving the valve that allows pouch contents to bypass the valve mechanism will also result in incontinence. Fistulas can be difficult to diagnose, but subtle differences in presentation may allow them to be differentiated as a cause of incontinence from valve slippage. The cause of CI fistulas is usually technical, mechanical, or disease-related. Fistulas that manifest in the early postoperative period are often related to the fundoplication sutures that are placed between the exit conduit and the pouch apex to stabilize the valve. If these sutures are placed too deeply into either the pouch wall or exit conduit, a fistula may result. The most common cause of fistula is likely mechanical trauma resulting from difficult intubation. Because early valve slippage is usually the cause of difficult intubation, a resultant fistula between the pouch and the valve is not infrequently encountered during surgery to repair a slipped valve. Ischemia of the valve due to slippage may also contribute to fistula formation. Fistulas that arise from the body of the pouch and present remotely from the time of surgery are often due to the presence of CD.

Patients acutely presenting with either inability to intubate or large-volume incontinence can be temporized until revision surgery is possible. In the former case, a nasogastric tube should be placed to relieve the mechanical obstruction; in the latter, the stoma can be pouched to collect leaking stool. Care of the patient should then be transferred to a center with experience in the management of CI patients. Flexible endoscopy of the pouch with retroflexion to examine the valve usually reveals the diagnosis (Fig. 47-11) and a special temporary catheter (NUVAL Continent Ostomy Valve, Bridgeville Plastics, Stevensville, MI) (Fig. 47-12) can be placed to convert the problem to one that can be electively handled. Unfortunately, patients are sometimes taken to the operating room in these situations at their local hospital by an inexperienced surgeon and the pouch is excised.

FIGURE 47-11 Fistula arising from the base of nipple valve. Fistula between the pouch and nipple valve can cause incontinence.

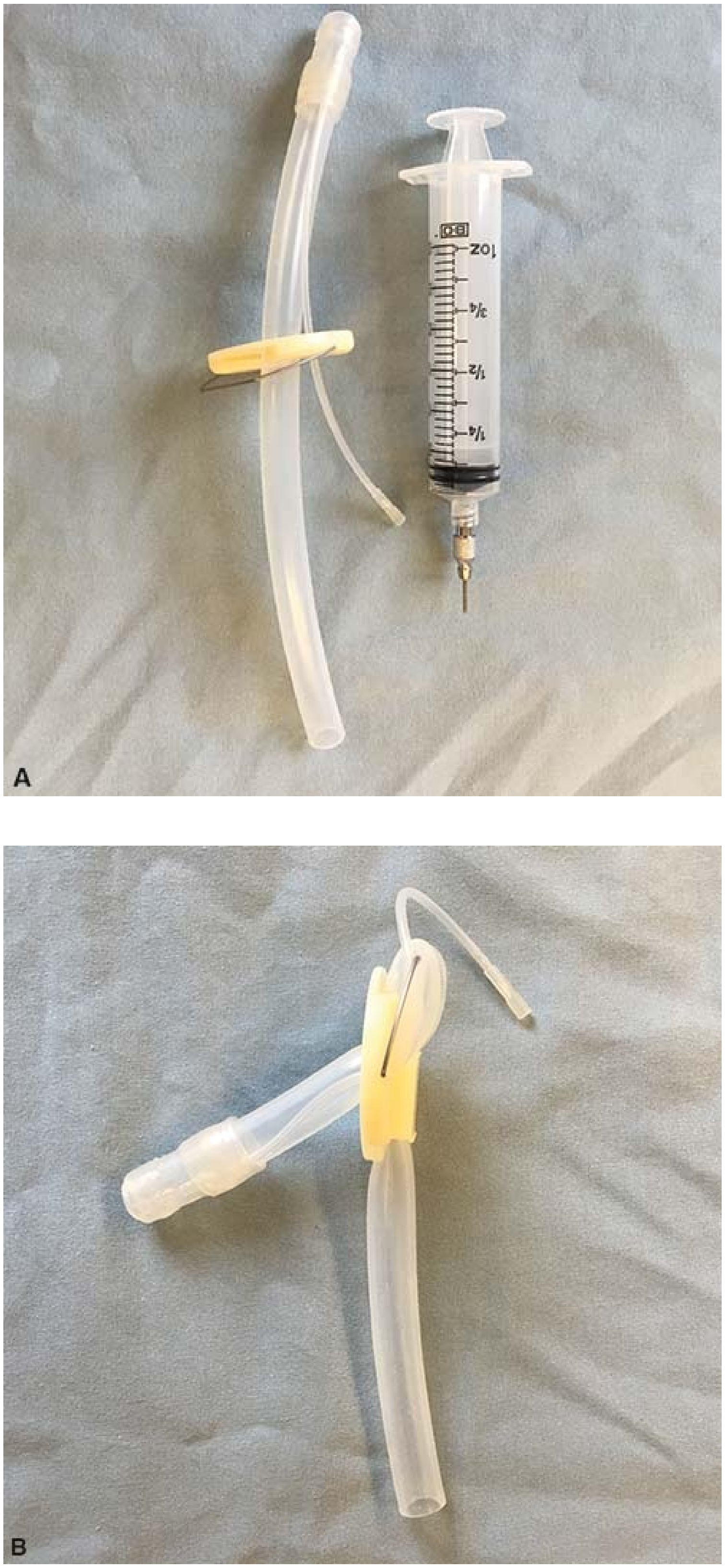

A
1oz
3/4
1/2
1/4
B

FIGURE 47-12 A. Photograph of a special temporary catheter (NUVAL Continent Ostomy Valve). B. This catheter allows a slipped or incontinent valve to be temporized until surgical repair can be undertaken.

In general, approximately 20% of continent ileostomies can be predicted to fail and require conversion to a conventional end ileostomy. Predictors of CI failure are a diagnosis of CD (hazard ratio [HR] 4.5), female gender (HR 2.4), development of a fistula (HR 3.0), and obesity. Weight gain is the greatest patient-controlled enemy of the CI valve and patients should be counseled extensively before surgery regarding the need to maintain a healthy weight. The risk of pouch failure increases nearly two-and-a-half times for every five unit increase in body mass index. The other predictors of pouch failure are not able to be controlled.

p. 466

---

p. 467

Continent Ileostomy Salvage

Surgery to salvage continent ileostomies, especially those with valve-related problems, is technically demanding and often requires considerable creativity on the part of the surgeon. Dense adhesions are often encountered at laparotomy in CI patients and great care must be taken to avoid enterotomies or mesenteric vascular injuries that might compromise the ability of the surgeon to reconstruct the valve or pouch. The most common procedure performed for both valve slippage and fistula is one in which the failed valve is excised and a new valve (neo-valve) is created using the afferent limb leading into the pouch. After disconnecting the stoma from the abdominal wall and mobilizing the pouch and distal small bowel completely, a pouchotomy is created along the original antimesenteric suture line. This maneuver allows the surgeon to inspect the interior of the pouch and to assess the condition of the valve. Fistulas from the pouch into the valve are often a surprise discovery at this time, are rarely amenable to simple repair, and usually require valve excision and neo-valve creation. The existing valve is first excised, taking care to minimize the size of the resultant pouchotomy that may eventually be used as the site for small bowel to pouch anastomosis. The efferent limb is then divided approximately 20 cm proximal to the pouch to provide a segment for neo-valve creation. The mesentery is transilluminated to define the vascular supply and then divided to the extent that the segment is able to be intussuscepted freely but without rendering it ischemic. The valve is then created in the same manner as described earlier. Finally, the pouch is rotated 180 degrees, the divided small bowel anastomosed to the pouch, and the stoma recreated using the existing abdominal wall aperture. Postoperative management is the same as after index CI creation.

In rare cases, usually when valve slippage has occurred within the first few months of the initial surgery, the existing slipped valve can simply be re-intussuscepted after pouchotomy and fixed in position with the stapler.

Quality of Life

The overall goal of CI surgery is to improve the patient's quality of life compared to that which exists, or is anticipated to exist, with a conventional end ileostomy. As most reported series of CI surgery demonstrate, both short-and long-term complication rates are high and the majority of patients will require further surgeries during their lifetime to maintain acceptable function of the CI pouch. It is imperative, therefore, to have reasonable evidence that CI patients do gain an improved quality of life compared to those with a conventional ileostomy, because the risks involved are considerable.

Several studies have examined quality of life in CI patients and have found that patient expectations, attitudes, and emotional reactions were "more positive" after CI surgery than just prior. These studies also demonstrated improved working capacity after conversion to a CI and reported that the greatest effect was seen in leisure activities and quality of sexual life. Family and social relations, however, were not influenced by conversion to a CI. In one large series, quality of life measures for patients with a CI were found to be higher on all scales in comparison to patients who had their CI removed and then reverted to a conventional ileostomy and 95% of patients stated that they would undergo CI surgery again and would recommend the procedure to another patient in need.

Two studies have compared quality of life between patients with a CI, conventional ileostomy, and IPAA. The Mayo Clinic authors found that their CI patients had fewer restrictions in sports and sexual activities compared to those with a conventional ileostomy, but had more difficulty with travel. As might be expected, patients with an IPAA had the fewest restrictions. No differences in social life, recreation, work, and family matters were seen between the three procedures. A study from the Netherlands found overall quality of life in CI patients was neither significantly better nor worse than in patients with either a conventional ileostomy or IPAA, although sexual enjoyment, gastrointestinal tract symptoms, and male sexual problems did differ between procedures. Nearly all patients were said to be "very satisfied" with the CI and all stated that they would undergo the procedure again and would recommend it to others. Similar results have been found following the BCIR procedure, with patients enjoying improved quality of life, state of mind, and overall health.

CONCLUSION

The CI retains an important, albeit small, role in the surgical treatment of patients with IBD and hereditary colorectal cancer syndromes. CI provides an alternative to the conventional ileostomy for patients who are not candidates for IPAA or who have an existing ileostomy that is adversely affecting their lifestyle. Despite a high reoperation rate related to valve complications, patients can maintain a well-functioning CI for many years that fulfills their expectations for enhanced quality of life.

RECOMMENDED REFERENCES AND READINGS

Barnett WO. Current experiences with the continent intestinal reservoir. *Surg Gynecol Obstet* 1989;168:1–5.

Cohen Z. Current status of the continent ileostomy. *Can J Surg* 1987;30:357–8.

Fazio VW, Tjandra JJ. Technique for nipple valve fixation to prevent valve slippage in continent ileostomy. *Dis Colon Rectum* 1992;35:1177–9.

Gottlieb LM, Handelsman JC. Treatment of outflow tract problems associated with continent ileostomy (Kock pouch). Report of six cases. *Dis Colon Rectum* 1991;34:936–40.

Hoekstra LT, de Zwart F, Guijt M, Bakx R, Gerhards MF. Morbidity and quality of life after continent ileostomy in the Netherlands. *Colorectal Dis* 2009;11:719–25.

Järvinen HJ, Mäkitie A, Sivula A. Long-term results of continent ileostomy. *Int J Colorectal Dis* 1986;1:40–3.

Kaiser AM, Stein JP, Beart RW. T-pouch: a new valve design for a continent ileostomy. *Dis Colon Rectum* 2002;45:411–5.

Kaiser AM. T-pouch: results of the first 10 years with a nonintussuscepting continent ileostomy. *Dis Colon Rectum* 2012;55:155–62.

Kock NG, Myrvold HE, Nilsson LO, Philipson BM. Continent ileostomy. An account of 314 patients. *Acta Chir Scand* 1981;147:67–72.

Kock NG. Continent ileostomy. *Prog Surg* 1973;12:180–201.

Kock NG. Intra-abdominal “reservoir” in patients with permanent ileostomy. Preliminary observations on a procedure resulting in fecal “continence” in five ileostomy patients. *Arch Surg* 1969;99:223–31.

Köhler LW, Pemberton JH, Zinsmeister AR, Kelly KA. Quality of life after proctocolectomy. A comparison of Brooke ileostomy, Kock pouch, and ileal pouch-anal anastomosis. *Gastroenterology* 1991;101:679–84.

Lian L, Fazio VW, Remzi FH, Shen B, Dietz D, Kiran RP. Outcomes of patients undergoing continent ileostomy after failed ileal pouch-anal anastomosis. *Dis Colon Rectum* 2009;52:1409–16.

Litle VR, Barbour S, Schrock TR, Welton ML. The continent ileostomy: long-term durability and patient satisfaction. *J Gastrointest Surg* 1999;3:625–32.

Mullen P, Behrens D, Chalmers T, *et al.* Barnett continent intestinal reservoir. Multicenter experience with an alternative to the Brooke ileostomy. *Dis Colon Rectum* 1995;38:573–82.

Nessar G, Fazio VW, Tekkis P, *et al.* Long-term outcome and quality of life after continent ileostomy. *Dis Colon Rectum* 2006;49:336–44.

Nessar G, Wu JS. Evolution of continent ileostomy. *World J Gastroenterol* 2012;18:3479–82.

Ojerskog B, Hallstrom T, Kock NG, Myrvold HE. Quality of life in ileostomy patients before and after conversion to continent ileostomy. *Int J Colorectal Dis* 1988;3:166–70.

Parks AG, Hicholls RJ. Proctocolectomy without ileostomy for ulcerative colitis. *Br Med J* 1978:2:85–8.

Sjödahl R, Lemon E, Nyström PO, Olaison G. Complications, surgical revision and quality of life with conventional and continent ileostomy. *Acta Chir Scand* 1990;156:403–7.

PART XI

STOMAL COMPLICATIONS

Chapter 48

Repair of Stomal Stenosis

Norbert Garcia-Henriquez and Jorge E. Marcet

INTRODUCTION

Intestinal stomal creation is a commonly performed procedure in colorectal surgery as part of an operation for a variety of disease processes including inflammatory bowel disease, diverticular disease, and malignancy. In certain circumstances, a stoma is created in the setting of traumatic gastrointestinal injury. The ileostomy or colostomy and the stoma may be permanent or temporary. Although stoma formation is a relatively “straightforward” undertaking, the complications associated with a stoma can be complex and, at times, life threatening. Complication rates following stoma creation range between 21% and 70%. These complications are characterized as early or late; however, the period of greatest risk seems to be within the first 5 years. Specific complications include stenosis, prolapse, parastomal herniation, retraction, necrosis, and cutaneous excoriation.

STOMAL STENOSIS

Stomal stenosis has a reported incidence of 2–17%. It is considered a late complication of stoma creation. The etiologies are numerous and include ischemia, retraction from lack of sufficient intestinal mobilization at the time of creation (Fig. 48-1), inadequate fascial aperture (Fig. 48-2a and b), and poor positioning (Fig. 48-3a and b), specifically in morbidly obese patients. In general, symptoms are obstructive in nature; and at times, patients experience constipation followed by a large-volume explosive decompression.

FIGURE 48-1 Stenotic colostomy.

FIGURE 48-2 A. Retracted stenotic stoma. B. Retracted stenotic stoma. Patient supine.


A

FIGURE 48-3 A. Retracted stoma. Large pannus. B. Retracted stoma. Patient prone.

INDICATIONS FOR REPAIR

Indications for repair include obstruction, inadequate pouching, or failure of general stomal care. The inability to adequately maintain the ostomy appliance because of explosive decompression may lead to severe skin irritation and chronic pain. Or, the reverse may occur, where the skin irritation next to the stenosis prevents adherence of a pouch.

PREOPERATIVE PLANNING

Preoperative planning is dictated by the etiology of the stenosis. The enterostomal therapist should be involved early in the management of the patient. When an enterostomal therapist is involved with preoperative and postoperative teaching and care, complication rates are significantly reduced. A study of 164 patients showed that preoperative enterostomal therapist consultation reduced the incidence of stomal complications sixfold. Modification in pouching techniques may alleviate some of the patient’s symptoms. A stoma should be properly sited in relation to the patient’s body habitus. Stomas placed with skin creases may need to be relocated for the stoma appliance to stay properly attached to the skin. Stomas located in the lower abdomen in morbidly obese patients made need to be relocated to the upper abdomen for the intestine to reach the skin with adequate length. Relocation of the stoma may also facilitate the patient’s ability to adequately reach the stoma and to provide self-care. During the preoperative planning stage, patients may need to be counseled on weight loss and modification of lifestyle factors that may reduce surgical risks.

SURGERY

Surgical management of stoma stenosis is predicated on the severity of symptoms and degree of stenosis. The degree of stenosis is assessed with digital and endoscopic examination. The ability or inability to introduce a finger and a flexible endoscope is noted. The length of the stenosis is assessed and the integrity of the intestinal mucosa is evaluated. Treatment may be as simple as performing digital dilation, local revision, or enlarging the opening with simple skin incisions. More complex procedures may be required, such as abdominal surgery with stoma relocation and intestinal resection.

Patients who are appropriate candidates for conservative therapy are individuals with stenosis that does not interfere with stomal care or negatively impact quality of life. Therapy may include a low-residue diet, stool softeners, and/or laxative agents to facilitate stool passage. There are no satisfactory data demonstrating the efficacy of conservative therapy. However, if conservative therapy fails to improve symptoms, there are several dilating techniques that can be implemented. Dilation can be performed digitally or with Hegar dilators. Digital dilation can be performed serially in 10-second increments starting with the smallest digit and progressing to the larger digits. Hegar dilation is performed similar to the latter. Regardless of the technique used, several sessions may be required to achieve symptom improvement. There is some controversy with dilation, because there are some authors who believe dilation may cause progression rather than regression of the stenosis. Moreover, this method can lead to bleeding and perforation.

Yet another dilation method that has been used with some success is the stoma plug. Stomal plugs are sometimes used to control excessive stoma output and aid in concealing the stoma; once a plug is inserted into the aperture, it expands to seal the stoma. The method of action is thought to be due to a constant radial dilating force, thus increasing the aperture and avoiding the need for future surgical intervention.

Those patients who fail to have any symptom improvement with these methods will require surgical revision. Local revision of the peristomal skin with W-plasty and Z-plasty has been described for the treatment of stenosis at the level of the skin. During a W-plasty, the stoma is mobilized beyond the fascia into the peritoneal cavity by an incision created around the mucocutaneous junction. The skin is then marked as to where the triangular flaps will be incised using a number 11 scalpel. Vertical flaps are made at right angles to the dermis with sides no more than 6 mm and corners of 90 degrees or less. The mucosa of the stoma is incised to fit the pattern made on the skin. The stoma is then matured using a Gillies' corner stitch (Fig. 48-4). This technique was used in four patents with stenotic colostomies; at 12.5 month follow-up, all were patent.

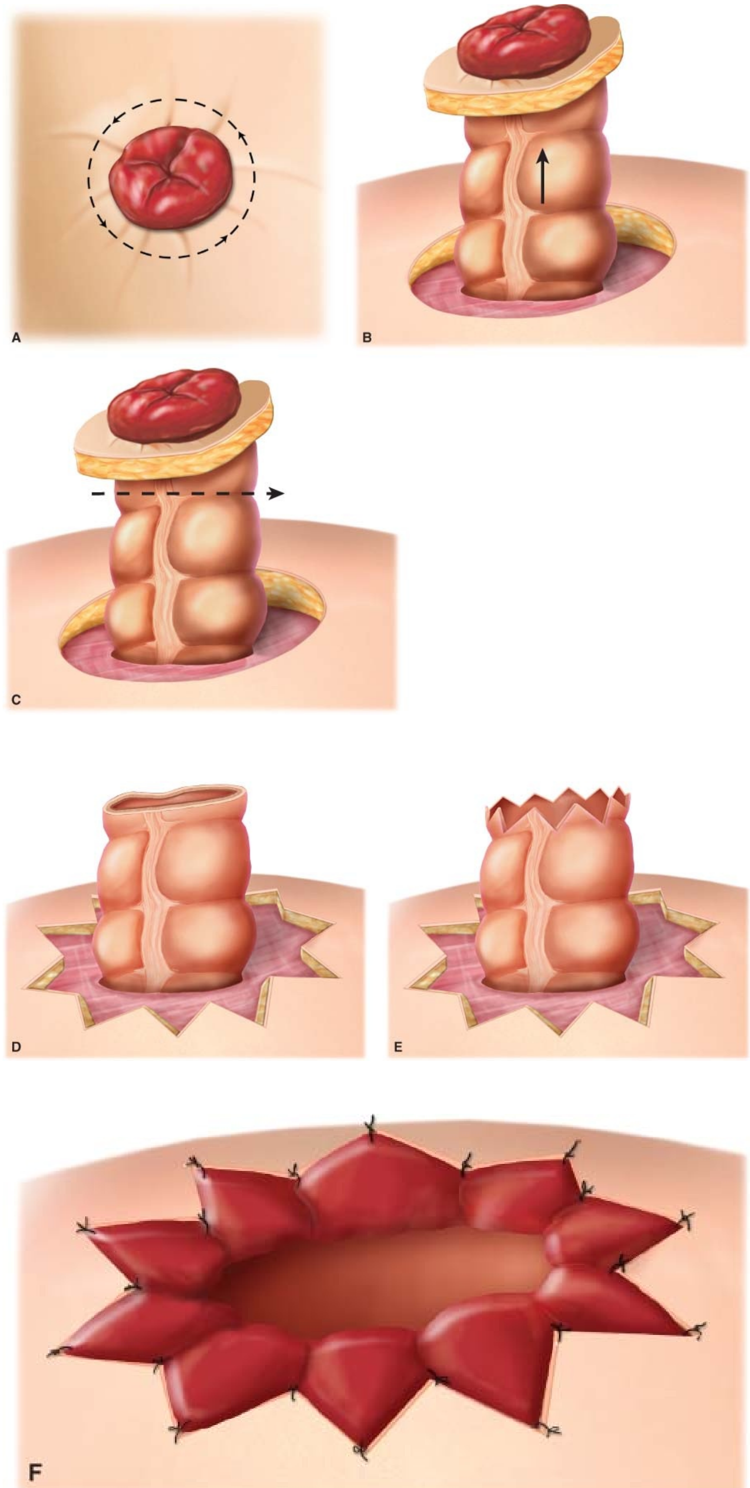


FIGURE 48-4 W-plasty for revision of stenotic ostomy. A and B. Peristomal skin is incised and the bowel is mobilized to the fascia. C. The stenotic stoma is excised. D. W-plasty is made by excising 8 to 10 small triangular flaps of skin, sides not more than 6 mm and angles 90 degrees or less, made with a number 11 scalpel vertically through the dermis. E. The corresponding mucosal margin is made to interdigitate with the skin incisions. F. The mucocutaneous margins are sutured with a Gilles corner stitch with absorbable suture.

The Z-plasty technique of peristomal skin revision requires an incision at the mucocutaneous junction followed by bowel mobilization into the peritoneal cavity. The corners of the skin incision (dermis) and bowel (serosa) are then secured by a mattress suture. The approximately 1.5-cm-long skin incision is made at an angle of 60 degrees to the skin edge. A corresponding thickness incision of the same length is made through the bowel, after which the stoma is matured (Fig. 48-5). This technique was used in six patients with stenotic colostomies, in which three had an Z-plasty performed on either side of the stoma and three had the Z-plasty performed on only one side of the stoma. There was no evidence of recurrent stenosis at 6-year follow-up. Local revision of the skin opening is not likely to be successful if the end of the intestine does not adequately reach the level of the skin tension free.

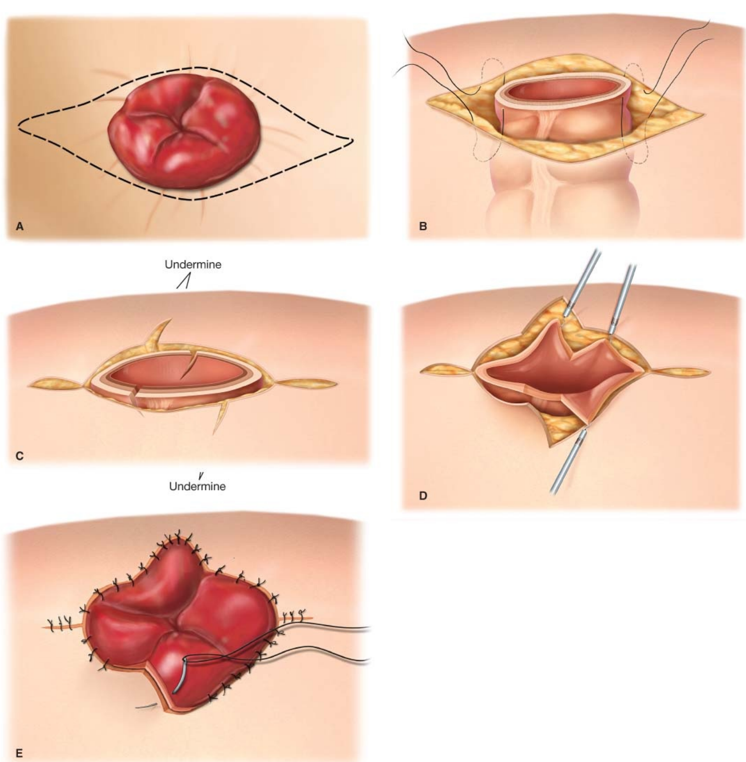


FIGURE 48-5 Z-plasty for revision of stenotic ostomy. A. Skin incision circumscribes the scared peristomal skin. The bowel is mobilized to the fascia and the stenotic stoma is excised. B. Angle sutures are placed to align skin and bowel. C. Z-plasty incisions are made in the skin on both sides of the stoma at an angle of 60 degrees to the skin edge. A corresponding incision is made through the bowel wall the same length as the skin incision, about 1.5 cm. D. The skin and bowel flaps are transposed, as shown. E. The bowel is sutured to the skin with interrupted absorbable sutures. The remaining skin incisions are also closed.

Stenosis caused by retraction or ischemia of the bowel revision will likely require an intra-abdominal approach for additional intestinal mobilization. The goal of surgery is to mobilize a sufficient length of bowel so that a tension-free ostomy is created. Achieving this may require mobilization of the splenic flexure for left-sided colostomies. Division of the inferior mesenteric vessels may also be necessary, and dissection of a well-vascularized pedicle, based on the marginal blood supply, is done to obtain sufficient length of the end of the intestine that will reach the abdominal skin without tension. A similar approach is taken when a major revision of an ileostomy is required. Dissection of the ileal mesentery is undertaken with judicious ligation of the mesenteric vessels, if necessary, to develop a well-vascularized pedicle of sufficient length to reach the skin and allow for adequate maturation. Before undertaking these procedures, the surgeon must evaluate the patient's abdominal wall and body habitus. The patient should be examined in supine, sitting, and standing positions to evaluate changes in the abdominal wall and their effect on the stoma position. For example, a patient with a large pannus may experience retraction of the stoma when standing if the pannus droops downward.

If relocation of the stoma is not necessary, then the same skin opening of the previously stenotic colostomy is used after a major revision. The skin opening may simply be made larger by excising a wider disk of skin. However, in some cases, relocation of the stoma more cephalad on the abdominal wall may be dictated by the inability of the mesentery to reach the previous site. It should be emphasized that before any in-depth revision of an ostomy, proper siting of the previous ostomy should be ascertained and relocation of the stoma is undertaken as necessary to enable proper stoma care.

POSTOPERATIVE MANAGEMENT

Patients should undergo routine postoperative care. The enterostomal therapist should participate and establish the appropriate appliance and all the necessary supplies as well as a care plan for the patient in preparation for hospital discharge.

COMPLICATIONS

To prevent postoperative complications, sound and meticulous surgical technique should be exercised. In the setting of a major intra-abdominal approach to revision, wound care is critical; and again the appropriate appliance must be sought out with the assistance the enterostomal therapist. Oral antibiotic and mechanical bowel preparation may be possible even with a stenotic stoma. This may reduce infection after complex repair.

RESULTS

Treatment of stomal stenosis is selected on a case-to-case basis. Most importantly, it is based on the severity of symptoms and degree of stenosis. There are patients who respond to conservative therapy. In those patients who fail conservative management, surgical intervention is indicated whether it is in the form of dilation or local revision. Although data is limited, there is evidence in support of either the W-or Z-plasty for local stomal revision with long-term follow-up and satisfactory patient outcomes.

CONCLUSION

The etiology of stomal stenosis is multifactorial. The best preventative measure is judicious preoperative planning and meticulous surgical technique. Avoiding ischemia and tension as well as appropriate stomal siting, in combination with pre-and postoperative enterostomal therapy consultation are paramount. Initial management should be conservative and should involve the care of an enterostomal therapist. When patients require stoma revision, consideration is given to local revision of the skin opening versus abdominal procedures for mobilization of additional bowel length with or without stoma relocation.

RECOMMENDED REFERENCES AND READINGS

Barr J. Assessment and management of stomal complications: a framework for clinical decision making. *Ostomy Wound Manage* 2004;50:50–2.

Beraldo S, Titley G, Allan A. Use of W-plasty in stenotic stoma: a new solution to an old problem. *Colorectal Dis* 2006;8:715–6.

Duchesne JC, Wang YZ, Weintraub SL, Boyle M, Hunt JP. Stoma complications: a multivariate analysis. *Am Surg* 2002;68:961–6.

Leong AP, Londono-Schimmer EE, Philips RK. Life table analysis of stomal complications following ileostomy. *Br J Surg* 1994;81:727–9.

Londono-Schimmer EE, Leong AP, Philips RK. Life table analysis of stomal complications following colostomy. *Dis Colon Rectum* 1994;37:916–20.

Lyons A, Simon B. Z-plasty for colostomy stenosis. *Ann Surg* 1960;151:59–62.

Porter JA, Salvati EP, Rubin RJ, Eisenstat TE. Complications of colostomies. *Dis Colon Rectum* 1989;32:209–303.

Riaz AA, Jeetle SS, Bobb KA, Jones PW, Thompson HH. Stomal plugs: a novel treatment option for stomal stenosis. *Tech Coloproctol* 2005;9:172.

Shellito P. Complications of abdominal stoma surgery. *Dis Colon Rectum* 1998;41:1562–72.

Chapter 49

Parastomal Repair: Open Techniques

Molly M. Ford and Charles B. Whitlow

BACKGROUND

Parastomal hernia is defined as a hernia in direct relation to an abdominal wall stoma (Fig. 49-1). Tangential forces on the circumference of the opening cause enlargement of the aperture in the abdominal wall around a stoma. Patients may be asymptomatic or describe symptoms such as a bulge, pain, or an obstruction.

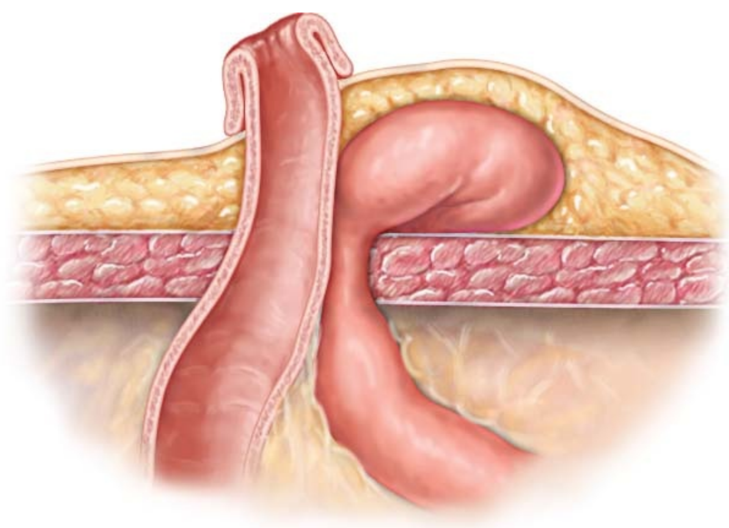


FIGURE 49-1 True parastomal hernia.

Because of the nature of the necessary fascial defect and the aforementioned forces, parastomal hernia occurrence is high. Radiographically, it is found in up to 80% of patients. The clinical rate of parastomal hernia has been reported to range between 5% and 52%. The great variance reported has been attributed to the utilization of different definitions of hernia and a wide range of follow-up criteria for patients. The most durable repair of a parastomal hernia defect is with reversal of the ostomy; however, there are many scenarios in which a stoma is permanent.

INDICATIONS

Indications for parastomal hernia repair depend on the symptoms. Obstruction or incarceration with strangulation is an absolute indication, but relative indications for repair include difficulty with appliance management, pain, and cosmesis. Patient-specific risk factors for the development of parastomal hernias include obesity, weight gain after ostomy creation, advanced age, malnutrition, increased intra-abdominal pressure, immunosuppression, creation in an emergent setting, and wound infection. Other suggested factors include stoma placement outside of the rectus muscle and creation of an excessively large fascial opening.

Open techniques for parastomal hernia repair include direct local tissue repair, application of prosthetic material around the stoma at different levels upon or within the abdominal wall including both the keyhole and Sugarbaker repair, and relocation of the intestinal stoma with closure of the primary aperture. This chapter discusses these open surgical approaches.

Worth mentioning is the consideration of mesh use at the primary stoma creation. Data from a recent meta-analysis suggest that parastomal hernia occurrence is significantly reduced with prophylactic mesh from 50.3% to 24.4%.

PREOPERATIVE PLANNING

Once the patient has completed an appropriate preoperative medical clearance, consideration should be given to a bowel preparation if the patient has a colostomy. An appropriate broad-spectrum antibiotic should be administered intravenously, 1 hour before the incision. As with other abdominal operations, venous thrombosis prophylaxis is utilized. The consent form should include information concerning the potential use of prosthetic materials in the management of the repair, as well as a clear discussion of alternatives, and reasonable clinical expectations including the possibility of recurrence.

SURGERY

Under general anesthesia, the patient is placed in the supine position with the extremities appropriately padded. The utilization of an oral gastric tube and urinary bladder catheter are at the discretion of the surgeon.

Operative Technique

Direct Fascial Repair

An arched incision is made through the skin around the hernia site. With careful retraction, the hernia sac and scar tissue is excised and the contents are reduced. The edges of healthy fascia are then approximated with a series of interrupted, nonabsorbable sutures to reduce the opening to one fingerbreadth around the stoma. This technique has generally fallen out of favor because of higher recurrence rates reported to range between 50% and 100%.

Relocation of Stoma

Preoperative marking of a new stoma site in another abdominal quadrant is important, usually on the contralateral side. After skin preparation and patient positioning, the existing ostomy is carefully isolated from the abdominal wall, and the stomal lumen is sutured closed to prevent contamination of the field. Dissection commences at the mucocutaneous junction until encountering the hernia sac; the hernia is reduced and the hernia sac is excised. A small midline incision is utilized to enter the abdominal cavity for adhesiolysis and exposure to both the new and old sites. The new ostomy site is created and the bowel is carefully brought through the new fascial opening without rotation or compromise to lumen or blood supply. Once the stoma has been mobilized and is in the abdominal cavity, the remaining hernia site is repaired with interrupted fascial sutures. It may be desirable to place prosthetic material in the sublay position under the muscle and external to the peritoneum to ensure an adequate repair for large hernia defects. Finally, the abdominal wound is closed, and the new stoma is matured in a Brooke manner for an ileostomy, and in a Brooke or flush manner for a colostomy.

An alternative to the use of a midline wound is possible with large parastomal hernias. The initial incision is around the stoma to free the bowel from the skin and hernia sac. With this technique, the hernia defect is used to gain access to take down the abdominal wall adhesions and accomplish the necessary bowel mobilization. The new stomal site can also be created using the hernia opening and a midline incision is avoided. After delivery of the bowel through the new stomal opening, the hernia is repaired as described; ultimately, the stoma is matured (Fig. 49-2). As with primary repair, re-siting of the stoma carries a high rate of recurrence, and so is also not the favored technique. However, if the parastomal hernia defect is very large, this may be the only option.

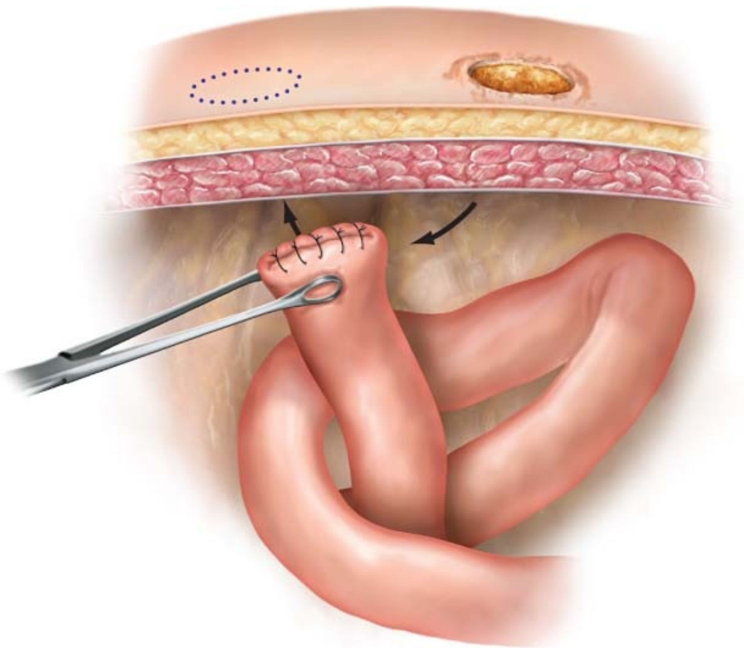


FIGURE 49-2 Open relocation technique.

The Open Onlay Procedure

The onlay involves placement of the mesh above the fascia. The theoretical advantage is that it may avoid the morbidity of an intra-abdominal operation in higher risk patients. A large semicircular incision is made in the skin at an appropriate distance from the stoma, and with adequate exposure, the subcutaneous tissues are dissected free from the fascia. The hernia sac is identified, the contents are reduced, and the peritoneum is closed. The edges of the fascial defect can then be re-approximated with interrupted sutures after which the repair is reinforced with a prosthetic material, which is wrapped around the subcutaneous portion of the colon, and sutured into place. Some surgeons place closed suction drains in the subcutaneous position exiting the skin outside of where the stomal appliance adheres to the skin (Fig. 49-3).

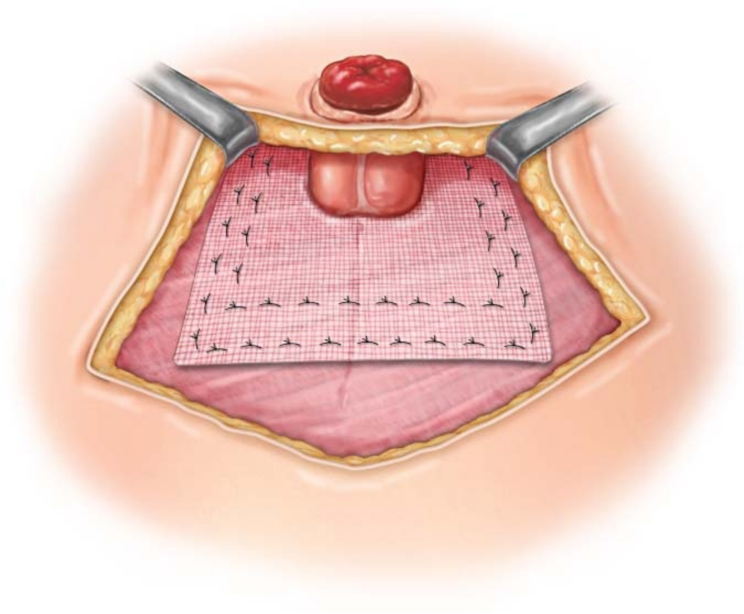


FIGURE 49-3 Open onlay technique (after reduction of hernia).

p. 479

p. 480

The Underlay Repair

Also referred to as a sublay technique, the mesh is placed below the anterior fascia and muscular levels but above the posterior sheath or peritoneum. The ostomy site is initially covered with a protective barrier to avoid contamination of the field, after which a laparotomy is performed using a portion of the existing midline incision away from the stoma. The hernia sac and its contents are then identified and reduced into the peritoneum. The sublay procedure is then performed by creating a space posterior to the rectus muscle but anterior to the posterior sheath. The mesh is cut with a cruciate incision, and if placed at the time of stoma creation, the stoma is brought up through the mesh. If it is placed as a repair to a hernia, the sublay–keyhole technique can be utilized where a keyhole is cut and the mesh is placed around the stoma in the same plane as mentioned. It is re-approximated on the other side of the stoma with nonabsorbable suture. It is important that the mesh be cut so that it can surround the colon, and extend at least 5 cm past the edge of the abdominal wall defect. The mesh can be sutured in place with interrupted or running technique, and then the abdominal cavity can be closed in a routine manner. Liberal use of closed suction drains may potentially help reduce the incidence of seroma formation.

The Intraperitoneal Repair

There are two primary intraperitoneal parastomal hernia techniques including the Sugarbaker and keyhole. The Sugarbaker begins with a midline laparotomy incision, dissection of the adhesions, reduction of the hernia, resection of the sac, and again closure of the hernia defect with nonabsorbable sutures until it only accommodates one finger. The mesh is then placed over the intraperitoneal ostomy defect and secured on three sides. The lateral, or fourth side, allows the bowel to come in through the lateral edge. Abdominal forces press ventrally against the mesh-covered defect, thus theoretically reducing recurrence rates (Fig. 49-4). This method mirrors the extraperitoneal colostomy technique of John Goligher. The editors often close the fascial defect by laparoscopic suture repair with braided sutures followed by mesh onlay.

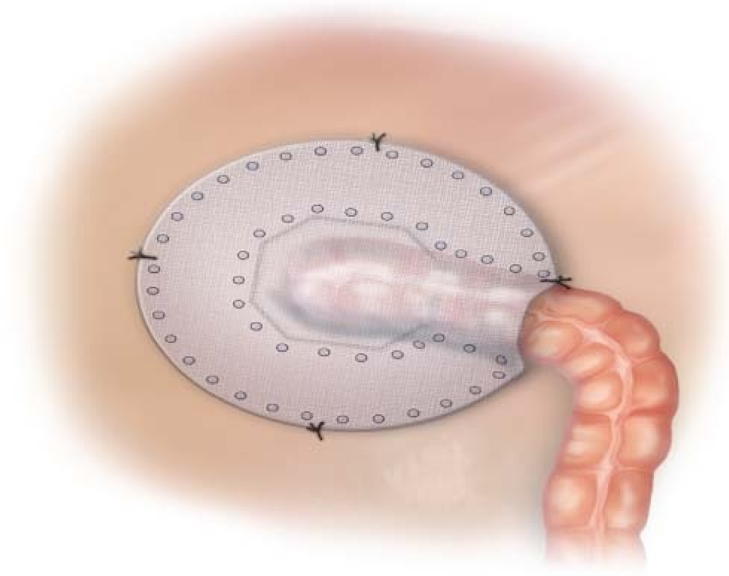


FIGURE 49-4 Open Sugarbaker technique.

To perform the keyhole technique, a keyhole defect is cut out of the center of the mesh and the mesh is made to surround the ostomy and cover the entire defect. Again, this method requires a midline laparotomy incision with reduction of the hernia, excision of the hernia sac, closure of the fascial defect primarily with suture to accommodate one finger, and then placement of the mesh. The opening or "keyhole" in the mesh should be large enough to avoid obstruction of the stoma, but small enough that it does not increase the risk of herniation (Fig. 49-5).

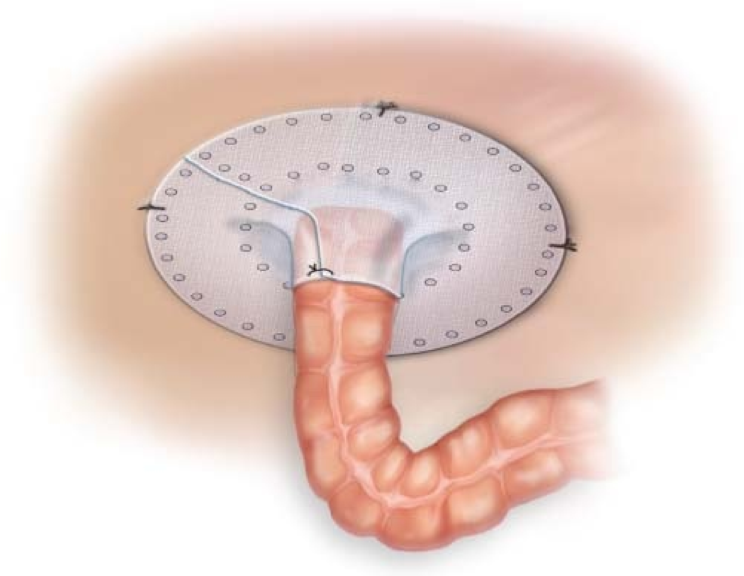


FIGURE 49-5 Open keyhole technique.

Special Considerations

The utilization of prosthetic material has been associated with complications inherent to the use of a foreign body. Multiple surgical experiences have been reported utilizing mesh materials including absorbable, nonabsorbable, partly absorbable, and acellular collagen matrix meshes. Although composite meshes are presently available, many recent authors advocate the use of biologic meshes.

POSTOPERATIVE MANAGEMENT

Routine postoperative care includes removal of the orogastric tube if used before extubation in the operating room. Reinstitution of diet is usually held until flatus has passed through the stoma, but is clinician dependent. A visit from the stomal nurse is also helpful before discharge.

COMPLICATIONS

Infection is of major concern with the open technique, because the case is considered contaminated. Thus, care always must be taken to isolate any stomal contents from its surrounding tissues, especially if a prosthetic mesh is used. Not surprisingly, infection and hernia recurrence are the main risks.

RESULTS

After relocation, the risk of recurrent parastomal hernia at new sites is at least as high as after the primary enterostomy; recurrence rates range from 24% to 86%. Parastomal hernia repair with prosthetic mesh is reported to produce lower recurrence rates when compared to relocation or direct suture repair of the stoma; but at the present time, large randomized studies are not available.

CONCLUSIONS

Parastomal hernias represent a major surgical challenge, presenting in up to 50% of patients receiving a colostomy. There are several non-laparoscopic techniques that have been attempted for repair. Significant recurrence rates are associated with relocation of the stoma and direct suture repair of the fascia. Lower recurrence rates have been reported with prosthetic or biologic material repairs, which should be considered when counseling patients and planning surgery.

RECOMMENDED REFERENCES AND READINGS

Carne PW, Robertson GM, Frizelle FA. Parastomal hernia. *Br J Surg* 2003;90(7):784–93.

Cingi A, Cakir T, Sever A, Aktan AO. Enterostomy site hernias: a clinical and computerized tomographic evaluation. *Dis Colon Rectum* 2006;49(10):1559–63.

---

de Ruiter P, Bijnen AB. Successful local repair of paracolostomy hernia with a newly developed prosthetic device. *Int J Colorectal Dis* 1992;7(3):132–4.

Devlin HB, Kingsnorth A. Parastomal hernia. In: Devlin HB, Kingsnorth A, eds. *Management of Abdominal Hernias*. 2nd ed. London: Butterworths, 1998:257–66.

Everingham L. The parastomal hernia dilemma. *World Council of Enterostomal Therapists J* 1998;18:32–4.

Fei Y. A modified sublay-keyhole technique for in situ parastomal hernia repair. *Surg Today* 2012;42(9):842–7.

Gillern S, Bleier JI. Parastomal hernia repair and reinforcement: the role of biologic and synthetic materials. *Clin Colon Rectal Surg* 2014;27(4):162–71.

Rieger N, Moore J, Hewett P, Lee S, Stephens J. Parastomal hernia repair. *Colorectal Dis* 2004;6(3):203–5.

Rubin MS, Schoetz DJ Jr, Matthews JB. Parastomal hernia. Is stoma relocation superior to fascial repair? *Arch Surg* 1994;129(4):413–8.

Wang S, Wang W, Zhu B, Song G, Jiang C. Efficacy of prophylactic mesh in End-Colostomy Construction: a systematic review and meta-analysis of randomized controlled trials. *World J Surg* 2016;40(10):2528–36.

Chapter 50

Peristomal Hernia Underlay Technique

David E. Beck

INDICATIONS/CONTRAINDICATIONS

Peristomal hernia is one of the more common late complications of an ostomy. Indications for repair include bowel obstruction, incarceration, or enlargement of the hernia to the point where it interferes with appliance wear or the hernia is unsightly. The repair can be performed with open or laparoscopic techniques. Laparoscopic repair is suitable when the patient’s stoma is appropriately sited, the patient lacks a history of extensive adhesions, and the hernia is not too large. Excessive large peristomal hernias are often more appropriately repaired with an open technique. Obtaining good results with underlay mesh usually requires a mesh with at least a 3–5 cm overlap of the mesh beyond the edges of the hernia. This is difficult to accomplish laparoscopically with large hernias. Another relative contraindication is the need for an associated open procedure. Repair of both paraileostomy and paracolostomy hernias is suitable for laparoscopic procedures and several techniques of repair have been described. This chapter discusses several methods of underlay mesh repair including a “keyhole” technique, a method similar to that described by Sugarbaker in 1980, and a combination of both that has been referred to as a sandwich technique.

PREOPERATIVE PLANNING

Preoperative Preparation

Standard bowel preparation is not mandatory. However, because the empty colon handles better than the stool-filled colon, it is the author's preference to have patients, who can tolerate a preparation, ingest a limited isotonic lavage prep, such as one-fourth to one-half gallon of a polyethylene glycol solution. Patients are instructed to take only clear liquids the day before surgery. Oral antibiotics are prescribed in patients with colostomies and all patients receive standard intravenous broad-spectrum antibiotics within 1 hour of skin incision. Deep vein prophylaxis is also ordered. Informed consent for laparoscopic procedures should include the potential for conversion to an open procedure.

SURGERY

Patient Positioning and Preparation

After induction of general anesthesia, an orogastric tube and indwelling urinary bladder catheter are placed. If a laparoscopic procedure is planned, the patient is then placed in modified lithotomy position with the thighs even with the hips and pressure points appropriately padded. One or both arms may be tucked to facilitate securing the patients for the extremes of positioning used during laparoscopy. If only one arm is tucked, it should be on the side opposite the side of the hernia and stoma. The patient is then secured to the table with straps or tape placed across the chest just below the armpits. The skin is prepped with antiseptic solution and draping is done in a manner to provide for lateral exposure for ports, especially on the side opposite the hernia and stoma. One author has suggested covering the abdominal wall with an adhesive drape to limit potential contamination of the mesh.

Open Procedures

Exposure

The patient is usually explored from the midline, although in very large hernias an elliptical incision at or below the stoma may be used. Once the abdomen is entered, adhesions to the previous incisions and those in the hernia sac are divided. The hernia sac is usually removed, but whether this is necessary remains unproved. From the midline, the stomal fascial defect is closed with permanent sutures (e.g., #2 polypropylene). Silva *et al.* (2014) prefer use of a quill suture.

Fascial reinforcement in the underlay position can be accomplished with two techniques: keyhole or a Sugarbaker-type technique.

Mesh Placement

With a keyhole technique, a mesh size is selected that will extend 5 cm beyond the edge of the closed hernia. A cruciate hole, the size of the bowel, is created in the center of the mesh, and a slit is created from the medial side of the mesh to the central defect (Fig. 50-1). A critical part of this technique is to not make the keyhole too small so as to cause a bowel obstruction, but to not make it so large as to increase the risk of herniation. The cut mesh is then maneuvered around the bowel and sutured in place with polypropylene sutures. The slit is closed with sutures and sutures are placed at the corners and the middle edge of the mesh. Abdominal pressure holds the mesh against the abdominal wall during the healing process.

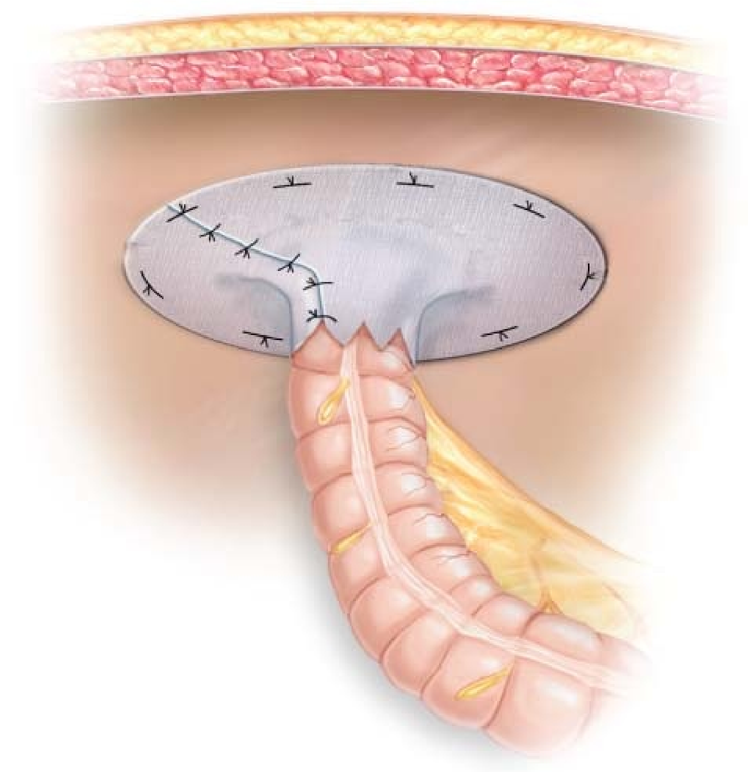


FIGURE 50-1 Keyhole mesh.

The Sugarbaker method requires that the bowel has adequate laxity to allow the bowel to track between the mesh and abdominal wall. If reduction of the hernia does not provide adequate laxity, additional mobilization of the bowel may be necessary to allow adequate lateralization of the bowel. The ostomy bowel is pulled intra-abdominally, to reduce any prolapse. The ostomy bowel is then pulled to the lateral or superior edge of the hernia defect. Some surgeons will then suture the ostomy bowel serosa to the peritoneum with absorbable sutures at the edge of the defect. The abdominal wall is also inspected for additional hernias that need repair. A piece of mesh that will cover the hernia defect with a 5-cm overlap is selected. Both synthetic and biologic meshes have been described. Synthetic mesh is less expensive and easier to fix to the fascia. The mesh is fixed at the edges, close to the bowel, and is medially sutured or tacked in position.

The sandwich is a combination of both the keyhole and Sugarbaker

The sandwich is a combination of both the keyhole and Sugarbaker techniques, using a piece of mesh in the intraperitoneal position as in the keyhole technique and then lateralizing the bowel and covering this with another piece of mesh using the Sugarbaker technique. This technique does result in an area of mesh overlapping with mesh.

Laparoscopic Procedure

Instrument/Monitor Positioning

The primary surgeon will usually stand on the patient's side opposite the stoma or between the patient's legs (Fig. 50-2). The primary monitor is placed on the patient's side that contains the stoma near the level of the hip. A secondary monitor can be placed at the patient's shoulder or at an alternate site viewable by the assistant or surgical technician. Insufflation tubing, suction tubing, cautery power cord, laparoscopy camera wiring, and a laparoscope light cord are brought off the patient's side. A 10-mm laparoscope with a 30-degree lens is preferred.

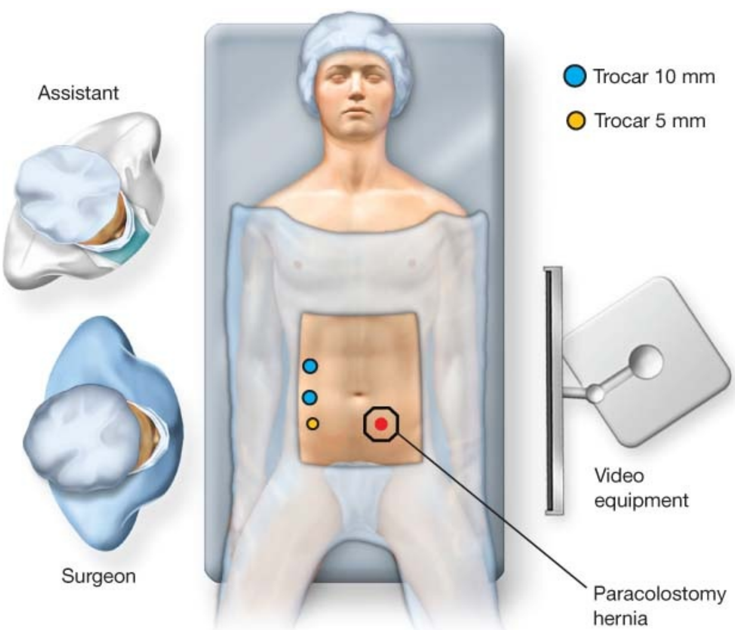


FIGURE 50-2 Positioning and port placement for laparoscopic-assisted colostomy.

Port Selection and Placement

A 10/11-mm balloon trocar is placed using an open (modified Hasson) technique in the lateral abdomen on the side opposite the ostomy and hernia. Laparoscopic inspection of the peritoneal cavity rules out unsuspected pathology and identifies the patient with dense extensive adhesions that would make a laparoscopic approach problematic. If the abdomen is suitable, additional ports are placed under laparoscopic visualization at the locations described in Figure 50-2. Unless a quality 5-mm camera and 5-mm mesh fixation device (tacker) are available, one of the ports needs to be at least 10 mm in diameter; the other port can be 5 mm. The exact location will vary depending on adhesions and the location and size of the hernia. In general, they are placed a hand's width apart and on the side of the abdomen opposite the hernia (Fig. 50-2—left-sided stoma). If the stoma is located on the right side of the abdomen, the trocar placement locations are reversed.

Division of Adhesions and Reduction of Hernia

Adhesions to the anterior abdominal wall are divided with sharp dissection and traction. This process can often be tedious and has the potential for bowel injury, especially if previous repairs have used mesh. Extensive dense adhesions may require conversion to an open technique. Bowel loops are gently reduced from the hernia using traction and carful division of adhesions. Alternate energy sources may be helpful for some vascular adhesions, but are not a substitute for careful dissection. When the entire bowel has been reduced, the bowel leading to the stoma will remain (Fig. 50-3). The peritoneal sac is left in place. Both keyhole and Sugarbaker methods have been described with laparoscopic techniques, but the Sugarbaker method is technically easier laparoscopically.

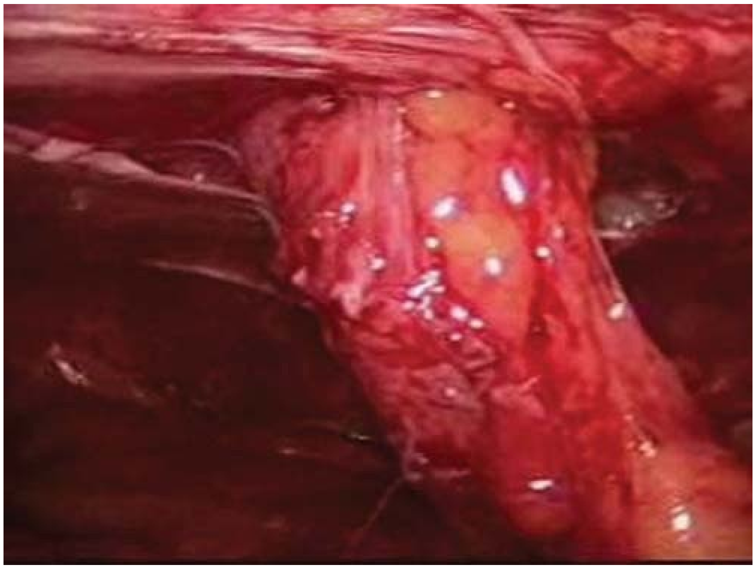


FIGURE 50-3 Completely reduced parastomal

hernia.

The Sugarbaker technique requires that the bowel has adequate laxity to allow the bowel to track between the mesh and abdominal wall. Reduction of the hernia will usually provide adequate laxity; but if it does not, additional mobilization of the bowel may be necessary to allow adequate lateralization of the bowel. The ostomy bowel is pulled intra-abdominally, to reduce any prolapse. The ostomy bowel is then pulled to the lateral or superior edge of the hernia defect. Some surgeons will then suture the ostomy bowel serosa to the peritoneum with absorbable sutures at the edge of the defect. The abdominal wall is also inspected for any additional hernias that need repair.

p. 485

---

p. 486

Mesh Placement

A piece of mesh that will cover the hernia defect with a 5-cm overlap is selected. It is often helpful to compare the mesh on the abdominal wall without touching the stoma itself or the skin. Several types of mesh have been used, including nonabsorbable, absorbable, partly absorbable, and acellular collagen matrix meshes. Polypropylene mesh, composite meshes, and biologic meshes are reported.

Two peripheral tacking sutures (0 polydioxanone), 4–5 cm apart, are placed at the edge of the mesh where the stoma will pass. The mesh is then tightly rolled and inserted through the 10-mm incision for the Hasson trocar, after which it is unrolled and moved toward the stoma and hernia and oriented. After orienting the mesh, the traction sutures are extracted with a "suture passer" technique through small separate skin incisions 4–5 cm apart; one located cephalad, the other caudad to the stoma, and 4–5 cm lateral to the hernia defect. The mesh is anchored to the abdominal wall by tying these sutures, creating a transabdominal fixation. Inspection should be carried out to ensure that the stoma is not obstructed where it passes between these two sutures (Fig. 50-4). Further fixation of the mesh is done with a mechanical fixation device (e.g., SorbaFix [C R Bard, Warwick, RI] or ProTack [Covidian, New Haven, CT]) at the margin of the mesh and along the bowel tract and edge of the fascial defect (Fig. 50-5). Care is taken to produce appropriate tension on the mesh and to avoid putting the tackers into the ostomy bowel or mesentery and to allow enough laxity for the ostomy bowel to exit the mesh (Fig. 50-6). As tacking devices have improved, the number of traction/fixation sutures has been reduced or eliminated. The authors currently use transfascial fixation sutures (0 polydioxanone) every 4–5 cm around the edges of the mesh. After mesh fixation, the bowel is again expected to exclude any unsuspected injury or bowel compression.

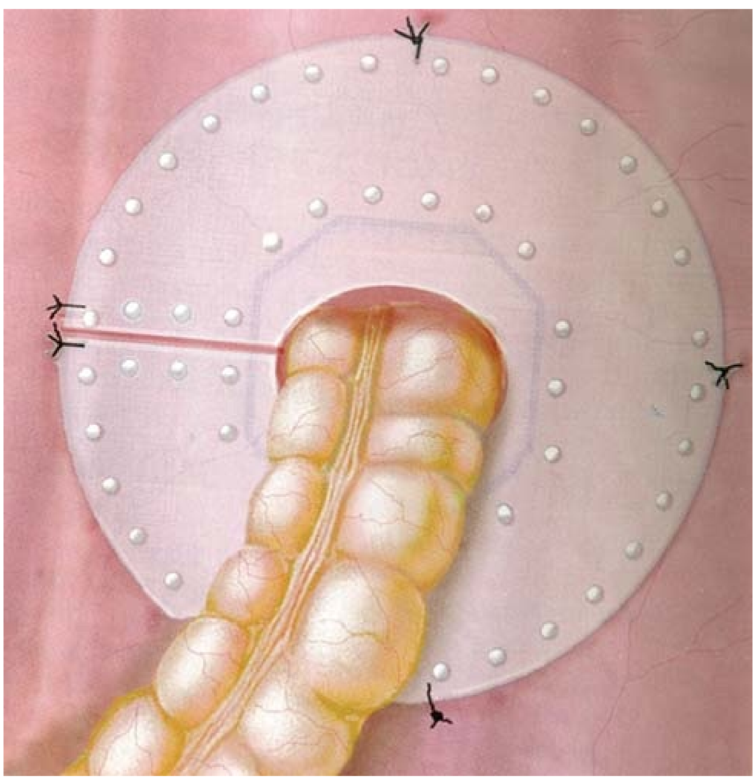


FIGURE 50-4 Using the two traction sutures, the mesh is anchored to the lateral abdominal wall.

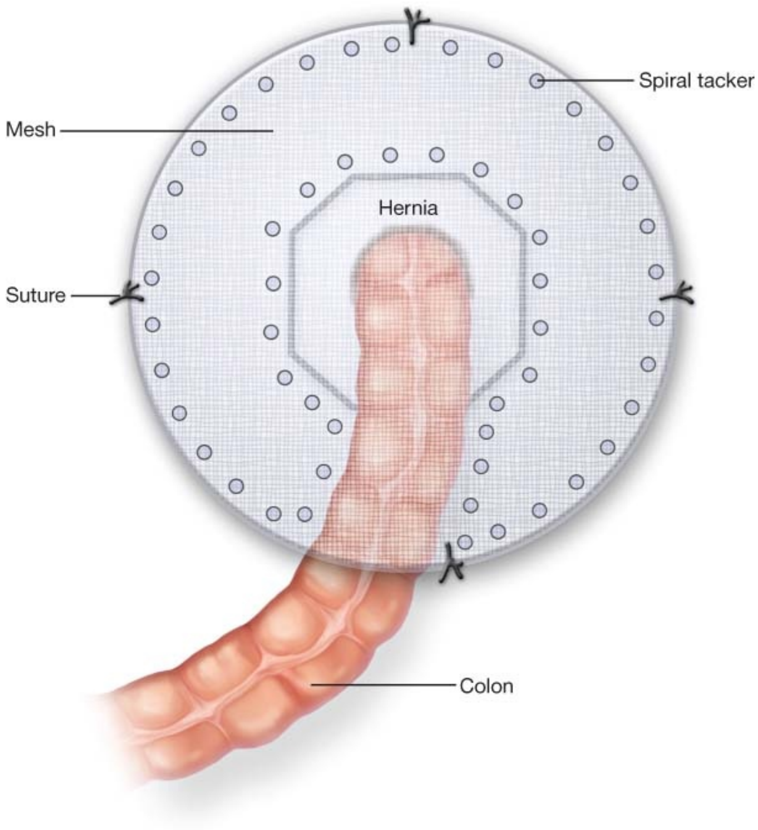


FIGURE 50-5 Fixation of mesh in a laparoscopic hernia repair.

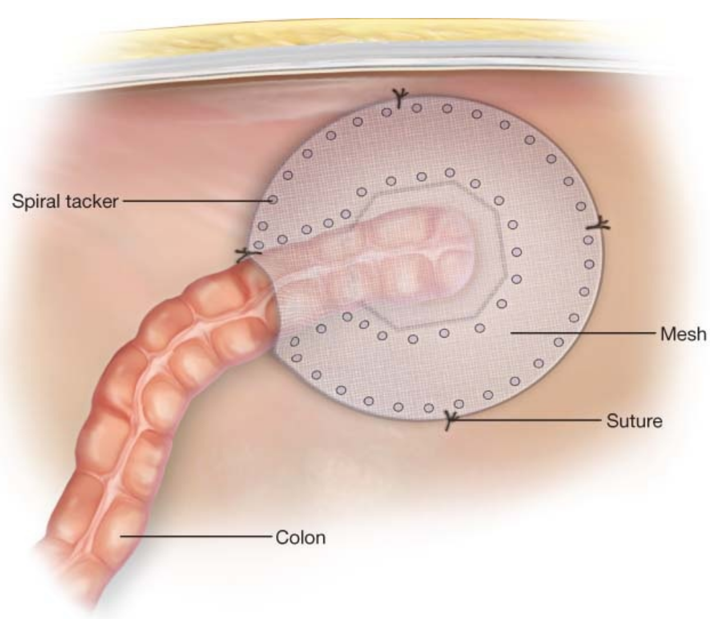


FIGURE 50-6 Intra-abdominal view of hernia repair.

POSTOPERATIVE MANAGEMENT

The orogastric tube is removed before extubation and the Foley catheter is removed later in the day or the next morning. Patients are supported with intravenous fluids and offered liquids when they are hungry. Solid food is started when flatus is expressed from the stoma. Pain management is usually provided by patient-controlled analgesia supplemented with ketorolac. The patients are switched to oral pain medication when they are taking fluids and early ambulation is encouraged. Patients are ready for discharge when they can care for their stoma, are tolerating a diet, and have evidence of bowel function. As the bowel is not detached from its skin attachment, and stomal education is not required, recovery is usually rapid.

COMPLICATIONS

Early complications include unsuspected bowel injury, infection, or obstruction of the colon. Longer term complications include hernia recurrence, bowel erosion, and rarely pain.

RESULTS

Pooling four nonrandomized studies resulted in seven recurrences out of 72 repairs. A laparoscopic technique is not feasible in all patients; and in one study, 15% of 55 patients had their operations converted to open procedures. In two studies of 59 patients, bowel injury occurred in 22% of patients. In a study of 47 patients in which expanded polytetrafluorethylene (ePTFE) (W L Gore & Associates, Newark, DE) mesh was used, 9% of patients had to have the mesh removed because of infection.

A systematic review in 2011 of four retrospective studies included 57 patients in whom biologic mesh was used to repair parastomal hernias. The studies used a variety of techniques for mesh placement with open and laparoscopic techniques. The recurrence rate was 15.7% and the wound-related complication rate was 26.2%. No mortality or graft infections were reported. The authors concluded that the results were similar to those published with synthetic mesh.

CONCLUSIONS

Parastomal hernia repair is feasible as well as safe. Increasing experience and randomized prospective studies will be needed to define the optimal technique of repair. Until such information is available, open or laparoscopic repair with an underlay technique is a viable option in selected patients.

RECOMMENDED REFERENCES AND READINGS

Ballas KD, Rafailidis SF, Marakis GN, Pavlidis TE, Sakadamis AK. Intraperitoneal ePTFE mesh repair of parastomal hernias. *Hernia* 2006;10(4):350–3.

Berger D, Bientzle M. Polyvinylidene fluoride: a suitable mesh material for laparoscopic incisional and parastomal hernia repair! A prospective, observational study with 344 patients. *Hernia* 2009;13(2):167–72.

Craft RO, Huguet KL, McLemore EC, Harold KL. Laparoscopic parastomal hernia repair. *Hernia* 2008;12(2):137–40.

Gillern S, Bleier JI. Parastomal hernia repair and reinforcement: the role of biologic and synthetic materials. *Clin Colon Rectal Surg* 2014;27:162–71.

Hansson BM, Slater NJ, van der Velden AS, *et al.* Surgical techniques for parastomal hernia repair: a systematic review of the literature. *Ann Surg* 2012;255(4):685–95.

Israelsson LA. Parastomal hernias. *Surg Clin North Am* 2008;88(1):113–25.

Jani K, Palanivelu C, Parthasarathi R, Madhankumar MV. Laparoscopic repair of a paracolostomy hernia: secure reinforced closure of the defect prevents recurrence. *J Laparoendosc Adv Surg Tech A* 2007;17(2):216–8.

Kozlowski PM, Wang PC, Winfield HN. Laparoscopic repair of incisional and perastomal hernias after major genitourinary or abdominal surgery. *J Endourol* 2001;15:175–9.

Mancini GJ, McClusky DA III, Khaitan L, *et al.* Laparoscopic parastomal hernia repair using a nonslit mesh technique. *Surg Endosc* 2007;21(9):1487–91.

Muysoms EE, Hauters PJ, Van Nieuwenhove Y, Huten N, Claeys DA. Laparoscopic repair of parastomal hernias: a multi-centre retrospective review and shift in technique. *Acta Chir Belg* 2008;108(4):400–4.

Muysoms F. Laparoscopic repair of parastomal hernias with a modified Sugarbaker technique. *Acta Chir Belg* 2007;107:476–80.

Safadi B. Laparoscopic repair of parastomal hernias: early results. *Surg Endosc* 2004;18(4):676–80.

Shakarchi AI, Williams JG. Systematic review of open techniques for parastomal hernia repair. *Tech Coloproctol* 2014;18:427–32.

Silva E, Szomstein S, Van Koughnett JA, Rosenthal R, Wexner S. A new combined technique of reinforced parastomal hernia repair. *J Am Coll Surg* 2014;219(5):e55–7. doi:10.1016/j.jamcollsurg.2014.08.005.

Slater NJ, Hansson BM, Buyne OR, Hendriks T, Bleichrodt RP. Repair of parastomal hernias with biologic grafts: a systemic review. *J Gastrointest Surg* 2011;15:1252–8.

Sugarbaker PH. Prosthetic mesh repair of large hernias at the site of colonic stomas. *Surg Gynecol Obstet* 1980;150(4):576–8.

Chapter 51

Parastomal Hernia: Laparoscopic Parastomal Hernia Repair

Samuel Szomstein and Aaron Lee

INDICATIONS/CONTRAINDICATIONS

Parastomal hernia (PSH) occurs after colorectal surgery that requires either an end ostomy or protective stoma after a resection, and the rate of PSH can be as high as 80%. Unfortunately, not only is PSH a common complication but it also significantly affects patients’ lives. Construction of colostomy or ileostomy at the time of any colorectal surgery can be as high as 50%. Over 120,000 new stomas are created each year in the United States and more than half of the patients with an ostomy will never have their stoma reversed. PSH results in an impingement of quality of life, high output, obstruction, prolapse, malnutrition, dehydration, parastomal skin disruption, and irritation. Patients may have different combinations of the aforementioned complications. The indications to repair PSH are the same regardless of the planned method of the repair, either by laparoscopy or open surgery.

Generally, the indications to operate on patients with PSH vary depending on the chronicity of PSH, severity of the condition, and the degree of disability and impairment. How aggressively a surgeon decides to approach the PSH will depend on the acuity of the hernia or the symptoms that arise from it. First, PSH can be divided into either acute or chronic, defined by the time elapsed from the original surgery. Acute PSH, especially the ones that occur within a few hours to days after the surgery, is usually due to technical error, and patients will most commonly present with obstruction, incarceration, or strangulation, where prompt surgical repair is usually indicated. Some authors believe that all patients will eventually have a PSH if they are followed up long enough; therefore, most patients who are evaluated for PSH will generally be under the chronic type of PSH. For chronic PSH, conservative management usually is effective for patients with mild to moderate symptoms. These measures including customized stoma support, skin protective sealants, stoma or abdominal support belt, and better utilization of wound care nursing services can effectively manage peristomal wound complications, decrease the leak because of better appliance management, and improve quality of life.

When conservative measures have failed to control the symptoms, surgery is

When conservative measures have failed to control the symptoms, surgery is indicated. The majority of patients who seek surgical consultation and undergo an operation have at least one episode of obstruction, chronic pain, or constant leakage. Operative therapy can also be offered on the basis of the patient's psychosocial factors, poor cosmesis, and financial implication. Patients with PSH are more likely to have a worse quality of life compared to patients without PSH. These patients have been shown to have higher rates of apprehension secondary to appliance failure, needing to know where the nearest toilet is, higher financial burden to maintain the stoma-related apparatus, and social isolation resulting from the foul odor with frequent leak. Also, the financial implication from society as a whole cannot be overlooked because it has shown that patients with PSH will go on disability on account of the physical restriction that ultimately leads to decreased work productivity.

Even for chronic PSH, the severity of the condition will dictate how aggressively a surgeon should approach the problem. When patients present with high-grade obstruction, incarceration, perforation, or strangulation of bowel at the hernia site, prompt surgical repair will reduce perioperative surgical complication, morbidity, and mortality.

In general, indications for the laparoscopic approach heavily rely on the physician's expertise. Laparoscopy usually yields better wound complication rate, faster recovery, and shorter hospital stay; however, it requires a trained surgeon, staff, equipment, and hospital to accommodate a laparoscopic procedure. Provided that patients are able to tolerate general anesthesia, pneumoperitoneum, and the surgeon who is performing the procedure is adequately trained, a laparoscopic approach is typically best.

When patients meet one or more indications to have their PSH repaired, there are some contraindications for the laparoscopic approach that should be preoperatively considered.

There are several absolute contraindications of laparoscopy. First, patients need to be hemodynamically stable because the procedure cannot be completed safely without full anesthesia support. If the patient is experiencing severe septic shock secondary to the underlying condition that is not responding to medical therapy preoperatively, laparoscopy should be abandoned. Even if the patient is stable enough to be induced and laparoscopy is attempted, it is advisable for the surgeon to abort the technique and convert it to open technique if patient's hemodynamic status changes after the induction.

Another contraindication is an uncorrectable coagulopathy. When the patient has medical conditions such as liver failure, Coumadin toxicity in the setting of an emergency, disseminated intravascular coagulation, or the patient has been taking irreversible anticoagulants, laparoscopy is contraindicated. Severe bleeding will interfere with adequate visualization of the operative field, which is a key component of a laparoscopic procedure.

Severe uncorrectable hypercapnia greater than 50 torr secondary to the patient’s underlying medical condition is an absolute contraindication because laparoscopy will inevitably raise the CO_2 level with insufflation. Although there are other gases that are available like argon or helium, the operating room (OR) or the hospital may not have those particular gases and those gases have their own set of problems such as high costs and flammability. Hypercapnia can be exacerbated by the pneumoperitoneum, which can result in a detrimental effect on the patient such as severe hemodynamic instability or arrhythmia.

The surgeon should be adequately trained and comfortable with the laparoscopic technique and the OR should be set up to accommodate the procedure with all the necessary components of basic laparoscopic surgery. Equipping the staff and OR with appropriate skills and tools provides the best outcome possible for the patient when laparoscopic surgery is offered.

Relative contraindications to laparoscopic PSH repair include multiple previous abdominal surgeries, suspected severe peritonitis, significant amount of bowel distention, and a tense abdominal wall. A previous midline abdominal incision should certainly raise concern when a surgeon is planning to perform laparoscopic surgery. During the preoperative visit, information such as when previous surgeries took place, the type of surgeries, and the number of interventions the patient had before he/she comes to your office should be accurately acquired. The laparoscopic approach may not be ideal for patients who had a recent open surgery within 6 weeks because of the large amount of expected dense adhesions.

Severe peritonitis, tense abdominal wall, and/or bowel distention may prevent an adequate surgical field because of limited pneumoperitoneum. Although these are not absolute contraindications, it is prudent to use these factors as relative contraindications when deciding to perform PSH repair laparoscopically.

PREOPERATIVE PLANNING

PSH is commonly diagnosed with physical examination and computed tomography (CT) scan is not necessary to make the diagnosis. History and physical examination are essential. Many of the indications used for PSH repair are subjective; thus, it is important to ascertain how long and to what degree the patient has been suffering. The hernia can be better assessed with the patient standing up while performing the Valsalva maneuver to accentuate the bulge.

Although it is not mandatory to obtain an imaging study, CT scans can be helpful preoperatively to characterize the PSH in patients whose hernia cannot be accurately assessed clinically. Patients with morbid obesity will benefit from a preoperative imaging study to measure the size of the hernia as well as to evaluate the contents of the hernia, which may help with the preoperative planning. There are three types of parastomal hernia based on the CT scan finding, which are summarized in the table below. Patients with a midline incision and a significant amount of bowel in the hernia may benefit from a different entry technique and different port placement than someone whose previous surgeries that were performed laparoscopically and contain only a small amount of omental fat in the hernia.

Once the diagnosis is made and the patient desires to have his or her PSH repaired, it is critical to establish the goal of care and to clarify the indication for the operation with the patient. Patients may have different expectations from the surgery; thus, it is critical that the indications for the repair are explained to the patient and the potential benefits and risks of the operation discussed as well as documented in the chart.

Type 1	—	Hernia sac containing stoma loop
Type 2	—	Hernia sac containing omentum
Type 3	—	Hernia sac containing a loop other than the stoma

SURGERY

Patients should receive venous thromboembolism (VTE) prophylaxis and perioperative antibiotics. Appropriate aspiration precaution should be followed during intubation. Usually, patients at the author's institution have a bladder catheter placed.

Positioning

Patients should be positioned supine with both arms tucked, which gives the most ergonomically comfortable position for the surgeon and the assistant. Padding around pressure points will prevent any inadvertent ulcer or skin disruption. The patient is secured with two different straps, one above the knees and one below. Once the patient is positioned and the airway is secured, the entire abdomen from the nipple line to the pubic symphysis is prepped using chlorhexidine prep solution. When draping the patient, it is important to place the sterile towels as wide as possible to place the ports that are necessary to perform the surgery.

Technique

Depending on the location of the stoma and the extent of the previous surgeries, different entry techniques can be considered and utilized. If the patient has a midline incision and previous history of severe peritonitis and dense adhesions throughout the abdomen, supraumbilical midline port placement using Hasson technique is a viable option. Right or left midclavicular site can also be safely used to enter the peritoneum using a direct visualization trocar technique. When entering the peritoneum in the right upper quadrant, the liver may be in the way and may potentially be injured. Pneumoperitoneum is established with O_2 to a pressure of 15 mm Hg.

It is the author's preference to use a three-trocar technique with optimal triangulation to the stoma and PSH. The 30-degrees 10-or 5-mm scope is utilized in all of the author's cases. Depending on the amount of intraperitoneal adhesion, more trocars can be placed to assist with the adhesiolysis. Usual trocar placement is shown in Figure 51-1.

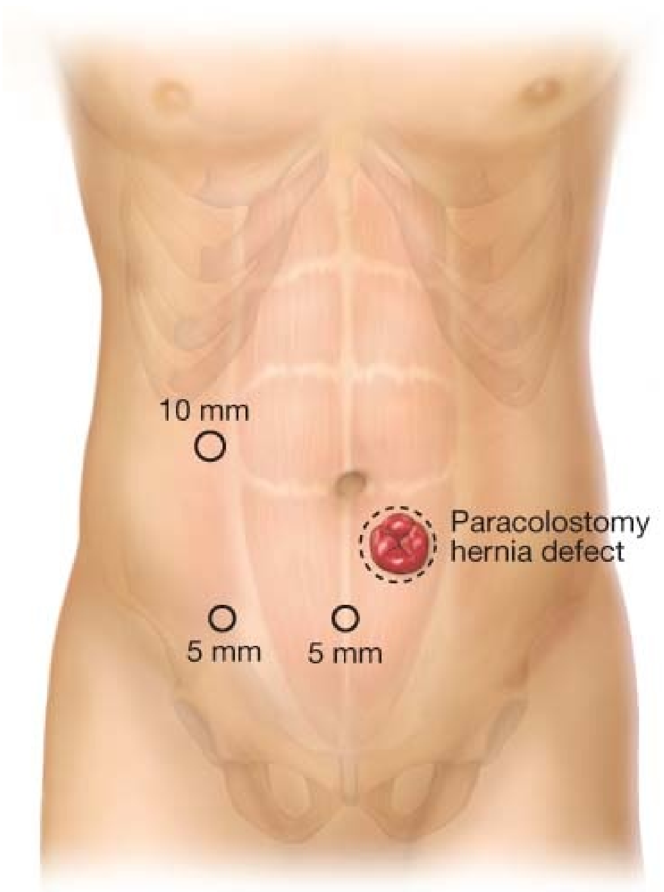


FIGURE 51-1 Usual port placement.

During the adhesiolysis, sharp dissection is preferred over any energy device because of the risk of delayed thermal injury to the bowel. When the omentum is safely dissected away from the bowel, an energy device can be utilized to seal any small vessel to prevent bleeding.

The hernia sac is dissected away from the hernia and excised. The author uses the modified keyhole technique, which involves the closure of the defect. When the hernia and the sac is dissected from the stoma, the defect is repaired using a nonabsorbable unidirectional barbed suture before mesh placement. Sometimes, suturing the defect is not the most desirable ergonomically but external pressure from the skin alleviates the level of difficulty by creating a more favorable suturing angle. Using the full length of the needle and full pronation of the wrist can facilitate suture placement. The steps of suturing the peristomal hernia are illustrated in Figs. 51-2 to 51-8.

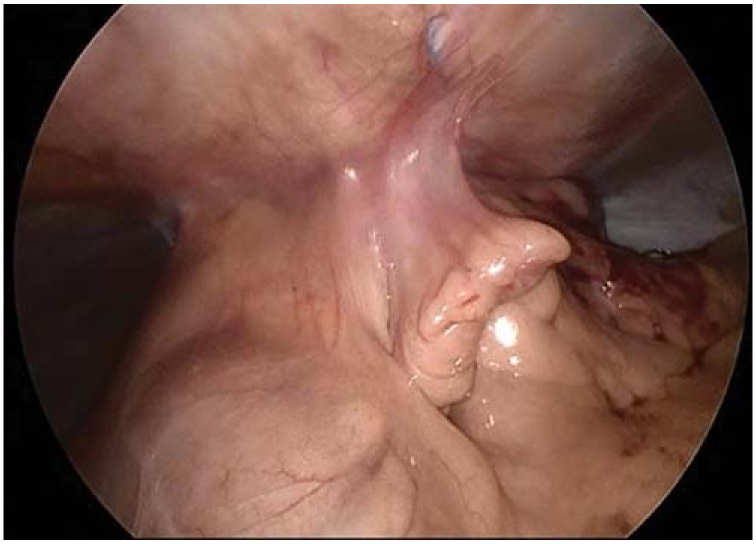


FIGURE 51-2 Parastomal hernia with adhesion.

FIGURE 51-3 During the adhesiolysis.

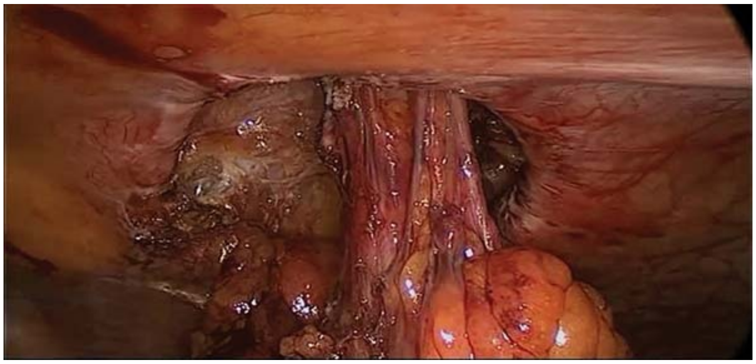


FIGURE 51-4 Post dissection.

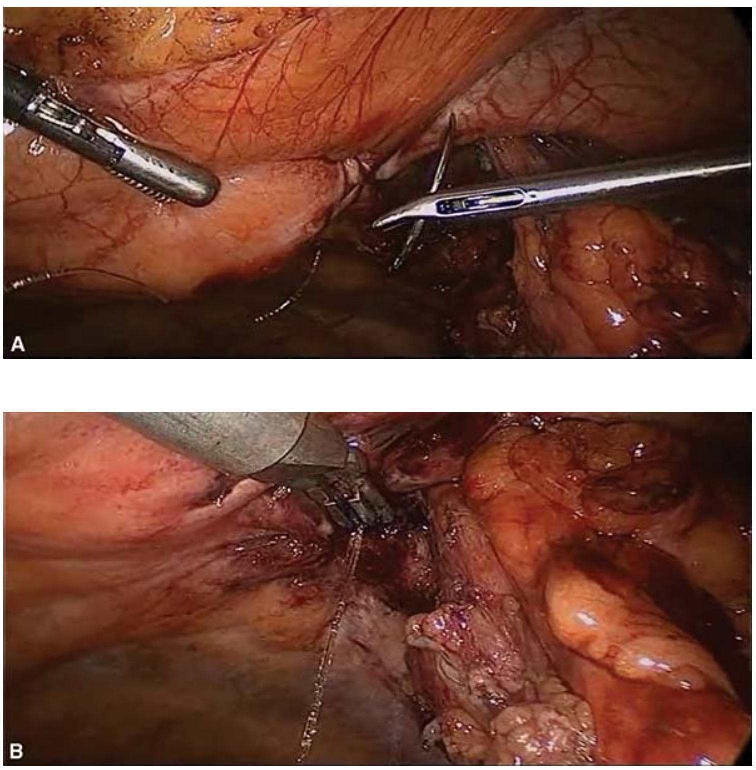


FIGURE 51-5 Suturing of the hernia defect. A. Hernia defect B. After the closure.

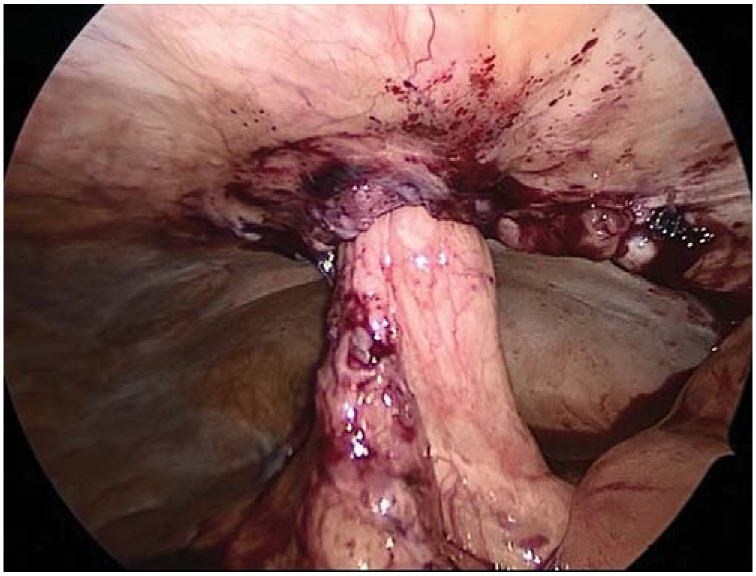


FIGURE 51-6 After the completion of the primary repair.

FIGURE 51-7 After the mesh placement.

FIGURE 51-8 Tact placement.

After the defect is closed primarily, the PSH is covered with a dual composite permanent mesh around the ostomy. Adequate coverage is the key to reducing recurrence. Although measurement of the defect can be taken either externally or internally, the author prefers to measure the marks externally with the patient completely flat with no pneumoperitoneum. The marks are made at the superior, inferior, and both right and left sides of the defect using a spinal needle while pneumoperitoneum is at 12 mm Hg.

While introducing the mesh, it is critical to roll the mesh tightly, so that the filament that is exposed to the bowel is undamaged. After the mesh is unrolled intraperitoneally, it is secured to the peritoneum, around the segment of bowel, using a nonabsorbable tacker. Depending on the location of the stoma, the mesh will invariably cover the area where the inferior epigastric artery is traveling, so the tack is placed away from the artery to prevent unwarranted postoperative hematoma. In cases that require bowel resection, because of iatrogenic injury or incarceration-induced strangulation, a biologic mesh is preferred to reduce potential mesh infection.

POSTOPERATIVE MANAGEMENT

Most patients can be safely managed on a regular surgical floor. Postoperative antibiotics are not indicated. The patient is kept on an isotonic intravenous fluid, sequential compression devices and VTE prophylaxis. The Foley catheter can be safely removed usually on post operative day 1.

A clear liquid diet can be advanced as the patient tolerates. If there was a significant bowel pathology such as severe bowel distension, strangulated bowel from incarceration that required a resection, or iatrogenic injury, a nasogastric tube may be elected to be left in place until its output is less than 300 ml per shift or until the patient is clinically not obstructed.

Adequate pain management prevents complications such as atelectasis or pneumonia. For the routine laparoscopic PSH case, oral analgesic is usually sufficient.

Incentive spirometry issued both preoperatively and postoperatively. Patients are instructed and encouraged to ambulate early after the surgery. All these measures are taken and executed as a part of the protocol to prevent atelectasis, pneumonia, deep vein thrombosis, and postoperative ileus.

COMPLICATIONS

Intraoperative Complications

Viscous injury or bleeding from the omentum or adhesion band is rare. Bowel injury can be repaired or resected depending on the extent of the injury. Bleeding is usually controlled with the energy device alone, clip, or suture ligation.

Postoperative Morbidity

Morbidity after a laparoscopic PSH is low (Table 51-1). The overall complication rate is approximately 25%, but the majority of the complications are nonoperative, such as ileus, pneumonia, and urinary tract infection. Other complications that contribute to the morbidities are surgical site infection (SSI), obstruction, and mesh infection (3.8%, 1.7%, and 1.7%, respectively). SSI or an abscess needs to be promptly treated because an undiagnosed or misdiagnosed SSI or abscess can lead to mesh infection and removal. Broad-spectrum antibiotics and drainage of abscesses are key components of the treatment of SSI or abscess. Mesh removal rate after the laparoscopic keyhole (LKH) repair ranges from 3.4% to 12.5%, and these removals are secondary to mesh related complications such as erosion, infection, fistula, bowel incarceration or strangulation. It has been reported that erosion rate after the LKH repair is about 1.5%.

Recurrence

The recurrence rate after an LKH repair ranges from 2.8% to 46.4%, as shown in Table 51-1. Although the literature seems to support the Sugarbaker or the modified Sugarbaker approach because of their low recurrence rates compared to the keyhole repair, our approach, using nonabsorbable barbed suture to close the defect, may further improve outcomes.

TABLE 51-1 Keyhole Technique Recurrences and Complications

Study	Year	Technique	Mesh type	No. of repairs	Recurrence % (N)	Wound infection % (N)	Obst %
Mizrahi et al.	2012	KH	PP/ePTFE	29	46.4 (13)	3.4 (1)	3.
Wara	2011	KH	PP/ePTFE	72	2.7 (2)	4.1 (3)	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

Hansson et al.	2009	KH	ePTFE	55	36.4 (20)	3.6 (2)	
Craft et al.	2008	KH	ePTFE	21	4.8 (1)	4.8 (1)	4.
Safadi	2004	KH	–	9	44.4 (4)	0	

KH, keyhole. PP, polypropylene mesh.

RESULTS

Table 51-1 summarizes the results of prevalent studies.

CONCLUSIONS

PSH is a common complication after the formation of a stoma for malignant or benign colorectal disease. There are several different ways to surgically repair PSH, which are simple suture repair, stoma relocation, different types of mesh, different mesh locations, and laparoscopic versus open surgery; there are no level 1 data. There are some data to support modified Sugarbaker repair with dual polytetrafluoroethylene (ePTFE). It is the author's preference to use this technique.

RECOMMENDED REFERENCES AND READINGS

Aquina CT, Lannuzzi JC, Probst CP, *et al.* Parastomal hernia: a growing problem with new solutions. *Dig Surg* 2014;31:366–76.

Berger D, Bientzle M. Laparoscopic repair of parastomal hernias: a single surgeon’s experience in 66 patients. *Dis Colon Rectum* 2007;50(10):1668–73.

Craft RO, Huquet KL, McLemore EC, Harold KL. Laparoscopic parastomal hernia repair. *Hernia* 2008 12(2):137–40.

DeAsis FJ, Lapin B, Gitelis ME, Ujiki MB. Current state of laparoscopic parastomal hernia repair: a meta-analysis. *World J Gastroenterol* 2015;21(28):8670–7.

Hansson BM, de Hingh IH, Bleichrodt RP. Laparoscopic parastomal hernia repair is feasible and safe: early results of a prospective clinical study including 55 consecutive patients. *Sur Endosc* 2007;21(6):989–93.

Hwang GS, Hanna MH, Carmichael JC, Mills SD, Pigazzi A, Stamos MJ. Repair of complex parastomal hernias. *Tech Coloproctol* 2015;19:127–33

Hotouras A, Murphy J, Thaba M, Chan CL. The persistent challenge of parastomal herniation: a review of the literature and future developments. *Colorectal Disease* 2013;15(5):e202–14.

Israelsson LA. Parastomal hernias. *Surg Clin of North Am* 2008;88(1):113–25.

Mizrahi H, Bhattacharya P, Parker MC. Laparoscopic slit mesh repair of parastomal hernia using a designated mesh: long term results. *Surg Endsoc* 2012;26(1):267–70.

Safadi B. Laparoscopic repair of parastomal hernias: early results. *Surg Endosc* 2004;18(4):676–80. Silva E, Szomstein S, Van Koughnett JA, Rosenthal R, Wexner S. A new combined technique of reinforced parastomal hernia repair. *J Am Coll Surg* 2014;219(5):e55-7.

Sugarbaker PSH. Prostehtic mesh repair of large hernias at the site of colonic stomas. *Surg Gynecol Obstet* 1980;150(4):576–8. Wara P. Parastomal hernia repair. An update. *Minerva Chir* 2011;66(2):123-8.

PART XII

HARTMANN’S REVERSAL

Chapter 52

Open Hartmann's Reversal

Roberta L. Muldoon

HARTMANN'S REVERSAL

The majority of diseases of the colon can be managed with a single-stage procedure. There are, however, still circumstances in which the operating surgeon is concerned about performing a primary anastomosis after having completed a segmental resection of the left colon, and feels that stool diversion is in the best interest of the patient. Severe inflammation or gross contamination of the abdominal cavity may preclude primary anastomosis. The most common scenarios in which Hartmann's procedures are performed are cancer, perforated diverticulitis with abdominal sepsis, or after an anastomotic leak. A Hartmann's procedure leaves the patient with an end colostomy as well as a rectal stump. Ideally, over time the inflammation or primary condition resolves, and Hartmann reversal or colostomy takedown can be considered. This procedure is known for its high morbidity, so careful patient selection is paramount.

INDICATIONS/CONTRAINDICATIONS

It is important to keep in mind a number of factors when deciding to proceed with Hartmann's reversal. These factors will impact the likelihood of a patient having a complication either during or after the procedure. By optimizing the condition of the patient, one may be able to decrease the morbidity associated with this procedure.

The timing of the reversal has been examined, but there is no clear consensus as to when is the appropriate time to proceed. Aydin *et al.* studied 121 patients who underwent successful Hartmann's reversal. They found that patients undergoing reversal at 4 months after the primary procedure were 2.5 times more likely to have a surgical complication when compared with those undergoing reversal within 4 months of the primary procedure. Those having their reversal at 8 months after the primary procedure were 5.5 times more likely to have a surgical complication when compared with those who had reversal within the 4-month window. This would suggest that closure within 4 months is the safest time to proceed. Pearce *et al.* reviewed 145 patients after Hartmann's reversal and found that 6 out of 12 patients (50%) who underwent reversal in under 3 months from the time of the primary surgery suffered an anastomotic leak. Twenty-eight patients underwent reversal between 3 and 6 months after their initial surgery. Seven of the 28 patients (25%) suffered an anastomotic leak. Forty patients had their reversal after 6 months from the original surgery, and all healed well without evidence of leak. This paper suggests that a waiting period of 6 months is the safest for the patient. When Keck *et al.* reviewed their data of 111 Hartmann's reversals, they found no difference in morbidity, mortality, or complication rates between those that had their takedown early (before 15 weeks) or late (after 15 weeks). They did find that those that were done early did have longer hospitalizations, and that the operations were perceived by the surgeon as being more difficult. It is important to note that none of these papers specifically looked at the severity or complexity of the original operation. This would clearly affect the recovery time of the patients and would clearly have an effect on the ease and success of the reversal procedure.

It is generally accepted that early reversal (less than 3 months) may lead to complications secondary to adhesions and residual inflammation still present from the inciting process and the original surgery. This can lead to more difficult cases, prolonged surgeries, increased blood loss, and prolonged hospitalization. On the other end of the spectrum, it is thought that waiting too long may lead to difficulty in mobilizing and anastomosing the rectal stump, which decreases in size over time due to lack of use. It is important when reviewing this literature to size over time due to lack of use. It is important when reviewing this literature to consider the effect of the original operation on the outcome. None of these papers specifically looked at the complexity or indication for the original operation. Perhaps the increase in complications that is sometimes seen with waiting may be a reflection of the difficulty of the original operation, the severity of the disease process, patient comorbidities, and a prolonged recovery time from a difficult original surgery, rather than a reflection of just the passage of time.

The decision as to the appropriate timing of the reversal needs to be made on an individual basis. First and foremost, the patient must be in overall good condition with recovery from the primary surgery and able to undergo a second operation. Consideration of the original disease process, the operative intervention itself, as well as how the recuperation progressed will be helpful information in planning when to proceed with the reversal. Ideally, the patients should be at or close to their premorbid state with regard to ambulation, nutrition, and overall strength. If they needed to be placed on steroids for treatment of their disease process, these should be weaned if possible before colostomy takedown. The initial inciting event should have resolved, and enough time given to have resolution of the inflammatory process. Finally, there should be no sign of ongoing infection that could lead to an increased risk of wound infection or intra-abdominal abscess formation. The author takes all these factors into consideration when deciding when to reverse a colostomy but tends to aim for 6 months after the primary procedure.

PREOPERATIVE EVALUATION AND PREPARATION

Preoperative workup includes evaluation of the remaining colon as well as the rectal stump. The colon should be evaluated endoscopically to rule out cancer or other possible pathology of the colon. The length of the remaining colon is also noted. The rectal stump should also be viewed to exclude associated pathology in the rectum, as well as give an indication as to the length of the rectal stump. Knowledge of the length can be helpful in determining where to look for the proximal end in a pelvis that may have a significant amount of scar tissue present. It is very helpful also to review the operative note of the primary surgery, especially if another doctor performed the original operation. Knowing, for example, that the bowel was secured to the anterior abdominal wall or that a stitch had been placed at the proximal end of the bowel can be valuable information. It is also helpful to know where the proximal end of the bowel might be located, so that it is not injured either with entry into the abdominal cavity or while lysing pelvic adhesions.

Patients should undergo a full-bowel mechanical and cathartic prep in preparation for the surgery. If inspissated mucus is found at the time of endoscopic evaluation of the rectum, then enemas per rectum can be given to clear this before the surgery. Lastly, the need for the use of ureteral stents should be considered. Although the use of stents does not eliminate the risk of ureteral injury, it has been shown to improve early detection of the ureters that is associated with decreased morbidity associated with this complication. The decision to use stents is usually based on the severity of the disease at the original operation, the difficulty of the primary operation, as well as the length of the rectal stump. The time interval between the two surgeries and the patient’s history of prior operation should also weigh into this decision.

TECHNIQUE

The patient should be positioned in the modified lithotomy position. Deep vein thrombosis prophylaxis should be administered as well as a dose of preoperative antibiotics. A bladder catheter should be inserted and bilateral ureteric stents placed at this time if indicated. The stoma can be sutured closed to minimize any contamination during the case. The abdomen is prepped and draped. The stoma is then covered with sterile gauze to collect any fluid that might leak out from the stoma, and then the entire abdomen is covered with an antimicrobial adhesive covering. A lower midline incision is made. Upon entering the abdomen, care should be taken to avoid injury of small bowel loops that may be adherent to the anterior abdominal wall. All adhesions in and around the stoma should be carefully taken down so that there is clear visualization of the distal colon exiting the anterior abdominal wall. Once the distal colon is freed circumferentially at the fascial level, the bowel can be divided. A linear cutting stapler is positioned just beneath the anterior abdominal wall with the intention of preserving as much of the bowel length as possible (Fig. 52-1). Once the colon is divided, it is usually easier to complete the remainder of the adhesiolysis, after which a retractor system can be placed. It is important to assess which vessels were divided at the primary operation and which are still intact. This will be important not only in assessing the remaining colon's blood supply but may also play a key role in the mobility of the colon reaching down to the proximal end of the rectum. The small bowel needs to be freed out of the pelvis and packed into the upper abdomen. The distal colon can usually also be temporarily packed into the upper abdomen.

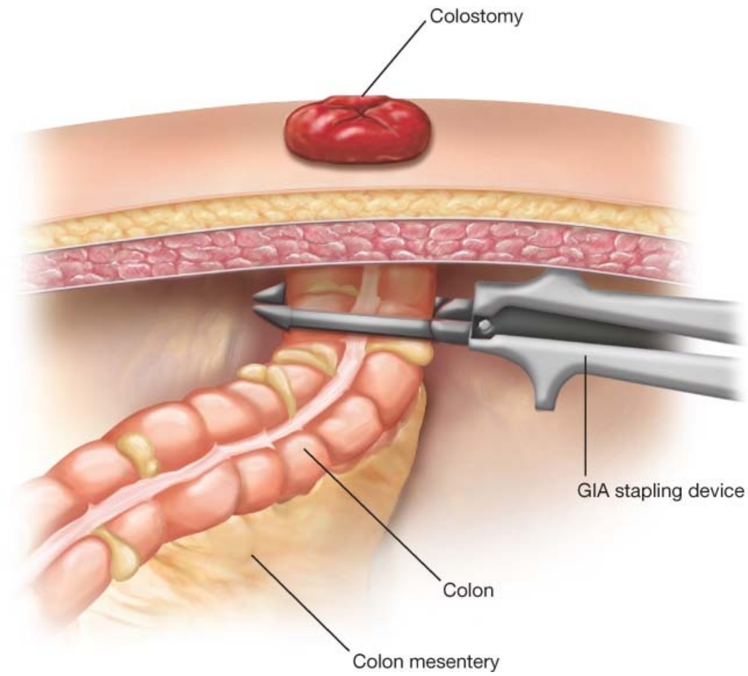


FIGURE 52-1 Abdominal wall with colostomy in place. Stapler aligned just beneath the abdominal wall ready to fire.

p. 498

---

p. 499

With good visualization of the pelvis, the rectal stump can be identified and mobilized. This step can be very easy at times or quite challenging. If at the original surgery the rectal stump was long and sutured to the anterior or lateral wall, the localization is usually fairly straightforward. More often though, the case is that the rectal stump is shorter and has retracted into the pelvis with reperitonealization, making location more challenging. If it is difficult, the following maneuvers can be helpful. Air can be gently insufflated with a rigid proctoscope to help identify the rectum. The rectal sizers can also be used to stent the rectum, thus giving some direction as to its location and boundaries. A flexible sigmoidoscope can also be inserted and advanced under direct visualization to help identify the most proximal end of the rectum. The amount of mobilization necessary depends on the length of rectum, the type of anastomosis planned (stapled vs. hand sewn) and the angulation of the rectum. If the rectum is straight, only the most proximal end needs to be mobilized ensuring that the edges are cleared for a “clean” anastomosis. If, however, the rectum has folded back on itself or has significant angulation present and a stapled anastomosis is planned, then further mobilization will be necessary for safe insertion of the stapler from below. It is imperative that the rectum be adequately cleared from the bladder in the male and the vagina in the female.

Sometimes it is difficult to assess the exact plane between the rectum and the vagina. In this case, it is often helpful to place either a finger or the rectal sizers in the vagina. The vagina can then be retracted anteriorly, which can assist in developing the plane between these two structures.

Once the rectum has been mobilized, it must be assessed for suitability for anastomosis. The original etiology needs to be contemplated, and adequacy of the primary resection assessed. At times, in the setting of acute perforated diverticulitis, the perforated and most diseased portion of the colon is resected leaving behind a segment of sigmoid colon down in the pelvis. In this setting, the distal portion of sigmoid needs to be resected so the anastomosis is performed to the top of the true rectum. Likewise, if the pathology had revealed cancer with inadequate margins, additional resection might be needed. Lastly, during a difficult pelvic dissection, the proximal end of the rectal stump may be injured or compromised and additional resection is needed. The compromised portion is then resected and a healthy rectal stump is now ready for anastomosis. Once the rectum is assessed and ready for anastomosis, the distal colon needs to be assessed and prepared for anastomosis.

The distal colon also should be assessed for suitability for anastomosis. The distal margin should have healthy tissue with a good blood supply. It should reach down to the pelvis without any tension. If there is tension present, then the splenic flexure should be mobilized. This step is done by retracting the colon medially and incising along the white line of Toldt. The plane between the colon mesentery and the retroperitoneum should be identified and developed medially and superiorly toward the splenic flexure; the splenocolic ligaments are divided. With difficult splenic flexures, it is sometimes beneficial to approach the flexure from medial to lateral. In this case, the omentum is retracted superiorly and the transverse colon inferiorly. The omentum is taken off the transverse colon, thus allowing entry into the lesser sac. This plane can then be developed toward the splenic flexure until it is completely mobilized. If after mobilization of the splenic flexure there still seems to be undue tension when the colon is assessed for anastomosis, then the blood vessels should be evaluated. It may be necessary to divide the inferior mesenteric artery and/or the inferior mesenteric vein, if this was not divided at the original operation. Care must be taken when dividing these vessels that the marginal artery is preserved because this will be the blood supply to the distal colon.

Once adequate length and viability is attained, the anastomosis can be performed. The anastomosis can be done with a stapling or hand sewn technique. Docherty *et al.* performed a prospective randomized trial comparing hand-sewn anastomoses to stapled anastomoses. They found that though there was a significantly higher rate of radiologic leak noted in the hand-sewn group, there was no difference in clinical anastomotic leak rates, morbidity, or mortality when comparing the two different methods. The hand-sewn technique can be challenging when performed deep in the pelvis. The author prefers a stapled anastomosis when possible and the technique to perform this type of anastomosis is described.

The distal end of the colon (approximately 1 cm) is prepared first by clearing any excess fat which may interfere with clear visualization of the colon or with the anastomosis. Towels should be placed around the bowel to maintain the sterility of the field. A purse string stitch is then placed at the distal end of the colon. If using the reusable purse string device, it is applied to the distal end of the colon just proximal to the staple line. Allis clamps help align the bowel. A permanent monofilament stitch on a straight needle is then passed through the purse string instrument. The staple line is then excised. The purse string device is then removed and the anvil to the circular stapler is placed into the lumen of the bowel. The purse string is then tightened around the anvil. Care should be taken to make sure that there is a small cuff of bowel present above the stitch and that there are no gaps around the anvil (Fig. 52-2A). The distal end of the bowel with the anvil should be carefully examined making sure there are no diverticula that could cause problems with the anastomosis. There should be minimal to no fat present and no additional tissue that would interfere with the staple line.

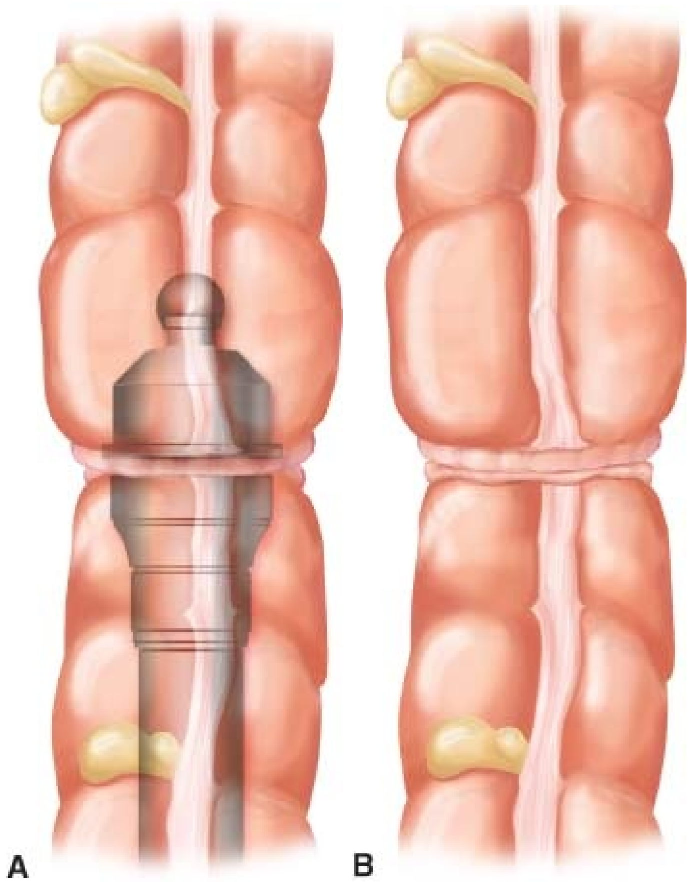


FIGURE 52-2 A. Stapler closed and fired. B. Anastomosis removal of stapler.

The circular stapler is then inserted into the rectum and carefully advanced to the proximal end of the rectum. If resistance is encountered, the stapler should be removed and either the dilators can be passed or the rectum can be visualized using the flexible endoscope. Excessive force should not be utilized in an attempt to advance the stapler, because this can result in tearing of the rectal wall. Most of the time the problem will be that the stapler is caught on a valve and simple dilation with the sizers will correct this problem. The stapler can then be reinserted and carefully advanced to the proximal end of the rectum. Care should be taken to make sure the stapler has reached the proximal end and that the rectum is lying flat over the stapler mechanism. The spike is then deployed, aiming to have it come out either just above or just below the middle of the staple line. Once the spike is fully deployed, the anvil is attached, making sure that the colon has not been twisted. It is imperative that no adjacent tissue is caught in the stapler. In the female patient, care should be taken to assure that the vagina has been fully separated from the rectum and retracted so as not to be incorporated into the staple line to avoid the complication of a rectovaginal or colovaginal fistula. Once the entire circumference of the anastomosis is cleared, the stapler is then closed and fired (Fig. 52-2B). The stapler is then opened, rotated, and gently removed. The tissue that has been excised and is in the stapler mechanism should be removed and examined to see if complete rings are present. Lack of complete rings could signify a problem with the anastomosis.

The anastomosis is evaluated for leaks by occluding the colon with a non-crushing bowel clamp above the anastomosis. Saline is instilled into the pelvis so that the anastomosis is submerged. A flexible sigmoidoscope is inserted into the rectum and air gently insufflated until the colon is dilated. The anastomosis should be assessed for escaping air bubbles. If none are seen, the air can be removed from the colon and the saline removed from the pelvis. If bubbles are seen, it signifies a leak at the anastomosis that will require repair. After repair, the anastomosis is again checked for leaks. The flexible scope can be advanced to the level of the anastomosis to assess for bleeding. If there is bleeding, sutures can be intra-abdominally placed while viewing the area with the endoscope to ensure accurate placement of the stitches and thus control of the bleeding site. Once it is confirmed there is no leak or bleeding issues, the air is removed from the colon and the scope removed. In case of a leak, it is the editor's preference to redo the anastomosis or divert the repaired anastomosis.

With completion of the anastomosis, the abdomen will be closed and the end of the stoma excised. Before closing the midline wound, the stoma site should be checked to make sure that there are no adhesions or small bowel that might still be attached to this portion of the bowel. It is also helpful to free this small remaining piece of bowel from the fascia before closing because this will assist in ease of removal from the exterior approach once the abdomen has been closed. The midline fascia and skin are then closed and a dressing is placed.

The remaining small portion of bowel and the stoma can be removed. A circular incision is made at the mucocutaneous junction. This incision is then taken down separating the small remnant of bowel from the subcutaneous tissue and the fascia. Once the bowel is removed, the fascia is closed. The wound is irrigated. The stoma site is partially closed by placing a 3-0 absorbable monofilament purse string at the dermal level. A small Penrose drain is placed in the center of this wound as the purse string is tied down. A dressing is placed over this wound.

At times it may be necessary to remove the stoma before closing the abdomen. When this occurs, one should try to minimize contamination of the abdomen. Towels should be placed around the stoma so as to cover the midline incision. The adhesive dressing can now be removed from the stoma and the stoma excised from the exterior approach. Once removed, the towels and dirty instruments should be passed off the field and all personnel should change their gown and gloves. Closure of the fascia of both the stoma site and the midline wound can then be undertaken.

wound can then be undertaken.

POSTOPERATIVE CARE

The bladder catheter is generally removed the morning after surgery or in the operating room unless the anastomosis is deep in the pelvis. Patients are allowed clear liquids until the time that they have some bowel function at which time they are advanced to a low-residue diet. The Penrose drain from the stoma site is removed when the patient is ready for discharge from the hospital. A clean dry dressing is placed over the stoma site and this is allowed to granulate closed.

COMPLICATIONS

Overall mortality for this procedure ranges from 0% to 3.7% and, as would be expected, is related to age and medical comorbidities. The Hartman reversal procedure has a known high morbidity rate, which ranges from 25% to 48.5%. These complications should be seriously considered when one is deciding to do the Hartmann's procedure in the first place. These risks need to be weighed against the benefits of doing this procedure. The most common complication experienced with this procedure is wound infection, as noted in 12.9% up to 21% of patients. Careful attention to detail can lower the risk of this complication. The second most common complication seen with this procedure is ileus, which can occur up to 18% of the time. Anastomotic leak can occur and has been found to range from 3.3% to 4%, and is comparable to other procedures with colonic anastomosis. Other complications associated with colostomy reversal are bleeding, dehiscence, rectovaginal fistula (3.7%), stricture formation (3.7%), pneumonia (5%), urinary tract infection (3%), and hernia formation either at the midline incision or at the stoma site. Schmelzer *et al.* analyzed their data and found that the only predictive risk factor for postoperative morbidity was hypoalbuminemia.

RESULTS

It is important to realize that a large number of patients who have a Hartmann's procedure will never have their stoma reversed. It has been shown that only 54–59% of patients have a reversal performed. Younger patients are more likely to have their stomas reversed, as are male patients. The disease process that required the stoma in the first place does play a role in the likelihood of having the stoma taken down. Mealy *et al.* noted that patients who had a stoma created secondary to diverticulitis were much more likely to have their stoma reversed than those who had a stoma created secondary to cancer, 84.6% versus 48.3%, respectively. Age also plays a role in the likelihood of reversal. Salem *et al.* looked at those patients who had a colostomy created secondary to diverticulitis. Eighty percent of patients who were less than 50 years of age had their stoma reversed compared to only 30% of those over 77 years of age.

One must also consider those patients who have reversal attempted but the procedure is not successful, and the patient is left with a permanent colostomy. Boland *et al.* reviewed 39 Hartmann reversals. They found that ten patients (26%) had stomas at the time of discharge from their reversal operation, 3 of whom were intended to be permanent and seven were temporary. Only 3 of these seven temporary stomas were closed, three were pending closure at the completion of the study, and one was a failure of the anastomosis and became a permanent stoma. On the basis of these numbers, they had a 10% failure rate at reversal of the Hartmann procedure. Mealy *et al.* also reviewed their data with regard to this issue. They found that 11.2% (8/71) of the patients who underwent attempted colostomy reversal had additional stomas created. Of these eight patients, two eventually had their stomas reversed for an overall failure rate of 8.4%. These failures also have to be added to the already large group that never comes to attempted Hartmann's reversal.

Considerations

Because of the high morbidity rate as well as the high rate of patients who never come to colostomy reversal, it is important to consider options at the initial operation to avoid this circumstance if possible. There are certainly instances where sound surgical judgment dictates that the best option for the patient is to have a Hartmann's procedure. Another option to consider is primary anastomosis and diverting loop ileostomy. Patients with a diverting loop ileostomy are five times more likely to have their stomas reversed compared to those patients with a colostomy. Ileostomy takedown is an easier procedure with a shorter operative time, making it an attractive option. Bell *et al.* compared complications associated with colostomy reversal to those associated with ileostomy reversal. They found that the overall morbidity from a Hartmann's reversal was 55% compared to 20% for an ileostomy reversal. Of those complications, 20% required operative intervention for the colostomy reversal group, whereas only 5% required operative intervention for the ileostomy reversal group.

CONCLUSION

Hartmann's reversal is a procedure known to have a high morbidity rate. All options should be considered at the time of the initial operation, carefully weighing the risks and benefits of the Hartmann's procedure. There will still be cases that the Hartmann's procedure is the safest option for the patient. In this case, thoughtful consideration needs to be given to the ideal time for colostomy closure. The difficulty of the initial operation, severity of disease, the patient recuperation period, and comorbidities all play an important role in deciding when to proceed. Finally, careful attention to detail during the procedure can minimize complication from this procedure.

RECOMMENDED REFERENCES AND READINGS

Alizai P, Schulze-Hagen M, Klink CD, *et al.* Primary anastomosis with a defunctioning stoma versus Hartmann’s procedure for perforated diverticulitis-a comparison of stoma reversal rates. *Int J Colorectal Dis* 2013;28:1681–8.

Aydin H, Remzi F, Tekkis PP, Fazio VW. Hartmann’s reversal is associated with high postoperative adverse events. *Dis Colon Rectum* 2005;48:2117–26.

Bell C, Asolati M, Hamilton E, *et al.* A comparison of complications associated with colostomy reversal versus ileostomy reversal. *Am J Surg* 2005;190:717–20.

Boland E, Hsu A, Brand MI, Saclarides TJ. Hartmann’s colostomy reversal: outcome of patients undergoing surgery with the intention of eliminating fecal diversion. *Am Surg* 2007;73:664–8.

Camacho-Mauries E, Rodriguez-Diaz J, Salgado-Nesme N, González QH, Vergara-Fernández O. Randomized clinical trial of intestinal ostomy takedown comparing pursestring wound closure vs conventional closure to eliminate the risk of wound infection. *Dis Colon Rectum* 2013;56:205–11.

Daluvoy S, Gonzalez F, Vaziri K, Sabnis A, Brody F. Factors associated with ostomy reversal. *Surg Endosc* 2008;22:2168–70.

Docherty J, McGregor J, Akyol A, Murray G, Galloway D. Comparison of manually constructed and stapled anastomoses in colorectal surgery. West of Scotland and Highland Anastomosis Study Group. *Ann Surg* 1995;221:176–84.

Ghorra S, Rzeczycki T, Natarajan R, Pricolo VE. Colostomy closure: impact of preoperative risk factors on morbidity. *Am Surg* 1999;65:266–9.

Keck JO, Collopy BT, Ryan PJ, Fink R, Mackay JR, Woods RJ. Reversal of Hartmann’s procedure: effect of timing and technique on ease and safety. *Dis Colon Rectum* 1994;37:243–8.

Mealy K, O’Broin E, Donohue J, Tanner A, Keane FB. Reversible colostomy—what is the outcome? *Dis Colon Rectum* 1996;39:1227–31.

Oberkofler C, Rickenbacher A, Raptis DA, *et al.* A multiceneter randomized clinical trial of primary anasotmosis or Harmann’s procedure for perforated left colonoic diverticulitis with purulent or fecal peritonitis. *Ann Surg* 2012;256:819–27.

Pearce N, Scott S, Karran SJ. Timing and method of reversal of Hartmann’s procedure. *Br J Surg* 1992;79:839–41.

Richards CH, Roxburgh CS; Scottish Surgical Research Group (SSRG). Surgical outcome in patients undergoing reversal of Harmann’s procedures: a multicenter study. *Colorectal Dis* 2015;17:242–9.

Roe A, Prabhu S, Ali A, Brown C, Brodribb AJ. Reversal of Hartmann’s procedure: timing and operative technique. *Br J Surg* 1991;78:1167–70.

Salem L, Anaya D, Roberts KE, Flum DR. Hartmann’s colectomy and reversal in diverticulitis: a population-level assessment. *Dis Colon Rectum* 2005;48:988–95.

Schmelzer TM, Mostafa G, Norton HJ, *et al.* Reversal of Hartmann’s procedure: a high risk operation? *Surgery* 2007;142:598–607.

Chapter 53

Laparoscopic Colostomy Reversal

Floriano Marchetti and Debbie Bakes

In 1923, Henry Hartmann introduced the concept of colonic resection, end colostomy, and rectal stump for the treatment of cancers of the distal colon. Since that time, this operation has been employed to treat a variety of conditions, mainly of the left colon such as complicated diverticulitis with peritonitis, trauma, obstructing or perforated neoplasms of the left colon or rectum, as well as volvulus or ischemia.

Although this procedure has proved effective in reducing mortality in such conditions, the reversal of the end colostomy remains a major surgical procedure associated with significant surgical morbidity up to 50–60%, and mortality as high as 5–10%.

Furthermore, this operation is burdened by a usually lengthy hospital stay and prolonged convalescence with significant socioeconomic cost.

Once laparoscopy was introduced to colon and rectal surgery, it was only natural to try to use a minimally invasive approach also for this operation with the goal of reducing morbidity, mortality, and especially hospital stay and convalescence.

The first case of laparoscopic reversal of the Hartmann's procedure was published in 1993 This case report was followed by other small studies that showed encouraging results. In one of the earliest reports of laparoscopic colostomy reversal, Sosa *et al.* found that laparoscopic-assisted Hartmann's reversal results in comparable morbidity, but may be associated with shorter hospital stay when compared to laparotomy.

Since then, laparoscopic colostomy reversal has been evaluated in many retrospective studies, which have indicated this approach to be safe and have shown results not only comparable to the open technique but also, in many cases, superior, particularly in terms of time to recovery. Although most of these studies include a small number of patients and come from single institutions, their data did show that a laparoscopic approach was associated with a reduced length of stay (LOS), lower rates of wound infection, and anastomotic leakage.

Many authors have reported the advantages of laparoscopic colostomy reversal in terms of lower morbidity. A meta-analysis of 12 studies comparing open Hartmann reversal (OHR) versus laparoscopic Hartmann reversal (LHR) found the following in the LHR group:

Overall morbidity was lower (mean 12.2% LHR vs. 20.3% OHR). Complications included wound infection (10.8% vs. 14.2%), anastomotic leakage (1.2% vs. 5.1%), and cardiopulmonary complications (3.6% vs. 6.9%).

Length of hospital stay was shorter (mean 6.9, range 3–11 vs. 10.7 days, range 3–18 days).

Rate of reoperation was lower (3.6% vs. 6.9%).

However, there are no randomized studies comparing OHR versus LHR. The available studies are all retrospective series with small numbers of patients (7–71 patients). Therefore, the impact of selection bias in these results remains to be determined. Furthermore, the statistical power of such studies is objectively limited.

More recently, however, two large reviews, one gathered from American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database and a systematic review and meta-analysis of LHR versus OHR that were published in 2015, lent more substantial support to these early findings.

LHR is a technically demanding operation with a steep learning curve, and conversion rates are as high as 22%. Khaikin *et al.* reported that laparoscopic colostomy reversal was technically challenging and required more operative time than did the open technique.

However, despite these limitations, in the hands of experienced laparoscopic surgeons, LHR is safe and associated with a reasonably low conversion rate. Furthermore, it is possible that newer prospective studies will confirm the relatively low morbidity rate, shorter hospital stay, and earlier return to bowel function. In fact, with the expansion and further development of minimally invasive surgery, morbidity and conversion rates may be reduced further. The advantages of smaller incisions, decreased postoperative pain, shorter recovery time, and early return to normal activity have been well described.

INDICATIONS/CONTRAINDICATIONS

Depending on the original surgical indication for the stoma and if the disease process has been resolved, the stoma can be reversed.

Indications

All Hartmann’s resections conducted on the left colon are potentially amenable to a laparoscopic reversal attempt. Complicated diverticulitis remains the most frequent indication to a Hartmann procedure, followed by obstructed or perforated left-sided colon cancer. Trauma, volvulus, and ischemia are less frequent indications.

A laparoscopic approach may also be attempted for patients with long Hartmann’s pouches such as after segmental transverse colectomies or right colectomies with end ileostomies.

It is possible to speculate that patients who have undergone laparoscopically performed Hartmann operations are the ideal candidates for subsequent LHR. However, most colorectal surgeons will have to manage patients who underwent open resections and were possibly operated in emergency by other surgeons. If the patient was operated elsewhere or by another surgeon, the operative note should be reviewed for the following:

- Use of adhesion barriers: It is possible that such patients will present with less adhesions and, therefore, be better candidates for laparoscopic reversal. Although the real advantages remain controversial, the use of such materials has been shown to be beneficial in decreasing postoperative adhesion formation.
- The presence of markers on the stapled end of the rectum: The identification of the rectal stump can be challenging. The presence of nonabsorbable sutures near the staple line aids in the identification of the rectum. In several series, the inability to identify the rectal stump was one of the most frequent reasons for conversion. In one series, this problem was the reason for seven of the eight conversions.
- The length of rectum or rectosigmoid stump: A longer stump is usually more promptly identified both at laparoscopy and at laparotomy. All sigmoid colon must be resected either during the first or second operation to ensure construction of a colorectal rather than a colosigmoid anastomosis.
- The presence of an intact superior rectal artery: This may help prevent the recoil of the rectum in the pelvis.
- The presence of the uterus in female patients: The rectum may retract behind the uterus and form with it dense adhesions, which will render the dissection more complicated.

Contraindications

Contraindications of stoma reversal include the following:

- Patient preference
- Unresolved disease process such as carcinomatosis, persistent inflammation, or ischemia

Incontinence or expectation of incontinence

Distal obstruction

The presence of medical conditions and comorbidities, which may also be contraindications to open surgery

Contraindications to Laparoscopic Hartmann’s Reversal

Technically unfeasible cases such as abdomens with extensive adhesions, or in presence of extensive radiation changes.

Hostile anatomy: The rectal stump or the ureter is not identified with certainty.

PREOPERATIVE PLANNING

Because most of these patients underwent emergency surgery without any preoperative screening, most surgeons prefer to evaluate the colon before the colostomy reversal by either colonoscopy or barium enema. In our practice, if a patient is 50 years or older, or if he/she has increased risk factors for colorectal cancer, the preferred option is a colonoscopy through the stoma and a flexible sigmoidoscopy of the rectal stump. We also obtain a contrast study with water-soluble contrast to assess two important parameters such as the length and the shape of the rectal stump and the level of the splenic flexure. Younger patients without risk factors for colorectal cancer may undergo only the contrast study with hydro-soluble contrast.

If the index procedure was done for cancer, a complete staging evaluation should be done to assess recurrent or metastatic cancer. Computed tomography (CT) as well as a carcinoembryonic antigen would serve well for this. Positron emission tomography/CT scan should be reserved when CT scan findings are unclear.

Patients are instructed to fast for the night before surgery. The issue of mechanical bowel preparation (MBP) remains controversial. Multiple reports have questioned the benefits of such practice. An initial meta-analysis performed in 2009 of 13 randomized studies involving 4,777 patients and a subsequent Cochrane review concluded that there is no statistically significant evidence to prove that patients benefit from bowel preparation.

Despite these reviews, current practice among colorectal surgeons varies, and, in fact, there is no universally accepted international consensus on the ideal preoperative regimen. However, during the past few years new evidence has surfaced, which supports the combined use of MBP, oral antibiotics, and systemic intravenous (IV) antibiotics at induction, but a number of unanswered questions remain.

A recent review article by Murray and Kiran concluded that there is "sufficient evidence to suggest that MBP along with nonabsorbable oral antibiotics and appropriate IV antibiotics at induction has the greatest effect on reducing common occurrences of postoperative septic complications in colorectal surgery."

It is obvious that more randomized controlled trials (RCTs) are needed to address this issue, given the apparent lack of level 1 evidence.

An Italian RCT is currently evaluating the clinical results in patients randomized to either full MBP or rectal enema alone ("Comparison of Mechanical Bowel Preparation Versus Enema for Candidates to Colorectal Resection for Adenocarcinoma (MBP)"; clinicaltrials.gov identifier NCT00940030); primary outcome measures of this trial: anastomotic leakage and wound infection (including deep abscess).

The preference of both the authors and the editors is to perform both a mechanical and oral antibiotic bowel preparation the day before surgery with or without two phosphate enemas to clean the rectum on the morning of surgery. The rationale is to allow for an easier manipulation of the bowel during the laparoscopic handling of the colon, which could be rendered quite difficult in the presence of varying amounts of hard stool. In addition, the presence of stool in the rectal stump would be a problem when an end-to-end or a side-to-end colorectal anastomosis is performed with the circular stapler or the anvil advanced through the rectum. Therefore, one or two phosphate enemas of the rectal stump should be given to the patient before surgery, particularly if no endoscopic examination of the stump has been performed before surgery.

The day before surgery, all patients receive oral metronidazole and neomycin. The support for combined oral and intravenous (IV) bowel preparation is growing, because it is becoming indeed clear that MBP alone may not be enough to reduce surgical site infection (SSI). Chen et al., in a large meta-analysis, noted that the group of patients receiving both oral and systemic antibiotics with MBP presented a significantly lower rate of SSI compared to patients receiving systemic antibiotics and MBP only.

Furthermore, all patients undergoing a colorectal anastomosis with a circular stapler introduced per rectum undergo a rectal lavage at the time of surgery, using a large-bore Pezzer drain, saline, and povidone/iodine. In addition, IV antibiotics should be given within 1 hour of the incision.

SURGERY

Surgery and Technique

There are different types of colostomies depending on the indication for diversion and the surgeon's preference, such as end and loop colostomies. However, in this chapter, we review the laparoscopic techniques for reversal of end colostomies typical of Hartmann's operations.

There are four different approaches to a laparoscopic reversal of colostomy:

- Laparoscopic Hartmann's reversal
- Hand-assisted Hartmann's reversal
- Single-port incision Hartmann's reversal
- Robotic Hartmann's reversal

Laparoscopic Hartmann's Reversal

After general endotracheal anesthesia is induced and a bladder catheter is placed, the patient will be placed in lithotomy position using Allen stirrups (Allen Medical Systems; Hill-Rom Holdings, Inc., Batesville, IN) ensuring easy access to the anus. (Pitfall: a patient not properly positioned at the edge of the table will preclude access to the anus when introducing the circular stapler for the anastomosis.) Thus, it is crucial that the patient is well secured to the bed, not only for obvious safety reasons but also because the steep Trendelenburg position often necessary for laparoscopic cases may lead to major cephalad shifting of the body. The consequence is that the buttocks may shift over the table, and, therefore, render transanal access with the circular stapler quite difficult.

Both arms should be tucked along the sides of the patient to ensure that adequate padding and protection are provided. In the rare cases that the anesthesiologists require access to one arm, the left arm can be left out given the need for tilting the bed toward the right side when the stoma is on the left side.

Next, as discussed, the patient needs to be secured to the bed, given the extreme positions the bed will assume during the operation (steep Trendelenburg and tilt). This maneuver is usually accomplished with a beanbag or alternatively with multiple strips of 3" cloth adhesive tape to strap the patient to the bed. The skin of the chest and breasts in female patients will have to be protected with towels and pads as necessary. Particular care needs to be taken to pad the arms to try to avoid compression of the radial nerve with subsequent risks of wrist drop. The patient is then prepped and draped in sterile manner. Placement of bilateral ureteric catheters can be very helpful.

ureteric catheters can be very helpful.

For the typical Hartmann reversal, where the colostomy is usually on the left side, the operation is conducted with the surgeon and assistant standing on the right of the patient with the monitor on the left side. The nurse stands in between the legs of the patient or on the right side of the patient as well.

The initial port placement depends on patient factors and surgeon's preferences. As suggested by Rosen et al., in the presence of a midline scar extending to the epigastrium the first port should be placed at the level of the colostomy, which should therefore first be taken down. Alternatively, a Hasson open technique could be used to place the initial port in the right upper quadrant. In the presence of a lower midline incision, a 5-or 10-mm port could be placed above the upper extent of the midline incision or in the right upper quadrant (Fig. 53-1).

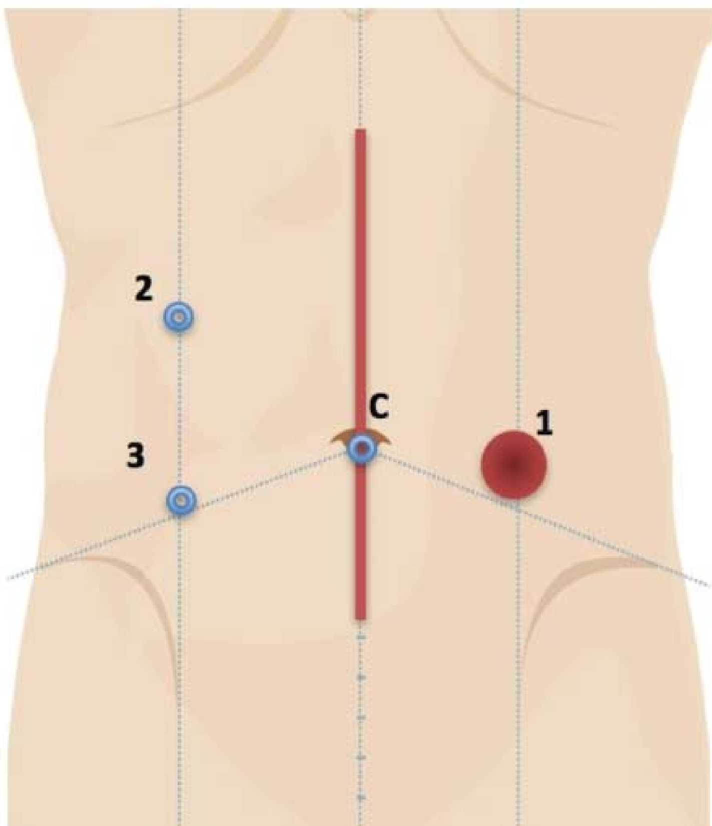


FIGURE 53-1 C, Camera port; 1, port at the site of the colostomy; 2, 3, right-sided 5-mm ports.

In our practice, the operation starts usually by circumferentially mobilizing the stoma with preservation of the mesentery. The colon is then trimmed to healthy tissue.

A purse string device or a purse string suture is used before the insertion of the anvil of the end-to-end anastomosis (EEA) stapling device in the colon. The purse string is then closed and tied and the colon then dropped back into the abdomen. A 12-mm trocar is inserted through the colostomy site for pneumoperitoneum and secured at the fascia either by running a purse string on the fascia and the rectus muscle or by placing figure-of-eight sutures on the fascia to ensure a good seal around the port.

However, over the past few years, it has become our practice to use at this point the GelSeal cap and the Alexis Wound Retractor (GelPort Laparoscopic System—Applied Medical Corp., Rancho Santa Margarita, CA) through the colostomy site. This device allows for easy access to the abdominal cavity, perfect maintenance of the pneumoperitoneum and placement of additional ports if needed. Finally, the possibility of using it as a hand-assist device provides further advantages. However, use of the GelPort as a hand-assist device will require, as we discuss in section “**Hand-assisted Hartmann’s Reversal**,” of this chapter, the extension of the incision for at least 7 cm.

Before inserting the remaining ports, the abdominal cavity should be carefully inspected by placing the camera through this port. The pneumoperitoneum helps separate the intra-abdominal structures and place the adhesions under tension allowing for visualization of the right side of the abdomen. If the visualization across the midline of the abdomen is satisfactory, then we proceed to place the other ports in the right upper quadrant and in the right iliac fossa. Obviously, the presence, the extension, and the locations of the adhesions with the anterior abdominal wall will affect the positioning of the other trocars. The camera can be carefully used to take down some of these adhesions to free space for the port insertion. However, in case adequate visualization is obstructed by the adhesions, one alternative is to place one or more ports on the left side where it is safe, to facilitate the lysis of the adhesions with the anterior abdominal wall. Additional ports can also be placed through the GelSeal cap if the GelPort is used.

This step is followed by the placement of ports on the right side as previously described. If this is not feasible, we place a port using an open technique in the right upper quadrant. The camera can then be moved to this port and a second port placed in the right lower quadrant. It is possible to use 5-mm ports in all cases. The use of bladeless ports is mandatory, particularly in this procedure.

Ideally, the camera port should be placed in the umbilical area to provide a good view of the entire left colon and pelvis. A 5-or a 10-mm camera is used according to the surgeon preference. We normally use a 0-degree camera, although with a rectum buried in the pelvis a 30-degree camera may be helpful.

The patient is then positioned in Trendelenburg position and tilted to the right so that the left side of the patient is up.

Once all ports are in place, the first undertaking is to address the adhesions involving the small bowel, the omentum, and the descending colon. Therefore involving the small bowel, the omentum, and the descending colon. Therefore, methodical careful dissection is initiated.

There are usually several loops of small bowel adherent to the pelvic structures. These adhesions need to be carefully mobilized to provide access to the rectal stump.

Next, attention should be turned to free the left gutter and the descending colon.

Adhesiolysis should be limited to what is necessary to provide good exposure of the left-sided pelvic structures.

Once this maneuver has been completed, there is no need to continue to divide any other adhesions as long as they will not interfere with the planned surgery.

At this point, the attention is directed toward the pelvis to identify the rectal stump. This maneuver can be quite difficult, especially if no “identifying” sutures were left on the staple line and/or if the superior rectal vessels were divided. Therefore, if no sutures are found, and the rectum is not clearly identifiable, the insertion of dilators, stapling devices, rigid or flexible sigmoidoscopy, or insufflation of air using a syringe is strongly recommended. In these cases, a 25-mm circular stapler sizer or a similar size Hegar dilator can be used.

However, our preference is to perform a rigid proctoscopy. In fact, particularly if the index surgery was done >6 months before, the rectum becomes more friable and rigid. The natural bends of the rectum might become more acute and fixed because of some pelvic fibrosis and, therefore, more difficult to negotiate blindly with a rigid instrument. Therefore, introducing a sizer or a dilator or even the stapler itself may result in a partial or full-thickness injury to the rectal stump. This problem is especially challenging when the rectal stump is long and includes part of the sigmoid colon.

The rectal stump is then dissected from the surrounding adhesions as needed to straighten its sharp and fixed turns in the pelvis. Particular care is needed to identify and protect the left ureter and the iliac vessels.

A frequent occurrence is the presence of extensive adhesions with the posterior wall of the bladder. It is usually necessary to fill the bladder with 250–300 ml of saline to better visualize the bladder and possibly find a safe plane for dissection. In women, the rectum may be found retracted and contracted in the pelvis behind the uterus. Usually, the introduction of rectal dilators as described will help the visualization.

When the original surgery was done for diverticulitis, any remnant of sigmoid colon found should be dissected and removed using an endoscopic linear cutting stapler, making sure that the anastomosis is to the rectum and not to the remnant sigmoid colon. The 12-mm port at the colostomy site can then be used to introduce the endoscopic GIA to transect the colon at the rectosigmoid junction. Alternatively, the 5-mm port on the right iliac fossa can be switched to a 12-mm port. Passing the endoscopic stapler from the right lower quadrant port may be simpler and straightforward. Therefore, many surgeons prefer to start the case with a 12-mm port in this position. The GelCap can be removed and the specimen is easily extracted through the wound retractor. The GelCap is then repositioned and the pneumoperitoneum reestablished quickly.

At this point, the anvil of the circular stapler is grasped and the descending colon is lowered down to the pelvis. If there is tension or the anvil does not reach the top of the rectal stump, the descending colon has to be mobilized more proximally. The splenic flexure is mobilized only if a tension-free colorectal anastomosis cannot be achieved.

The circular stapler is then very carefully advanced through the rectum. As stated, it may be very difficult to advance the stapler in a rectum that has become more rigid and tortuous and at the same time more fragile after months of fecal diversion. One should avoid, at all costs, forcing the stapler through this resistance. Although an intraperitoneal tear of the rectum could be repaired, an extraperitoneal injury to the rectum could have disastrous consequences especially if overlooked at the time of surgery.

p. 509

p. 510

As stated, it is beneficial to free the rectum of secondary adhesions with the pelvic walls that formed as a consequence of the previous inflammation and surgery. At times, this helps to the point that no further maneuver is required to advance the stapler. More frequently, however, the use of progressive sizers or Hegar dilators is necessary. Once again, we recommend the use of a rigid proctoscope before using any of these tools that will be pushed blindly against the rectal walls. Mobilization of the rectum to ensure a straight stapler insertion to the most proximal rectum is the safest technique.

An end-to-end colorectal anastomosis is then completed under direct vision by deploying the spike of the stapler through the top of the rectal stump. It is very important to deploy the spike completely through the rectum to ensure a watertight closure of the stapler. Furthermore, it is important to ensure that the spike is not accidentally pulled back into the rectum, because this problem could lead to two separate openings on the rectal top, thus increasing the chances of a leak, if one of the openings falls outside the anastomosis area.

The anvil in the descending colon is held using an endoscopic Babcock. (Tip: Some surgeons place the camera in the right iliac fossa port to facilitate the connection of the anvil with the spike.) After securing the anvil to the spike, and before closing the stapler, one should ensure that the colon is not rotated. The stapler is then closed under direct vision ensuring that surrounding structures such as ureter, bladder, gonadal vessels, hypogastric nerves, and, in some cases, the vagina are not accidentally grasped and incorporated into the anastomosis. Indocyanine green fluorescence perfusion assessment can be used before stapler firing.

The EEA device is then fired and carefully removed. The completeness of the two donuts is verified. The anastomosis is then tested: The colon is clamped with a bowel clamp proximal to the staple line and saline is placed in the pelvis to submerge the anastomosis. The rectum is then insufflated either with a rigid or flexible sigmoidoscopy or using a bulb syringe. The absence of air bubbling from the anastomosis will confirm a good seal. If air bubbles are seen, one should first locate the area or areas of leak, and then proceed to repair the gap(s) either using an Endo stitch (Medtyronic, Minneapolis, MN) device or freehand suturing. The anastomosis is then tested again. If no leak is witnessed, a diverting loop stoma may be created or omitted at the surgeon's discretion. If the leak persists, or the gap seems to be excessive for a simple repair, consideration should be given to resecting the anastomosis and perform a new one. Converting to an open operation or hand-assist approach should also be considered.

Hand-assisted Hartmann's Reversal

The use of the surgeon's trained hand during this particularly challenging operation may facilitate the successful completion of laparoscopy by reducing the technical difficulty of the operation. In fact, this could additionally expedite the case, thereby avoiding excessive operating time while possibly maintaining the benefits of a smaller incision. It is also conceivable that in cases that are particularly intricate laparoscopically, converting to a hand-assisted technique might avoid proceeding to a longer laparotomy incision. The use of hand-assisted laparoscopy in Hartmann reversal may also be seen as a bridge to laparoscopic surgery by providing a tactile feedback during the learning curve of advanced laparoscopic colorectal surgery. Conversely, one might argue that using a blunt dissection in a limited, fibrotic space during Hartmann reversal could lead to excessive bleeding. In addition, the recommended minimal 7-cm incision necessary to accommodate a hand (for 7½ glove) compares poorly to the fascial defect left by the previous colostomy, which should be limited to 2–3 cm.

In 2000 (Dexterity Surgical Inc., Bartlesville, OK), Lucarini *et al.* described the hand-assisted Hartmann reversal using the Dexterity Pneumo Sleeve. Today, the procedure can be more simply performed using the GelPort.

The operation begins by mobilizing the colostomy. This is done by extending the incision transversely for at least 7 cm. The descending colon is completely mobilized and brought into the operative field. The anvil is placed within the colon, secured, and then returned into the abdomen; the GelPort is then placed. An initial exploration of the abdomen can be done at this time by carefully introducing the hand. If the area near the umbilicus is free of adhesions, the Hasson trocar can be placed at this time. If there is no space to place the trocar or if extensive local adhesions prevent further progress, we normally place trocars through the GelPort including the camera and generate the pneumoperitoneum. Two working ports and the camera port are helpful to start mobilizing the adhesions from the anterior abdominal wall. In a few lucky cases, the entire operation could be completed through this access. However, in general, as soon operation could be completed through this access. However, in general, as soon as possible, the Hasson trocar is placed at the umbilicus and one or two ports are placed on the right side. In the original technique, the authors recommend having the surgeon stand on the left side of the patient and use his/her left hand through the port. If the surgeon has difficulty working against the camera, he/she could move to the right side of the patient.

p. 510

---

p. 511

In this procedure, the hand can be used to assist in the identification and the dissection of the rectal stump and in the mobilization of the splenic flexure, particularly in cases where considerable difficulty is encountered. The use of the hand could be particularly helpful in patients with very extensive adhesions or in morbid obesity. Alternatively, the hand-assisted device could be inserted using a Pfannenstiel incision, which allows for an unobstructed view of the rectum and direct access to the colorectal anastomosis.

Once the rectum is identified and the descending colon properly mobilized, the operation can be completed as described previously. If a Pfannenstiel incision had been made, the colorectal anastomosis can be created under direct visualization; and in case of air leaks, the anastomosis can be reinforced in an open manner.

Single-Port Laparoscopic Hartmann’s Reversal

The reduction in the number of port access to the abdomen and the absence of incision may not be a simple cosmetic advantage, which in these patients who already have a midline incision might be relative, but may minimize the risks of wound infections as well as incisional hernia, and improve postoperative pain.

Nevertheless, despite the theoretical advantages, the single-port technique in the reversal of Hartmann has not gained popularity. In an earlier, systematic review of the English literature from July 2008 to July 2010, comprising 29 articles, and one systematic review, a total of 149 patients have been reported as undergoing colorectal single-port procedures. Not a single case of Hartmann reversal was found in this review.

However, we found a recent (2015) report from Korea with 23 cases of single-port LHR. The procedure was successfully completed in 22 cases. The authors reported no need for additional incisions for trocars and no conversions to hand-assisted or open surgery; temporary loop ileostomies were created. One case of anastomotic site leakage was reported (4.5%) and it was treated with single-port surgery with resection and re-anastomosis without fecal diversion. Another patient suffered a colovesical fistula, requiring open surgery and a new Hartmann’s procedure. However, complication rates were within the reported standards. There was no mortality and the morbidity rate (18.2%) compared favorably with that reported in open surgery (10–50%) and conventional laparoscopic surgery (14–25%).

Borowski *et al*. reported five patients undergoing single-port laparoscopic reversal of Hartmann (four diverticular perforations and one pT3N0 colon cancer). The mean operating time was 155 (range 137–187) minutes with a median LOS of 3 (range 2–11) days. No conversions, major surgical morbidity, or deaths occurred in this group of patients.

We have performed only four cases of single-port reversal of Hartmann. Although no particularly negative result was noted, we abandoned this approach because in our hands it was labor intensive and time consuming. In the study from Korea, 16/22 patients had their index Hartmann's surgery done laparoscopically and 11/22 had no peritonitis at the time of the original surgery.

There are many commercial single-port laparoscopic devices and the selection depends on the surgeon's preference and comfort.

The single-port device is inserted through the stoma site after taking down the stoma and inserting the anvil as described. After inserting the single port, the 5-mm Olympus EndoEYE Surgical Videoscope (Olympus Corporation of the Americas, Center Valley, PA USA) is used as a camera and is placed through the single-port device. The patient is tilted to the right and in Trendelenburg position. After positioning of the patient, the mobilization of the left colon is started. One can use a 5-or 10-mm sealing device and bowel grasper for the dissection. In some single-port devices, there is the provision to use a fourth port. The lysis of adhesions is, at least initially, undertaken by standing on the left side of the patient.

Subsequently, during the mobilization of the descending colon, the surgeon may find it helpful to stand between the legs of the patient. The dissection is started via a lateral-to-medial approach extended all the way to the splenic flexure using a 5-mm energy device of choice such as electrocautery or a vessel-sealing device. By medially retracting the colon, the ureter and the gonadal vessels are visualized and protected. The mesentery is also mobilized toward the midline from the retroperitoneum and the Gerota's fascia. The splenic flexure is then mobilized as needed, a maneuver facilitated by placing the patient in a reverse Trendelenburg position.

Once this part is completed, the surgeon returns to the left side of the patient and the bed is returned to the Trendelenburg position.

The rectal stump is subsequently mobilized in the same manner as described. If a remnant sigmoid colon needs to be resected, an a linear cutting stapler can be used to resect the remnant and the specimen is extracted through the single-port device.

The descending colon is then gently delivered through the single-port device and the anvil of the appropriate size circular stapler is inserted in the colon. Next, the anvil is secured with a purse string and the colon is repositioned within the abdominal cavity.

It has become our practice in all laparoscopic, single-port, and robotic operations when a circular stapler is used to avoid the use of a purse string. To facilitate this step, the plastic ancillary trocar available in the original set of the circular stapler is securely inserted on the shaft of the anvil. At this point, before placing the anvil in the colon, and to avoid migration of the anvil proximally, a suture of 2-0 Prolene is passed through the small opening in the ancillary trocar and the thread is not cut. Next, the anvil is pushed backward while holding the ends of the suture and the colon is closed by firing another linear stapler. Although the stapler will transect the suture, by inspecting the staple line the remainder of the Prolene stitches is visible as short stumps of the sutures and can be pulled through the staple line without difficulty. This step can be either intra- or extracorporeally undertaken. By pulling on the sutures, the ancillary trocar and the whole anvil is pushed through the staple line, after which the ancillary trocar is removed. If this part had been performed extracorporeally through the single-port device, the colon with the anvil is repositioned in the peritoneal cavity.

The colorectal anastomosis is then created in the same manner as described.

On the basis of these results, it appears as though single-port laparoscopic reversal of Hartmann's colostomy through the stoma site carries no apparent additional morbidity in comparison with standard multiport laparoscopic surgery.

Robotic Hartmann's Reversal

The robotic system offers colorectal surgeons another platform to navigate the abdomen and pelvis. Although the long-term outcomes of robotic resections remain unknown and are currently being investigated, robotic assistance has been shown to have a role in completing more complex surgical cases in a minimally invasive manner. The enhanced vision, precision, dexterity, and increased degrees of freedom that the robotic platform provides in these cases theoretically offer a potential technical benefit. To date, there has only been a case report describing a robotic-assisted reversal of a Hartmann's procedure for diverticulitis. De'Angelis *et al.* found the robotic system to be a safe, feasible, and valuable approach for the Hartmann's reversal. With the increasing usage of the robotic platform in colon and rectal surgery, one can expect to see more cases with clinical data points presented in the literature.

We have not performed any colostomy reversals using our da Vinci Xi System (Intuitive Surgical, Sunnyvale, CA).

As described by De'Angelis et al., the operation started with circumferentially mobilizing the colostomy from the abdominal wall and excising it. The anvil of the EEA stapler was then placed into the transected proximal colon via purse string suturing. The Alexis Laparoscopic System wound protector was then introduced into the colostomy site to obtain pneumoperitoneum. The robotic trocars were then placed in a straight tangential position off the umbilicus, with the first 8-mm trocar placed in the right lower quadrant, the 12-mm trocar for the camera at the right lateral side of the umbilicus, and another 8-mm trocar below the xiphoid process. The other 8-mm trocar was placed at the colostomy site (Fig. 53-2). The da Vinci Si robot was then docked from the left side of the patient. Once access into the abdomen was obtained, the operation continued with lysing adhesions. The left colon was then mobilized along the white line of Toldt to obtain tension-free anastomosis. The rectal stump was circumferentially freed, after which the EEA stapler device was used for the colorectal anastomosis. This anastomosis was tested with an air-leak test and the prior colostomy site was closed with three layers of interrupted nonabsorbable sutures.

FIGURE 53-2 Ports placement for robotic Hartmann closure.

POSTOPERATIVE MANAGEMENT

We have been using enhanced recovery techniques for patients undergoing laparoscopic colostomy reversals. These techniques involve avoiding nasogastric tubes unless the patient develops a postoperative ileus, restriction or goal-directed intraoperative fluid administration as permitted by patients' health status, early and frequent ambulation, and discontinuation of bladder catheter on postoperative day 1. On demand, patent-controlled analgesia is available to all patients for additional pain medication until they pass flatus. Clear liquids are started on the day of surgery or on postoperative day 1. The diet is advanced as tolerated with return of bowel function. Drains are not routinely used; the exception is represented by extensive pelvic dissection of the rectum, potentially associated with more bleeding. Deep vein thrombosis prophylaxis is always implemented until discharge.

In an effort to decrease narcotic consumption and increase recovery time, our anesthesiologists are placing bilateral transversus abdominis plane blocks under ultrasound guidance and dosing it with Exparel (bupivacaine liposome injectable suspension). In addition, the patients receive IV acetaminophen and Entereg (alvimopan). The patients are given a dose of Entereg before surgery and then twice daily for up to 7 days while in-house.

In our practice, the patient is discharged home when tolerating a solid diet and after a bowel movement. However, it is becoming more common among colorectal surgeons to discharge the patient even without a bowel movement if he/she tolerates a solid diet and is passing flatus.

COMPLICATIONS

Wound infection was found to be one of the most common complications of LHR (10.8%). Early complications include also anesthesia and cardiopulmonary complications.

These problems are followed by other common postoperative complications such as anastomotic leak, abscess, postoperative bleeding, and prolonged postoperative ileus.

Two meta-analyses available in the literature showed a benefit in terms of complications in the LHR group. Both reviews showed a lower rate of perioperative complications and a shorter postoperative stay. Van de Wall *et al.* found an overall morbidity rate of 12.2% in LHR versus 20.3% in OHR. In this review, the decrease in complication rate was mainly found for wound infection (mean 10.8% vs. 14.2%), anastomotic leakage (mean 1.2% vs. 5.1%), and cardiopulmonary complications (mean 3.6% vs. 6.9%). In addition, a lower incidence of reoperation was found in LHR versus OHR (mean 3.6% vs. 6.9%). However, the other meta-analysis by Siddiqui *et al.* found no difference in infection rates, ileus, and leak rates. Conversely, this review found a statistically significant reduction in blood loss in the LHR ($P < 0.001$).

Late complications are adhesions, small bowel obstruction, and stricture. No significant data is available to show any difference in terms of incidence of late complications between LHR and OHR.

RESULTS

On the basis of the data available, it appears that LHR is safe and results in fewer complications and shorter hospital stays compared with OHR.

The operation is obviously burdened by a considerable technical complexity. Conversion rates of up to 22% and a limited number of series available in the literature reflect this. In addition, these series tend to comprise a limited number of patients. Therefore, selection biases may have had a role in the results presented in these series. Van de Wall found, for example, that patients treated with LHR were slightly younger (55 vs. 61 years), tended to have different indications for the original surgeries, and had a shorter mean interval between the Hartmann procedure and its reversal, compared to those who underwent OHR. In this analysis, 12 series comprising a total of 396 patients in the LHR group versus 5,853 patients in the OHR were reviewed.

In another meta-analysis by Siddiqui et al., eight studies with a total of 450 patients were included in the final analysis. There were only 193 patients in the laparoscopic group and 257 in the open group. Interestingly, in this review, OHR appeared to have longer operative times than LHR, although this was not statistically significant. Conversion rate was around 10%.

Faure *et al.* reported a conversion rate of 14.28% of LHR with a shorter operating time and less morbidity compared with open Hartmann's reversal.

This trend is confirmed in more recent and more robust series. Arkenbosch *et al.* published a review of all cases of Hartmann's closure in the ACS-NSQIP database from 2005 to 2012 (Table 53-1). Of the 4,148 patients who underwent stoma closure and Hartmann's reversal, 732 patients (17.6%) underwent laparoscopic procedures (LHR) and 3,416 patients (82.3%) OHR. As previously reported, the LHR group did not appear to carry longer operative times: in fact, mean surgery times were similar in the LHR group (187.6 ± 86.5 minutes) versus the open group (190.4 ± 90.7) (*P* = 0.442).

TABLE 53-1 ACS-NSQIP Database: Comparison of Complications in LHR Vs. OHR

Postoperative complications	Laparoscopic (n = 732)	%	Open (n = 3,416)	%	P value
Overall complications	135	18.4	921	27.0	

Overall complications	[illegible]	18.4	[illegible]	27.0	<0.0001*
Incisional SSI	76	10.4	483	14.1	0.006*
Organ/space SSI	23	3.1	170	5.0	0.033*
Wound complications	88	12.0	621	18.2	NS*
Pulmonary complications	13	1.8	92	2.7	NS*
Cardiac complications	2	0.3	32	0.9	NS*
DVT	2	0.3	35	1.0	NS*
UTI	12	1.6	113	3.3	0.005*
CVA/stroke	1	0.1	6	0.2	NS*
Bleeding/transfusion	22	3.0	116	3.4	NS*
Septic	25	3.4	204	6.0	0.038*
Reoperation	23	3.1	183	5.4	0.011*
Death	2	0.3	19	0.6	NS*

*Fisher's exact test.

CVA, cerebrovascular accident; DVT, deep vein thrombosis; SSI, surgical site infection; UTI, urinary tract infection ; NS, statistically not significant.

Source: Adapted from Surg Endosc 2015;29:2109–14.

As in previous reports, the median LOS was shorter in the LHR versus OHR groups (5 vs. 6 days, $P < 0.0001$).

Although mortality rates were statistically similar (0.3% vs. 0.6%, respectively), overall morbidity rates were lower in the LHR group (18.4%) versus open (27%), ($P < 0.0001$).

In particular, significantly lower rates were found in the LHR group for the following complications:

Incisional SSI (10.4% vs. 14.1%, $P = 0.033$)

Organ space SSI (3.1% vs. 5.0%, *P* = 0.033)

Urinary tract infection (1.6% vs. 3.3%, *P* = 0.005)

Sepsis (3.4% vs. 6.0%, *P* = 0.038)

Reoperation (3.1% vs. 5.4%, *P* = 0.011) (Table 53-1).

Similar results were found in another recent meta-analysis of 13 studies and 862 patients with 403 LHRs (46.75%) and 459 OHRs (53.25%) (Table 53-2).

TABLE 53-2 Metanalysis of 13 Studies: Complications in LHR Vs. OHR

Postoperative outcomes	Laparoscopic (n = 403)	%	Open (n = 459)	%	S/NS	OR/WMD
30-d mortality	1	4.03	1	4.59	NS	1.13 (95% CI, 0.41–3.15)
Overall complications	61	15.97	139	31.81	S	0.24 (95% CI, 0.17–0.34)
Wound infection	33	8.6	63	14.4	S	0.54 (95% CI, 0.35–0.85)
Postop ileus	16	4.19	35	8.01	S	0.47 (95% CI, 0.25–0.87)
Anastomotic leak	2	0.52	12	2.74	NS	0.42 (95% CI, 0.14–1.27)
Intra-abdominal collections	3	0.78	9	2.06		
Operative time (mean)	197.6 ± 57.01		208.2 ± 67.38		NS	−10.02 (95% CI, −32.68 to 12.64)
Length of stay	7.6 ± 3.1		14.1 ± 8.6		S	−3.34 (95% CI.

						−4.97 to −1.71)
30-d reoperation	5	1.52	16	4.42	NS	0.48 (95% CI, 0.20–1.15)

S, statistically significant; NS, statistically not significant.

Odds ratio (OR) and 95% confidence intervals (95% CI) were used as summary measures for dichotomous outcomes; weighted mean difference (WMD) and 95% CI were used for continuous outcomes.

Source: Calculated from Celentano V, Giglio MC, Bucci L. Laparoscopic versus open Hartmann's reversal: a systematic review and meta-analysis. Int J Colorectal Dis 2015;30:1603–15.

p. 514

p. 515

This review found that conversion to open surgery was low and occurred in 65 patients (with mean of 16.1%, range 0–50%).

Findings of the review are summarized in Table 53-2.

Significant differences were found in the following:

Overall postoperative 30-day morbidity: **lower in the LHR group** compared to OHR (OR, 0.24; 95% CI, 0.17–0.34)

Estimated blood loss was found to be **lower in the LHR group** (weighted mean difference [WMD] −103.432, 95% CI −131.712 to −75.152, Q 7.87 *P* = 0.248)

Incidence of wound infection: **higher in the OHR group** (OR, 0.54; 95% CI, 0.35–0.85; Q = 8.82, *P* = 0.64)

Postoperative ileus: **higher in the OHR group** (OR, 0.47; 95% CI, 0.25–0.87; Q = 6.72, *P* = 0.45)

LOS: **shorter in the LHR group** (WMD, −3.34; 95% CI, −4.97 to −1.71)

Time to flatus: **shorter in the LHR group** (WMD, −0.99; 95% CI, −1.41 to −0.58)

p. 515

p. 516

No difference was found in the following:

In the 30-day mortality (OR, 1.13; 95% CI, 0.41–3.15)

In anastomotic leak rate (OR, 0.42; 95% CI, 0.14–1.27; Q = 3.54, *P* = 0.83)

In operating time (WMD, −10.02; 95% CI, −32.68 to 12.64)

In the 30-day reoperations (OR, 0.48; 95% CI, 0.20–1.15; Q = 5.34, *P* = 0.8)

On the basis of the results of these large reviews and meta-analysis, it appears that the learning curve may now be to the point where a shorter operative time may direct more patients to undergo LHR.

These results may hopefully facilitate randomized studies with larger cohorts of patients. To date, the data show that patients undergoing OHR do not appear to fare better than patients treated with LHR and that LHR is comparable or even superior to OHR in terms of shorter hospital stay, reduced complications rate, reduced postoperative pain, and earlier return to normal activity. Therefore, LHR is feasible and safe, but does require experience and is not one of the easiest laparoscopic operations.

CONCLUSION

Despite the technical advancements and the increasing popularity of laparoscopy, it appears as though only a minority (18%) of Hartmann's reversals are performed using laparoscopy despite mounting evidence that minimally invasive surgery has the following features:

- It does not require longer operative times.
- It leads to a reduction in LOS of at least 1 day.
- It is associated with a significantly lower overall morbidity, including lower rates of incisional and deep SSI, sepsis, and reoperations.
- It offers short-term results that are superior to the results of OHR.

RECOMMENDED REFERENCES AND READINGS

Arkenbosch J, Miyagaki H, Kumara HM, Yan X, Cekic V, Whelan RL. Efficacy of laparoscopic-assisted approach for reversal of Hartmann's procedure: results from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database. *Surg Endosc* 2015;29:2109–14.

Khaikin M, Zmora O, Rosin D, *et al.* Laparoscopically assisted reversal of Hartmann's procedure. *Surg Endosc* 2006;20(12):1883–86.

Alves A, Panis Y, Slim K, et al; Association Français de Chirurgie. French multicentre prospective observational study of laparoscopic versus open colectomy for sigmoid diverticular disease. *Br J Surg* 2005;92(12):1520–5.

Anderson CA, Fowler DL, White S, Wintz N. Laparoscopic colostomy closure. *Surg Laparosc Endosc* 1993;3:69–72.

Bell C, Asolati M, Hamilton E, *et al.* A comparison of complications associated with colostomy reversal versus ileostomy reversal. *Am J Surg* 2005;190(5):717–20.

Borowski DW, Kanakala V, Agarwal AK, Tabaqchali MA, Garg DK, Gill TS. Single-port access laparoscopic reversal of Hartmann operation. *Dis Colon Rectum* 2011;8;1053–6.

Braga M, Vignali A, Gianotti L, *et al.* Laparoscopic versus open colorectal surgery: a randomized trial on short-term outcome. *Ann Surg* 2002;236(6):759–66; discussion 767.

Braga M, Vignali A, Zuliani W, Frasson M, Di Serio C, Di Carlo V. Laparoscopic versus open colorectal surgery: cost-benefit analysis in a single-center randomized trial. *Ann Surg* 2005;242(6):890–5, discussion 895–6.

Celentano V, Giglio MC, Bucci L. Laparoscopic versus open Hartmann's reversal: a systematic review and meta-analysis. *Int J Colorectal Dis* 2015;30:1603–15.

Chen M, Song X, Chen LZ, Lin ZD, Zang XL. Comparing mechanical bowel preparation with both oral and systemic antibiotics versus mechanical bowel preparation and systemic antibiotics alone for the prevention of surgical site infection after elective colorectal surgery: a meta-analysis of randomized controlled clinical trials. *Dis Colon Rectum* 2016;59:70–8.

Choi BJ, Jeong WJ, Kim YK, Kim SJ, Lee SC. Single-port laparoscopic reversal of Hartmann's procedure via the colostomy site. *Int J Surg* 2015;14:33–7.

De'Angelis N, Felli E, Azoulay D, Brunetti F. Robotic-assisted reversal of Hartmann's procedure for diverticulitis. *J Robotic Surg* 2014;8:381–3.

Degiuli M, Mineccia M, Bertone A, *et al.* Outcome of laparoscopic colorectal resection. *Surg Endosc* 2004;18(3):427–32.

Demetriades D, Pezikis A, Melissas J, Parekh D, Pickles G. Factors influencing the morbidity of colostomy closure. *Am J Surg* 1988;155:594–6.

Diana M, Dhumane P, Cahill RA, Mortensen N, Leroy J, Marescaux J. Minimal invasive single site surgery in colorectal procedures: current state of the art. *J Minim Access Surg* 2011;7(1):52–60.

Faure JP, Doucet C, Essique D, *et al.* Comparison of conventional and laparoscopic Hartmann's procedure reversal. *Surg Laparosc Endosc Percutan Tech* 2007;17(6):495–9.

Ghorra SG, Rzeczycki TP, Natarjan R, Pricolo VE. Colostomy closure: impact of preoperative risk factors on morbidity. *Am Surg* 1999;65:266–9.

Golash V. Laparoscopic reversal of Hartmann procedure. *J Minim Access Surg* 2006;2:211–5.
Gorey TF, O'Connell PR, Waldron D, Cronin K, Kerin M, Fitzpatrick JM. Laparoscopically assisted colostomy closure after Hartmann's procedure. *Br J Surg* 1993;80:109.
Guenaga KF, Matos D, Wille-Jorgensen P. Mechanical bowel preparation for elective colorectal surgery. *Cochrane Database Syst Rev* 2011;9:CD001544.
Guenaga KK, Matos D, Wille-Jørgensen P. Mechanical bowel preparation for elective colorectal surgery. *Cochrane Database Syst Rev* 2009;(1):CD001544.
Hartmann H. Nouveau procede d'ablation des cancers de la partie terminale du colon pelvien. *Trentieme Congress de Chirurgie*. 1923;411–3.
Keck JO, Collopy BT, Ryan PJ, Fink R, Mackay JR, Woods RJ. Reversal of Hartmann's procedure: effect of timing and technique on ease and safety. *Dis Colon Rectum* 1994;37 (3):243–8.
Lucarini L, Galleano R, Lombezzi R, Ippoliti M, Ajraldi G. Laparoscopic-assisted Hartmann's reversal with the Dexterity Pneumo Sleeve. *Dis Colon Rectum* 2000;43(8):1164–7.
Mazeh H, Greenstein AJ, Swedish K, *et al.* Laparoscopic and open reversal of Hartmann's procedure—a comparative retrospective analysis. *Surg Endosc* 2009;23(3):496–502.
Mazeh H, Greenstein AJ, Swedish K, *et al.* Laparoscopic and open reversal of Hartmann's procedure. *Surg Endosc* (2009);23:496–502.
Murray AC, Kiran RP. Benefit of mechanical bowel preparation prior to elective colorectal surgery: current insights. *Langenbecks Arch Surg* 2016;401:573–80.
Regadas FS, Siebra JA, Rodrigues LV, Siebra JA, Furtado DC, Regadas SM. Complications in laparoscopic colorectal resection: main types and prevention. *Surg Laparosc Endosc* 1998;8:189–92.
Rosen MJ, Cobb WS, Kercher KW, Heniford BT. Laparoscopic versus open colostomy reversal: a comparative analysis. *J Gastrointest Surg* 2006;10(6):895–900.
Rosen MJ, Cobb WS, Kercher KW, Sing RF, Heniford BT. Laparoscopic restoration of intestinal continuity after Hartmann's procedure. *Am J Surg* 2005;189:670–4.
Schilling MK, Maurer CA, Kollmar O, Buchler MW. Primary vs. secondary anastomosis after sigmoid colon resection for perforated diverticulitis (Hinchey Stage III and IV): a prospective outcome and cost analysis. *Dis Colon Rectum* 2001;44:699–703.
Schwenk W, Haase O, Neudecker J, Müller JM. Short term benefits for laparoscopic colorectal resection. *Cochrane Database Syst Rev* 2005;(3):CD003145.
Siddiqui M, Sajid M, Baig M. Open versus laparoscopic approach for reversal of Hartmann's procedure: a systematic review. *Colorectal Dis* 2010;12(8):733–41.
Sosa JL, Sleeman D, Puente I, McKenney MG, Hartmann R. Laparoscopic-assisted colostomy closure after Hartmann's procedure. *Dis Colon Rectum* 1994;37 (2):149–52.
Vacher C, Zaghloul R, Borie F, *et al.* Laparoscopic re-establishment of digestive continuity following Hartmann's procedure. Retrospective study of the French Society of Endoscopic Surgery. *Ann Chir* 2002;127:189–92.
van de Wall BJ, Draaisma WA, Schouten ES, Broeders IA, Consten EC. Conventional and laparoscopic reversal of the Hartmann procedure: a review of literature. *J Gastrointest Surg* 2010;14:743–52.

Vermeulen J, Coene PP, Van Hout NM, *et al.* Restoration of bowel continuity after surgery for acute perforated diverticulitis: should Hartmann's procedure be considered a one-stage procedure? *Colorectal Dis* 2008;11:619–24.

Chapter 54

Hand-Assisted Hartmann’s Reversal

John P. Ricci and David E. Rivadeneira

INDICATIONS/CONTRAINDICATIONS

Indication

The benefits of laparoscopic techniques in colon and rectal surgery have been extensively reported and discussed. Shorter hospital stay, reduction in postoperative pain, decreased narcotic requirements, faster return of gastrointestinal function, improved cosmesis, reduction in postoperative wound complications, and decrease in adhesion formation have all been reported as advantages of a laparoscopic approach.

Often, the largest incision in laparoscopic colon and rectal procedures is dictated by the specimen extraction site. In laparoscopic or laparoscopic-assisted methods, the extraction site can measure anywhere from 3 to 10 cm. The incision is frequently created after identification of vital structures, dissection of soft tissue planes, isolation and ligation of mesenteric vessels, and transection of bowel wall have occurred. This approach may seem counterintuitive, in that a surgeon could potentially spend a significant amount of time and effort to perform a minimally invasive laparoscopic colon or rectal resection, and, at the end of the case, create a larger incision for extraction. Hand-assisted laparoscopy allows the incision to be created at the beginning of the procedure to help perform the critical portions of the procedure.

Hand-assisted laparoscopic surgery (HALS) is a method in which the surgeon is able to place an entire hand into the abdomen using a specially designed port while maintaining pneumoperitoneum. In addition to using the extraction site from the outset of the operation, the potential benefits of HALS include tactile sensation potentially, improved spatial relationships, rapid exploration of the abdomen, palpation of intra-abdominal organs and masses, improved atraumatic retraction, and blunt finger dissection. Introduction of the hand-assisted method can assist in dealing with a hostile abdomen with inflammatory processes and/or extensive adhesions; in addition, it can allow for rapid control of hemorrhage, decreased operating time, and overall allow laparoscopic completion of a procedure that might otherwise require conversion.

Hartmann’s procedure is the creation of an end colostomy and rectal stump after sigmoid colectomy, usually for complicated diverticular disease. One of the after sigmoid colectomy, usually for complicated diverticular disease. One of the more challenging colorectal procedures can be the “Hartmann’s reversal” or restoration of bowel continuity by creation of a coloproctostomy. The hand-assisted laparoscopic method can be an ideal approach in certain patients undergoing this procedure. Owing to the initial pathology, the reoperation can prove to be treacherous. The HALS approach can facilitate the procedure and allow a surgery that may not be as easily achieved by as many surgeons as a laparoscopic approach. During the operation, the colostomy site on the abdominal wall can be used as an entrance for the hand-assisted laparoscopic port. In addition, a substantial amount of adhesiolysis and mobilization can be performed open through this stoma incision. At this time, the surgeon can assess intraperitoneal conditions and decide whether proceeding laparoscopically is appropriate. If the laparoscopic equipment is kept unopened in the operating theatre before this assessment, cost savings can be realized in those patients who require formal laparotomy. This “Peek Port” concept has been described in other complex laparoscopic colorectal procedures. Often, a parastomal hernia that facilitates the placement of a hand through the colostomy incision is present. Once it has been decided to proceed with a hand-assist method, dissection and mobilization of the descending colon and splenic flexure, as well as preparation of the rectal stump can be performed in anticipation of a colorectal anastomosis.

PREOPERATIVE PLANNING

Patients undergoing a hand-assisted Hartman's reversal should undergo all necessary preoperative preparations required for open and laparoscopic surgeries, including the following:

Colonoscopy through the colostomy

Colonoscopy through the rectum

Retrograde contrast studies through the rectum and colostomy site

These studies should allow the surgeon to evaluate the length and the quality of the rectal/Hartman’s stump, and to evaluate the position of the splenic flexure. The surgeon can determine whether splenic flexure mobilization is necessary to create a tension-free anastomosis. The surgeon can also help decide whether completion sigmoid resection at the rectosigmoid junction is required to perform the appropriate therapeutic procedure in the case of diverticular disease. It is imperative that the remaining colon and rectum is endoscopically surveyed so that no synchronous pathology is present. Other preoperative considerations include the following:

Bowel preparation (per surgeon’s preference)

Preoperative antibiotics

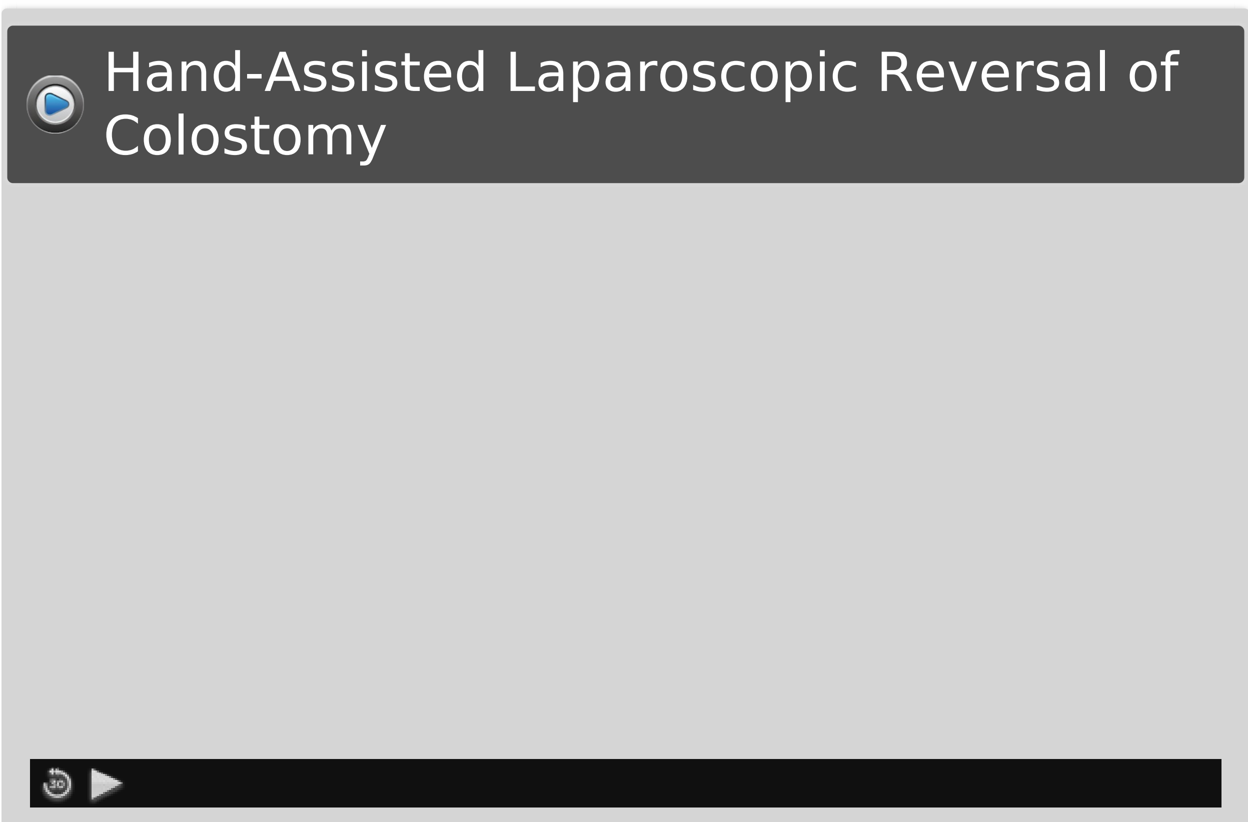
Preoperative deep venous thrombosis prophylaxis

SURGERY

Positioning

Patients are positioned on an electric bed in the modified Lloyd-Davies/lithotomy position. A proctosigmoidoscopy is performed to wash out any retained stool or mucus. After the abdomen is prepped with chloraprep or Betadine, a large sheet of antibiotic-impregnated adhesive drape (Ioban) is placed over the entire abdomen with a folded 4 × 4 gauze over the colostomy site. This will allow for minimal cross contamination to other areas of the abdominal wall. Laparoscopic monitors are placed to the right and left side of the patient. Standard bowel graspers, dissectors, sheers, and energy-based devices should be chosen and used as per surgeon preference during laparoscopic procedures.

Technique



There are several approaches to a hand-assisted reversal of a Hartman's procedure. The most common technique involves the use of the colostomy site as the location of the hand-assist port. The colostomy is dissected away from the mucocutaneous junction, with an incision that extends both medially and laterally for several centimeters around the colostomy. Detaching the colon from the subcutaneous tissue is often a fairly unencumbered dissection because of the high incidence of paracolostomy hernia. Entrance into the abdomen and placement of the hand through the hand-assisted device is also aided by this parastomal hernia and fascial separation. Direct visualization into the abdomen can be performed from the incision and local adhesions can be dealt with effectively, particularly those intimate with the previous midline incision from the initial operation. Once the colostomy has been detached from the abdominal wall and the colon resected to a healthy bowel, the distal end is prepared for anastomosis in standard manner with a purse string stitch and the anvil of a circular stapler (Fig. 54-1). This maneuver will allow the colon to be reduced into the abdominal cavity without contamination. The healthy bowel can just be stapled across and prepared for anastomosis after complete dissection. If the underlying abdominal wall is clear of adhesions, the hand-assist port is placed into the colostomy site incision and pneumoperitoneum is achieved (Fig. 54-2). One to three 5-mm trocars are placed in the right lateral abdomen and suprapubic area. An umbilical port can also be placed to provide a more traditional camera angle. Frequently, the camera will need to be introduced through the hand-assist port to survey the abdomen and to perform initial adhesiolysis. The surgeon can approach the operation from a position in between the legs or on the patient's right side with the right hand through the hand-assisted device and the left hand using a laparoscopic instrument. The assistant will be positioned between the legs or on the patient's right side. This orientation will allow for complete descending colon and splenic flexure mobilization with the distal end already prepared. The procedure should be performed as if it were open. The ureter is identified in the retroperitoneum, and the rectal stump is dissected and prepared in standard manner. At times, it may be necessary to remove partial or complete remnant sigmoid colon. This step can usually be achieved if the surgeon stands on the patient's left-hand side and inserts the left hand through the device to grasp the sigmoid colon or rectal stump. Additional dissection can be undertaken with the right hand with laparoscopic instruments through the trocars on the right side. The specimen is extracted through the hand port. A standard stapled anastomosis is created with a circular stapler.

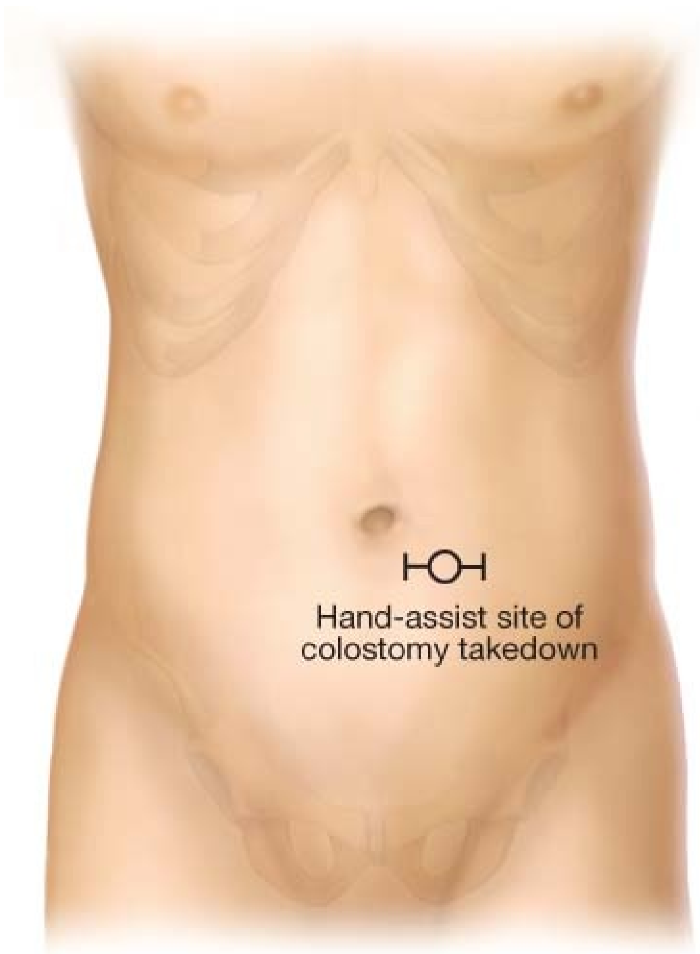


FIGURE 54-1 Hand assist port through colostomy site.

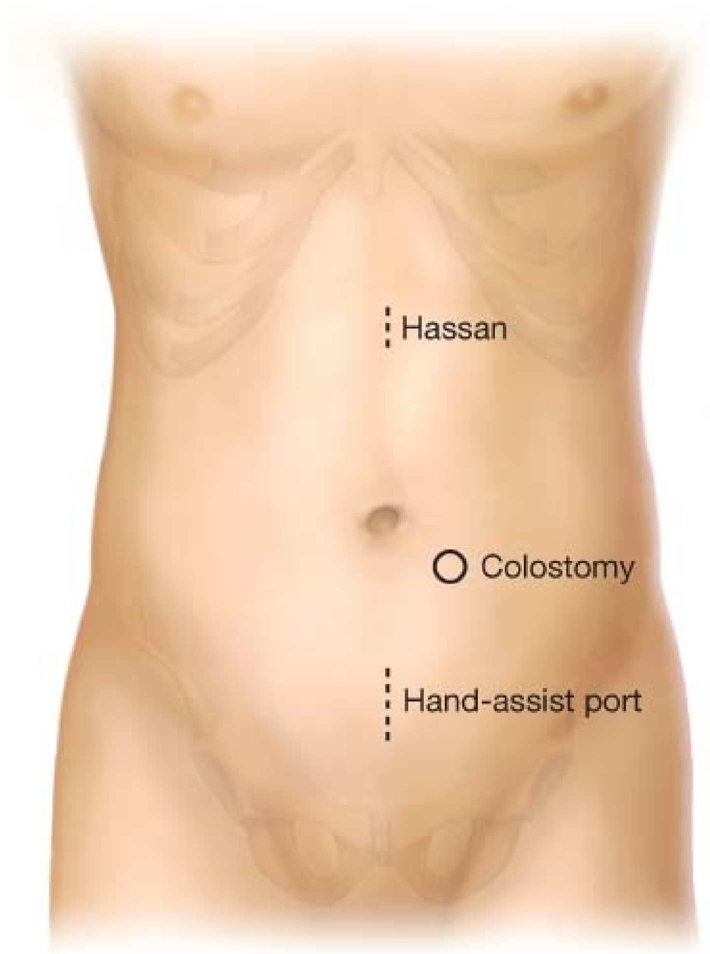


FIGURE 54-2 Hand assist port through lower midline incision.

p. 520

p. 521

An alternate technique is sometimes utilized when a surgeon anticipates a difficult rectal stump dissection. A Hassan trocar is placed as an initial step in the upper abdomen away from prior incisions to gain pneumoperitoneum. Once this goal is achieved, laparoscopic ports can be placed and lysis of adhesions performed until the midline incision is free of underlying bowel. A lower midline incision is then made starting 2–3 cm from the pubic symphysis and extending 6–10 cm proximally (Fig. 54-3). This incision is generally through the patient's previous scar, and is used as the hand-assist site. The colostomy is then laparoscopically dissected at the abdominal wall aperture and stapled as it enters the fascia (Fig. 54-4). The splenic flexure and descending colon are mobilized in standard manner. The rectal dissection can then be performed laparoscopically or open through the hand-assist port depending on the patient's anatomy, scar tissue, and surgeon’s comfort level. This is a well-described method for low anterior resections. The anastomosis is performed in standard manner. The colostomy will need to be taken down after the procedure if this technique is employed. Regardless of technique, it is imperative that a healthy, supple, compliant, distensible non-diverticular-laden colon free of muscular hypertrophy anastomose to the rectum and not to the distal sigmoid colon. Although it is not imperative that all proximal diverticular disease be excised, it is imperative that all distal sigmoid be excised. The editor’s preference is to use ontable endoscopic assessment of the rectal stump to ensure anastomosis of colon to rectum and not to distal sigmoid colon. Adjunct measures to ensure safety include air testing as is the case after any pelvic anastomosis as well as the more recent Indocyanine green profusion assessment measures. In some cases, it may be appropriate to perform a proximal loop ileostomy after reestablishment of colorectal continuity.

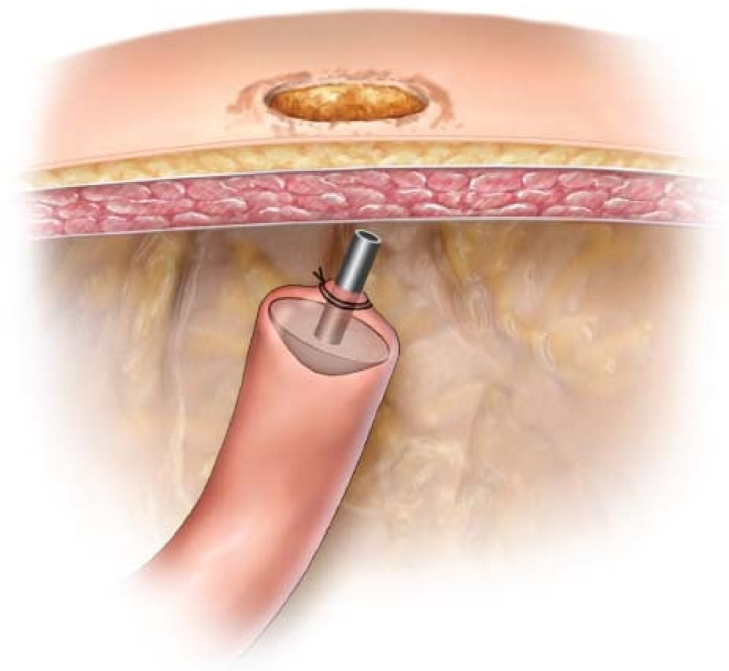


FIGURE 54-3 Placement of anvil through colostomy site.

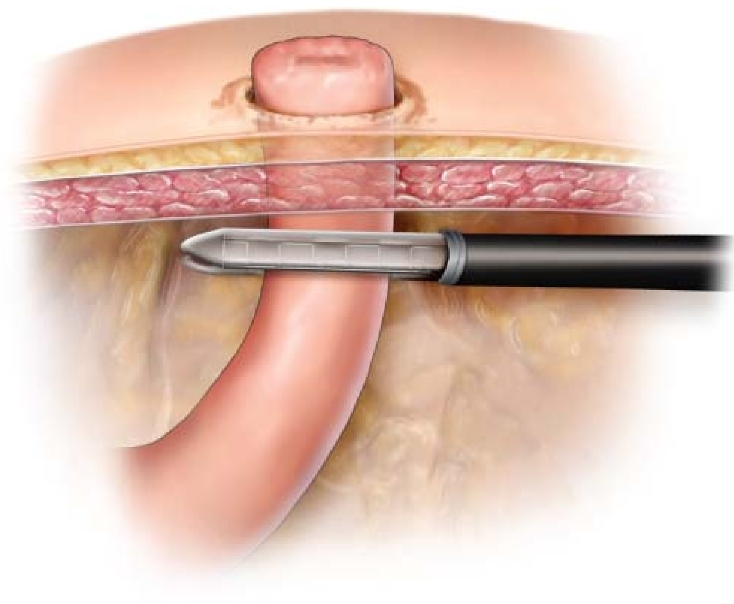


FIGURE 54-4 Colostomy transection at fascial opening.

POSTOPERATIVE MANAGEMENT

The postoperative management of patients undergoing a hand-assisted reversal of a colostomy should follow the same protocols as those undergoing open or straight laparoscopic methods.

COMPLICATIONS

To our knowledge, there are no intrinsic complications exclusively attributed to the hand-assisted approach. Postoperative complications will mirror those as performed in open or laparoscopic methods.

RESULTS

Although there is extensive data in regard to hand-assisted laparoscopic colon and rectal operations, there is a paucity of data specifically dealing with hand-assisted methods in this procedure. There are no prospective, randomized studies looking at the laparoscopic versus hand-assisted methods in Hartman's reversals. Anecdotally, both authors have used a hand-assisted approach on many patients undergoing Hartmann's reversal with very positive outcomes.

RECOMMEND REFERENCES AND READINGS

Allardyce RA, Bagshaw PF, Frampton CM, et al; Australasian Laparoscopic Colon Cancer Study Group. Australasian Laparoscopic Colon Cancer Study shows that elderly patients may benefit from lower postoperative complication rates following laparoscopic versus open resection. *Br J Surg* 2010;97(1):86–91.

Hand-assisted laparoscopic surgery vs standard laparoscopic surgery for colorectal disease: a prospective randomized trial. HALS Study Group. *Surg Endosc* 2000;14:896–901.

Kang JC, Chung MH, Chao PC, *et al.* Hand-assisted laparoscopic colectomy versus open colectomy: a prospective randomized study. *Surg Endosc* 2004;18:577–81.

Kennedy GD, Heise C, Rajamanickam V, Harms B, Foley EF. Laparoscopy decreases postoperative complication rates after abdominal colectomy: results from the national surgical quality improvement program. *Ann Surg* 2009;249(4):596–601.

Lee SW. Laparoscopic procedures for colon and rectal cancer surgery. *Clin Colon Rectal Surg* 2009;22(4):218–24.

Litwin DE, Darzi A, Jakimowicz J, *et al.* Hand-assisted laparoscopic surgery (HALS) with the HandPort system: initial

experience with 68 patients. *Ann Surg* 2000;231:715–23.

Lucarini L, Galleano R, Lombezzi R, Ippoliti M, Ajraldi G. Laparoscopic-assisted Hartmann's reversal with the Dexterity Pneumo Sleeve. *Dis Colon Rectum* 2000;43:1164–7.

Marcello PW, Fleshman JW, Milsom JW, *et al.* Hand-assisted laparoscopic versus laparoscopic colorectal surgery: a multicenter, prospective, randomized trial. *Dis Colon Rectum* 2008;51:818–26.

Orenstein SB, Elliott HL, Reines LA, Novitsky YW. Advantages of the hand-assisted versus the open approach to elective colectomies. *Surg Endosc* 2011;25(5):1364–8.

Pietrabissa A, Moretto C, Carobbi A, Boggi U, Ghilli M, Mosca F. Hand-assisted laparoscopic low anterior resection: initial experience with a new procedure. *Surg Endosc* 2002;16:431–5.

Read TE, Salgado J, Ferraro D, Fortunato R, Caushaj PF. "Peek port": a novel approach for avoiding conversion in laparoscopic colectomy. *Surg Endosc* 2008;23(3):477–8.

Rivadeneira DE, Marcello PW, Roberts PL, *et al.* Benefits of hand-assisted laparoscopic restorative proctocolectomy: a comparative study. *Dis Colon Rectum* 2004;47:1371–6.

Rivadeneira DE, Marcello PW. Current status of hand-assisted laparoscopic colon and rectal surgery: do we need a hand? *Semin Colon Rectal Surg* 2003;14:154–60.

Targarona EM, Gracia E, Garriga J, *et al.* Prospective randomized trial comparing conventional laparoscopic colectomy with hand-assisted laparoscopic colectomy: applicability, immediate clinical outcome, inflammatory response, and cost. *Surg Endosc* 2002;16:234–9.

Veldkamp R, Kuhry E, Hop WC, *et al.* Laparoscopic surgery versus open surgery for colon cancer: short-term outcomes of a randomised trial. *Lancet Oncol* 2005;6(7):477–84.

Weeks JC, Nelson H, Gelber S, Sargent D, Schroeder G; Clinical Outcomes of Surgical Therapy (COST) Study Group. Short-term quality-of-life outcomes following laparoscopic-assisted colectomy vs open colectomy for colon cancer: a randomized trial. *JAMA* 2002;287(3):321–28.

PART XIII

ABDOMINAL OPERATIONS FOR RECTAL PROLAPSE

Chapter 55

Open Rectopexy Surgery for Rectal Prolapse

Laurence R. Sands and Jean A. Knapps

INTRODUCTION

Rectal prolapse remains a relatively rare colorectal problem that affects women more often than men. There have been many theories proposed as to the cause of this disabling condition, including a lack of fixity of the rectum to the sacrum, sigmoid colon redundancy, a deep rectovaginal or rectovesical pouch or space, poor lateral rectal attachments, and a weakened pelvic floor musculature. Operative procedures designed for repair of prolapse all address one or several of these specific etiologies, thereby resulting in numerous different procedures to treat this condition (Fig. 55-1).

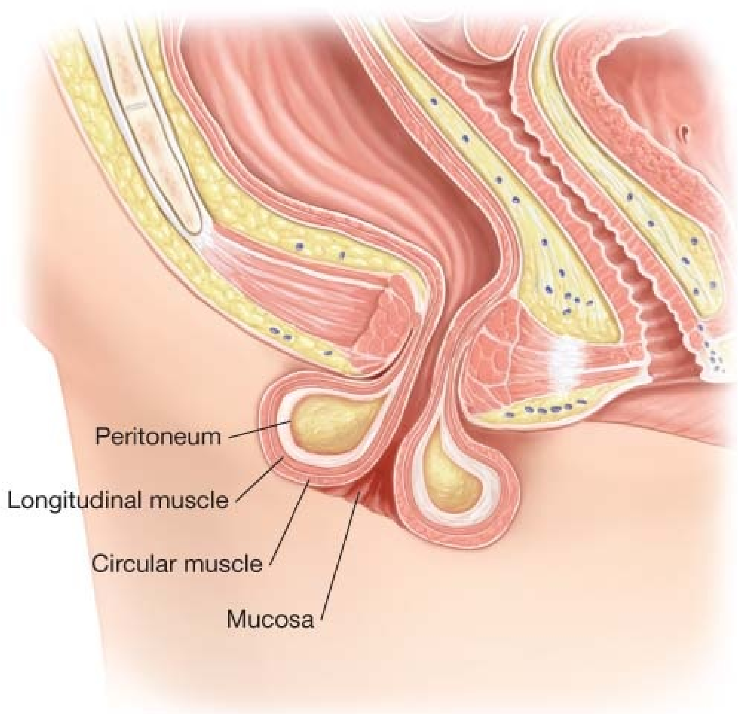


FIGURE 55-1 Redundant bowel prolapsing via lax

pelvic floor.

Fortunately, rectal prolapse is a completely benign disease process. However, it often causes significant disability and anxiety to those affected patients as well as their family members. Elderly and more infirm patients may be affected in even greater numbers; and in many cases those individuals may not be competent to make decisions about their own health care, leaving the burden of whether to have the prolapse repaired and what type of repair to be done to other family members or a designated health care surrogate.

One certain fact is there is no nonoperative approach to repair prolapse and the alternative to surgery is simply to live with the condition. Fortunately, in many cases, chronically affected patients simply achieve reduction of the prolapse spontaneously; however, other individuals require daily manual reduction. Some patients may present with frank incarceration of the prolapse that could result in gangrene of the bowel, requiring emergent surgical repair. Long-term complications from chronic relapsing prolapse may also result in anal sphincter laxity, which may result in varying degrees of fecal incontinence. In addition, many affected patients may suffer long-term constipation, which may lend itself as a causative factor in creating this condition.

One of the more contentious debates within the discipline of colon and rectal surgery arises from the proper method in which to repair rectal prolapse. There have been numerous procedures described to surgically fix this problem, which may make both the patient and surgeon wary that no one has ever found the perfect operation to treat this condition. This is in part due to the fact that there is a general lack of consensus on what really causes rectal prolapse. As such, each operation is designed to address a particular aspect of the theory behind the cause of rectal prolapse.

The repair debate generally focuses on either abdominal or perineal repairs. The abdominal procedures, mainly open surgical options, are the focus of this chapter. The basic premise behind all of these approaches is to lift the rectum and fixate it to the sacrum in some sort of way to prevent recurrence. This may be combined with resection of a portion of redundant sigmoid colon, another potentially causative factor in creating the condition, which may also alleviate some of the constipation symptoms often seen in patients with prolapse.

INDICATIONS AND CONTRAINDICATIONS

The indications for surgery for rectal prolapse are quite simple: the mere existence of prolapse is an indication for repair because, as previously mentioned, there is no nonsurgical remedy for this problem. Although not currently a standard practice, a new innovative minimally invasive method of treating rectal prolapse has been described using anal encirclement combined with a percutaneous method of rectal fixation using sclerotherapy. A study was conducted on 20 mostly younger patients, with a median age of 39, who underwent this procedure. Although nearly half the number of the patients who underwent this procedure developed recurrent prolapse, the mean procedure time was short at 17 minutes, hospitalization was minimal, and there were no serious postoperative complications. Complete rectal prolapse occurred in six patients with all of them undergoing successful open rectopexy with mesh fixation. Three other patients with mucosal-only prolapse underwent mucosectomy. None of these procedures were more complicated as a result of the minimally invasive technique, leading the authors to conclude that this may be reasonable first-line therapy in the treatment of rectal prolapse even in younger patients.

One of the most important aspects for the surgeon before attempting repair is to be certain of the diagnosis. The most commonly confused diagnosis that may resemble full-thickness rectal prolapse is severe hemorrhoidal disease. In fact, at many institutions, the emergency room physicians, who initially encounter these patients as they arrive at the hospital, incorrectly refer to prolapsing internal hemorrhoids as full-thickness rectal prolapse. Although it may require a more experienced clinician to determine the difference between these two entities, it is important to make the distinction because the therapies for each condition are quite different.

As in many medical conditions, the history is critical in making the correct diagnosis from the very beginning. The chronicity, the timing of the prolapse (whether it occurs spontaneously or with a bowel movement), and the degree of prolapse to which the patient complains may allow the physician to distinguish between the two entities. A detailed history of stool control and constipation, if any, should also be elicited.

Physical examination is confirmatory as the appearance of full-thickness rectal prolapse is often very obvious and distinct from hemorrhoidal disease (Fig. 55-2).

FIGURE 55-2 Full-thickness rectal prolapse.

It often has characteristic concentric rings as opposed to the wedge-shaped abnormalities associated with prolapsing hemorrhoids (Fig. 55-3 A and B).

FIGURE 55-3 A. Prolapsing internal hemorrhoids.
B. Prolapsing internal hemorrhoids with gangrene.

Rectal prolapse may not be visible on initial examination of the patient and it may require the patient squatting on the toilet to reproduce the prolapse. This evaluation should be part of the physical examination if the prolapse is not immediately obvious. In addition, one should assess sphincter tone and whether the anus appears patulous at the time of the physical examination, often a sign of chronicity of the condition.

The reasons for not repairing a prolapse may vary; but may be as simple as the patient not wishing to have the surgery or being too ill with many comorbidities, making the patient a prohibitively high operative risk. Because this condition is more often found in the aging population, more conservative surgical approaches may be considered in view of the inability of these sicker and more infirm patients to tolerate a major surgical procedure. Such patients have traditionally undergone a perineal procedure for prolapse because of the lower morbidity of these operations. One study revealed that laparoscopic repair of rectal prolapse in the group over age 70 was associated with an acceptable morbidity and an average length of stay of 3.8 days. The authors felt that it is reasonable to perform a more durable procedure using an abdominal approach in these patients rather than a perineal operation. Abdominal procedures for prolapse are often an approach used by many surgeons because of their durability, low recurrence rates, and correction of many of the anatomic deficiencies that may have caused the prolapse in the first place. The Ochsner Clinic report their results for surgery for rectal prolapse over a 10-year period revealed that the majority of the procedures performed at their institution (82.7%) were done via a perineal approach, with only 10.7% of their patients undergoing open abdominal surgery. The length of hospital stay was shorter in the patients undergoing a perineal procedure, whereas the recurrence rate between the two groups was similar (16.1% vs. 15.4%). They concluded that because of the lower morbidity, the perineal approach for rectal prolapse was their preferred route of repair.

PREOPERATIVE PLANNING

The essential element in planning for surgery includes deciding on the proper approach to repair the prolapse. Perhaps making the decision of which operation to perform even more difficult, as seen in the recent review of the Cochrane Database relating to rectal prolapse. A massive review of the literature in this database found 12 randomized controlled trials relating to rectal prolapse surgery; one trial compared abdominal with perineal approaches for surgery; three trials compared different fixation methods; three trials reviewed division of lateral ligaments; one trial compared techniques of rectosigmoid resection; two trials compared laparoscopic with open surgery, and two trials compared resection with no resection and rectopexy. The reviewers concluded that there were insufficient data to determine whether abdominal or perineal approaches for rectal prolapse were better. They found no differences in the various techniques used for rectopexy, but did see lower recurrence rates with division of the lateral ligaments, although with increased incidences of constipation. Lower constipation rates were noted in patients who underwent segmental resection. In addition, laparoscopic cases had fewer complications and shorter hospital stays. This study was updated in 2015 by the same authors, this time reviewing just over 1,000 patients, divided among 15 randomized trials. Although such a comprehensive review made it very difficult to draw any specific conclusions because of the heterogeneity within the study population, some basic facts remained evident. Once again, it was noted that the patients undergoing laparoscopic repair had a shorter length of hospital stay with fewer complications compared to those undergoing open surgery. In addition, division of lateral ligaments resulted in lower rates of recurrent prolapse, but higher incidences of constipation and recurrence were seen more frequently in those patients undergoing simple rectal mobilization rather than with formal rectopexy. Formal sigmoid bowel resection resulted in lower incidences of constipation, and there was no difference in any of the types of fixation used for rectal prolapse. The authors concluded that because of the relatively small number of patients within the trials, no specific conclusions that would alter current practice guidelines could be made.

One publication attempted to demonstrate a clinical examination that may help determine whether a patient should undergo abdominal or perineal repair of the prolapse. These authors describe a “hook test” based on rectal examination to decide whether patients have a low-type of prolapse or a high type. They claim that better results may be obtained with a perineal procedure for low-type prolapses.

A single surgeon experience over 21 years evaluated and compared those patients with external rectal prolapse who underwent repair either perineally or transabdominally. He found that those undergoing an abdominal procedure had a significantly lower recurrence rate, an improved incontinence score, but a higher constipation rate. He concluded that one must consider the alternatives in repair and tailor them to the individual patient based on the presenting patient's overall degree of fitness and functional disorders.

The addition of robotic surgery may lend some belief that abdominal procedures should be more strongly considered in treating rectal prolapse. A potential benefit of robotic surgery may be in improved visualization, especially upon pelvic dissection, better ergonomics, and surgeon comfort, as well as the ease of robotic suturing for the rectopexy portion of the procedure. However, a recent study comparing robotic to laparoscopic repair failed to show any statistically significant benefit of the robot over laparoscopy. Another study comparing robotic to laparoscopic ventral mesh rectopexy showed similar safety and efficacy between the two groups with no recurrences in either group. Yet another study comparing open, laparoscopic, and robotic procedures for rectal prolapse repair showed a lower incidence of recurrence in the open group, although all the groups collectively improved from a functional standpoint.

A study comparing laparoscopic to open rectopexy showed 5-and 10-year recurrence rates of 6.9% and 10.8% in the laparoscopic group, whereas there was only a 2.4% recurrence (one patient) in the open group. Again, these groups did not show any functional outcome differences.

As previously mentioned, if the patient is younger and generally fit, an abdominal procedure is ideal. Once this decision has been made, one must then choose which abdominal procedure to actually perform. A basic list of the procedures includes the following:

- Sigmoid resection and rectopexy with or without the use of the laparoscope or robot
- Rectopexy alone with or without the use of the laparoscope or robot

This author's preference in abdominal repair for rectal prolapse is an open resection with rectopexy. The rationale to this approach lies in the pathology associated with this disorder. The redundant colon often makes robotic or laparoscopic dissection and resection more difficult in terms of visualization and the entire procedure can be completed via an initial Pfannenstiel incision with simple resection, full pelvic mobilization of the rectum, and then sutured rectopexy to the sacral bone, all within a very reasonable operative time.

There have been numerous ways in which to accomplish the rectopexy. Although it is often done with the use of straight nonabsorbable suture material, it may also be accomplished with a variety of prosthetic products including mesh or a polyvinyl alcohol sponge. Some surgeons have advocated simply mobilizing the rectum within the presacral space and allowing natural scar tissue to form, thereby preventing recurrence of the prolapse without the use of suture or mesh products. However, as mentioned earlier and seen in the meta-analysis and Cochrane review, simple mobilization without fixation may result in higher incidences of recurrence.

The decision to combine colon resection with rectopexy is typically made before surgery. This decision is often made on the basis of the patient's history and preoperative physiologic studies. Patients with fecal incontinence or constipation are often evaluated preoperatively with anal manometry and colonic transit studies. Those with severe constipation are generally offered concomitant segmental colon resection, whereas those with incontinence, diarrhea, or normal function may be safely offered rectopexy without sigmoid resection.

Rectal mobilization should be preoperatively planned as well, because many surgeons differ in their approach of freeing up the rectum. Although many surgeons perform a posterior mobilization, many others oppose this approach for fear of injuring presacral nerves and veins and leaving the patients with sexual and urinary complications. Some surgeons divide the lateral ligaments, whereas others leave them intact. Still others prefer to mobilize the rectum circumferentially to lift the rectum as high as possible out of the pelvis. Again, there is no data to truly suggest that one approach is superior to the others mentioned.

As in every case of abdominal surgery, the patients should be deemed medically fit to undergo the procedure, and they should receive both antibiotic prophylaxis to cover gram-negative organisms and anaerobes as well as prophylaxis to prevent deep vein thrombosis.

The planning steps for this procedure may be summarized as follows:

I. Careful history and physical examination

I.

A. Fecal incontinence score

B. Assess for signs and symptoms of constipation

   1. If constipation is present, then perform anorectal physiologic studies and colonic transit studies.

I.

A. Assess sphincter tone

1. If tone is diminished or incontinence is present, consider anorectal manometry.

2. If manometry demonstrates low squeeze pressures and patient is incontinent, consider perineal repair with levatorplasty.

II. Preoperative clearance and surgical risk assessment

III. Decide on abdominal versus perineal procedure

I. Abdominal procedures

A. Open resection with rectopexy (no suture, suture, prosthetic material)

B. Open rectopexy (no suture, suture, prosthetic material)

I.

A. Laparoscopic resection with rectopexy

B. Laparoscopic rectopexy (no suture, suture, prosthetic material)

I.

A. Robotic resection with rectopexy

B. Robotic rectopexy (often with suture)

SURGERY

Patient Positioning and Preparation

The patient is placed under general anesthesia and then in a low-lying modified lithotomy position. The arms may be tucked at each side in the event laparoscopy is being done. The rectum may also be irrigated in preparation for a rectal anastomosis if sigmoid resection is contemplated.

Surgical Technique

The use of the laparoscope or the robot in the treatment of rectal prolapse may have greater benefit in the event that sigmoid resection is not being done and only rectopexy is to be performed. The rationale to this is that the sigmoid colon is often very redundant and the resection requires that an incision be made to extract the specimen. The resection is often easy to perform through this rather small incision, thereby obviating the need for the laparoscope. This may save time and operative expense, and remains this author's preference.

Once the abdominal incision has been made, the presacral space may be easily entered through lateral windows, taking care not to injure the superior rectal vessels, and the dissection is taken down posteriorly all the way to the pelvic floor. This space is an avascular plane and the mobilization should be performed to the tip of the coccyx. The surgeon must decide whether to leave the lateral ligaments of the rectum attached; many feel that these attachments prevent recurrent prolapse. There are still many other surgeons who circumferentially mobilize the entire rectum to be sure that the rectum is lifted up as high as possible before suturing and securing it to the presacral fascia. This fixation may be undertaken with simple sutures or may be performed with prosthetic materials such as mesh. The sutures are placed in the lower aspect of the mesorectum and sutured to the fascia overlying the top of the sacral promontory. One must be careful not to injure the presacral veins, the nerves overlying the promontory, or the ureters when placing these sutures. At least two such stitches are placed, one on each side of the mesorectum.

The original procedure described by Ripstein involved mobilizing the rectum down to the coccyx and then placing a piece of mesh around the anterior aspect of the rectum at the level of the peritoneal reflection and then suturing this mesh to the presacral fascia. He felt that changing the angle of the rectum with this type of anterior sling would prevent recurrent prolapse. He reported his series of

289 patients in 1972 and demonstrated just one death and no recurrences with this technique (Figs. 55-4 and 55-5).

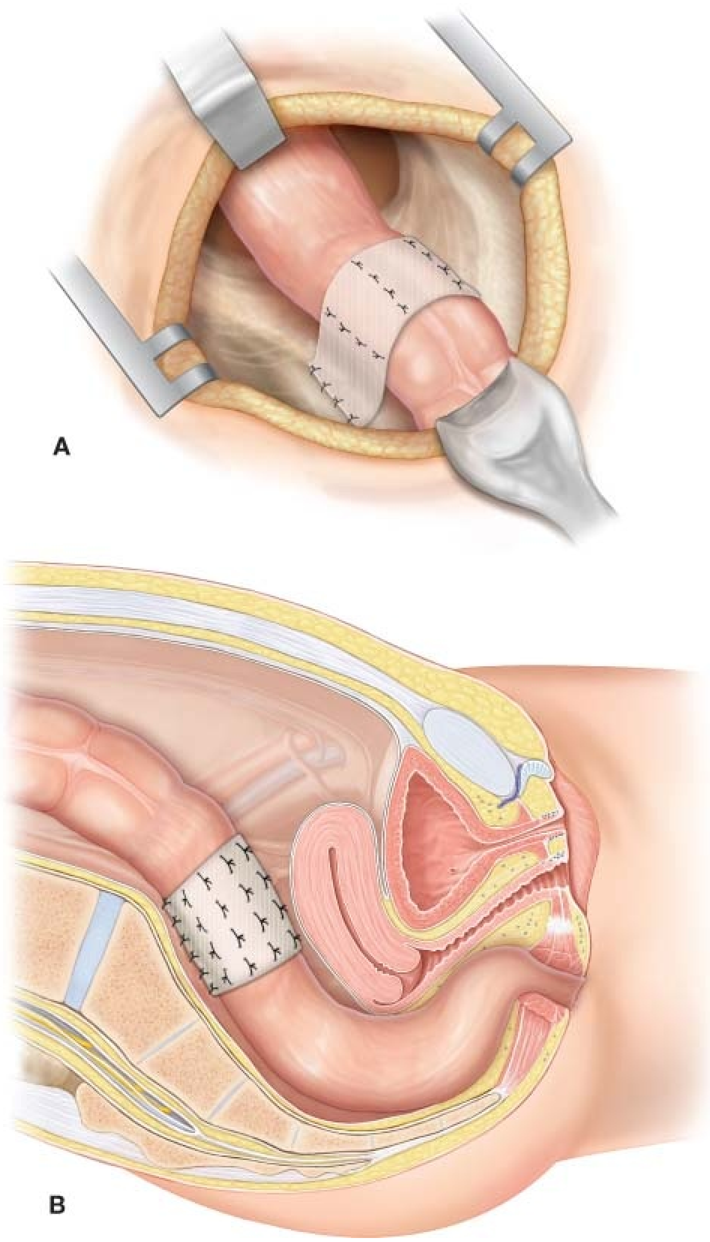


FIGURE 55-4 A. Ripstein procedure with mesh rectopexy. B. Mesh placement anteriorly.

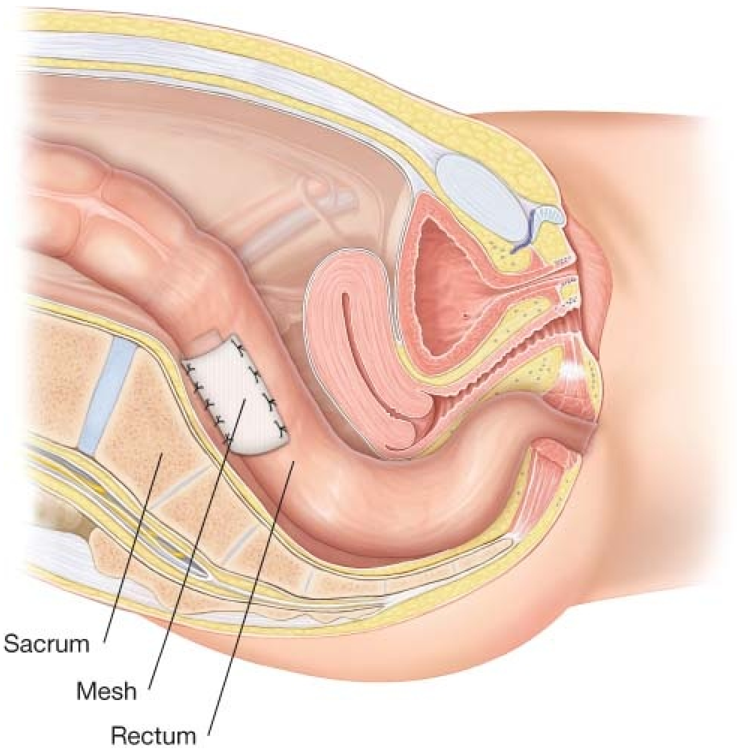


FIGURE 55-5 Modified Ripstein with posterior mesh placement.

Drs. Gordon and Hoexter later reported a multicenter review of this approach in over 1,000 patients. Although they showed a recurrence rate of only 2.3%, they did find considerable morbidity with a complication rate of 16.6%, the most common of which was fecal impaction due to the sling being too tight or the angle of the rectum being too acute. Mesh erosion was also noted in a very small percentage of patients.

The procedure described by Wells using an Ivalon (a polyvinyl alcohol) sponge has been readily adopted in the United Kingdom. This procedure mobilizes the rectum, fixes the sponge posteriorly to the mesorectum, and then attaches the sponge to the presacral fascia. The advantage of this technique is that the anterior rectal wall is not wrapped as in Ripstein's procedure and thus the rectal lumen is not narrowed. This narrowing was felt to be the main cause of the constipation and fecal impaction that was seen in the Ripstein procedure. The most serious complication of the Well's procedure is pelvic abscess, which may require sponge removal. Abscess rates as high as 16% have been reported with this technique. This is no longer approved for use in the United States (Fig. 55-6).

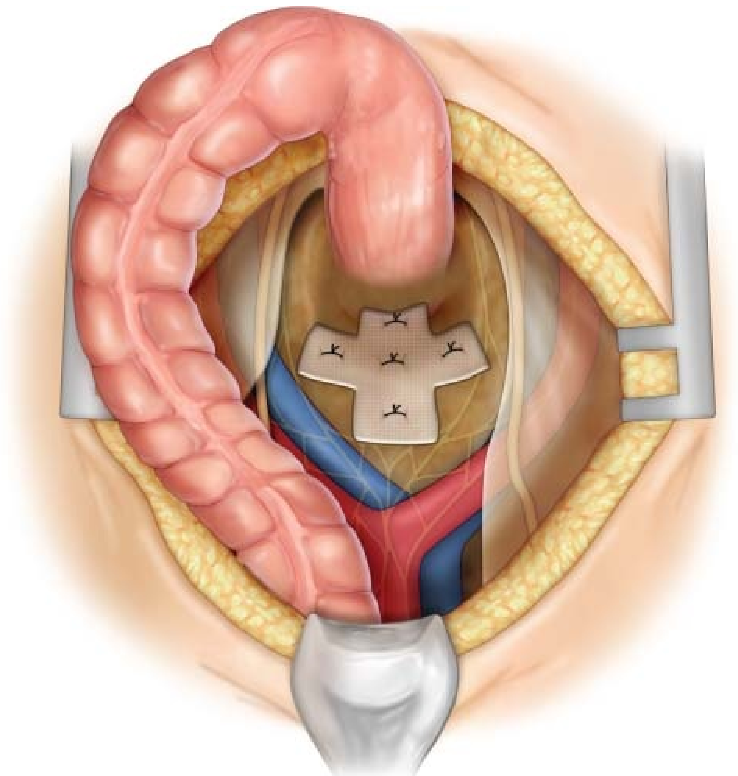


FIGURE 55-6 Rectopexy with Ivalon sponge.

Frykman introduced the idea of sigmoid resection combined with rectopexy in 1955. He described the procedure removing the redundant sigmoid colon after adequate mobilization to create a tension-free anastomosis to the high rectum, full rectal mobilization to the pelvic floor by lifting the rectum and suturing the lateral ligaments to the periosteum of the sacrum, and then suturing the endopelvic fascia anteriorly to obliterate the deep pelvic cul-de-sac. Dr. Goldberg popularized this procedure and it is now more commonly referred to as the Frykman–Goldberg procedure for prolapse. Recurrence rates have generally been reported between 0% and 9%, but with operative morbidity varying from 0% to 23%.

Other techniques of repairing rectal prolapse include the use of laparoscopy and the robot. True benefits in the management of many colonic diseases have been clearly demonstrated with minimally invasive techniques. Senagore and Delaney have shown shorter hospital stays, lower wound infection rates, and improved postoperative cardiopulmonary status in over 1,000 laparoscopic colectomies for various pathologies in a single institution. The laparoscopic approach for prolapse may include rectal mobilization, mesh placement, sutured approach for prolapse may include rectal mobilization, mesh placement, sutured rectopexy, sigmoid colectomy, and any combination of these procedures.

Alternatively, exclusion procedures have been rarely done to treat rectal prolapse, and they are mentioned in this chapter merely for completeness. The technique as described by Lahaut is performed by mobilizing the rectosigmoid colon and then implanting it within the posterior rectus sheath. Thirty-four patients who underwent this type of surgery reported no recurrent prolapse, although one patient died postoperatively. Eleven out of 12 patients reported improvement in continence with this procedure.

POSTOPERATIVE MANAGEMENT

Patients are admitted to a regular surgical floor immediately after the recovery room. Nasogastric tubes are not routinely used and orders are written for a clear liquid diet after immediate recovery from surgery. Patients are generally offered regular food once they have passed flatus or stool. Bladder catheters are typically left in place for 1–2 days after surgery to monitor urinary output. Because of the pelvic dissection, urinary retention may occur upon bladder catheter removal; if retention occurs, the catheter is replaced for several more days to leave the bladder at rest. Patients are considered ready for discharge home once they are tolerating a regular diet and able to have bowel movement.

Some centers have even questioned the need for hospital admission to treat this condition transabdominally. Clearly, any patient undergoing an open abdominal procedure, especially with bowel resection, will require an inpatient admission. However, one publication suggested that a laparoscopic rectopexy may be performed as an outpatient. The surgeons specifically selected 12 patients for this type of surgery based on their personal motivation, younger age, and generally overall fit state. Only one of the patients required a return visit to the emergency room for diarrhea. Many of the others were able to stop analgesia soon after surgery. The patients were so pleased with the procedure that most would even recommend it to other patients needing this type of surgery. As one might expect, the authors demonstrated a significant cost savings with this approach.

COMPLICATIONS

Immediate operative complications of bleeding or injuring other intra-abdominal structures during surgery are quite rare. The left ureter should be seen crossing the pelvic brim in order not to injure it during the procedure. In addition, thermal injury from the harmonic scalpel or bipolar device must be considered when nearing the pelvic sidewall structures.

Anastomotic leak, although relatively rare for high colorectal anastomoses, may be completely avoided in those patients merely undergoing rectopexy without resection. The use of minimally invasive surgical techniques has been shown to minimize the risk of wound infection as well.

Recurrence, while not an immediate complication after abdominal procedures for prolapse, remains relatively low.

RESULTS

The results of abdominal procedures for rectal prolapse are quite good. Although the procedures generally carry a higher morbidity than perineal procedures, they do seem to withstand the test of time and have fewer recurrences of the prolapse overall. The results, however, are difficult to summarize and compare because there have been so many different abdominal procedures done for prolapse. However, a study from Norway clearly demonstrated the superiority of long-term success of abdominal procedures for this condition. In their retrospective review, they demonstrated a 5-year success of abdominal procedures of 93% with improved continence and stool evacuation. All patients undergoing either a Delorme or Thiersch procedure had a recurrence within 5 years. They reported no recurrences after mesh rectopexy and concluded that abdominal procedures for prolapse are far more durable.

Some surgeons have advocated anterior rectal dissection and rectopexy rather than posterior or full-thickness rectal mobilization in an effort to minimize sexual and urinary dysfunction. This ventral rectopexy procedure was performed in 65 consecutive older patients with full-thickness rectal prolapse through a laparoscopic approach with improvement in fecal incontinence scores as well as constipation in the majority of patients. Only one patient experienced recurrent rectal prolapse. The authors felt that even older patients may benefit from this procedure with a low morbidity and avoid the risk of bowel resection and anastomosis (Figs. 55-7 and 55-8).

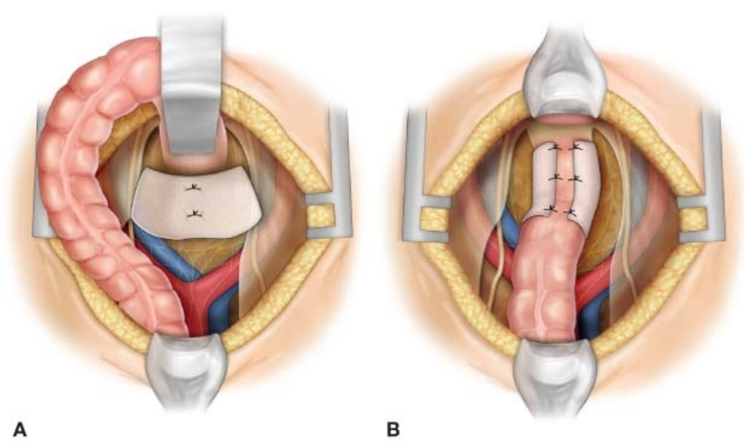


FIGURE 55-7 Mesh placement. A. Posteriorly in presacral space and B. Wrapped anteriorly.

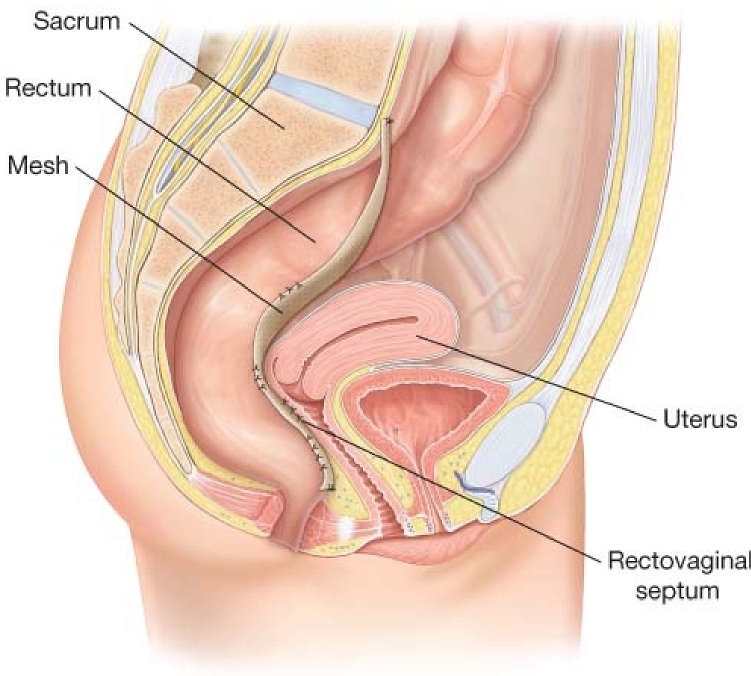


FIGURE 55-8 Ventral mesh rectopexy.

A pooled data study regarding abdominal procedures for rectal prolapse was designed to address the issue of whether full circumferential mobilization of the rectum was necessary and its affect on rectal prolapse recurrence. This study recognized that among the four factors identified as leading to recurrent prolapse (constipation, incontinence, sigmoid resection, and full rectal mobilization), full circumferential rectal mobilization was associated with a decreased long-term recurrence rate. The type of rectal fixation did not influence recurrence nor did whether the operation was performed via a laparoscopic or an open approach.

A Belgian study presented 109 consecutive patients with full-thickness rectal prolapse who underwent laparoscopic ventral rectopexy avoiding posterior dissection and risk of injuring presacral nerves and vessels. The authors applied an anterior mesh to prevent intussusception and recurrent prolapse. Four patients underwent conversion to open surgery, with an overall recurrence rate of 3.6%.

Laparoscopic compared to open repair for rectal prolapse yielded similar recurrence rates long term but shorter hospital stays with laparoscopy. Continence and constipation were generally improved in each group. A meta-analysis comparing laparoscopic to open procedures for rectal prolapse reviewed 12 comparative studies and showed that although the operative time took longer in the laparoscopic cases, there was a reduction in hospital stay compared to the open group with no difference in morbidity, mortality, or bowel function.

Other surgeons have also claimed that the need for and risk of resection may not be necessary. In a recent publication, 70 patients with rectal prolapse and normal preoperative transit studies underwent suture fixation of the rectum alone after mobilizing the rectum but leaving the lateral stalks intact. These procedures were all done through a low-lying left lower quadrant incision exposing the presacral space. Although they reported a recurrence rate of 7%, they showed that no patients became constipated after surgery and 81% of patients had improvement in fecal control with a significant improvement in both anal canal manometric resting and squeeze pressures.

An Australian group compared their results of laparoscopic rectopexy to those done in an open manner. They found that 5 patients of the 126 (4%) who underwent laparoscopic rectopexy developed recurrence compared to 1 patient of the 46 in the open group (2.2%). These results did not reach statistical significance and they concluded that a laparoscopic approach to treat rectal prolapse was reasonable and safe.

The issue of whether abdominal surgery for prolapse is well tolerated in the older and infirmed patients was evaluated in a study from Finland. These authors performed either laparoscopic or open abdominal procedures for prolapse with half of the patients having an American Society of Anesthesiologists (ASA) class of III or IV. There was no mortality and only minor morbidity, and operative times were similar for both laparoscopic and open rectopexy. Each surgical approach improved fecal control and nearly all of the patients were pleased with their results. There were only two recurrences among the 75 patients treated in total. The majority of the patients underwent laparoscopic surgery with a shorter hospital stay than those undergoing open surgery.

A retrospective review of the American College of Surgeons National Surgical Quality Improvement Program of over 3,000 patients who underwent surgery for rectal prolapse found that an open abdominal approach was used in 30% of the patients. These patients had a higher risk-adjusted morbidity compared to the perineal approaches that were used in other patients, whereas those patients undergoing a laparoscopic approach with or without rectopexy had a similar risk-adjusted morbidity compared to the perineal approaches even though the perineal procedures were done in older patients with a higher ASA classification.

CONCLUSION

In summary, abdominal procedures for rectal prolapse are well tolerated even among the elderly. These approaches provide a durable and excellent solution, with good outcomes for a socially debilitating problem. These procedures may even address problems associated with constipation if combined with sigmoid resection. As such, they remain the approach of choice to which all other methods of repair of rectal prolapse need be compared.

RECOMMEND REFERENCES AND READINGS

Ammar SA, Kottb MB. A novel percutaneous technique for treating complete rectal prolapse in adults. *Surg Innov* 2015;22(3):240–4.

Bishawi M, Foppa C, Tou S, Bergamaschi R; Rectal Prolapse Recurrence Study Group. Recurrence of rectal prolapse following rectopexy: a pooled analysis of 532 patients. *Colorectal Dis* 2016;18(8):779–84.

Boons P, Collinson R, Cunningham C, Lindsey I. Laparoscopic ventral rectopexy for external rectal prolapse improves and avoids de novo constipation. *Colorectal Dis* 2010;12(6):526–32.

Byrne CM, Smith SR, Solomon MJ, Young JM, Eyers AA, Young CJ. Long-term functional outcomes after laparoscopic and open rectopexy for the treatment of rectal prolapse. *Dis Colon Rectum* 2008;51(11):1597–604.

D'Hoore A, Penninckx F. Laparoscopic ventral recto(colopo)pexy for rectal prolapse: surgical technique and outcome for 109 patients. *Surg Endosc* 2006;20(12):1919–23.

de Hoog DE, Heemskerk J, Nieman FH, van Gemert WG, Baeten CG, Bouvy ND. Recurrence and functional results after open versus conventional laparoscopic versus robot-assisted laparoscopic rectopexy for rectal prolapse: a case-control study. *Int J Colorectal Dis* 2009;24(10):1201–6.

Delaney CP. Laparoscopic management of rectal prolapse. *J Gastrointest Surg* 2007;11(2):150–2.

Frykman HM. Abdominal proctopexy and primary sigmoid resection for rectal procidentia. *Am J Surg* 1955;90:780–9.

Gordon PH, Nivatvongs S. *Principles and Practice of Surgery for the Colon, Rectum, and Anus*. St Louis: Quality Medical Publishing, 1999.

Gordon PH, Hoexter B. Complications of Ripstein procedure. *Dis Colon Rectum* 1978;21:277–80.

Hammond K, Beck DE, Margolin DA, Whitlow CB, Timmcke AE, Hicks TC. Rectal prolapse: a 10-year experience. *Ochsner J Spring* 2007;7(1):24–32.

Hoel AT, Skarstein A, Ovrebo KK. Prolapse of the rectum, long-term results of surgical treatment. *Int J Colorectal Dis* 2009;24(2):201–7.

Keighley MRB, Williams NS. *Surgery of the Colon Rectum and Anus*. London: WB Saunders, 1993.

Kupfer CA, Goligher JC. One hundred consecutive cases of complete prolapse of the rectum treated by operation. *Br J Surg* 1970;57:481–7.

Marzouk D, Ramdass MJ, Haji A, Akhtar M. Digital assessment of lower rectum fixity in rectal prolapse (DALR): a simple clinical anatomical test to determine the most suitable approach (abdominal versus perineal) for repair. *Surg Radiol Anat* 2005;27(5):414–9.

Mehmood RK, Parker J, Bhuvimanian L, *et al.* Short-term outcome of laparoscopic versus robotic ventral mesh rectopexy for full-thickness rectal prolapse. Is robotic superior? I*nt J Colorectal Dis* 2014;29(9):1113–8.

Mortensen NJ, Vellacott KD, Wilson MG. Lahaut's operation for rectal prolapse. *Ann R Coll Surg Engl* 1984;66(1):17–8.

Pescatori M, Zbar AP. Tailored surgery for internal and external rectal prolapse: functional results of 268 patients operated upon by a single surgeon over a 21 year period. *Colorectal Dis* 2009;11(4):410–9.

Poylin V, Bensley R, Nagle D. Changing approaches to rectal prolapse repair in the elderly. *Gastroenterol Rep (Oxf)* 2013;1(3):198–202.

Ramage L, Georgiou P, Tekkis P, Tan E. Is robotic ventral mesh rectopexy better than laparoscopy in the treatment of rectal prolapse and obstructed defecation? A meta-analysis. *Tech Coloproctol* 2015;19(7):381–9.

Ripstein CB. Procidentia: definitive corrective surgery. *Dis Colon Rectum* 1972;15:334–46.

Senagore AJ, Delaney CP. A critical analysis of laparoscopic colectomy at a single institution: lessons learned after 1000 cases. *Am J Surg* 2006;191(3):377–80.

Tou S, Brown SR, Malik AI, Nelson RL. Surgery for complete rectal prolapse in adults. *Cochrane Database Syst Rev* 2008;(4):CD001758.

Tou S, Brown SR, Nelson RL. Surgery for complete (full thickness) rectal prolapse in adults. *Cochrane Database Syst Rev* 2015;(11):CD001758. doi: 10.1002/14651858.CD001758.pub3.

Vijay V, Halbert J, Zissimopoulos A, Siddiqi S, Warren S. Day case laparoscopic rectopexy is feasible, safe, and cost effective for selected patients. *Surg Endosc* 2008;22(5):1237–40.

Wells C. New operation for rectal prolapse. *Proc R Soc Med* 1959;52:602–3.

Chapter 56

Open Resection Rectopexy

Christina V. Warner and Anders Mellgren

OPEN RESECTION RECTOPEXY

The majority of patients affected by external rectal prolapse are women. The primary symptom is a full-thickness prolapse of the rectum through the anus. Initially, the rectum occasionally comes out with bowel movements. However, with time, the prolapse protrudes more frequently and can sometimes prolapse between bathroom visits, with frequent development of concomitantly increasing fecal incontinence symptoms. Other common symptoms may include constipation, rectal bleeding, and mucus discharge. A spectrum of anatomic and functional disorders of the pelvic floor have been associated with rectal prolapse, including a deep cul-de-sac of Douglas, levator ani diastasis, lax rectal wall attachments, redundant rectosigmoid colon, and impaired resting and voluntary sphincter function (Fig. 56-1). Unfortunately, few patients with rectal prolapse experience improvement of symptoms with dietary changes or pelvic floor physical therapy. Generally, surgical intervention needs to be considered.

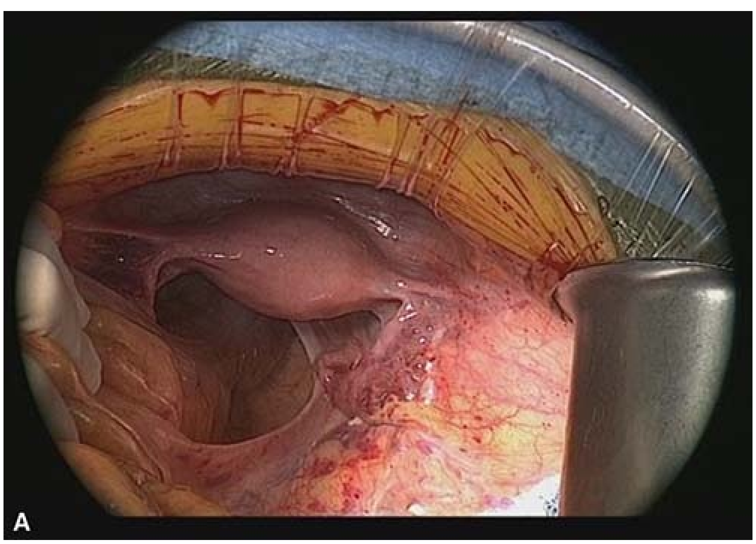


FIGURE 56-1 Image demonstrating (A) a deep cul-de-sac of Douglass and (B) a redundant sigmoid colon in a patient with full-thickness rectal prolapse.

Resection rectopexy was first described by Frykman and Goldberg in 1969. In this chapter, the open technique is described (see Chapters 63 and 64 for the minimally invasive and hand-assisted techniques, respectively). Specifically, the rectum is mobilized, the redundant sigmoid colon is resected followed by a primary colorectal anastomosis, and thereafter the rectum is straightened and suspended with suture fixation to the presacral fascia. The subsequent fibrosis that develops between the mobilized rectum and the sacrum secures the fixation.

INDICATIONS AND CONTRAINDICATIONS

Posterior rectopexy with resection is generally performed in patients with full-thickness rectal prolapse with preoperative constipation. Patients with significant fecal incontinence without preoperative symptoms of constipation are usually not candidates for this procedure. Patients with significant vaginal prolapse may benefit from concomitant sacrocolpopexy or a ventral rectopexy. Similarly, patients deemed medically unfit because of advanced age or comorbidities are usually considered for a perineal prolapse repair.

PREOPERATIVE PLANNING

The diagnosis of rectal prolapse should be confirmed with a careful history and physical examination. The prolapse can be diagnosed with the patient in the lateral position, but frequently the patient needs to sit on a commode to see the full extent of the prolapse.

Digital rectal, perineal, and vaginal examination should be performed, noting the degree of rectal prolapse, external sphincter and puborectalis muscle contraction, and the presence of other anorectal disorders and genital prolapse. Concomitant disorders can be diagnosed with pelvic examination (referral to urogynecology) and/or defecography.

A full-thickness prolapse must be distinguished from a mucosal prolapse, because surgical treatment options differ. A full-thickness prolapse contains all layers of the rectal wall, frequently has circular folds, and the intussusception that forms the prolapse starts inside the rectum. On clinical examination, a full-thickness external prolapse is diagnosed with protrusion of the rectum beyond the anus while the patient exercises the Valsalva maneuver in the upright, seated, or lateral decubitus position. The procidentia can sometimes be felt on digital rectal examination with the patient pushing. Some patients may have a solitary ulcer and/or distal proctitis in the distal rectum. Defecography, with fluoroscopic or magnetic resonance imaging technique, can confirm the presence of a rectal prolapse and concomitant genital prolapse.

p. 537

---

p. 538

Patients should undergo preoperative colonoscopy to exclude colorectal neoplasia. Anal manometry can objectively assess sphincter function and the presence of a non-relaxing pelvic floor. To evaluate functional outcomes, documentation of pre-and postoperative bowel function with standardized symptom questionnaires can be useful.

Patients should undergo a preoperative risk assessment and “clearance.” Preoperative nutritional optimization can reduce postoperative morbidity, including delayed wound healing, surgical site infection, and anastomotic dehiscence. There is usually minimal operative blood loss during the procedure, but there is a potential for significant bleeding from pelvic veins. Patients should be recommended to suspend antiplatelet and anticoagulant therapy 5–7 days before the surgery. A complete mechanical and oral antibiotic bowel preparation is utilized to prevent surgical site infection and anastomotic leak.

SURGERY

A prophylactic dose of antibiotics should be administered intravenously within 60 minutes of the incision per the Surgical Care Improvement Project guidelines. Deep venous thromboembolism (DVT) prophylaxis should be given before induction of anesthesia. A urinary catheter is placed to allow intraoperative and postoperative fluid monitoring and to maintain the bladder deflated during the procedure.

Positioning

The patient is placed in the modified lithotomy position using Allen stirrups and both arms remain abducted at 80 degrees (Fig. 56-2). A modest Trendelenburg position will improve exposure of the pelvis. The patient is secured to the table with a safety strap, and all bony prominences are well padded. The operating surgeon stands on the left side of the patient, with the assistant on the contralateral side. After hair from the abdomen and pubis is removed using clippers, a sterile preparation is applied.

FIGURE 56-2 The patient is placed in the modified lithotomy with Allen stirrups and arms abducted at 80 degrees.

Technique

Access to the peritoneal cavity may occur via a Pfannenstiel or a lower midline incision. Both provide excellent access to the lower abdomen. However, the

Pfannenstiel incision is the authors’ preferred approach because of the cosmetic result combined with patient tolerance.

A semicircular skin incision is placed just above the pubic symphysis for an approximate length of 10–12 cm. The anterior rectus fascia is exposed and transversely divided, yielding a superior and inferior leaflet. Each leaflet is carefully dissected from the underlying rectus muscle to the extent of the umbilicus superiorly and the pubic symphysis inferiorly (Fig. 56-3). The rectus muscles are laterally retracted and the abdomen is entered between the rectus muscles by vertically incising the peritoneum. If needed, for increased access, the Pfannenstiel incision can be combined with mobilization of the rectus muscles from the pubic bone.

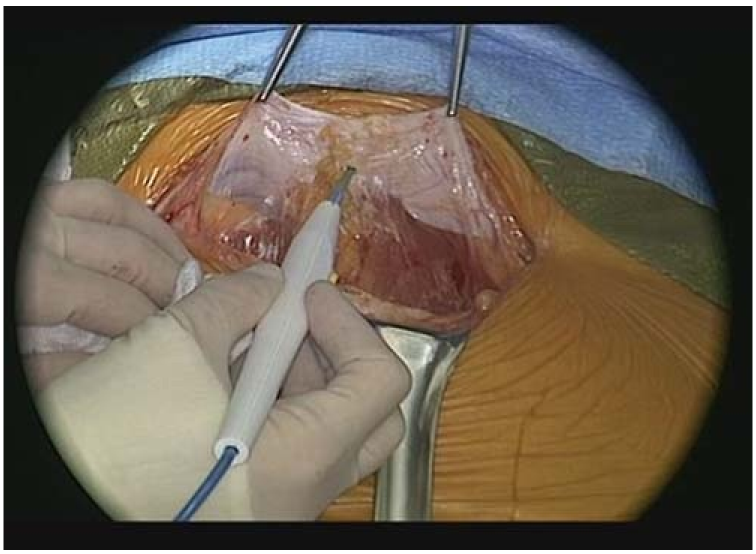


FIGURE 56-3 Pfannenstiel incision: The inferior leaflet of the divided anterior rectus fascia is dissected from the underlying rectus muscle down to the pubic symphysis.

Once the peritoneal cavity is opened, a wound protector is inserted and a retractor is placed. The contents of the peritoneal cavity are inspected for any abnormalities. Next, the transverse colon and small bowel are tucked cephalad into the upper right abdomen with moist laparotomy pads.

Sigmoid and Rectal Mobilization

The sigmoid colon is reflected medially and upward to visualize its lateral attachments to the left pelvic wall along the line of Toldt. Using electrocautery, the sigmoid colon and the upper rectum are mobilized, and care is taken to identify the ureters. Both ureters are identified and confirmed with visualization of peristaltic waves, and they are kept safe during the procedure.

Laterally, the rectosigmoid mesentery is mobilized along the presacral avascular plane down to the level of the levator muscles. The peritoneum is opened 1–2 cm lateral to each side of the rectum. Effort is made to preserve the inferior hypogastric plexus nerves. Posteriorly, the rectum is mobilized in the avascular plane down to the coccyx. Effort is also made to preserve the superior hemorrhoidal artery, if possible. Anteriorly, the rectum is mobilized 2–4 cm into the plane between the vagina/prostate and rectum.

Sigmoid Resection

The colorectal anastomosis is usually performed at the level of the sacral promontory. At this location, the mesorectum is divided using ties or a bipolar tissue sealant device. The rectosigmoid colon is then divided at the promontory and in the proximal sigmoid colon using bowel clamps. The amount of resected bowel needs to be adapted to comfortably achieve a tension-free, well vascularized anastomosis and the specimen is removed from the operative field.

Purse string sutures are placed in the proximal and distal bowel segments. A circular stapler is thereafter introduced through the anus and navigated up through the rectum. The anvil is kept in place on the stapler instrument to facilitate the advancement of the stapler through the rectum. When the top of the rectum is reached, the anvil is removed from the stapler instrument, and the purse string in the top of the rectum is tied around the pin of the stapler instrument. Care is taken to ensure there is no additional tissue that will interfere with the anastomosis.

The anvil of the circular stapler is then placed in the proximal sigmoid bowel segment, and the purse string is secured tightly around the anvil shaft. Care is taken to ensure there is no additional tissue that will interfere with the anastomosis.

The anvil is then connected with the pin of the circular stapling device at the top of the rectum. The circular stapling device is then carefully closed, and care is taken to ensure that both bowel ends have appropriate blood supply, that no additional tissue will interfere with the anastomosis, that the proximal segment is not rotated, and that there will be no tension in the anastomosis. A stapled end-to-end anastomosis is created between the upper rectum and proximal sigmoid colon at the level of the sacral promontory. The stapler is removed from the rectum and both donuts are inspected to verify that they are complete. The editors would also endoscopically visualize and simultaneously air test the anastomosis at this time. The authors and editors find it easier to address any anastomotic problems at this time rather than after performance of the rectopexy.

Suture Rectopexy

Two double-armed nonabsorbable sutures (e.g., 2/0 Prolene) are needed for this step of the procedure. Each suture is placed through the presacral fascia approximately 3–4 cm distal to the promontory, with an interval space of 1 cm between each suture. The needle ends are tagged with a mosquito clamp when not in use to prevent the sutures from coiling into the operative field (Fig. 56-4).

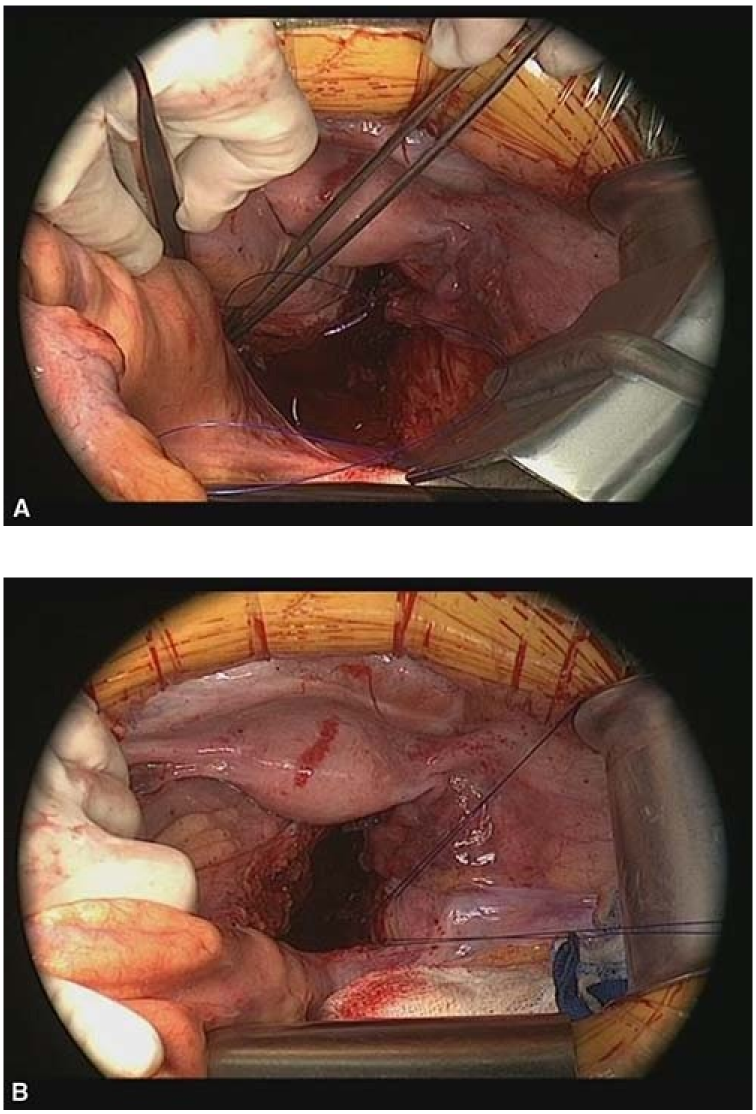


FIGURE 56-4 A. One end of a double-armed suture is passed through the presacral fascia 3-4 cm inferior to the sacral promontory. B. A second anchoring stitch is passed through the presacral fascia.

A long Babcock clamp is applied to the mesorectum on the right side. With the clamp, appropriate suspension can be estimated. The Babcock clamp will then serve as a guide for placing the sutures through the mesorectum to achieve the appropriate suspension. On the right side of the rectum, both arms of each suture are passed through the mesorectum from behind, and each suture is tied anteriorly in the mesorectum (Fig. 56-5). Care is taken to ensure enough tissue in the mesorectum is incorporated into the suture; and, at the same time, it is important that the sutures are not introduced into the rectum itself. No attempt is made to close the deep sac of Douglas nor to approximate the levator hiatus.

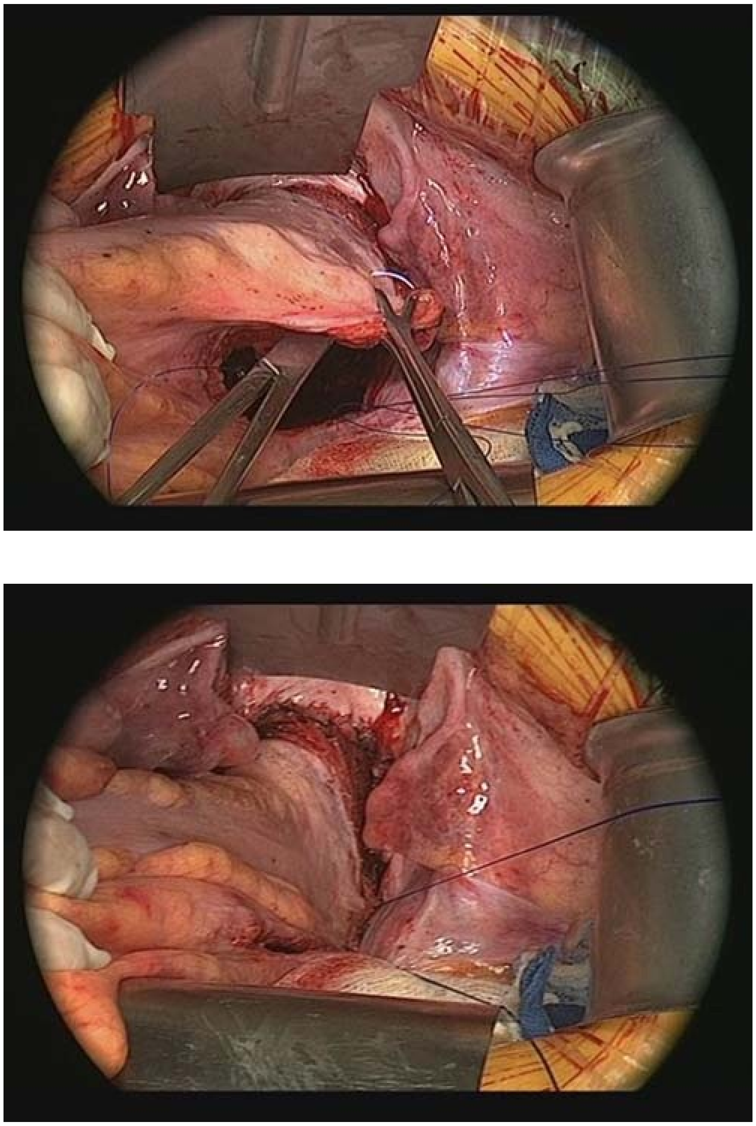


FIGURE 56-5 Both arms of each suture are passed through the mesorectum directly adjacent to the rectal wall, while the rectum is held elevated and straightened.

The pelvis and lower abdomen are filled with a warm saline solution. A flexible sigmoidoscopy is performed to visualize and air test the anastomosis.

An alternative employed by the editors is to place the rectopexy sutures before sigmoid resection and anastomosis but not tie them until after anastomotic construction and confirmation. The editors also routinely employ Indocyanine green perfusion assessment before and after anastomosis.

Closure

No drain is left in place; after hemostasis is achieved, the peritoneum and fascia are closed with polydioxanone sutures. The subcutaneous tissue is irrigated, and the skin is closed using staples or a running subcuticular stich.

POSTOPERATIVE MANAGEMENT

Most patients undergoing an open resection rectopexy are safely managed in the general surgical ward; however, vital signs and urinary catheter output should be frequently monitored. Intravenous fluids with an isotonic solution are administered during the first 24 hours and switched to 5% dextrose/0.45% sodium chloride solution for maintenance hydration until a liquid diet is tolerated. Most patients can start a liquid diet immediately, and a low-residue diet can usually be resumed on postoperative day 1 or 2 upon return of bowel function. If the patient remains clinically stable, the urinary catheter is removed by the second postoperative day. Postoperative antibiotics are not administered to patients unless there is evidence of infection.

Ambulation should occur within 8 hours of the operation and continue each day thereafter to minimize risk of DVT. For the same reason, patients should be placed on subcutaneous DVT prophylaxis.

Standard analgesia is appropriate for postoperative pain management and should be adjusted per the patient’s degree of pain. Patients are usually placed on laxatives, typically sennoside-docusate or polyethylene glycol, to avoid postoperative constipation.

COMPLICATIONS

A 2015 Cochrane review analyzed 15 randomized-controlled trials involving surgical operations for full-thickness external rectal prolapse. Two studies compared abdominal resection rectopexy with perineal rectosigmoidectomy, demonstrating a postoperative complication rate of 38% versus 22%, respectively (not statistically significant). In comparison of resection or not, there was a non-statistically significant tendency for more complications in the resection group (50% vs. 34%).

Most complications are minor and mirror those common to bowel operations, including superficial surgical site infection, small bowel obstruction, ileus, hernia, and sexual dysfunction. Major risks are rare and include mortality, anastomotic leakage or stricture, pelvic sepsis, hemorrhage, and cardiopulmonary events. The overall mortality rate is 0–7%, depending on the included patient population. Expected length of hospital stay with the open resection rectopexy is usually 4–6 days.

RESULTS

The primary outcomes examined after surgery for rectal prolapse include recurrence, constipation, and incontinence. Open resection rectopexy has a recurrence rate of 0–13%. Patients with preoperative constipation sometimes report less postoperative constipation, but not all patients will experience this relief (Table 56-1). There is even a limited risk for postoperative worsening of constipation.

TABLE 56-1 Preoperative and Postoperative Constipation and Incontinence Complaints After Open Sigmoid Resection Rectopexy

Study type	No. of patients	Preoperative constipation (%)	Postoperative constipation (%)	Prec inco
Retrospective (Watts et al., 1985)	138	–	–	
Prospective (Sayfan et al., 1990)	13	38	8	
Prospective(Luukkonen et al., 1992)	15	33	13	
Prospective(McKee et al., 1992)	9	44	22	
Retrospective (Tjandra et al., 1993)	18	67	11	
Prospective (Deen et al., 1994)	10	–	–	
Prospective(Huber et al., 1995)	42	44	26	
Retrospective(Kim et al., 1999)	176	53	23	

CONCLUSIONS

Open resection with rectopexy is a safe procedure for medically fit patients with full-thickness rectal prolapse and constipation.

RECOMMENDED REFERENCES AND READINGS

Deen KI, Grant E, Billingham C, Keighley MR. Abdominal resection rectopexy with pelvic floor repair versus perineal rectosigmoidectomy and pelvic floor repair for full-thickness rectal prolapse. *Br J Surg* 1994;81(2):302–4.

Frykman HM, Goldberg SM. The surgical treatment of rectal procidentia. *Surg Gynecol Obstet* 1969;129(6):1225–30.

Garland B, Zutshi M. Rectal prolapse. In: Steele SR, ed. *The ASCRS Textbook of Colon and Rectal Surgery*. 3rd ed. New York, NY: Springer, 2016:1077–89.

Huber FT, Stein H, Siewert JR. Functional results after treatment of rectal prolapse with rectopexy and sigmoid resection. *World J Surg* 1995;19(1):138–43; discussion 143.

Kim DS, Tsang CB, Wong WD, Lowry AC, Goldberg SM, Madoff RD. Complete rectal prolapse: evolution of management and results. *Dis Colon Rectum* 1999;42(4):460–6; discussion 466–9.

Luukkonen P, Mikkonen U, Jarvinen H. Abdominal rectopexy with sigmoidectomy vs. rectopexy alone for rectal prolapse: a prospective, randomized study. *Int J Colorectal Dis* 1992;7(4):219–22.

Madiba TE, Baig MK, Wexner SD. Surgical management of rectal prolapse. *Arch Surg* 2005;140(1):63–73.

McKee RF, Lauder JC, Poon FW, Aitchison MA, Finlay IG. A prospective randomized study of abdominal rectopexy with and without sigmoidectomy in rectal prolapse. *Surg Gynecol Obstet* 1992;174(2):145–8.

Sayfan J, Pinho M, Alexander-Williams J, Keighley MR. Sutured posterior abdominal rectopexy with sigmoidectomy compared with Marlex rectopexy for rectal prolapse. *Br J Surg* 1990;77(2):143–5.

Senapati A, Gray RG, Middleton LJ, et al; PROSPER Collaborative Group. PROSPER: a randomised comparison of surgical treatments for rectal prolapse. *Colorectal Dis* 2013;15(7):858–68.

Tjandra JJ, Fazio VW, Church JM, Milsom JW, Oakley JR, Lavery IC. Ripstein procedure is an effective treatment for rectal prolapse without constipation. *Dis Colon Rectum* 1993;36(5):501–7.

Tou S, Brown SR, Nelson RL. Surgery for complete (full-thickness) rectal prolapse in adults. *Cochrane Database Syst Rev* 2015(11):CD001758.

Watts JD, Rothenberger DA, Buls JG, Goldberg SM, Nivatvongs S. The management of procidentia. 30 years' experience. *Dis Colon Rectum* 1985;28(2):96–102.

Yakut M, Kaymakcioglu N, Simsek A, Tan A, Sen D. Surgical treatment of rectal prolapse. A retrospective analysis of 94 cases. *Int Surg* 1998;83(1):53–55.

Chapter 57

Laparoscopic Rectopexy

Howard M. Ross and Cindy Wu

INDICATIONS/CONTRAINDICATIONS

Laparoscopic rectopexy is an important technique for the treatment of rectal prolapse. The procedure can be combined with sigmoid resection or performed alone as a means for treating full-thickness rectal prolapse when resection is not desired. Laparoscopic rectopexy without resection is especially useful when patients have problems with fecal incontinence or when a patient or surgeon does not want to accept the risk of an anastomotic leak.

PREOPERATIVE PLANNING

Before surgery, patients should undergo a full preoperative evaluation including a thorough history of the presenting symptoms, including the presence of constipation or fecal incontinence, and a physical examination. A colonoscopy should be performed to identify possible underlying colorectal pathology. In addition, these studies can be supplemented with anoscopy for better evaluation of the anal canal, with anal manometry to determine preoperative resting anal pressure, and defecography to determine if a patient has concurrent rectocele, enterocele, or internal rectal prolapse. Colonic transit studies can be considered in patients who present with constipation to evaluate for colonic inertia. Patients should also undergo appropriate preoperative cardiac and pulmonary evaluation to establish that they can tolerate general anesthesia.

We utilize a combined oral antibiotic and mechanical bowel preparation the evening before surgery. The mechanical preparation facilitates physical manipulation of the rectum with laparoscopic and robotic instruments.

SURGERY

Laparoscopic rectopexy is a relatively easily performed technique that includes full circumferential mobilization of the rectum to the level of the pelvic floor. Surgeons should be facile with laparoscopic suturing techniques and have equipment that will permit the secure attachment of the mesorectum to the presacral fascia.

Positioning

Patients should be placed in the supine position in stirrups. The patient's thighs should be level with the torso to enable the unencumbered motion of the surgeon's arms. The surgeon and camera operator typically stand on the right side of the patient. The first assistant stands on the patient's left side. Generally, a camera port is placed at the superior edge of the umbilicus and the abdomen is insufflated to 15 mm Hg. Two additional lateral 5-mm ports are placed in both the right and left lower quadrants under direct vision. A 30-degree angled laparoscope is used to facilitate lateral viewing. On each side of the patient, the most inferior port is placed two fingerbreadths medial and superior to the anterior superior iliac spine. The superior lateral port is placed four fingerbreadths superior to the lower port (Fig. 57-1). Alternatively, one 5-mm port can be placed to the left and one 5-mm port to the right at the level of the umbilicus.

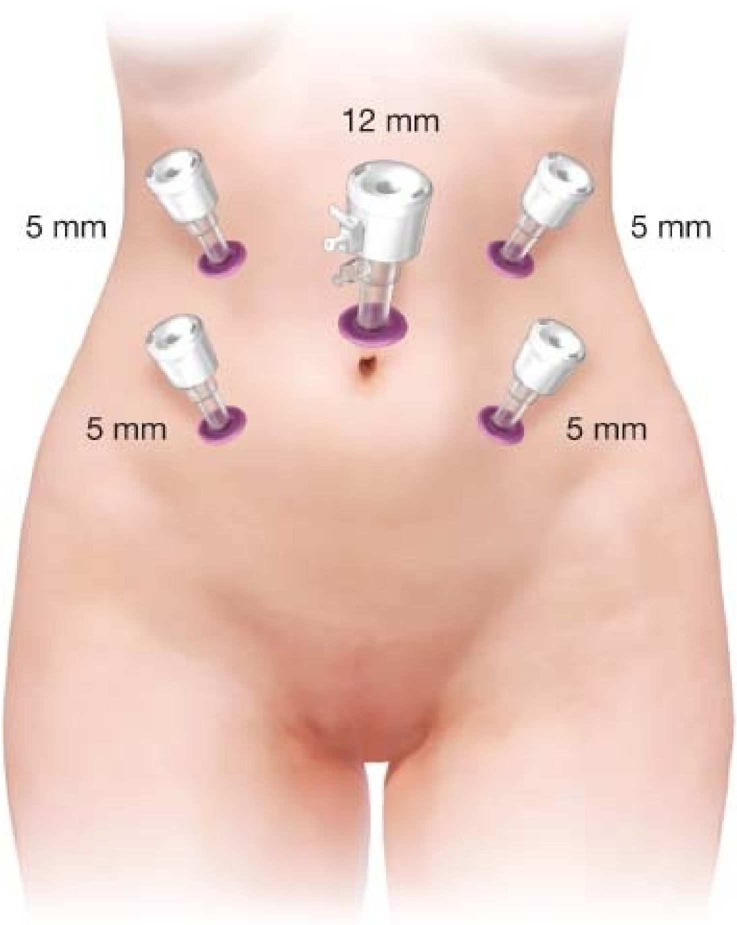


FIGURE 57-1 Port placement for laparoscopic rectopexy.

Technique

The operation begins by lifting the rectum toward the abdominal wall and retracting the proximal rectum superiorly and to the left. This motion creates tension on the redundant rectal mesentery. Positioning the patient in steep Trendelenburg will help displace the small bowel from the pelvis. Tilting the operating table to the left at this time will expose the right side of the rectum. The right lateral peritoneum overlying the mesorectum is then scored with electrocautery or diathermy scissors beginning at the sacral promontory (Fig. 57-2). The retrorectal space is developed in a proximal-to-distal direction toward the pelvic floor. We mobilize the right side of the rectum, first extending distal and then to the left (Figs. 57-3 and 57-4). The right and left ureters are identified and protected. When only the peritoneum remains on the left, the rectum is retracted to the right and the left peritoneum is opened (Fig. 57-5). Inclining the table to the right at this point in the operation may help exposure.

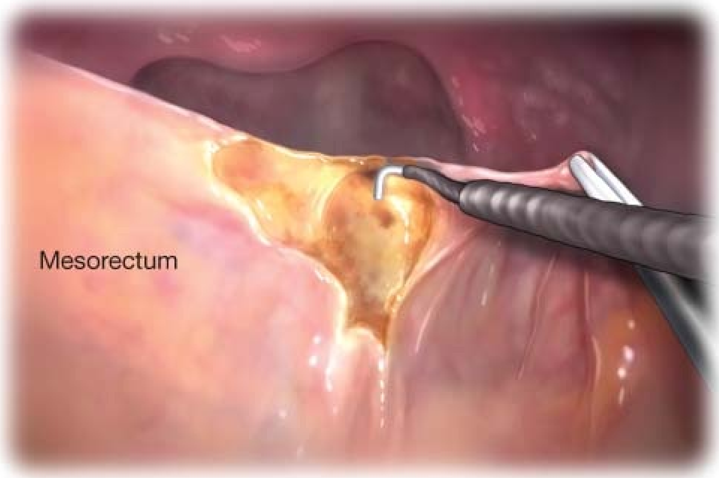


FIGURE 57-2 Opening the right lateral peritoneum at the level of sacral promontory.

FIGURE 57-3 Developing retrorectal space.

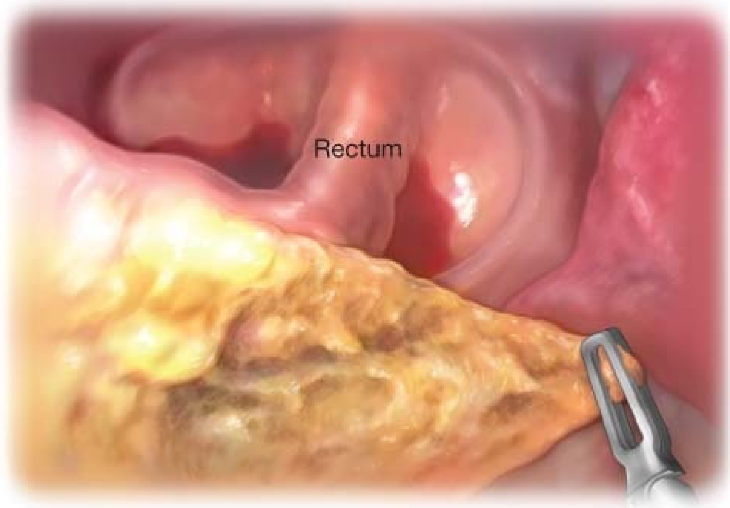


FIGURE 57-4 Rectum mobilized by developing retrorectal space distally and from right to left.

FIGURE 57-5 Left peritoneum opened.

Division of the lateral stalks is undertaken according to the individual surgeon's preference and the patient's presenting symptoms. Division of the stalks has been shown in several studies to be associated with increased postoperative constipation but lower recurrence. If the surgeon elects to divide the lateral stalks, they may be divided with an energy source.

The anterior rectum should be mobilized from the posterior vagina distally to the anal canal, especially if a rectocele is present in conjunction with rectal prolapse (Fig. 57-6). Once completely mobilized, the rectum is elevated to straighten the rectum and remove the redundancy. Next, the fascia propria of the mesorectum is attached to the sacral fascia with interrupted sutures (Fig. 57-7). We prefer a permanent 2-0 nonabsorbable suture. The laparoscopic tacking device can also be used to secure the rectum to the presacral area at the pelvic brim with good results (Fig. 57-8).

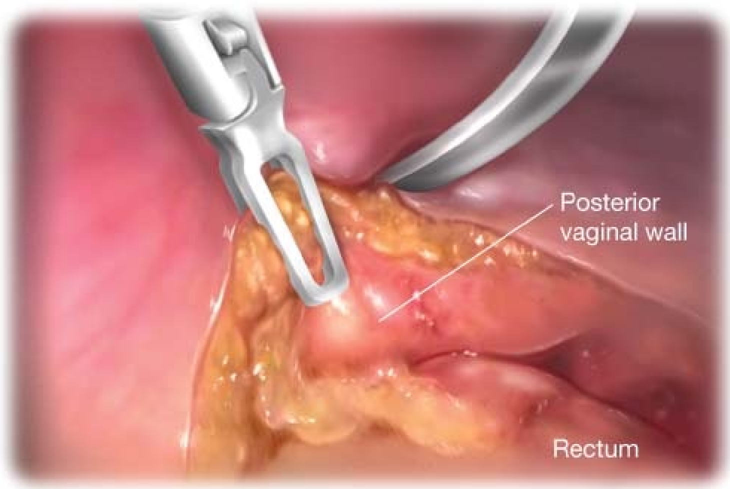
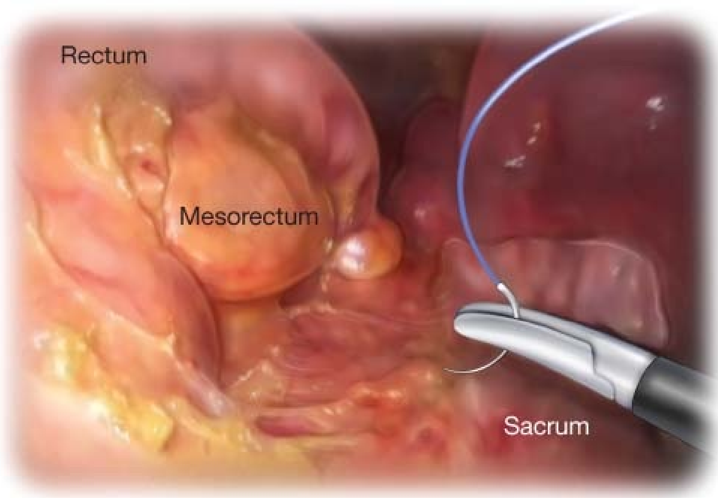


FIGURE 57-6 Anterior rectum dissected from posterior vaginal wall.



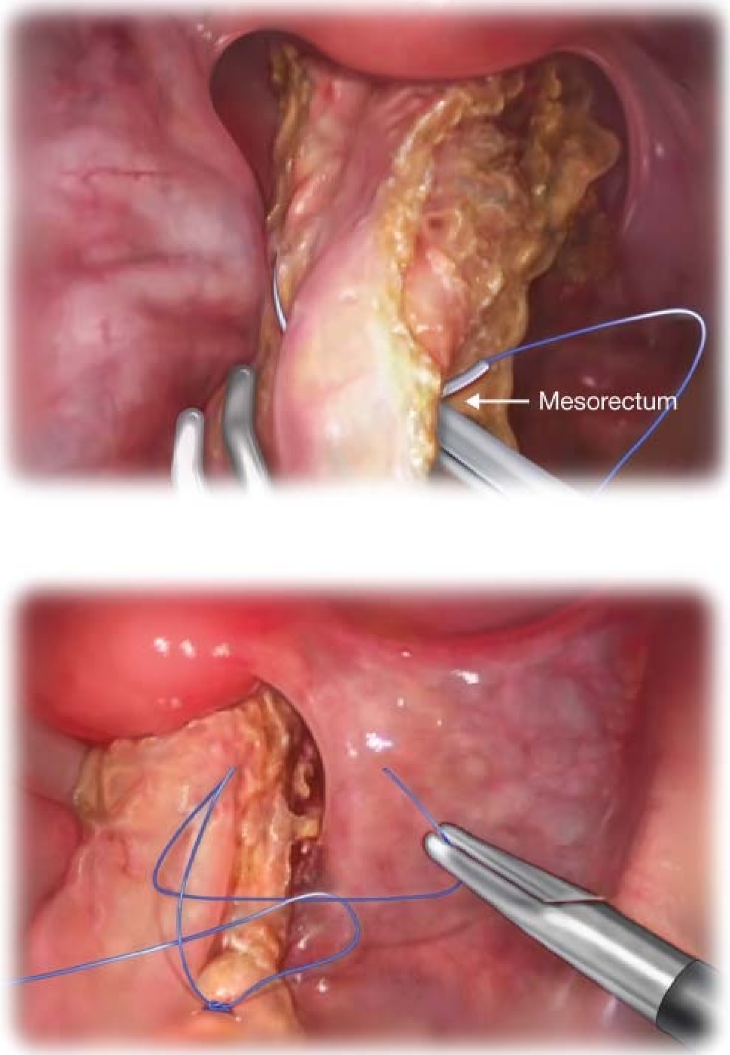


FIGURE 57-7 Suturing fascia propria of the mesorectum to the sacral fascia.

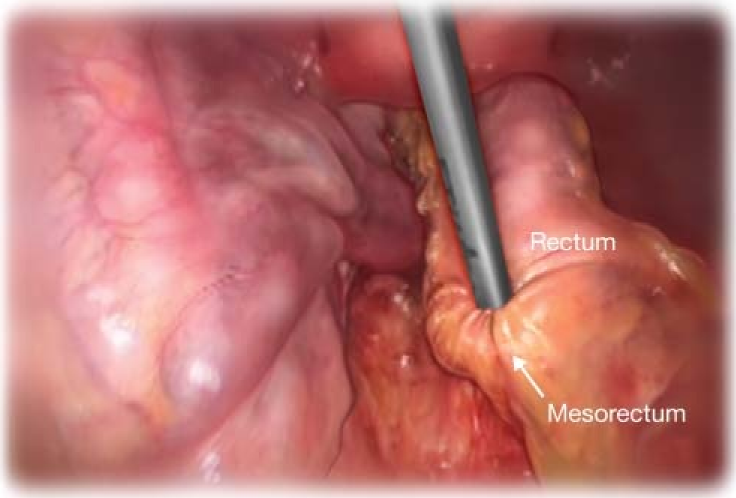


FIGURE 57-8 Laparoscopic tacking device used to secure mesorectum to presacral area at the level of pelvic brim.

POSTOPERATIVE MANAGEMENT

Clear liquids are started in the immediate postoperative period and the diet is advanced as tolerated. When the patient demonstrates adequate oral intake and return of bowel function, the patient is discharged. Parenteral and enteral opiates are utilized for postoperative analgesia. Ideally, with effective local anesthetic and the addition of acetaminophen, opiate intake can be minimized.

COMPLICATIONS

The overall major and minor complication rates with laparoscopic rectopexy are low. Complications identified in the literature include bleeding, infection, and worsening of constipation.

RESULTS

A multicenter randomized trial, conducted by Karas *et al.* in 2011 compared 136 patients who underwent rectopexy to 116 patients who had rectal mobilization without rectopexy and found that rectopexy patients had a lower rate of full-thickness rectal prolapse recurrence at 5 years 1.5–8.6% (log rank, $P = 0.003$). The results suggest that foreign material used to pex the rectum is critical in decreasing recurrence and that rectal mobilization alone is inadequate.

p. 545

---

p. 546

Retrospective and prospective studies indicate that laparoscopic suture rectopexy has a minor complication (Dindo I–II) rate of 0–16%, a major complication rate (Dindo III–IV) rate of 2–11%, and mortality of 0%. Retrospective studies have shown recurrence rates generally range from 0% to 20% in studies with 8-to 30-month follow-up. The rate of conversion to open technique is 0–5%. Laparoscopic suture rectopexy shows a postoperative improvement in incontinence of 48–82% and constipation of 11–70%.

There are few high-quality studies comparing laparoscopic and open rectopexy and most have a small sample size. Meta-analysis has been useful in determining morbidity and recurrence rates, as well as comparisons of length of hospitalization. Purkayastha *et al.* identified six studies including a total of 195 patients (98 open and 97 laparoscopic) and found that there were no significant differences in recurrence or morbidity between laparoscopic abdominal rectopexy and open abdominal rectopexy. The length of stay was significantly reduced in the laparoscopic group by 3.5 days (95% CI, 3.1–4; $P < 0.01$), whereas the operative time was significantly longer in this group, by approximately 60 minutes (60.38 minutes; 85% CI, 49–71.8 minutes). Morbidity was the same for laparoscopic rectopexy and the open technique. The most recent Cochrane systematic review from 2015 compared laparoscopic versus open rectopexy and found longer operating time but fewer postoperative complications with the laparoscopic technique. There was also a significantly shorter length of stay (mean difference, 2.35 days fewer, 95% CI 1.37–3.33). Comparison of trials examining abdominal rectopexy with and without sigmoid resection suggested that resection decreases constipation without statistically significant higher complications than rectopexy alone. However, these analyses were limited by inclusion of studies with varying objectives, comparison of different operative interventions, and small sample size.

The PROlapse surgery perineal or rectopexy (PROSPER) trial, a randomized comparison of multiple surgical treatments for rectal prolapse concluded that there was no statistically significant difference in recurrence between transabdominal suture rectopexy compared to resection rectopexy. Similarly transabdominal suture rectopexy compared to resection rectopexy. Similarly, there was no significant difference among quality-of-life scores, incontinence, and bowel function at a median follow-up of 36 months. A limitation, however, was that the study included both laparoscopic and open techniques.

p. 546

---

p. 547

The ongoing randomized control trial ACTRN12605000748617 aims to address the lack of specific data on laparoscopic rectopexy. The trial will produce results comparing laparoscopic resection rectopexy with laparoscopic fixation rectopexy for constipation, incontinence, recurrence, postoperative morbidity, and length of hospital stay.

CONCLUSIONS

Laparoscopic rectopexy is a safe and effective means to treat rectal prolapse. The laparoscopic technique results in a shorter hospital stay than does the equivalent open resection. Recurrence and complication rates are low and the absence of an anastomosis and need to make a larger incision for specimen removal are appealing attributes of this approach. The technique of laparoscopic rectopexy requires knowledge of pelvic anatomy and the ability to laparoscopically mobilize the rectum and subsequently laparoscopically fix it to the presacral fascia.

RECOMMENDED REFERENCES AND READINGS

Bordeianou L, Hicks CW, Kaiser AM, Alavi K, Sudan R, Wise PE. Rectal prolapse: an overview of clinical features, diagnosis, and patient-specific management strategies. *J Gastrointest Surg* 2014;18:1059–69.

Heah SM, Harley JE, Hurley J, Duthie GS, Monson JR. Laparoscopic suture rectopexy without resection is effective treatment for full-thickness rectal prolapse. *Dis Colon Rectum* 2000;43:638–43.

Karas JR, Uranues S, Altomare DF, et al; Rectal Prolapse Recurrence Study Group. No rectopexy versus rectopexy following rectal mobilization for full-thickness rectal prolapse: a randomized control trial. *Dis Colon Rectum* 2011;54:29–34.

Nunoo-Mensah JW, Efron JE, Young-Fadok TM. Laparoscopic rectopexy. *Surg Endosc* 2007;21:325–6.

Purkayasha S, Tekkis P, Athanasiou T, *et al.* A comparison of open vs laparoscopic abdominal rectopexy for full-thickness rectal prolapse: a meta-analysis. *Dis Colon Rectum* 2005;48:1930–40.

Rickert A, Kienle P. Laparoscopic surgery for rectal prolapse and pelvic floor disorders. *World J Gastrointest Endosc* 2015;7(12):1045–54.

Senapati A, Gray RG, Middleton LJ, et al; PROSPER Collaborative Group. PROSPER: a randomised comparison of surgical treatments for rectal prolapse. *Colorectal Dis* 2013;15:858–70.

Tou S, Brown SR, Nelson RL. Surgery for complete (full-thickness) rectal prolapse in adults (review). *Cochrane Database Syst Rev* 2015;11:CD001758.

Chapter 58

Robotic Rectopexy

Colette Inaba and Alessio M. Pigazzi

INDICATIONS/CONTRAINDICATIONS

Indications

Rectopexy may be indicated for full-thickness external rectal prolapse or, much less commonly, for internal rectal prolapse with significant functional complaints. Complex rectoceles causing obstructed defecation symptoms are often associated with internal rectal prolapse and can be, on rare occasions, another indication for rectopexy.

Rectal prolapse occurs most often in females 50 years and older, with a male-to-female ratio of 1:6. Other risk factors for rectal prolapse include a deep pouch of Douglas, pelvic floor dysfunction, weak anal sphincters, connective tissue disorders, or high parity. Patients with rectal prolapse typically present with complaints of fecal incontinence, rectal bleeding, tenesmus, pain, or symptoms of obstructed defecation. These symptoms can be socially debilitating and have a significant effect on quality of life.

Rectal prolapse can be repaired using an abdominal approach or a perineal approach. The abdominal approaches include primarily rectopexy with or without sigmoid resection, whereas the perineal approaches include primarily the Delorme's procedure (mucosal sleeve resection) and Altemeier's procedure (perineal rectosigmoidectomy). Although the abdominal approaches typically require longer operative times, they allow for simultaneous correction of other pelvic organ prolapse. Overall, the abdominal approaches also have lower risk of recurrence compared to the perineal approaches (1.6–27% vs. 4–38%, respectively). In general, an abdominal approach should be offered to all patients without truly prohibitive medical comorbidities or technical factors that preclude an abdominal operation.

The primary abdominal surgical procedure to repair rectal prolapse is rectopexy, either posterior or ventral. Posterior rectopexy involves mobilization of the rectum and posterior fixation of the mesorectum to the sacral promontory, either with mesh or with suture (Fig. 58-1). This procedure is often associated with postoperative constipation, thought to be due to autonomic denervation caused from posterior dissection or kinking from redundant sigmoid colon. The risk of postoperative constipation can be mitigated by combining sigmoid resection with suture rectopexy, but with the disadvantage of risking anastomotic leak or stricture. However, resection rectopexy continues to be a good option for patients who complain of constipation and have a redundant sigmoid colon.

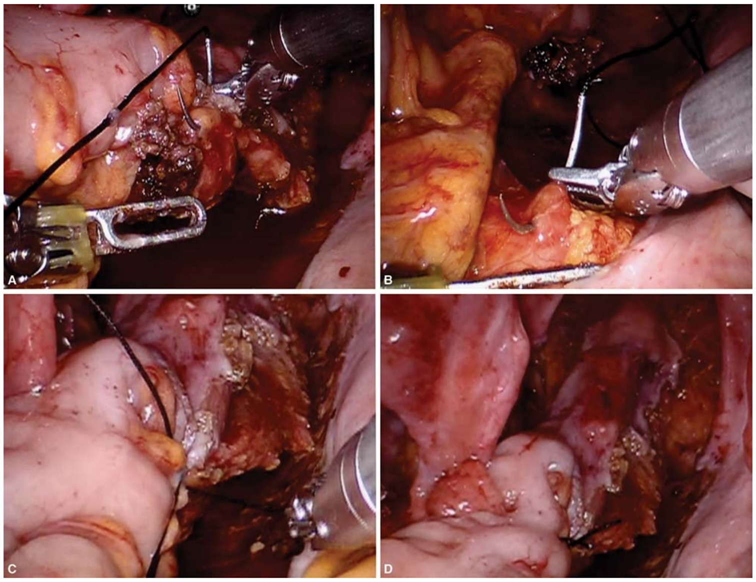


FIGURE 58-1 Robotic posterior suture rectopexy. The posterior upper rectum (A) is sutured to the sacral promontory after colorectal anastomosis (B–D).

Ventral rectopexy involves mobilizing the anterior rectum and attaching it to the sacral promontory using a piece of mesh. It has the advantage of avoiding posterior rectal mobilization, thus minimizing the risk of postoperative constipation and limiting the need for sigmoid resection. Given evidence for reduced postoperative constipation with good functional outcomes and low recurrence, ventral rectopexy has become the procedure of choice for rectal prolapse in some countries.

Typically, ventral rectopexy is laparoscopically performed, because this approach has multiple advantages over the open technique, including less blood loss, less postoperative pain, faster recovery, and fewer procedure-related complications. Robotic surgery builds upon the advantages of laparoscopic surgery by providing the surgeon with three-dimensional imaging and a stable camera. Use of a robot also provides tremor elimination and articulated instruments for greater surgical precision, which is particularly helpful for dissecting and suturing in the limited pelvic space. Robotic ventral rectopexy is the standard approach at the authors’ institution institution, and is the main focus of the rest of this chapter.

Contraindications

Although there are no absolute contraindications for robotic surgery, severe adhesions may limit the ability to perform any type of minimally invasive surgery in general. In addition, patients should be considered for a perineal approach instead of an abdominal approach if they have an incarcerated prolapse or significant comorbidities precluding general anesthesia. Relative contraindications for robotic surgery are similar to those for laparoscopic rectopexy, and include pregnancy, coagulopathy, increased intracranial pressure, or compromised cardiopulmonary status.

PREOPERATIVE PLANNING

Patients should undergo a thorough history and physical, with particular focus on history of bowel symptoms and assessment of degree of prolapse. Prolapse is typically best evaluated with the patient sitting on a commode or toilet while performing a Valsalva maneuver. A history of constipation should prompt a transit study to assess for colonic inertia. Pelvic floor dysfunction can be assessed with defecography and anal manometry. Patients should also be screened for colorectal cancer with a thorough family history and colonoscopy.

Patients are placed on a clear liquid diet the day before surgery and are instructed to perform an enema the day of surgery. Preoperative antibiotics are administered within an hour of the first incision.

SURGERY

Positioning

The patient is positioned supine directly onto a foam pad that is fixed to the operating table. The friction between the patient and pad helps to minimize any sliding during the steep Trendelenburg positioning that is required during surgery. The legs are positioned in low lithotomy using Allen stirrups with the patient's buttocks aligned at the edge of the table and are also wrapped in sequential compression devices for deep venous thrombosis prophylaxis. Arms are tucked and all bony prominences are padded to prevent any pressure injury. The patient is strapped to the table across the chest and a Foley catheter is placed. Any prolapsed rectum should be manually reduced at this time. Vaginal and perineal preparation is performed in addition to the standard abdominal preparation, and the patient is draped widely from just below the nipples down to the pubis.

Technique

Port Placement

The abdomen is insufflated as per routine laparoscopic cases. We prefer to use a Veress needle inserted at Palmer's point in the left upper quadrant. A 12-mm camera port is placed first, midway between the xiphoid and pubis. The camera port should not be placed any more than 15–20 cm from the pubis, because placement too far cephalad will limit visibility of the deep pelvis. Under direct camera visualization, a port is placed bilaterally, each located 8–10 cm from the camera port along an imaginary line extending from the camera port to the anterior superior iliac spine. The right lower quadrant port is 8 mm and used for Robot Arm 1, and the left lower quadrant port is 8 mm and used for Robot Arm 2. An additional 8-mm port for Robot Arm 3 is placed laterally in the left lower quadrant, and may require sigmoid mobilization for safe insertion. A 12-mm assistant port is placed in the right upper quadrant and a 5-mm assistant port is placed in the epigastric area. Figure 58-2 depicts the final position of all ports.

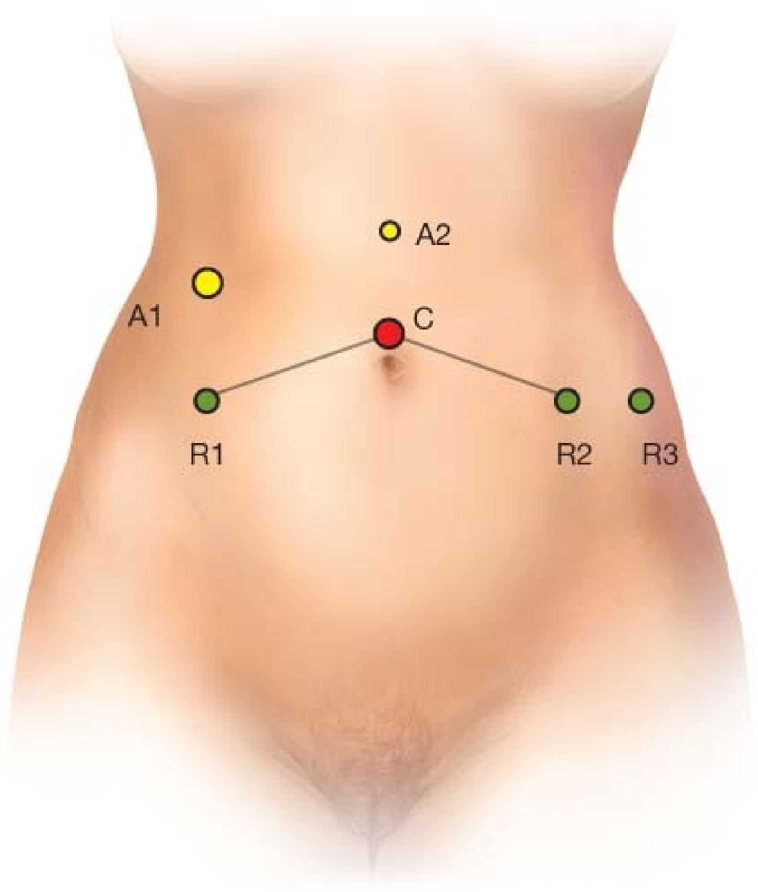


FIGURE 58-2 Port placement for robotic ventral mesh rectopexy. A1, 12-mm assistant port; A2, 5-mm assistant port; C, 12-mm camera port; R1, 8-mm robotic port for Arm 1, monopolar scissors; R2, 8-mm robotic port for Arm 2, fenestrated bipolar grasper; R3, 8-mm robotic port for Arm 3, atraumatic grasper.

Rectal Mobilization

The patient is positioned in Trendelenburg to promote displacement of the bowel out of the pelvis. If present, the uterus is retracted by a 0-polydioxanone (PDS) suture passed through the anterior abdominal wall on a straight Keith needle. The needle is passed through the uterus and out though the anterior abdominal wall, where it is tied externally under some tension to provide better exposure to the rectovaginal plane. The suture is removed before abdominal closure.

At this point we dock the robot. At our institution, we use a four-arm da Vinci Si robotic system (Intuitive Surgical Inc, Sunnyvale, CA, USA). We prefer to dock the robot over the patient's left hip instead of between the patient's legs to facilitate intraoperative rectal examination and manipulation of vaginal elevators. The main post of the robot should be positioned in line with the left anterior superior iliac spine and the camera port.

anterior superior iliac spine and the camera port.

p. 551

p. 552

We begin rectal mobilization with monopolar scissors in Arm 1, a fenestrated bipolar grasper in Arm 2, and an atraumatic grasper in Arm 3. The upper rectum is elevated off the sacral promontory using sharp dissection through the peritoneum along the right side of the rectum (Fig. 58-3). Care must be taken to preserve the hypogastric nerves. Dissection continues distally along the pelvic side wall with no posterior mobilization. The plane of dissection then moves anteriorly across the rectum along the rectovaginal or rectovesical septum to form a "lazy J-shape" dissection line (Fig. 58-4). This process is facilitated by vaginal retraction using a flat acrylic vaginal manipulator combined with rectal retraction using an obturator. The lateral stalks of the rectum are preserved, because division of the stalks has been associated with an increased risk of pelvic floor dysfunction and constipation. Performing a digital rectal examination to assess the extent of distal dissection can help minimize excessive dissection into the intersphincteric space.

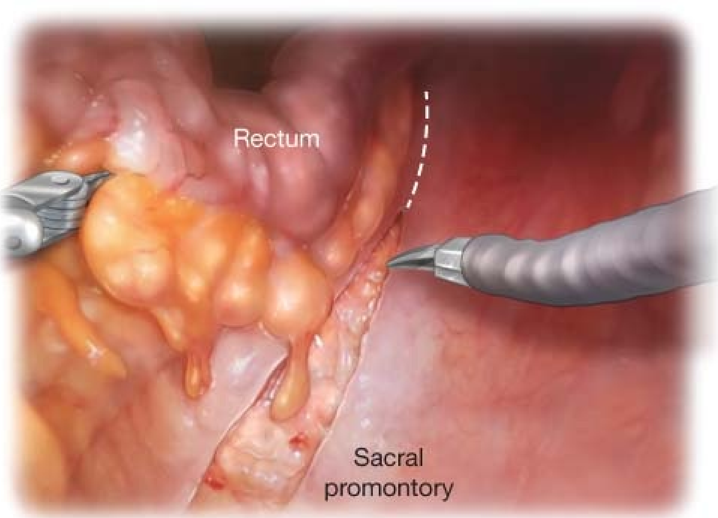


FIGURE 58-3 Opening the peritoneum on the right side of the rectum.

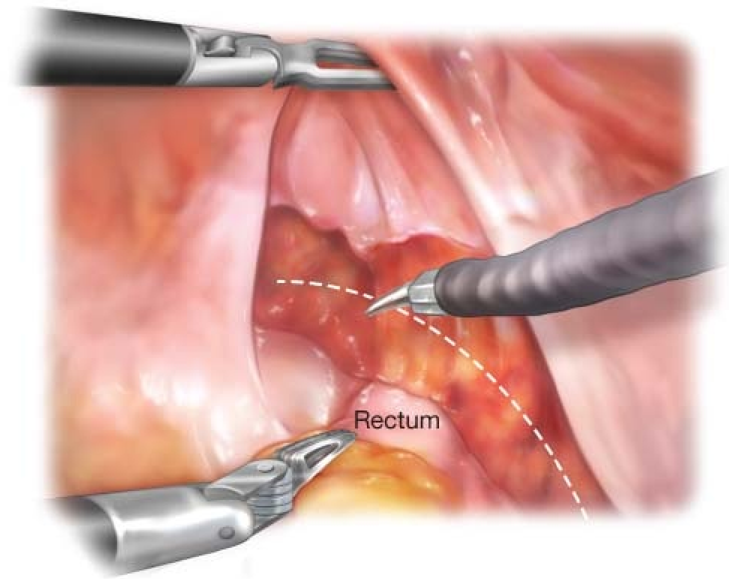


FIGURE 58-4 “Lazy J-shaped” dissection along anterior rectum.

Mesh Placement

In our practice, we use a composite polypropylene surgical mesh cut about 18 cm long by 3 cm wide. The mesh is tapered from 3 cm distally to 2 cm proximally for insertion on the sacral promontory. At this point of the procedure, the robotic monopolar scissors are exchanged for the robotic needle driver on Arm 1. After delivery through the 12-mm assistant port, the 3-cm end of the mesh is placed on the anterior rectum (Fig. 58-5) and secured with four or six interrupted 2-0 silk sutures placed along the edges of the mesh. The unprotected side of the mesh is placed against the rectum. The mesh is then passed along the right side of the rectum and secured to the sacral promontory with two interrupted 0-silk sutures or laparoscopic titanium tacks (Fig. 58-6). The mesh should lie without redundancy or tension. Care must be taken to avoid any injury to the presacral veins, hypogastric nerves, right ureter, or iliac vessels. The peritoneum is then closed over the mesh using running 3-0 absorbable braided suture (Fig. 58-7).

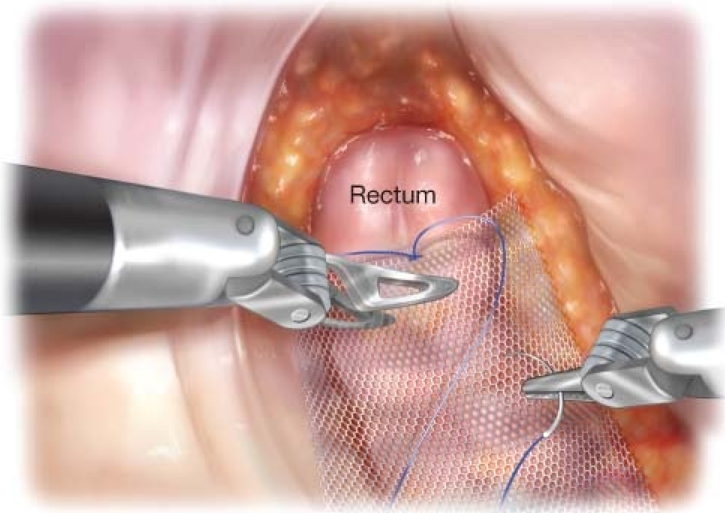


FIGURE 58-5 Mesh placement at the distal anterior rectum.

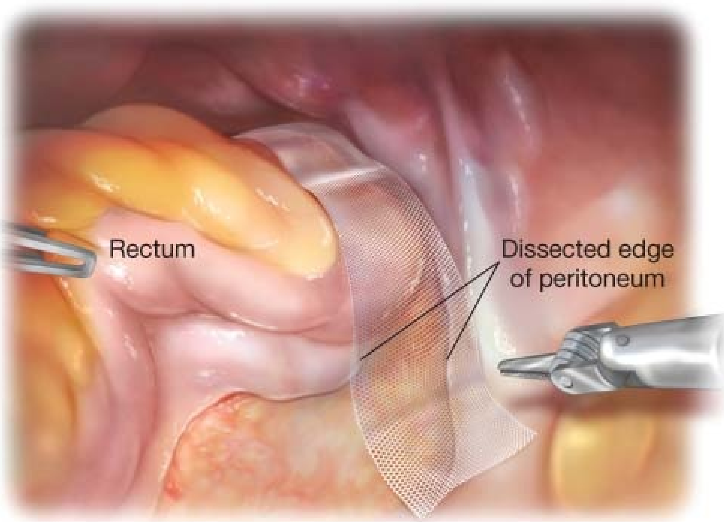


FIGURE 58-6 Mesh placement along the right side of the rectum up to the sacral promontory.

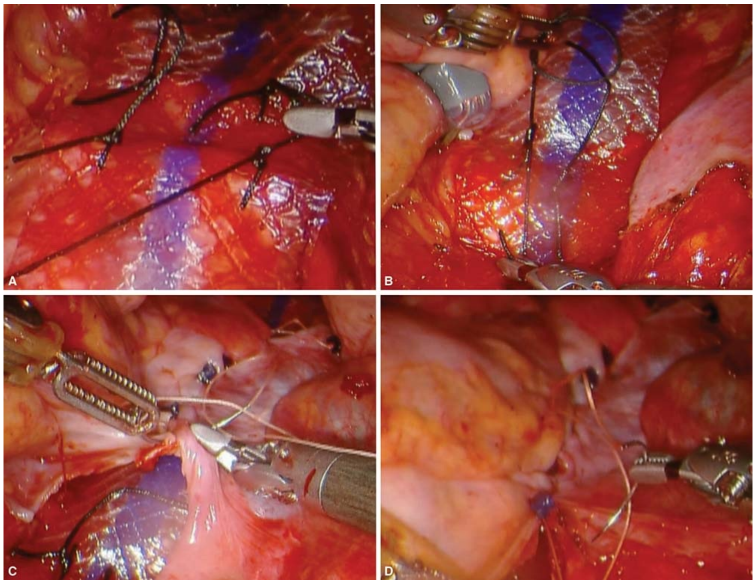


FIGURE 58-7 Robotic ventral mesh rectopexy. Mesh is sutured to the anterior rectum (A) and is then passed along the right side of the rectum to be suspended from the sacral promontory (B). The peritoneum is then closed over the mesh (C and D).

p. 552

p. 553

Sigmoid Resection with Suture Rectopexy

If the patient has a redundant sigmoid colon with preoperative complaint of constipation, we often perform sigmoid resection with posterior suture rectopexy instead of ventral mesh rectopexy (VMR). Because resection should be limited to the redundant portion of the colon, it is unnecessary to mobilize the left colon for this procedure. The rectum is mobilized posteriorly along the embryologic plane between the fascia propria and the presacral fascia, taking care to preserve the lateral stalks as much as possible. Anteriorly, the rectum is freed from the vagina or prostate by fully opening the rectovaginal or retroprostatic septum. After mobilization of the rectum, the mesorectum is divided with an endoscopic vessel-sealing device. Extra care should be taken to avoid injury to the superior rectal artery, which will supply blood to the colorectal anastomosis. An endoscopic stapler is used to transect the rectosigmoid, which is externalized through a 4-cm Pfannenstiel incision lined with a wound protector. The proximal extent of resection is divided sharply, and an end-to-end anastomosis (EEA) anvil is secured in the opening with a purse string suture. The proximal colon is then returned to the abdomen and the Pfannenstiel fascia is closed. The abdomen is reinsufflated and an end-to-end colorectal anastomosis is constructed using an EEA stapler. The anastomosis is checked for integrity with a leak test using a

EEA stapler. The anastomosis is checked for integrity with a leak test using a flexible sigmoidoscope. It is also important to inspect the anastomosis for any duskiness that suggests poor perfusion. Once satisfied with the anastomosis, the posterolateral edges of the mesorectum distal to the anastomosis are sutured to the sacral promontory with 2-0 silk suture.

POSTOPERATIVE MANAGEMENT

Patients are typically admitted to the general surgical ward postoperatively. The Foley catheter is removed postoperative day 1. The patient is started on clears immediately postoperatively and is rapidly advanced to a regular diet as tolerated. Discharge is typically postoperative day 2, after return of bowel function.

COMPLICATIONS

The postoperative major complication rates for robotic rectopexy range from 0% to 7.7%, and mortality rates range from 0% to 1.1%. Conversion rates range from 0% to 5.9%, and typically are associated with extensive intra-abdominal adhesions.

Recurrent Prolapse

Long-term recurrence rates range from 7% to 15%, and typically occur within the first 36 months of surgery. Recurrence is more frequent in patients with a history of pelvic floor surgery or in patients younger than 60 years. There is no difference in recurrence rate between laparoscopic and robotic rectopexy.

Mesh Complications

Mesh complications include mesh erosion into either the vagina or rectum. The rate of mesh complications after laparoscopic rectopexy ranges from 0.7% to 2%, with no difference between use of synthetic and biologic mesh. Risk factors include smoking, steroid use, poorly controlled diabetes mellitus, pelvic hematoma or infection, and a history of pelvic radiation or surgery. Recent reports specifically on robotic ventral rectopexy outcomes have shown mesh complication rates of 0%; however, follow-up in these studies is less than 2 years.

Constipation

Although 50% of patients report resolution of their constipation after rectopexy, up to 24% may experience de novo constipation. The risk of postoperative constipation can be reduced by combining suture rectopexy with sigmoid resection, thought to minimize kinking of the rectosigmoid junction in patients with a redundant sigmoid colon. Another way to limit the risk of postoperative constipation is to preserve the autonomic nerves of the rectum by avoiding division of the lateral rectal ligaments and limiting dissection to the anterior rectum, as is done with VMR.

RESULTS

Robotic rectopexy has been shown to improve fecal incontinence, obstructive defecation symptoms, sexual function, and quality of life. In Perrenot et al.'s study on long-term outcomes of robotic rectopexy using various abdominal approaches, the patients reported improved fecal incontinence, with a decreased mean Wexner score from 10.5 preoperatively to 5.1 postoperatively. Constipation likewise improved in 50% of patients, although 24% of patients reported de novo constipation. Seventy-three percent of patients denied any postoperative symptoms and 81% reported satisfaction with the surgery.

Currently, there is no long-term evidence to support superiority of either the laparoscopic or robotic approaches to rectopexy. A study by Mehmood *et al.* in 2014 on 51 consecutive patients undergoing either laparoscopic or robotic VMR suggested that short-term functional outcomes were better after robotic VMR based on scores for fecal incontinence and quality of life.

In contrast, in a recent randomized control trial of 29 patients undergoing either robotic or laparoscopic ventral rectopexy published in 2016 by Mäkelä-Kaikkonen et al., the type of repair did not affect the degree of improvement in obstructive defecation symptoms or sexual function.

Rondelli et al.'s (2014) meta-analysis of robotic versus laparoscopic rectopexy for rectal prolapse showed no difference in rates of recurrence, conversion, major complications, or reoperations. Robotic surgery was associated with longer operative time, but was also associated with less blood loss, shorter hospital stay, and fewer minor complications, although there was no difference in major complications that required reoperation.

CONCLUSIONS

Robotic rectopexy is an effective treatment for rectal prolapse and complex rectocele, with good functional outcomes and low complication rates. A robotic approach to rectopexy may provide improved visibility and surgical precision in the limited pelvic space as compared to laparoscopy. Additional long-term comparative studies are needed to address whether the additional cost and operative time associated with robotic rectopexy might be offset by shorter hospital stay or superior long-term outcomes.

RECOMMENDED REFERENCES AND READINGS

Evans C, Stevenson AR, Sileri P, *et al.* A multicenter collaboration to assess the safety of laparoscopic ventral rectopexy. *Dis Colon Rectum* 2015;58(8):799–807.

Faucheron JL, Voirin D, Riboud R, Waroquet PA, Noel J. Laparoscopic anterior rectopexy to the promontory for full-thickness rectal prolapse in 175 consecutive patients: short-and long-term follow-up. *Dis Colon Rectum* 2012;55(6):660–5.

Mäkelä-Kaikkonen J, Rautio T, Pääkkö E, Biancari F, Ohtonen P, Mäkelä J. Robot-assisted versus laparoscopic ventral rectopexy for external, internal rectal prolapse and enterocele: a randomized controlled trial. *Colorectal Dis* 2016;18(10):1010–5.

Mantoo S, Podevin J, Regenet N, Rigaud J, Lehur PA, Meurette G. Is robotic-assisted ventral mesh rectopexy superior to laparoscopic ventral mesh rectopexy in the management of obstructed defaecation? *Colorectal Dis* 2013;15(8):e469–75.

Mehmood RK, Parker J, Bhuvimanian L, *et al.* Short-term outcome of laparoscopic versus robotic ventral mesh rectopexy for full-thickness rectal prolapse. Is robotic superior? *Int J Colorectal Dis* 2014;29(9):1113–8.

Melton GB, Kwaan MR. Rectal prolapse. *Surg Clin North Am* 2013;93(1):187–98.

p. 555

---

p. 556

Perrenot C, Germain A, Scherrer ML, Ayav A, Brunaud L, Bresler L. Long-term outcomes of robot-assisted laparoscopic rectopexy for rectal prolapse. *Dis Colon Rectum* 2013;56(7):909–14.

Ramage L, Georgiou P, Tekkis P, Tan E. Is robotic ventral mesh rectopexy better than laparoscopy in the treatment of rectal prolapse and obstructed defecation? A meta-analysis. *Tech Coloproctol* 2015;19(7):381–9.

Rondelli F, Bugiantella W, Villa F, *et al.* Robot-assisted or conventional laparoscopic rectopexy for rectal prolapse? Systematic review and meta-analysis. *Int J Surg* 2014;12(Suppl 2):S153–9.

Smart NJ, Pathak S, Boorman P, Daniels IR. Synthetic or biological mesh use in laparoscopic ventral mesh rectopexy–a systematic review. *Colorectal Dis* 2013;15:650–4.

Tou S, Brown SR, Nelson RL. Surgery for complete (full-thickness) rectal prolapse in adults. *Cochrane Database Syst Rev* 2015;(11):CD001758.

Van Iersel JJ, Paulides TJ, Verheijen PM, Lumley JW, Broeders IA, Consten EC. Current status of laparoscopic and robotic ventral mesh rectopexy for external and internal rectal prolapse. *World J Gastroenterol* 2016;22:4977–87.

Chapter 59

Abdominal Rectopexy: Hand Assisted

Edward Borrazzo and Neil H. Hyman

INDICATIONS/CONTRAINDICATIONS

Rectal prolapse may cause considerable life-altering disability including bleeding, pain, and fecal incontinence. Numerous remedial operations have been described, with very few high-quality studies available to facilitate evidence-based recommendations.

In general, abdominal approaches have been recommended for fit patients and perineal procedures for the elderly and/or infirmed patients. Rectopexy allows for fixation of the rectum to the sacrum, thereby preventing the rectum from prolapsing outside of the anal canal. The role of/need for concomitant resection remains uncertain and controversial.

Rectopexy can be performed utilizing open, laparoscopic, robotic, or hybrid techniques, such as the hand-assisted laparoscopic approach. Laparoscopic ventral rectopexy has become a very popular option to treat rectal prolapse primarily in European centers, but has a mesh erosion rate of approximately 2%. It is our custom to perform rectopexies with or without resection using a purely laparoscopic approach and to avoid the use of mesh. However, patients with recurrent prolapse after a previous open or laparoscopic abdominal approach are often best served by the hand-assisted technique. Similarly, a hand-assisted rectopexy can be used to obviate the need for conversion to a larger laparoscopic incision when technical problems are encountered during laparoscopic rectopexy.

Extensive adhesions or previous pelvic sepsis can be considered a relative contraindication to hand-assisted rectopexy; however, it is often difficult to predict a hostile pelvis based on history alone. Laparoscopic visualization is often an appropriate first step.

As with all operative procedures, surgeons must candidly assess their skill set and decide what they can best offer the patient. Hand-assisted rectopexy may be the best and safest approach for many surgeons with which to perform an effective procedure to correct the prolapse and minimize the risk of recurrence. Whether the procedure is performed open, laparoscopically, robotically, or with hand assistance is truly a secondary consideration and should be made on a case-by-case basis by the individual surgeon based on their training, experience, and comfort level.

PREOPERATIVE PLANNING

Planning is similar to the planning for any abdominal colorectal procedure. If the patient is not suitable for laparotomy/laparoscopy, a perineal procedure should be chosen. It is important to consider why the patient has developed the prolapse and whether there are other manifestations of pelvic floor relaxation.

A careful history may elicit causative factors for the prolapse such as bulimia or a connective tissue disorder. Patients who excessively strain and/or have a defecation disorder such as a non-relaxing puborectalis can be appropriately counseled or referred for biofeedback to minimize the risk of recurrence after corrective surgery. Individuals suspected to have slow-transit constipation may be scheduled for colonic transit studies and considered for colectomy at the time of rectopexy on a highly selective basis. Women with concomitant uterine prolapse or cystocele, for example, can be treated in a multidisciplinary manner with a joint surgical approach.

Flexible endoscopy (or suitable radiologic studies) should usually be performed, especially in age-appropriate patients, to make sure that the rectal prolapse is not caused by a neoplasm that is acting as the lead point for the prolapse.

If the patient has recurrent prolapse and/or has undergone previous pelvic surgery, review of the previous operative report(s) can be invaluable. Quite often, “recurrent” prolapse actually is persistent prolapse and represents a failure to adequately mobilize the rectum by an inexperienced pelvic surgeon.

Operative Technique

Not all rectopexy cases are undertaken with hand assistance. However, hand-assisted techniques are helpful for dissection of the mid and lower rectum, especially in reoperative cases. An intracorporeal hand can facilitate identification of the ureters if stents are used and also provides countertraction for dissection of the lower third of the rectum down to the pelvic floor as desired. Tactile sensation affords assessment of the true tension on the rectum and the appropriate degree of cephalad traction when fixing the rectum to the sacral promontory. If a concomitant sigmoid resection is performed, hand assistance can allow for precise cephalad countertraction while ensuring a tension-free anastomosis.

We position the hand-assist device at the level of the umbilicus (Fig. 59-1). This position keeps the hand from obscuring the field of view as compared to more inferior placement and provides acceptable cosmesis with the subsequent incision hidden in the umbilical fold. Alternatively, a hand port placed in a Pfannenstiel incision may allow wide exposure to the pelvis as necessary without extending the incision. Ports are placed in the mid abdomen on each side. An additional working port is placed in the right lower quadrant. The camera alternates between the two lateral ports to get a view on each side of the rectum as the dissection is performed in the pelvis.

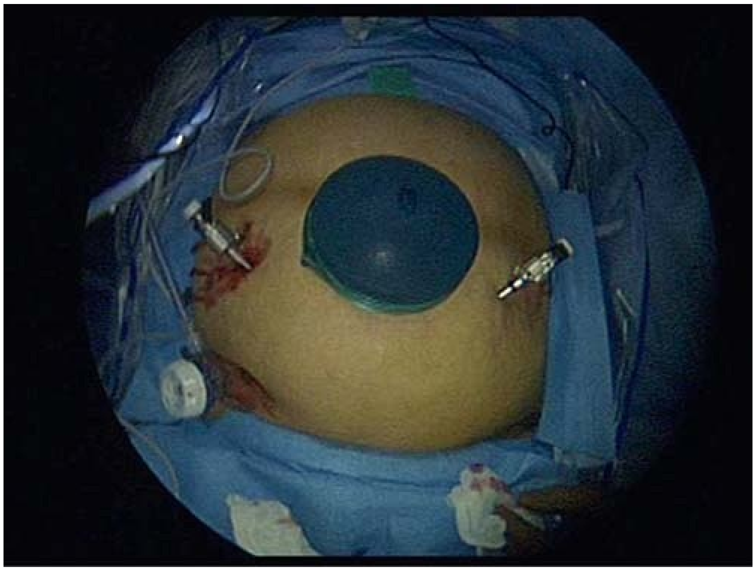


FIGURE 59-1 Port position. Operating surgeon stands on the patient's right side. The hand port is positioned at the umbilicus. The two mid abdominal ports, here 5 mm, are used for the laparoscope and assistant retractor, alternating sides as needed. Right-hand working port is in the right lower quadrant.

In reoperative cases, anatomic planes are often difficult to visually identify at first. Use of the hand can help define the proper plane of dissection. It is often easiest to begin along the white line of Toldt at the level of the descending colon, because this area has usually been untouched in the first operation even if a resection has been performed. The left ureter can then be inferiorly traced, while mobilizing the intact mesocolon and mesorectum from the retroperitoneum, pelvic brim, and lateral sidewall (Fig. 59-2).

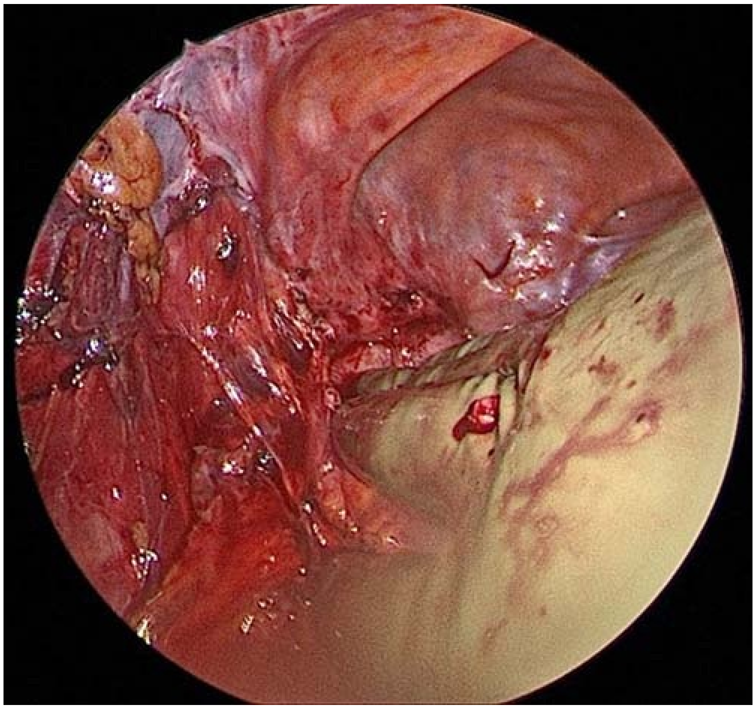


FIGURE 59-2 Dissection along the left side of the rectum in pelvis. The surgeon's left hand is seen in the foreground at the bottom of the picture. Fingers are used to splay tissues for dissection. The uterus is suspended anteriorly with a transabdominal suture that is released at the completion of the procedure. The rectum and mesorectum are retracted superiorly.

In a similar manner, the right ureter may be identified. Dissection is undertaken inferiorly along the lateral aspect of the rectum (Fig. 59-3). The lateral stalks are usually divided in reoperative cases to facilitate mobilization of the distal third of the rectum and improve access to the pelvic floor. This may increase the risk of constipation, but appears likely to decrease the risk of prolapse recurrence.

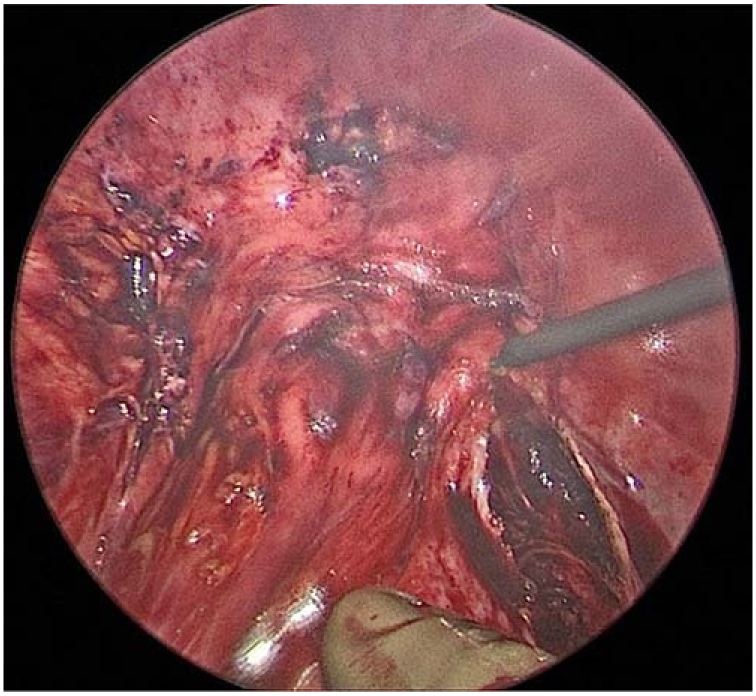


FIGURE 59-3 Dissection along right side of the rectum in pelvis. Some of the posterior dissection has already been completed. The hook electrocautery tool is useful for dissection of the peritoneal reflection, especially as it is carried toward the anterior rectum and the rectovaginal septum.

One difficult part of the dissection is the mobilization of the mesocolon and/or mesorectum off the sacrum in the previously dissected presacral plane, when some form of fixation has previously been attempted to the sacrum or sacral promontory. Care should be taken to identify and avoid the hypogastric nerves. Here, an energy source such as ultrasonic shears is particularly helpful in keeping the field relatively bloodless for optimal visualization. However, hook electrocautery may be a more appropriate tool if anatomic planes of dissection are well visualized to avoid entry into a nonanatomic plane, which could increase the risk of nerve injury. This posterior rectal dissection is commonly the first to be completed down to the level of the pelvic floor (Fig. 59-4).

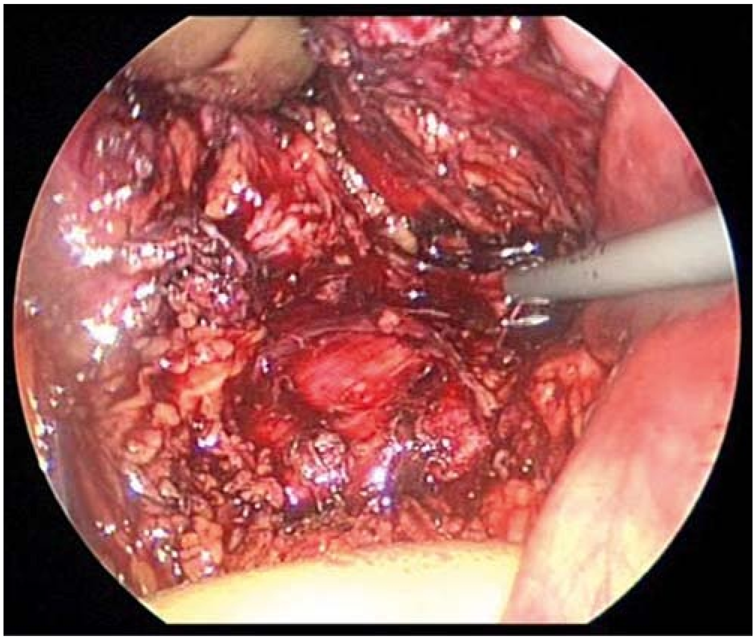


FIGURE 59-4 Dissection of distal posterior rectum is accomplished. The mesorectum is pushed anteriorly, countertraction is obtained posteriorly, all done with the left hand. The levator ani musculature is identified.

p. 558

p. 559

Often, the most distal dissection is easiest in cases of recurrent prolapse, because the previous mobilization may not have extended to the lower rectum. After posterior dissection is completed, the lateral stalks are divided or mobilized. Finally, the anterior dissection is performed. The nondominant hand is used to create traction-countertraction between the rectum and the vagina as well as lateral pelvic wall. The hand may also be useful in circumferential traction on the rectum to help in distal access to the very low rectum and surrounding soft tissue (Fig. 59-5).

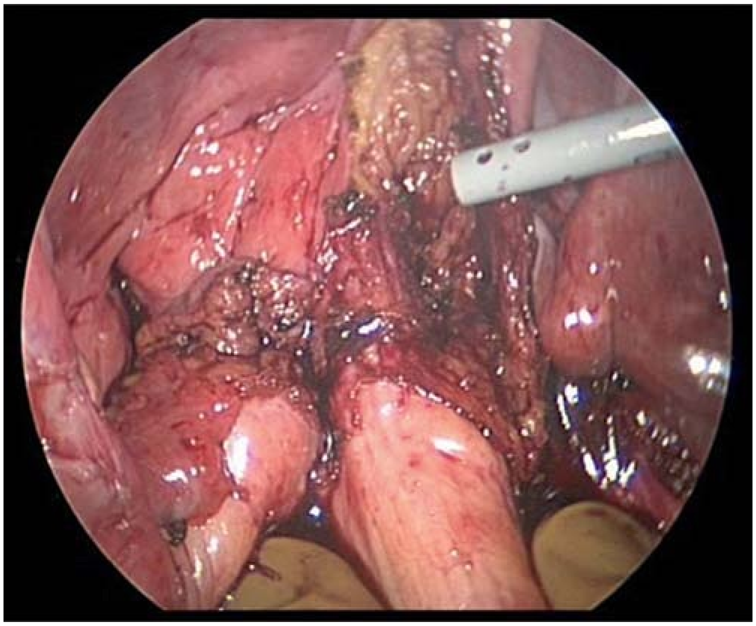


FIGURE 59-5 Anterior rectal dissection is performed. The left hand acts as an excellent retractor, and also helps create a plane between the vagina and rectum.

The left hand acts as an excellent retractor, and also helps create a plane between the vagina and rectum. If a cervical speculum or assistant's finger is used, the vagina can be palpated for identification and dissection of Denonvilliers' fascia. This area may be scarred if a previous resection has been performed, with the anastomosis adherent to the posterior cervix or vaginal wall. The hand may help identify and dissect the area of the previous anastomosis. If mesh is placed, hand assistance can facilitate opening the rectovaginal septum for placement of the mesh. However, we do not use any form of mesh fixation because this does not appear to reduce recurrence rates, and can lead to vaginal mesh erosion, rectal mesh erosion, rectovaginal fistula formation, or perineal mesh erosion in 2.4% of cases.

Hand access can also facilitate fixation of the rectum to the sacrum. Tension is easily assessed with tactile feedback (Fig. 59-6), and fixation to the sacral promontory with sutures and/or tacks is facilitated by the exposure provided by manual retraction and the ability to palpate the rectal wall/associated soft tissue (Fig. 59-7). Figure 59-8 shows the completed rectopexy, fixed on each side to the sacrum. The hand-access site placed in the suprapubic area allows for transabdominal-wall incision suturing of the rectum to the sacral promontory.

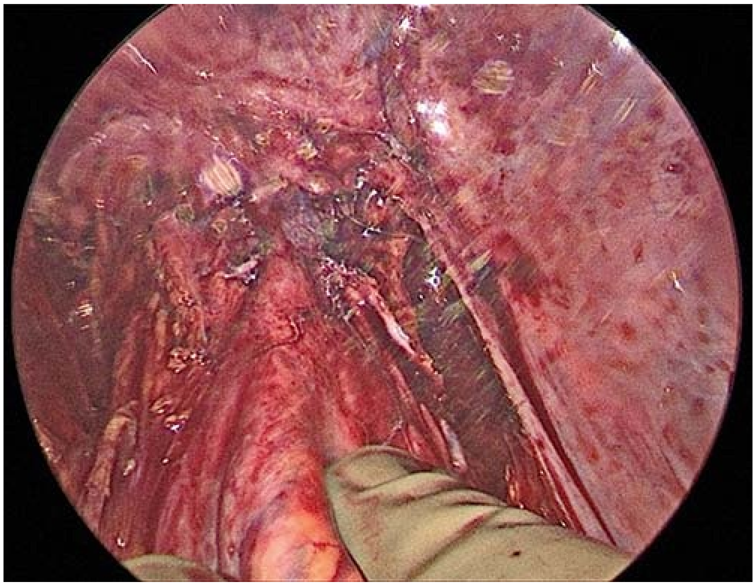


FIGURE 59-6 Tension assessed using tactile sensation with gentle superior traction.

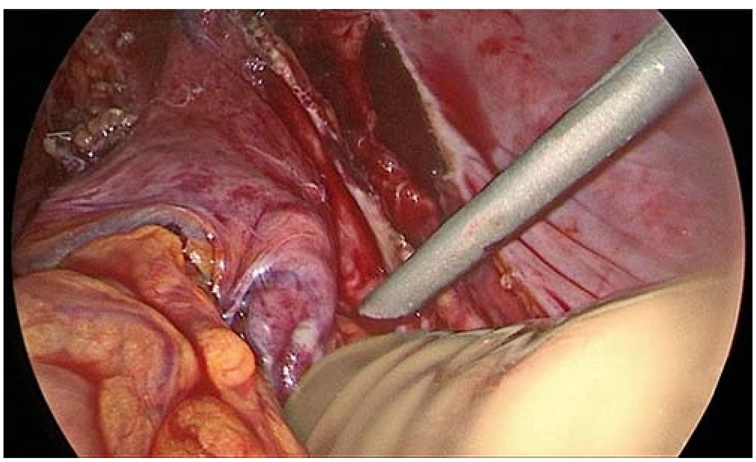


FIGURE 59-7 The hand port can facilitate fixation. Adequacy of the tissue as well as tension on the rectum can be monitored continuously.

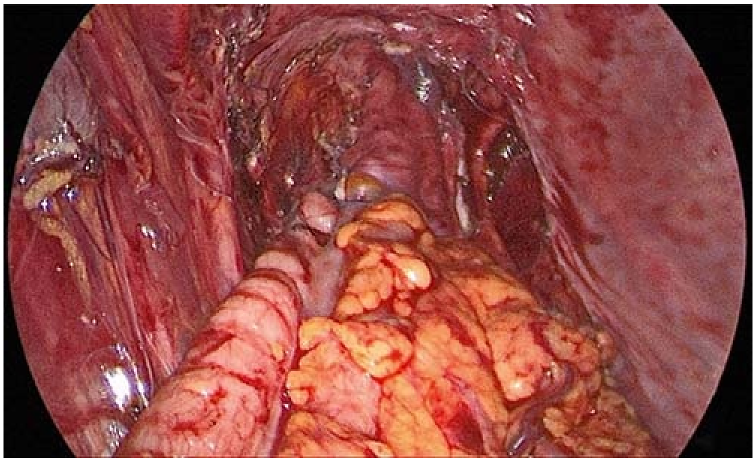


FIGURE 59-8 Completed rectopexy (including sigmoid resection in this case). The rectum is fixed to the sacral promontory.

POSTOPERATIVE MANAGEMENT

Patients undergoing hand-assisted rectopexy are started on an enhanced recovery pathway with diet as tolerated. No postoperative antibiotics are prescribed. Unless specifically indicated, no special dietary considerations or bowel regimen really needs to be provided. Hospital stay in uncomplicated cases is usually 1–2 days.

COMPLICATIONS

Complications after hand-assisted rectopexy are no different than those after other abdominal colorectal procedures. Wound infections, pelvic hematoma or abscess, and inadvertent bowel injury are usually the major concerns. Long-term sequela, such as bowel obstruction or incisional hernias, appear to be lower in laparoscopic approaches than with open surgery.

RESULTS

The reported recurrence rate after rectopexy is usually ≦10%. However, it must be acknowledged that the results reported in the literature are usually the best outcomes owing to publication bias and the recurrence rates in actual practice are likely much higher. Further, the incidence of recurrent prolapse clearly increases over time. As such, length of follow-up is a critical factor in interpreting the case series that are available in the literature.

CONCLUSIONS

Hand-assisted rectopexy is a valuable technique in the management of rectal prolapse. We find it particularly useful in cases of recurrent prolapse or to avoid conversion to open in cases where a purely laparoscopic approach has proved difficult or otherwise problematic. Long-term results should be similar to those achieved with open surgery, but there is outcomes data to support this assertion. As with all laparoscopic techniques, proper training and individualized patient selection is critical.

RECOMMENDED REFERENCES AND READINGS

Boccasanta P, Rosari R, Venturi M, *et al.* Comparison of laparoscopic rectopexy with open technique in the treatment of complete rectal prolapse: clinical and functional results. *Surg Laparosc Endosc* 1998;8(6):460–5.

Evans C, Stevenson AR, Sileri P, *et al.* A multicenter collaboration to assess the safety of laparoscopic ventral rectopexy. *Dis Colon Rectum* 2015;58:799–807.

Galili Y, Rabau M. Comparison of polyglycolic acid and polypropylene mesh for rectopexy in the treatment of rectal prolapse. *Eur J Surg* 1997;163(6):445–8.

Lukkonen P, Mikkonen U, Jarvinen H. Abdominal rectopexy with sigmoidectomy versus rectopexy alone for rectal prolapse: a prospective, randomized study. *Int J Colorectal Dis* 1992;7(4):219–22.

Mollen RM, Kuijpers JH, van Hoeck F. Effect of rectal mobilization and lateral sphincter division on colonic and anorectal function. *Dis Colon Rectum* 2000;43:1283–7.

Novell JR, Osborne MJ, Winslet MC, Lewis AA. Prospective randomized trial of Ivalon sponge versus sutured rectopexy for full-thickness rectal prolapse. *Br J Surg* 1994;81(6):904–6.

Senapati A, Gray RG, Middleton LJ, *et al.* PROSPER: a randomized comparison of surgical treatments for rectal prolapse. *Colorectal Dis* 2013;15(7):858–68.

Solomon MJ, Young CJ, Eyers AA, *et al.* Randomized clinical trial of laparoscopic versus open abdominal rectopexy for rectal prolapse. *Br J Surg* 2002;89(1):35–39.

Speakman CT, Madden MV, Nicholls RJ, Kamm MA. Lateral ligament division during rectopexy causes constipation but prevents recurrence: results of a prospective randomized study. *Br J Surg* 1991;78(12):1431–3.

Tou S, Brown SR, Malik AI, Nelson RL. Surgery for complete rectal prolapse in adults. *Cochrane Database Syst Rev* 2015;(11):CD001758.

Chapter 60

Nonresectional and Resectional Rectopexy

Donato F. Altomare and Pierpaolo Sileri

INTRODUCTION

Full-thickness rectal prolapse (FTRP) is a disabling condition, well known since ancient times, which, unlike hemorrhoids, can affect also four-footed mammalians. Its etiology is poorly understood and, consequently, its appropriate surgical treatment is one of the most controversial issues in colorectal surgery, with many options having been proposed. Prolapse recurrence and the functional considerations of constipation and fecal incontinence (FI) are concerns in the management of these patients.

PREOPERATIVE PLANNING

Preoperative planning, including the choice of a perineal or an abdominal approach (robotic, laparoscopic, hand-assisted or open techniques), with the use or not of a mesh (biologic or unresorbable), should be individualized on the basis of history and both physical and functional evaluation. Considerations include general status of health, body mass index, and American Society of Anesthesiology grade.

Elderly frail patients are often selected for a perineal approach, possibly under spinal anesthesia. The addition of a sigmoid resection may be indicated in the patient with constipation or dolichocolon. A nonabsorbable mesh is discouraged if an anastomosis is planned because of the high risk of septic complication. Although a biologic absorbable mesh should lower this risk, this theory has never been clearly demonstrated.

FI is reported to improve in some patients with intact anal sphincters following abdominal rectopexy, particularly when it is caused by the inhibition of the anal resting tone by the prolapse itself. Anorectal manovolumetry and transanal ultrasound may be of great help in the evaluation of patients with incontinence to help select the most appropriate treatment.

Some patients with prolapse also complain of obstructed defecation and/or of perineal descent, which can be evaluated by a dynamic videoproctography. The occurrence of an associated enterocele and/or rectocele could discourage a perineal approach and suggest an abdominal approach combined with repair of the middle and posterior pelvic compartments.

Finally, the association of rectal prolapse with genital prolapse or cystocele should be an indication for a combined operation with the help of a urogynecologist.

SURGERY

General Considerations and Prescriptions

Surgery for FTRP can be performed by open surgery through either a midline or Pfannenstiel incision, by laparoscopy, hand-assisted surgery, or a robotic approach.

The operation is performed following a mechanical cathartic and oral antibiotic bowel preparation. A general anesthetic with perioperative parenteral antibiotic prophylaxis and urinary catheterization are employed.

Irrespective of the surgical approach, a partial (anterolateral) or full mobilization of the rectum following the mesorectal plane is the first surgical step. This surgical maneuver must respect the pelvic innervation to help prevent the sexual problems of impotence and retrograde ejaculation and to minimize the new onset or exacerbation of FI and constipation. The use of radiofrequency or ultrasound devices instead of diathermy has facilitated this step. The depth of rectal mobilization has been an issue of debate among colorectal surgeons because the division of the lateral ligaments of the low rectum has been blamed to cause de novo constipation. Therefore, the lateral ligaments are spared in most of the modern techniques of rectal mobilization for prolapse.

The pelvic brim must be exposed to allow safe suturing of the mesh to the sacral periosteum with nonabsorbable sutures, avoiding the presacral vein and artery and preventing any damage to the hypogastric nerves during the rectal mobilization. This step of the rectopexy can be made easier and faster by the use of self-retaining titanium pins (ProTack 5-mm Instrument by Covidien-Medtronic, Minneapolis, MN).

An issue of debate is the economic impact of the laparoscopic approach, which is today preferred over the open approach. Despite the use of disposable devices and the longer operating time, a randomized controlled trial has demonstrated that the laparoscopic approach is more advantageous than the open because of a significantly shorter hospitalization. Conversely, the robotic approach has proved to be more expensive compared with laparoscopy, even if the better ergonomic instrument performance can facilitate suturing the mesh.

Main Surgical Options in the Treatment of Full-Thickness Rectal Prolapse by Abdominal Approach

Rectal Mobilization Without Rectopexy

Adhesions inevitably follow any surgical dissection in the pelvis, and may provide passive fixation of the mesorectum to the sacrum. The need for suturing or placement of a mesh to treat rectal prolapse has been questioned since 2001.

In this operation, the rectum is fully mobilized from the sacrum following the “holy plane” of the technique for anterior resection of the rectum for cancer. The rectum is not sutured to the sacrum and is left inside the pelvis after accurate hemostasis. The peritoneum is usually closed with absorbable continuous sutures and the placement of a pelvic drainage is not always necessary.

Results

A study from Nelson in 2001 reported three recurrences in 13 patients after 3 years' follow-up, whereas no recurrences were reported in another study of 32 patients who underwent rectal mobilization without rectopexy after a long-term follow-up. This issue was recently clarified by a prospective randomized controlled multicenter trial on 252 patients operated for full-thickness external rectal prolapse, showing that the 5-year recurrence rates in the no-rectopexy group was significantly higher than those in the rectopexy group (8.6% vs. 1.5%) (log-rank, $P = 0.003$).

Suture Rectopexy

Direct suture rectopexy without the use of mesh is a further surgical option to be considered when the risk of infection of the mesh is increased, for example, in case of an inadvertent intraoperative rectal perforation or concomitant sigmoid resection with anastomosis.

Technique

The surgical technique of full circumferential mobilization of the rectum from the sacrum down to the levator muscles does not differ from other techniques for rectopexy, but in this case the posterior wall of the mesorectum is sutured without tension to the sacral promontory using four to six nonabsorbable sutures.

Results

One of the few studies on a large series of patients with suture rectopexy with long-term follow-up shows that the recurrence rate increased to 20% after 10 years. Nevertheless, the patient's quality of life and fecal continence improved significantly without significant exacerbation of constipation.

Ripstein Procedure

First described by Ripstein and Lanter, it is no longer one of the most commonly used techniques in the United States. They started using a fascia lata sling to fix the rectum to the sacrum, but later other mesh materials like Teflon, Marlex mesh, and Gore-Tex were used.

Technique

The rectum is fully mobilized down to the tip of the coccyx, and the dissection goes posteriorly to free the rectum from the sacrum. The upper portions of the lateral ligaments are divided. Anterior mobilization is done by continuing the two lateral incisions to meet anteriorly in the deepest part of the cul-de-sac. A 5-cm rectangular mesh is placed around the rectum 5 cm below the sacral promontory, and secured to the presacral fascia by nonabsorbable sutures 1 cm from the midline on both sides.

p. 564

---

p. 565

Care should be taken to avoid injury to the presacral blood vessels. It is also important to apply traction on the rectum to bring the redundant rectum cephalad, because redundant rectum below the mesh can cause recurrence. The sling should allow passage of two fingers between the rectum and the presacral fascia to prevent constipation or fecal impaction.

Results

The largest series by Ripstein was on 289 patients, in which the authors reported 0% recurrence, 0.3% mortality because of pulmonary embolism, and 3% need for further rectosigmoid resection. The largest pooled data (1,111 patients) were collected by Gordon and Hoexter through a questionnaire to the members of the American Society of Cataract and Refractive Surgery, reporting a 2.3% recurrence rate, 16.5% of sling-related complications, and an overall re-intervention of 4.1%. In a review on the Ripstein procedures by Madiba and Wexner, a recurrence rate 0–13% and a mortality rate 0–3% are reported.

Complications and Limitations

According to Gordon and Hoexter, the most frequent complications are fecal impaction (6.7%), presacral hemorrhage (2.6%), rectal stricture (1.8%), pelvic abscesses (1.5%), small bowel obstruction (1.4%), impotence (0.8%), and mesh erosion. Today, the Ripstein procedure is not considered a good option for patients with slow-transit constipation or obstructed defecation because of the potential worsening of these conditions. In fact, Tjandra *et al.* reported an incidence in persistence constipation of 33% after Ripstein operation, 12% of them of new-onset constipation.

Well's Technique or "Wrap Operation"

The concept of placing a mesh for rectopexy posteriorly was described by Wells using the polyvinyl alcohol sponge (Ivalon, Fabco, New London, CT USA). The largest series reported by Morgan *et al.* was complicated by 3.2% recurrence rate, 2.6% mortality rate, and 3% morbidity rate.

The Ivalon sponge was able to induce a strong inflammatory response, leading to the development of a steady fibrous tissue to fix the rectum to the sacrum and prevent its perineal dislocation. The method became very popular in the United Kingdom in the second half of the last century because of a very low recurrence rate; however, it was progressively abandoned as being less safe and effective compared to straight suture rectopexy.

Technique

Similar to the Ripstein operation, the rectum is mobilized down to the tip of the coccyx, posteriorly to free the rectum from the sacral hollow, with division of the upper portions of the lateral ligaments. Anterior mobilization is accomplished when the two lateral incisions meet anteriorly in the deepest part of the cul-de-sac. A rectangular sheet of Ivalon is sutured to the midline of the presacral fascia between the promontory and the third or fourth sacral segment, wrapped around the rectum, and sutured to the rectum to form an open “trough” enclosing the rectum leaving free its anterior wall. Finally, the cul-de-sac is closed over the operative field.

Care should be taken to ensure meticulous hemostasis, and not to open the rectum during dissection; if the rectum is inadvertently entered, the sponge should be removed because of the high risk of infection. Cephalad traction on the rectum should be maintained.

Modifications

Mann and Hoffman adopted an extended abdominal rectopexy; and after a complete mobilization of the rectum, the lateral ligaments to the rectum were divided and then re-sutured, the rectovaginal septum reinforced, the uterus suspended ventrally, and the Ivalon sponge was attached to the rectum rather than the presacral fascia to elevate, stiffen, and straighten the rectum.

Complications and results were similar to those reported following the Ripstein operation except for the risk of fecal impaction and stricture, because the wrap excluded the anterior wall. Pelvic abscess is the most common major complication of this procedure; the reported incidence varies from 2.6% by Morgan *et al.* to 16% by Kupfer and Goligher. Ross and Thomson recommended removal of the sponge as an initial approach; they removed the implant per rectum or per vagina in four of five attempts successfully.

Orr–Loygue Technique

Orr described his technique in 1947 using two strips of fascia lata. Loygue later (1984) modified the procedure using synthetic mesh and better described the operative details of the technique: the rectum is fully mobilized sparing the hypogastric nerves and the lateral ligaments are not divided; the Douglas pouch is opened exposing the posterior wall of the vagina. Two strips of mesh about 7–8 cm long are sutured distally to the lateral side of the lower extraperitoneal rectum using absorbable sutures and fixed to the sacral promontory without tension using nonabsorbable sutures or clips (Fig. 60-1).

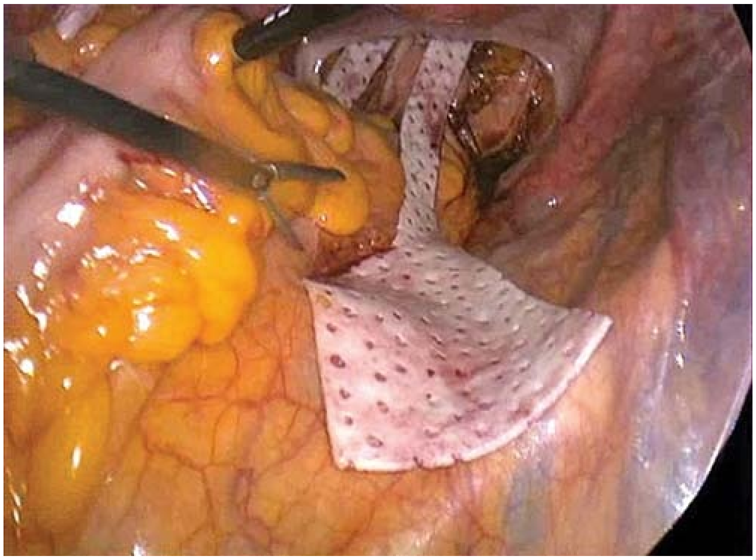


FIGURE 60-1 Mesh placement on both lateral sides of the rectum (modified Orr–Loygue).

Results

Prolapse recurrence ranges between 0% and 3% and FI may be cured in one-third of patients.

Complications

Morbidity of the procedure is scarce, often 0% in several case series; and de novo or deterioration of preexisting constipation has been reported in 5% of the patients.

Proctopexy and Sigmoid Resection ("Frykman–Goldberg" Technique)

A composite technique involving a sigmoid resection and rectopexy was described by Frykman and Goldberg in 1955 with the aim of preventing postoperative constipation due to the redundant sigmoid colon displacing into the pelvis. The operation was indicated for patients with severe preoperative complication or in those with dolichocolon. Because the risk of contamination was high, the implant of a mesh was discouraged and a direct suture rectopexy was proposed.

Technique

The technique of full mobilization of the rectum is similar to another technique for rectopexy described by Frykman where the lateral ligaments are preserved. The mobilized rectum is brought up into the abdomen, which straightens the lateral ligaments. The elevated lateral ligaments are sutured to the sacrum by placing mattress sutures of silk on each side. The cul-de-sac is sutured anterior to the rectum. Rectopexy is followed by the resection of the redundant sigmoid colon, and an end-to-end or side-to-end colorectal anastomosis.

Results

The largest series by Watts *et al.* reported a 1.9% recurrence rate, without mortality, and a 4% morbidity rate. However, a significant morbidity (20%) and mortality (6.7%) has been reported by Luukkonen *et al.*

Complications and Limitations

Complications are similar to those associated with low anterior resection of the rectum with potential anastomotic leak and pelvic sepsis.

Ventral Rectopexy

Laparoscopic Ventral Mesh Rectopexy

Since its initial description by D'Hoore in 2004, laparoscopic ventral mesh rectopexy (LVR) has gained acceptance as a promising surgical treatment for rectal prolapse and internal rectal intussusception associated with obstructed defecation syndrome and FI.

An increasing amount of published data show functional improvement in terms of FI (4–91%), constipation (37–86%), and dyspareunia and sexual dysfunction (39%) for patients with internal and external rectal prolapse treated with LVR.

Technique

An anterolateral dissection is carried out between the rectum and the vagina starting from the cul-de-sac, down to the levator ani muscle using a four-trocar technique and a 30-degree scope. A 3 × 10–18 cm tailored strip of biologic or synthetic mesh is positioned in this pocket at the level of the levator ani muscle and sutured to the anterior wall of the rectum using two parallel rows of nonabsorbable 2-0 sutures (Fig. 60-2).

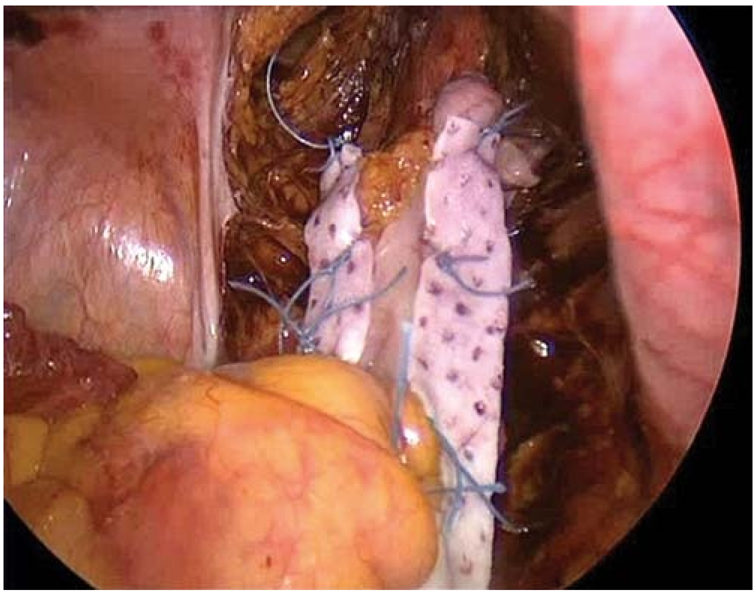


FIGURE 60-2 Mesh fixation using nonabsorbable 2-0 interrupted sutures.

During this maneuver the rectum is gently and fully retracted cranially to visualize the levator ani muscle and the level of the first two distal sutures confirmed to be approximately at 2–3 cm above the dentate line by rectal examination or proctoscopy. The mesh is then secured to the sacral promontory using the ProTack device, covered in the incised right pelvic peritoneum, and the vaginal vault or cervix is fixed to the mesh without traction by two additional absorbable sutures (Vicryl 2-0) (Fig. 60-3).

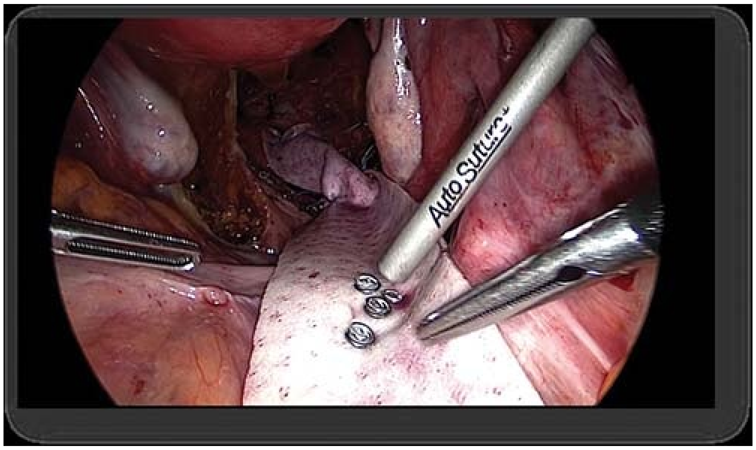


FIGURE 60-3 The mesh is secured on the sacral promontory using the ProTack device.

Before stitching the posterior vaginal vault, a retractor is positioned and pulled to completely distend the posterior vaginal wall. The peritoneum is closed using a running absorbable suture 2-0. Drains are inserted only in special circumstances such as intraoperative rectal perforation.

Literature Results

Advantages of ventral rectopexy consist in the mobilization of the rectovaginal space down to the levator ani muscle and the anterior placement of a mesh, which is sutured distally to the anterior wall of the rectum as well as to the posterior wall of the vagina, and secured proximally to the sacral promontory. In contrast to other methods of repair posteriorly, only a small patch of the promontorium needs to be freed with little risk of injury to the hypogastric nerves that run more laterally.

Consideration

The LVR technique not only respects the pelvic nerves and therefore avoids rectal inertia due to denervation but also offers the advantage of a concomitant repair of middle pelvic floor compartment pathologies like rectoceles and enterocoeles.

Minor complications after LVR may range from 4% to 8%, according to the literature.

D'Hoore and colleagues reported a recurrence rate of only 5% in a subgroup of 42 patients with a 5-year follow-up. The average recurrence rate is 4–5% (range 0–27%).

Functional Outcome

FI may improve in the short term in up to 91% of patients and constipation in up to 86% when a synthetic mesh is used. These percentages are reduced to about 80% when longer term follow-up is considered.

In case series where the biologic mesh was used instead of the synthetic one, improvement was reported up to 95% for constipation and incontinence, although only short-term follow-up is available.

POSTOPERATIVE MANAGEMENT

Appropriate perioperative antibiotic prophylaxis is advisable in all patients with an intra-abdominal mesh implant, and particularly in individuals who undergo a sigmoid resection. Postoperative pain is usually negligible after the laparoscopic operation; most patients do not need analgesics. However, some patients complain of sacral pain after the implant of the self-retained pins.

Drains are usually omitted. Oral feeding and ambulation immediately commence with the expectation of discharge within 2–3 days.

COMPLICATIONS

Postoperative bleeding or infection may occur as after any abdominal surgery but is very rare. Specific complications are rectal perforation that sometimes can go undetected and become evident a few days after surgery. A possible cause may be related to the energy sources used during dissection. Another fearsome complication is mesh erosion that can occur into the vagina and/or into the rectum causing bleeding, infection, and pelvic pain. Removal of the mesh is always challenging and some patients need to have a temporary or definitive abdominal stoma. Despite its high cost, the choice of biologic absorbable mesh instead of synthetic nonabsorbable ones is supported by several authors because of the lower risk of infection and vaginal/rectal erosion. However, its use is criticized for the hazard of a potentially higher recurrence rate in the long term. The 2008 National Institute for Health and Clinical Excellence review of surgery for pelvic organ prolapse showed that mesh-related complications depend on the type of mesh used and on the duration of follow-up. As demonstrated by this review, erosion rates for biologic meshes (Xenografts) were absent, whereas they increased to 7% for synthetic and to 14% for combined synthetic ones. On the other side, the failure rate was higher for biologic than that for synthetic meshes (23% vs. 9%).

Lumbosacral discitis has also been described in patients having the sacral mesh fixation by metallic clips.

Other possible complications are related to the potential pelvic nerve injuries by diathermy or ultrasound or radiofrequency device. FI or constipation may follow any operation involving the mobilization of the rectum but is very rare after rectopexy. Sexual or urinary dysfunction can also occur after these operations, although fortunately they are infrequent occurrences.

CONCLUSIONS

The myriad of methods of prolapse repair attests to the lack of panacea. The surgeon should tailor the option to match the patient. Whatever method is selected should be offered in a safe and effective manner.

RECOMMENDED REFERENCES AND READINGS

Altomare DF, Pucciani F, eds. *Rectal Prolapse. Diagnosis and Clinical Management*. Berlin: Springer-Verlag, 2008.

D'Hoore A, Cadoni R, Penninckx F. Long-term outcome of laparoscopic ventral rectopexy for total rectal prolapse. *Br J Surg* 2004;91(11):1500–5.

Faucheron JL, Trilling B, Girard E, Sage PY, Barbois S, Reche F. Anterior rectopexy for full-thickness rectal prolapse: technical and functional results. *World J Gastroenterol* 2015;21(16):5049–55. doi:10.3748/wjg.v21.i16.5049.

Foppa C, Martinek L, Arnaud JP, Bergamaschi R. Ten-year follow up after laparoscopic suture rectopexy for full-thickness rectal prolapse. *Colorectal Dis* 2014;16(10):809–14. doi:10.1111/codi.12689.

Franceschilli L, Varvaras D, Capuano I, *et al.* Laparoscopic ventral rectopexy using biologic mesh for the treatment of obstructed defaecation syndrome and/or faecal incontinence in patients with internal rectal prolapse: a critical appraisal of the first 100 cases. *Tech Coloproctol* 2015;19(4):209–19. doi:10.1007/s10151-014-1255-4.

Heemskerk J, de Hoog DE, van Gemert WG, Baeten CG, Greve JW, Bouvy ND. Robot-assisted vs. conventional laparoscopic rectopexy for rectal prolapse: a comparative study on costs and time. *Dis Colon Rectum* 2007;50(11):1825–30.

Karas JR, Uranues S, Altomare DF, *et al.* Rectal Prolapse Recurrence Study Group. No rectopexy versus rectopexy following rectal mobilization for full-thickness rectal prolapse: a randomized controlled trial. *Dis Colon Rectum* 2011;54(1):29–34. doi:10.1007/DCR.0b013e3181fb3de3.

Novell JR, Osborne MJ, Winslet MC, Lewis A. A prospective randomized trial of Ivalon sponge versus sutured rectopexy for full-thickness rectal prolapse. *Br J Surg* 1994;81(6):904–6.

Ogilvie JW Jr, Stevenson AR, Powar M. Case-matched series of a non-cross-linked biologic versus non-absorbable mesh in laparoscopic ventral rectopexy. *Int J Colorectal Dis* 2014;29(12):1477–83. doi:10.1007/s00384-014-2016-6.

Salkeld G, Bagia M, Solomon M. Economic impact of laparoscopic versus open abdominal rectopexy. *Br J Surg* 2004;91:1188–91.

Samaranayake CB, Luo C, Plank AW, Merrie AE, Plank LD, Bissett IP. Systematic review on ventral rectopexy for rectal prolapse and intussusception. *Colorectal Dis* 2010;12(6):504–12. doi:10.1111/j.1463-1318.2009.01934.x.

Tou S, Brown SR, Nelson RL. Surgery for complete (full-thickness) rectal prolapse in adults. *Cochrane Database Syst Rev* 2015;(11):CD001758. doi:10.1002/14651858.CD001758.pub3.

Chapter 61

Laparoscopic Resection Rectopexy

Martin A. Luchtefeld and James W. Ogilvie Jr

INDICATIONS/CONTRAINDICATIONS

There are many surgical options from which to choose when treating a patient with rectal prolapse. The sheer number and diversity of choices suggests there is no perfect answer for all circumstances. The choices can be broadly categorized into three types: (a) sigmoid resection with rectopexy (Frykman–Goldberg procedure), (b) rectopexy with or without mesh, and (c) perineal approaches including perineal rectosigmoidectomy (Altemeier procedure) or rectal mucosectomy and plication (Delorme procedure). The first two options, both abdominal procedures, can be done either via an open or a minimally invasive approach. The first consideration while selecting the appropriate operation is whether or not the patient is medically fit to undergo a major abdominal operation. Abdominal approaches are felt to have a lower recurrence rate but are associated with a greater risk of complication, especially when combined with a sigmoid resection. The perineal approaches are traditionally associated with higher recurrence rates but are usually performed on older patients with more comorbidities. Nevertheless, they are most often well tolerated with few complications.

In patients medically fit for an abdominal surgery, rectal mobilization and rectopexy with or without sigmoid resection have good perioperative outcomes with low recurrence rates. However, rectopexy alone in some series has a higher risk of postoperative constipation, even in patients with normal bowel habits before the procedure. The addition of sigmoid resection with rectopexy may mitigate the disturbed effect on rectosigmoid motility related to posterior rectal mobilization and therefore may be a better choice for the patient with constipation. Nevertheless, it carries the small but real risk of anastomotic leak that is not an issue for the patient undergoing rectopexy alone. Therefore, sigmoid resection with rectopexy is a reasonable option for the medically fit patient who already suffers from moderate constipation.

Resection rectopexy can be performed via an open or a minimally invasive approach. Early in the history of laparoscopic colon and rectal surgery, rectal prolapse surgery was thought to be an ideal disease process for the new laparoscopic approach: a benign disease, noninflammatory, and the mesentery tending to be redundant and relatively easy to address. Multiple studies have confirmed that laparoscopic-aided sigmoid resection and rectopexy have decreased perioperative complications, shorter hospital stays, and less postoperative pain. Although there are fewer studies that address long-term outcomes, they demonstrate functional outcomes and recurrence rates comparable to other approaches.

PREOPERATIVE PLANNING

Before surgery, the diagnosis of rectal prolapse must be verified during physical examination. Visualizing and identifying rectal prolapse is occasionally not straightforward. Evaluating the patient on an examining table may be insufficient to confirm rectal prolapse. If the diagnosis has not been made during the usual examination, the patient can be placed on the commode and then reexamined after several minutes of straining. Once the prolapse has been reproduced, the diagnosis is usually quite obvious. However, occasionally, it can be difficult to distinguish full-thickness rectal prolapse from mucosal prolapse or significant prolapsing hemorrhoids disease. If uncertainty remains, identification of the circular folds of the full-thickness rectal prolapse will confirm the diagnosis. Small-volume or occult prolapse in addition to patient discomfort and/or embarrassment may also limit the ability to discover a prolapse. In such circumstances, fluoroscopic-or magnetic resonance imaging-based defecography (or ultrasound-based in some centers) will often reveal the hidden prolapse.

A focused history and digital rectal examination are also important to assess the integrity of the sphincter complex and any related fecal incontinence that may alter the decision to perform a resection rectopexy. Adjunct studies such as anal manometry, endoanal ultrasound, and pudendal nerve terminal motor latency testing may be useful if there is a significant history of concomitant incontinence, but in most cases they do not alter the decision-making process. It is also important to endoscopically or radiographically evaluate the colon to ascertain whether other significant pathology that might alter the surgical plan exists.

Although the majority of patients suffer some degree of constipation in addition to the prolapse, it is a rare occasion that a total abdominal colectomy is combined with the rectopexy. In most circumstances there is a significant postoperative improvement in constipation. If severe constipation persists following surgery, then further evaluation with a colonic transit study is warranted after excluding technical complications such as an anastomotic stricture. It is the author’s opinion that only after intense multidisciplinary medical management has failed should one consider a minimally invasive resection rectopexy.

PREOPERATIVE PREPARATION

Data continue to amass regarding preoperative mechanical and oral antibiotic bowel preparation. Recent meta-analyses suggest that systemic antibiotics in addition to mechanical preparation with oral antibiotics are safe and lower the risk of surgical site infections, possibly even anastomotic leak. There is controversy surrounding the extent of the benefit, but the authors routinely implement this practice. It is also technically superior to no preparation in that it facilitates bowel handling and allows easy passage of an endoscope and of an intraluminal stapling instrument. The administration of intravenous antibiotics within 1 hour of incision time is well documented to decrease surgical site infections and should be routinely given. Resection rectopexy lends itself well to enhanced recovery; however, specific adjuncts to enhanced recovery that have been directly linked to avoiding perioperative complications have not been well elucidated.

SURGERY

Positioning

Following general endotracheal anesthesia, the patient should be placed in the dorsal lithotomy position (Fig. 61-1). The legs are arranged in stirrups that can be easily positioned and changed. An indwelling bladder catheter is placed as well as gastric decompression to decrease the chance of gastric injury. It is important to have the patient secured to the operating room table to ensure that the patient does not move during intraoperative positioning, both to avoid peripheral nerve damage and also altering the ability to access the anus for intraluminal stapling. Various commercial devices exist to safely secure the patient when in Trendelenburg position, although other methods such as taping, straps, or wrapped sheets may be acceptable and are operating room specific. Having the ability to safely place the patient in steep Trendelenburg, reverse Trendelenburg, right side up, and right side down is essential to allow the small bowel to move out of the operative field. The right arm is carefully tucked and padded as well, allowing two surgeons to be on the right-hand side of the patient.

FIGURE 61-1 The patient is placed in a dorsal lithotomy position with the legs in adjustable stirrups. The patient should be fixed in place with a beanbag mattress or some other combination of straps or fixation devices.

Trocar Placement

The placement of trocars is an important part of the success of this operation and is essentially the same as for sigmoid colectomy or low anterior resection (Fig. 61-2). A periumbilical port is used for the camera. Although usually the camera port is placed in an infraumbilical position, in a shorter patient with less distance between the pubis and the umbilicus, moving the port site to just above the umbilicus affords a better view with the laparoscope. Additional ports are placed as illustrated. If stapling is performed via the right lower quadrant port, then it should be a 12-mm port to allow passage of an endoscopic linear staple. In this case, a left lower quadrant or lower midline incision could be used for extraction. The larger 12-mm port may also be placed in the suprapubic position allowing the larger port to double as a mini-Pfannenstiel extraction site. After pneumoperitoneum is achieved, the right lower quadrant port should be placed just lateral to the inferior epigastric vessels at a level ~2 cm superior to the anterior superior iliac spine. An additional 5-mm port on the left side allows the assistant to provide retraction and countertraction for the primary surgeon and is best positioned at the level of the umbilicus or lower.

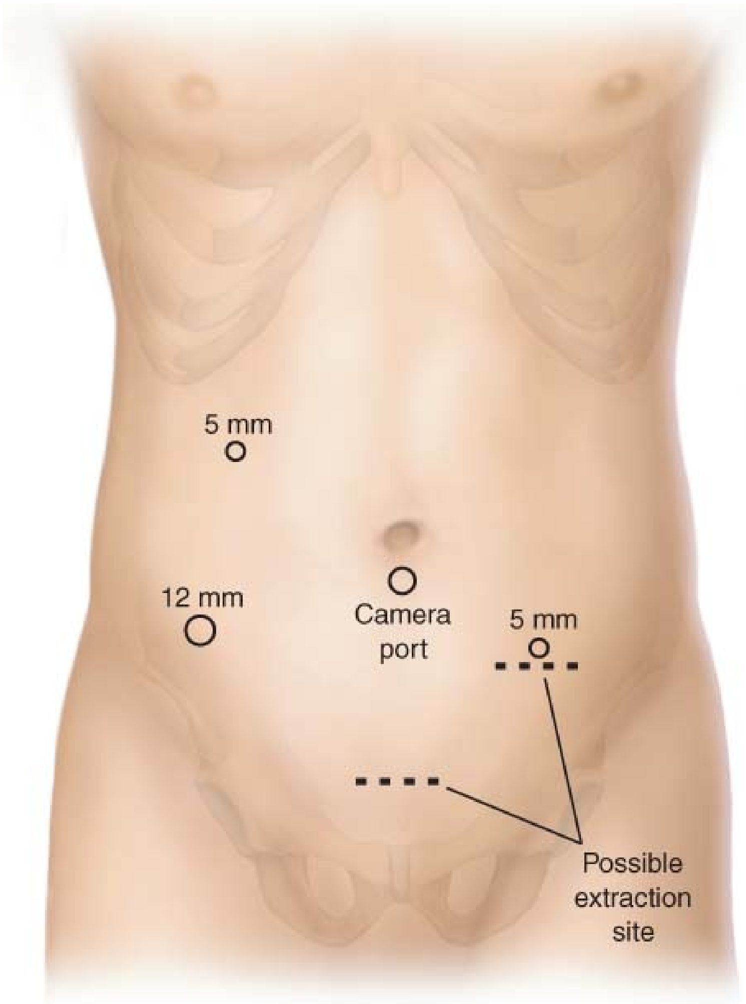


FIGURE 61-2 The placement of the trocars is illustrated as well as possible extraction sites.

Vascular Division

Once the trocars are in place, the patient is placed in steep Trendelenburg and right side down positions to facilitate moving the small bowel out of the pelvis and thus optimizing the continued retraction of the small bowel. This simple maneuver will optimize visualization of the pelvic structures. The vascular division is done at the level of the superior hemorrhoidal vessels (Fig. 61-3) at the level of the sacral promontory. Dissection is most commonly undertaken in a medial-to-lateral manner. The sigmoid colon is usually very redundant and the first step is to elevate the redundant colon out of the pelvis. By doing so, the superior hemorrhoidal vessels can be identified coursing over the sacral promontory. The mesentery can then be grasped and placed on traction. The step of placing the mesentery on tension makes the vasculature stand out even in the patient with a thick or very fatty mesentery (Fig. 61-4).

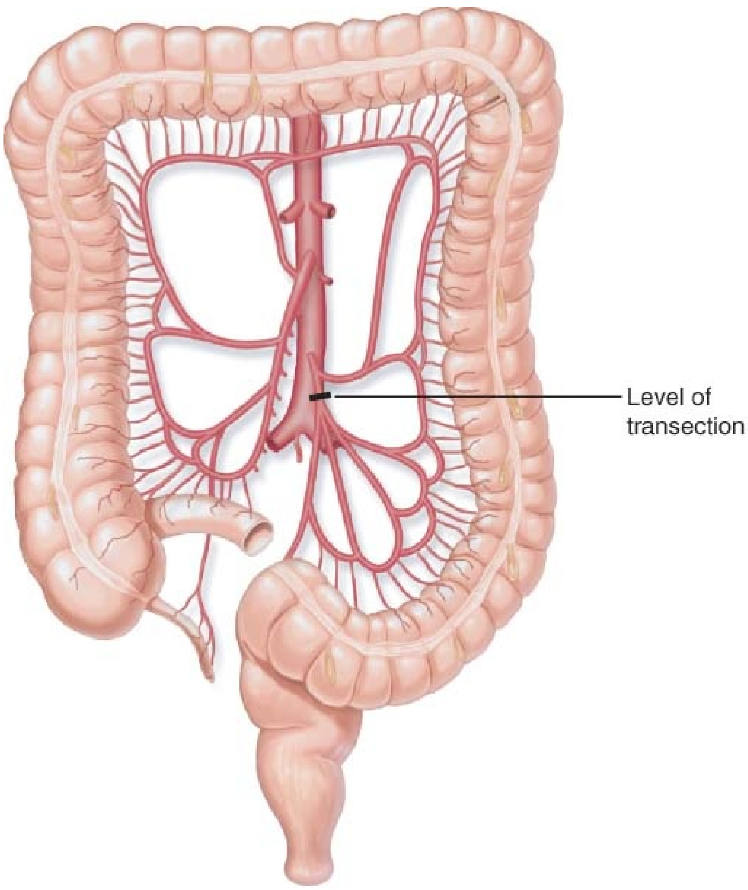


FIGURE 61-3 The vascular division occurs at the level of the superior hemorrhoidal vessels.

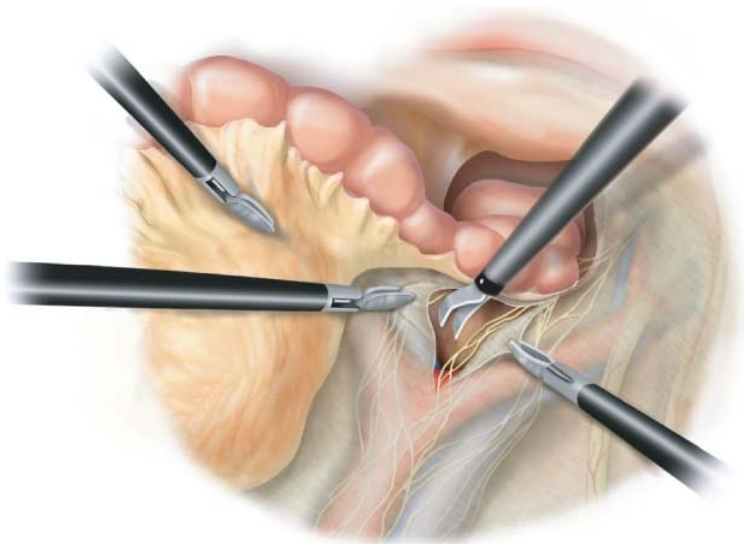


FIGURE 61-4 With the patient in steep Trendelenburg, the mesentery to the rectosigmoid is carefully grasped and put on tension to have the superior hemorrhoidal vessels in relief. A peritoneal incision is then made over the vessels and down over the sacral promontory.

The sacral promontory serves as an essential and a reliable landmark. The haptic feedback from touching this bony prominence helps identify anatomy even in the obese patient. Once comfortable with the anatomy, the peritoneum is then opened along the medial and inferior aspect of the vasculature so that the areolar tissue behind the mesorectum can be identified just below the sacral promontory. Care should be taken to reflect the hypogastric nerves that course over the sacral promontory. Injury here can lead to sexual dysfunction. Getting into the proper plane is critical. Once the proper plane is obtained, the remainder of the dissection usually can proceed with very little difficulty. If not, the dissection is tedious, identification of anatomic landmarks is difficult, and lack of clear visualization induces technical errors and organ injury. If, at any time it is not clear that one is in the right plane, it is well worth the time and effort to review all the anatomic landmarks until the correct plane is identified. Once the correct plane is entered, dissection can then be undertaken in a medial-to-lateral manner (Fig. 61-5). This window should be made as large as possible to facilitate identification of retroperitoneal structures. This step can be accomplished by extending the peritoneal incision both inferiorly and superiorly. The dissection continues until important structures (the ureter, the gonadal vessels, and the iliac vessels) are identified and preserved. If the proper plane of dissection is difficult to identify or the ureter cannot be found after a reasonable amount of time and effort, the dissection can be initiated from the lateral aspect by incising the lateral peritoneal attachments and then reflecting the colon and mesentery medially.

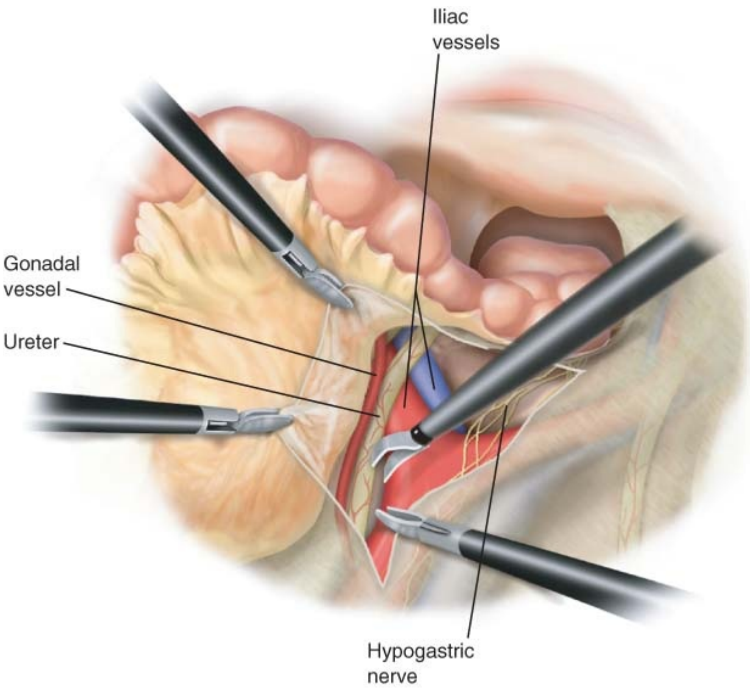


FIGURE 61-5 The areolar plane behind the rectosigmoid mesentery is entered at the level of the sacral promontory and dissection is carried out in a medial-to-lateral manner. The hypogastric nerves, left ureter, and iliac vessels should all be identified.

p. 574

p. 575

Once the ureter and iliac vessels have been identified and reflected away from the mesentery, the vascular pedicle can be isolated with a combination of sharp and blunt dissection. The vessels can then be ligated and divided by whatever means the surgeon prefers (Fig. 61-6). Alternatively, because the procedure is for benign disease, some surgeons will opt to save the main trunk of the superior hemorrhoidal vessels and perform division of the mesentery close to the colon wall.

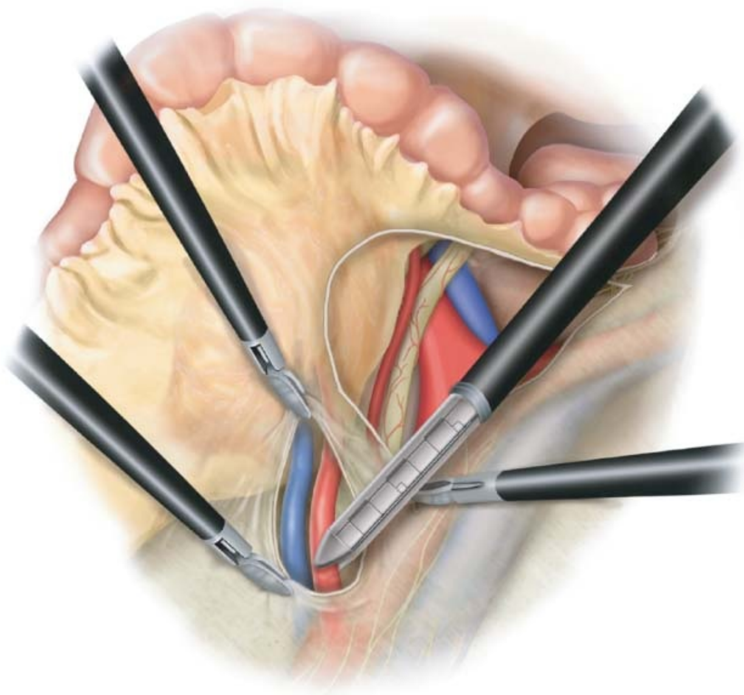


FIGURE 61-6 The superior hemorrhoidal vessels are isolated, ligated, and divided (shown here with laparoscopic linear stapler).

Rectal Mobilization

The rectum is mobilized in the previously identified areolar tissue. The presacral space serves as an ideal entry point to start the dissection. With the assistant surgeon providing retraction of the rectosigmoid junction out of the pelvis and off of the sacrum, the operating surgeon has an exceptional view to dissect in this plane posteriorly to the rectum and all the way to the pelvic floor (Fig. 61-7). In the course of this dissection, Waldeyer's fascia will be encountered and divided. If needed, the completeness of the dissection can be confirmed by having one surgeon go between the legs and do a digital rectal examination. The examining finger can easily be seen with the laparoscopic view of the pelvis and the assistant can also feel the instruments doing the dissection through the rectal wall.

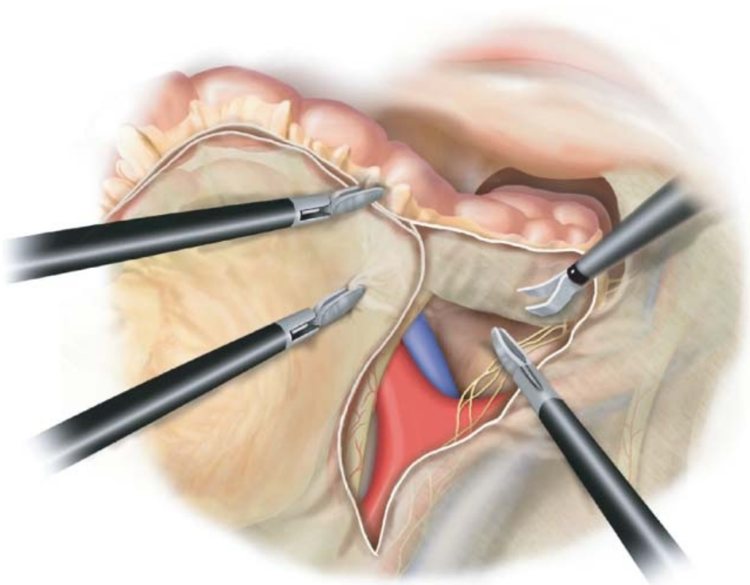


FIGURE 61-7 The dissection starts at the level of the sacral promontory and proceeds in the areolar plane just behind the mesorectum all the way down to the pelvic floor.

Once sufficient posterior dissection has been achieved posteriorly, the lateral attachments can be readily identified and divided. There is controversy regarding the handling of the lateral stalks. Part of the controversy stems from the lack of consensus on the exact anatomy and even the existence of well-defined lateral stalks. Given this controversy, it is not surprising that the literature is confusing regarding both the necessity for and the subsequent results of division of the lateral stalks. In our practice, it has been the authors' habit to perform a complete dissection posteriorly to the pelvic floor and to leave the most distal of the lateral attachments untouched. Likewise, there is varying opinion about adding an anterior dissection to the rectal mobilization. Unlike the complete anterior mobilization that is performed during a ventral rectopexy, ~5 cm of anterior dissection is usually the extent that is performed when combined with the complete posterior mobilization.

Division of Bowel with Extraction of Specimen

Once the dissection has been completed, the next step is to decide where to perform the distal transection of the rectosigmoid. The division of bowel is planned to allow an anastomosis to be created at or slightly above the level of the sacral promontory to avoid division of the rectum and allow reach of the intraluminal stapler. When identifying this level, it is important that the mobilized rectum be pulled up out of the pelvis and placed on gentle but firm traction. This maneuver will avoid marking a spot for transection that is too high. To initiate the division, the peritoneal attachments at the proposed level of division are opened up both to mark the level and to help initiate dissection. The plane between the rectosigmoid and its mesentery is carefully identified and dissection carried out bluntly medially to laterally. A meticulous dissection is important to minimize the risk of inadvertently entering the bowel. Once a plane has been developed all the way across, an endoscopic linear stapler can be used to divide the bowel at the previously identified level (Fig. 61-8).

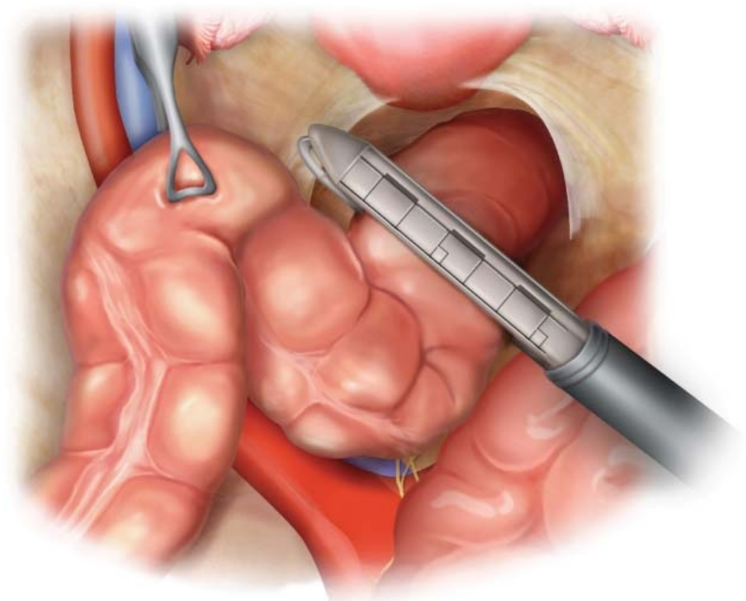


FIGURE 61-8 Once a plane has been developed between the rectosigmoid junction and its mesentery, the upper rectum can be divided with an endoscopic linear stapler.

Ideally, a single firing of the stapler should be used to completely transect the rectosigmoid. If not possible, it is important to be meticulous in the placement of the stapler directly at the intersection of the previous staple lines so that the subsequent stapler firing does not create an irregularity or dog-ear on the rectal stump. After this is accomplished, the only remaining tissue will be the mesorectum. At this level there are still significant large vessels that require division by whatever means the surgeon chooses. The distal end of the bowel to be resected will then be completely freed up and usually is quite mobile. Any remaining lateral attachments that need to be divided can now be identified.

Exteriorization of the Bowel

The proximal point of resection now needs to be identified and marked in some manner. Endoscopic clips, cautery, or simply using a locking grasper can serve this purpose. The level of proximal transection should allow for an anastomosis at the level of the sacral promontory. The bowel can then be exteriorized. There are several options for the site of exteriorization. A short transverse (mini-Pfannenstiel) incision 2 cm above the pubis functions well. There are several advantages of the suprapubic incision. It serves as a second check on the level of the proximal resection margin. If the transected bowel can be brought to the skin level, it will also comfortably reach the sacral promontory for a tension-free anastomosis. Also, if the surgeon is uncomfortable with certain parts of the procedure laparoscopically, this site can serve as an access site for transection of the rectosigmoid, placement of the rectopexy stitches, and performing an anastomosis.

Using a Pfannenstiel incision is also associated with less incisional hernias when compared to midline incisions. Another “off-midline” incision option is a muscle splitting, Rockey–Davis type, incision in the left lower quadrant. Transvaginal extraction of the specimen is another option.

Anastomosis

Once exteriorized, the bowel is transected at the site previously identified. The remaining mesentery is divided under direct vision at the extraction site and then a purse string suture is placed into the cut end of the proximal bowel. The editors also routinely employ indocyanine green (ICG) perfusion assessment prior to anvil placement. An anvil from an appropriate-sized end-to-end stapling device is placed and the purse string is pulled tight (Fig. 61-9). The proximal end is then placed back into the abdominal cavity, the extraction site closed to at least at the level of the fascia, and pneumoperitoneum reestablished. A second surgeon places the end-to-end stapling device into the rectum. Under direct view with the aid of the laparoscope, the stapler is advanced up to the end of the rectal stump. The spike can then be advanced out through the rectal stump (Fig. 61-10). The abdominal surgeon then identifies the proximal bowel with the anvil and mates the two ends together (Fig. 61-11). The anastomosis is then carried out in the usual manner. Once completed, the anastomotic rings are checked for completeness and the anastomosis itself is air tested under water to check for leaks. Mucosal perfusion can be verified with ICG testing while transanally endoscopically visualizing the anastomosis.

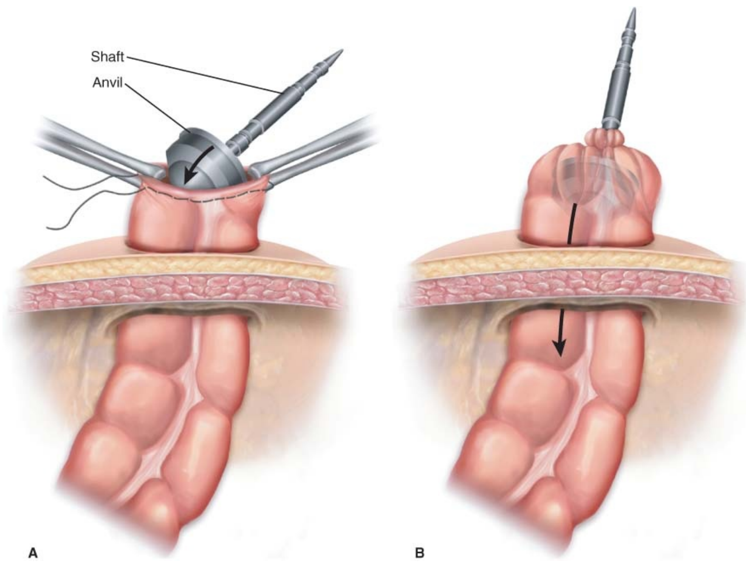


FIGURE 61-9 A. The bowel has been exteriorized and resected at the appropriate level. After the purse string is completed, the anvil of the stapling device is put in place and the purse string tied down. B. The end of the bowel with the anvil attached is placed back into the abdominal cavity.

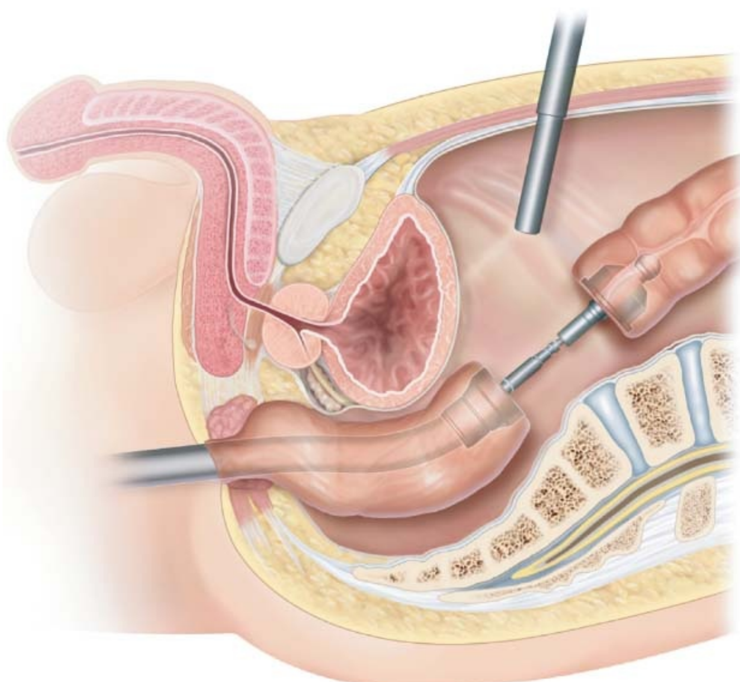


FIGURE 61-10 Once pneumoperitoneum is reestablished, the circular stapler is passed up through the rectal stump and the spike advanced out through

the end.

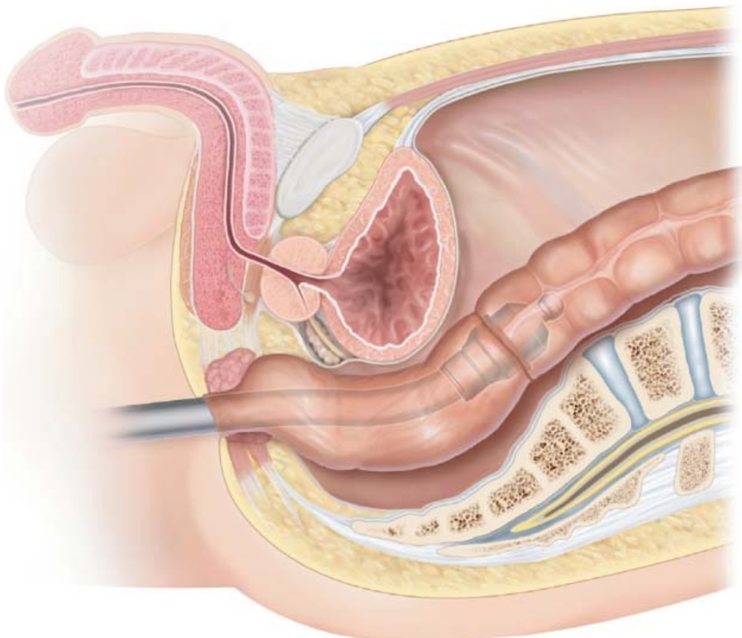


FIGURE 61-11 The two ends of the circular stapler are mated and the stapler fired to complete the anastomosis.

Rectopexy

The intent of the rectopexy is to fix the mobilized rectal stump to the sacral promontory so that the risk of recurrent prolapse is minimized. A permanent suture (0 or 2-0) is used to fix the lateral stalks of the rectum to the top of the sacral promontory (Fig. 61-12). The stitch into the sacral promontory needs to include the periosteum; but at the same time, be careful to avoid the sympathetic nerves and any vascular structures. Usually, this is accomplished with laparoscopic needle drivers. Some surgeons have found it easier to use other fixation devices such as a laparoscopic tack applier for this same purpose.

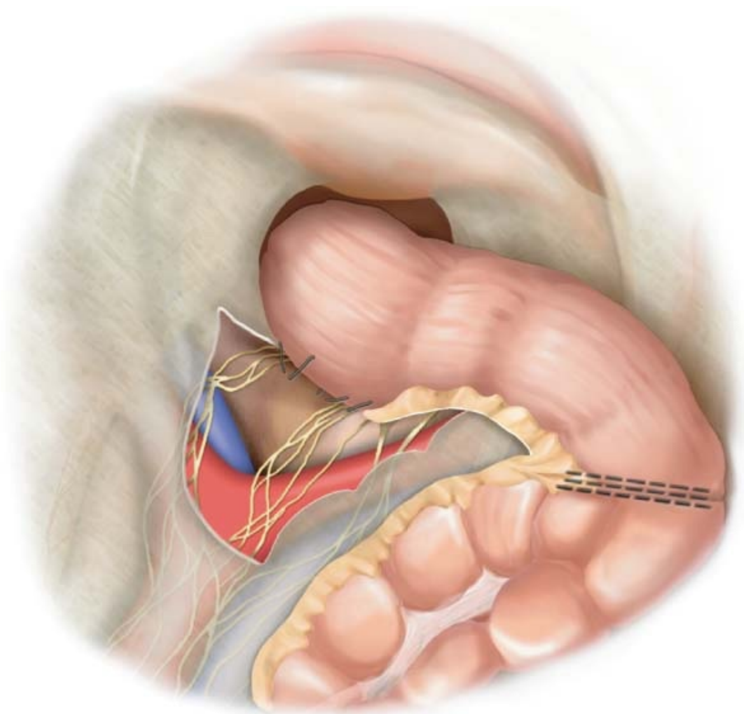


FIGURE 61-12 A permanent suture is passed through the lateral stalk and subsequently tacked to the sacral promontory to accomplish the rectopexy.

p. 578

p. 579

Another option is to perform the rectopexy portion through the open Pfannenstiel incision while the circular stapler is still within the rectum, thereby facilitating stitch placement to the elevated rectum. Alternatively, the rectopexy sutures can be placed through the lateral stalks before rectosigmoid junction division or anastomosis creation. This latter method may limit excessive manipulation of the new anastomosis. Specifically, the sutures are placed through the lateral stalks and the sacral periosteum but left intact until after the anastomosis has been created. Regardless of the timing of the rectopexy suture placement, the suture should not cause any ischemia, or angulation of obstruction of the anastomosis.

p. 579

p. 580

An alternative approach is to close the entire length of the peritoneum to the rectum with absorbable suture. In closing the peritoneum, the lateral aspect of the bites of the peritoneum is more craniad. When the suture is tightened, this closure serves to pull the rectum up and secure it in place higher in the pelvis. As is apparent, there are many technical variations that have not been compared one to another. Nevertheless, it is valuable to be familiar with various options given the variable anatomy and particular patient circumstances.

POSTOPERATIVE MANAGEMENT

Postoperative management following a resection rectopexy is no different than after any other laparoscopic-aided colectomy. In our institution, like in many others, an enhanced recovery program is instituted immediately postoperatively. Although some of the details vary depending on institution, many of the elements are common: early feeding, early ambulation on the day of surgery, early removal of the bladder catheter on the morning following surgery, and minimization of intravenous fluids. Of great importance is the effort to minimize narcotic analgesia by using nonnarcotic adjuncts including peripheral nerve blocks, gabapentin, acetaminophen, and nonsteroidal anti-inflammatory agents in various combinations. Before discharge, the patient needs to be tolerating solid food for at least two meals and taking enough fluids orally to avoid dehydration. The patient does not need to have a bowel movement before discharge but should at least be passing flatus. Successful implementation of this enhanced recovery program will require extensive staff and patient education regarding the rationale, benefit, and safety of such an approach.

Given that the most common morbidity after surgery is prolapse recurrence, steps should be taken to avoid any postoperative constipation. After return of bowel function, a patient’s routine laxative regimen should be restarted and titrated to the optimal effect. After complete convalescence (usually 4 weeks), another useful adjunct is pelvic floor retraining by a specially trained physiotherapist. Improving toilet mechanics and avoidance of straining can be difficult for some patients and, in some cases, could even be done preoperatively before surgery if the prolapse is mild.

COMPLICATIONS

Many of the complications that occur after this procedure are the same as can be expected after any segmental colectomy. Anastomotic leaks are feared but are fortunately uncommon. Because of the area of dissection, there can be injuries to the ureter and hypogastric nerves (with resultant sexual dysfunction). Even with the laparoscopic approach, ileus can occur and lead to a prolonged hospital stay. However, ileus is unusual enough in this setting that its occurrence should always make one search for an underlying cause of the ileus.

RESULTS

Both the short-term and the long-term results of laparoscopic-aided resection rectopexy are very good. Conversion to an open procedure is necessary in only a small percentage (5% or less) of the cases. Although operative times are longer for the laparoscopic approach, they do improve with surgeon experience. With a minimally invasive approach, the recovery of bowel function is quicker and length of hospital stay is shorter compared to the open procedure. With long-term follow-up, the risk of recurrence is low (6–7% at 5 years in pooled studies).

Most patients see an improvement in overall bowel function. For those patients with incontinence related to the prolapse, at least 50% will improve, depending on how much of the incontinence is related to the prolapse itself. For those with constipation, undergoing this procedure has been shown to provide some relief from constipation; and if the lateral stalks are not divided, at least the condition does not typically worsen.

CONCLUSIONS

Laparoscopic-aided resection rectopexy is an excellent choice for the medically fit patient with rectal prolapse accompanied by constipation.

RECOMMENDED REFERENCES AND READINGS

Ashari L, Lumley J, Stevenson A, Stitz RW. Laparoscopically-assisted resection rectopexy for rectal prolapse: ten years's experience. *Dis Colon Rectum* 2005;48:982–7.

Brazzelli M, Bachoo P, Grant A. Surgery for complete rectal prolapse in adults. *Cochrane Database Syst Rev* 1999;(4):CD001758. doi:10.1002/14651858.

Canfrere VG, des Barannos SB, Mayon J, Lehar PA. Adding sigmoidectomy to rectopexy to treat rectal prolapse: a valid option? *Br J Surg* 1994;581:2–4.

Laubert T, Kleemann M, Schorcht A, *et al.* Laparoscopic resection rectopexy for rectal prolapse: a single-center study during 16 years. *Surg Endosc* 2010;24(10):2401–6.

Luukkonen P, Mikkonen U, Jarvinen H. Abdominal rectopexy with sigmoidectomy vs rectopexy alone for rectal prolapse: a randomized prospective study. *Int J Colorectal Dis* 1992;7:219–22.

McKee RF, Lauder JC, Poon FW, Aitchison MA, Finlay IG. A prospective randomized study of abdominal rectopexy with and without sigmoidectomy in rectal prolapse. *Surg Gynecol Obstet* 1992;174:145–8.

Purkayastha S, Tekkis P, Aziz O, *et al.* A comparison of open vs. laparoscopic abdominal rectopexy for full-thickness rectal prolapse: a meta-analysis. *Dis Colon Rectum* 2005;48:1930–40.

Raftopoulos Y, Senagore AJ, Di Giuro G, Bergamaschi R. Rectal Prolapse Recurrence Study Group. Recurrence rates after abdominal surgery for complete rectal prolapse: a multicenter pooled analysis of 643 individual patient data. *Dis Colon Rectum* 2005;48:1200–6.

Chapter 62

Abdominal Rectopexy: Hand Assisted

Greta V. Bernier and Sowsan H. Rasheid

INDICATIONS/CONTRAINDICATIONS

Indications

Similar to many disorders of the pelvic floor, rectal prolapse is a complex and likely underreported disease process. It is frequently observed in patients who have a history of straining associated with intractable constipation or frequent diarrhea. It is most commonly seen in older patients with a peak incidence in the seventh decade and in individuals with a history of multiparity, neuromuscular deficit from previous operation, neurologic disorder, or psychiatric illness. Rectal prolapse often occurs in conjunction with other disorders of the pelvic floor, including cystocele and rectocele. Chronic prolapse may be associated with progressive fecal incontinence due to trauma to the anal canal from repeated prolapse and reduction of rectal tissue as well as pudendal neuropathy.

Despite the many benefits of medical management and/or physiotherapy for other disorders of the pelvic floor, surgical intervention is the gold standard of care in the management of full-thickness rectal prolapse. Therefore, there is no benefit in waiting, and surgery is indicated for patients who are good operative candidates once full-thickness prolapse is identified. Traditionally, relapse can be managed either via an abdominal or a perineal approach. The choice of surgical approach is highly personalized and based on the balance of operative morbidity, long-term outcome, recurrence, and any prior repair. It is generally accepted that an abdominal rectopexy has a lower recurrence rate and better postoperative function; however, it carries with it an increased complication rate and longer hospitalization. For these reasons, the perineal approach was previously selected for patients who have significant medical comorbidities. Given improvements in anesthesia and laparoscopy, the abdominal approach is now offered to a wider range of patients.

The most common operation offered for primary rectal prolapse in North America may be suture rectopexy with or without sigmoid colon resection. Laparoscopic rectopexy is appealing over the open approach because laparoscopic colorectal surgery has consistently been shown to decrease length of hospital stay, postoperative pain, and cost as compared to open surgery. However, laparoscopic rectal dissection and intracorporeal suturing are difficult

However, laparoscopic rectal dissection and intracorporeal suturing are difficult and advanced laparoscopic techniques. Some surgeons overcome this difficulty with a hand-assisted laparoscopic approach to abdominal rectopexy. Benefits of this approach include improved tissue handling with tactile feedback, more effective and versatile rectal retraction, and ability to apply direct pressure for management of difficult to control presacral bleeding. For some, these benefits would result in decreased operative time with very little increase in morbidity, particularly if the hand port site doubles as the specimen extraction site in the case of resection rectopexy. Hand-assisted surgery for segmental colorectal resection has been shown to decrease conversion rate to open as well as operative time with no difference in length of hospital stay, severity of postoperative pain, time to flatus, or rate of functional recovery as compared to straight laparoscopy. The hand-assisted technique may be of further benefit in those elderly or highly morbid patients who would previously have been offered a perineal approach alone. Hand assistance can also be considered when a laparoscopic surgeon who does not utilize the hand-assisted technique encounters a difficult case where conversion may be the next step in proceeding to completion. Hand assistance is also useful for surgeons who are in the beginning of their laparoscopic learning curve or who are not tremendously laparoscopically adept because it may also prevent conversion to an open procedure, particularly if the case is complex or difficult.

Contraindications

Standard contraindications to laparoscopic surgery apply to hand-assisted rectopexy, such as inability to tolerate CO_2 insufflation, prohibitively high comorbidities, and extensive prior abdominal surgery, particularly low abdominal incisions.

A relative contraindication to this procedure is constipation without full-thickness prolapse but either mucosal prolapse or internal intussusception. Abdominal rectopexy alone yields varying results with respect to constipation, with some studies showing 50% rate of onset or worsening of constipation postoperatively. It is debatable whether constipation is the inciting cause of prolapse due to significant straining, or if prolapse is causing constipation via outlet obstruction. It is likely a spectrum and is different for each patient. For this reason it is important to rule out other sources of constipation if this is the sole patient complaint. For example, total colonic inertia with prolapse may require subtotal colectomy rather than resection rectopexy alone. These patients would benefit from colonic transit study, such as radiopaque marker study.

Internal rectorectal or rectoanal intussusception is regarded by some surgeons as part of a continuum with full-thickness rectal prolapse, and therefore possibly benefiting from surgical intervention. There is no association, however, with worsening constipation or incontinence with increased degree of internal intussusception; therefore, surgical management with rectopexy would place the patient at increased risk for worsening of the constipation, without the benefit of reduction of external rectal prolapse. Ventral mesh rectopexy is a procedure that has gained widespread acceptance for management of full-thickness rectal prolapse as well as for management of posterior compartment conditions, such as rectorectal intussusception. This procedure is not described in detail in this chapter.

PREOPERATIVE PLANNING

As previously mentioned, there is no medical treatment that is curative for full-thickness rectal prolapse. However, patients do benefit from medical optimization with respect to their defecatory function before an operation. Persistent constipation, diarrhea, and pelvic floor dysfunction with increased straining all increase the risk of recurrence postoperatively. Constipation should be managed with high water intake, high fiber diet, and laxatives. This is particularly important in internal rectal intussusception because surgery must be reserved as a last resort owing to unpredictable and mixed outcomes, including possibly worsened constipation or incontinence with rectopexy, as previously mentioned.

A complete history should be obtained including pelvic floor history, gynecologic history, traumatic vaginal deliveries, sexual abuse or assault, and trauma. Eliciting surgical history is important both for prediction of intra-abdominal adhesions as well as location of hand port potentially within a prior surgical incision. Physical examination should focus on abdominal and pelvic examination, including commode or toilet test with pseudodefecation to provoke rectal prolapse. Digital rectal examination is performed to evaluate sphincter tone. There is little benefit to anorectal manometry or physiologic testing because this will likely be abnormal given the presence of prolapse and therefore will potentially be vastly different postoperatively and, therefore, not meaningful. Likewise, routine defecography is not necessary in the presence of clinical full-thickness prolapse. Defecography is helpful if there is concern for other occult pelvic floor disorder not evident on physical examination that may change the operative approach or for evaluation of internal rectal intussusception. The only preoperative study we routinely recommend is recent colonoscopy to evaluate for concurrent disease. A colonic transit marker study is recommended if there is concern for colonic inertia as the cause of chronic straining and resultant rectal prolapse.

OPERATIVE TECHNIQUE

Positioning and Operating Room Setup

Patients are prepped in low lithotomy position with draping such that there is access to both the abdomen and the perineum. It is important to have access to the perineum for digital rectal and vaginal examinations intraoperatively to guide dissection. Arms are bilaterally tucked to allow adequate space for both operating and assisting surgeons on either side of the patient. Monitors should be placed at the foot of the bed or off the left leg. This operation will require steep Trendelenburg position; therefore, the patient should be adequately secured to the bed and the bed tested to ensure steep Trendelenburg capability.

A bladder catheter is placed for bladder decompression and bilateral ureteric catheters may be used at the discretion of the surgeon. It is important to note that the catheter may not work as well in steep Trendelenburg position. This fact should be communicated to the anesthesia team for monitoring fluid status as well as be noted by the operating team. If bladder distension obstructs exposure to the pelvis, the patient may need to be returned to the horizontal position momentarily to drain the bladder. Orogastric tube placement, rectal irrigation, and preoperative mechanical bowel preparation are optional and may be elected on the basis of the surgeon’s preference.

Technique

Hand-assisted rectopexy begins with open incision access to the abdomen to a length of 1 cm smaller than the surgeon’s glove size. Both low midline and Pfannenstiel incisions have been described for this technique, and the choice is largely surgeon dependent. Pfannenstiel incisions have the benefit of both decreased hernia rate as well as decreased rate of surgical site infection. In addition, a Pfannenstiel is appropriately positioned to allow access to the rectum and presacral fascia if open dissection is required. Midline incisions may be beneficial for those patients in whom a straight laparoscopic approach was started and the periumbilical port site can be extended to allow for hand port placement. Midline incision can be either periumbilical or infraumbilical based on the patient’s body habitus.

Additional working ports include a 12-mm right lower quadrant port and a 5- or 10-mm camera port in the right mid-to-upper quadrant. The right lower quadrant 12-mm size port is required to accommodate stapling and suturing devices as well as to pass needles into the abdomen for intracorporeal suturing with laparoscopic needle drivers. The hand port is primarily used for blunt with laparoscopic needle drivers. The hand port is primarily used for blunt dissection and retraction of the rectum and sigmoid out of the pelvis.

p. 585

p. 586

The operation follows the steps of an open procedure with some modifications. It begins with medial-to-lateral mobilization of the sigmoid colon (Fig. 62-1). The plane of mobilization is then carried distally into the presacral space to the pelvic floor (Fig. 62-2). Care is taken to identify and preserve the bilateral ureters and hypogastric nerves. The peritoneum over the rectovaginal septum is then incised and the dissection carried distally until at least 4–5 cm past the peritoneal reflection, if not fully to the pelvic floor (Fig. 62-3). Anterior and posterior dissection and retraction of the rectum out of the pelvis is facilitated by division of the lateral peritoneal attachments of the upper and mid rectum. It is important to leave adequate peritoneum with the rectum such that there is tissue to suture for the rectopexy. Lateral peritoneal division is carried distally to the level of the lateral rectal stalks. These lateral rectal stalks of the mid-to-distal rectum may be left intact or divided on the basis of surgeon preference and patient presenting symptoms. Division of the lateral stalks is associated with a decreased rate of prolapse recurrence, but worsening constipation. The latter is attributed to denervation of the distal rectum by dividing the parasympathetic nerve branches from the inferior hypogastric plexus. On the basis of these findings, division of the lateral stalks is frequently avoided, particularly for those patients whose primary preoperative symptom is constipation.

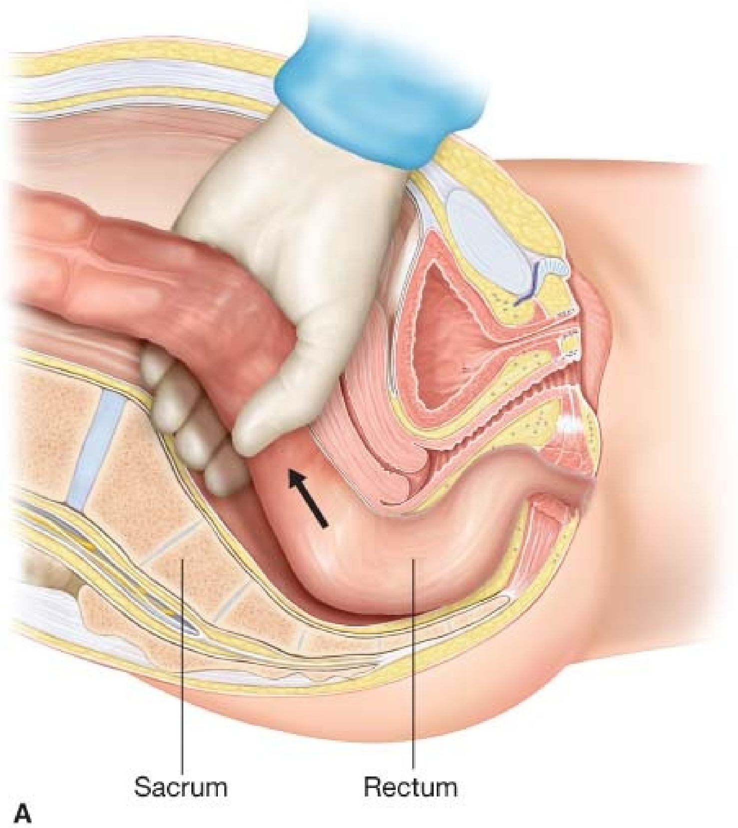


FIGURE 62-1 Laparoscopic rectal mobilization using the medial-to-lateral approach. A. The operator's left hand is used to aid in retracting the rectum superiorly as indicated by the direction of the arrow. B. An incision is made at the right lateral peritoneal reflection of the rectum and the energy device is used for to commence dissection of the presacral space.

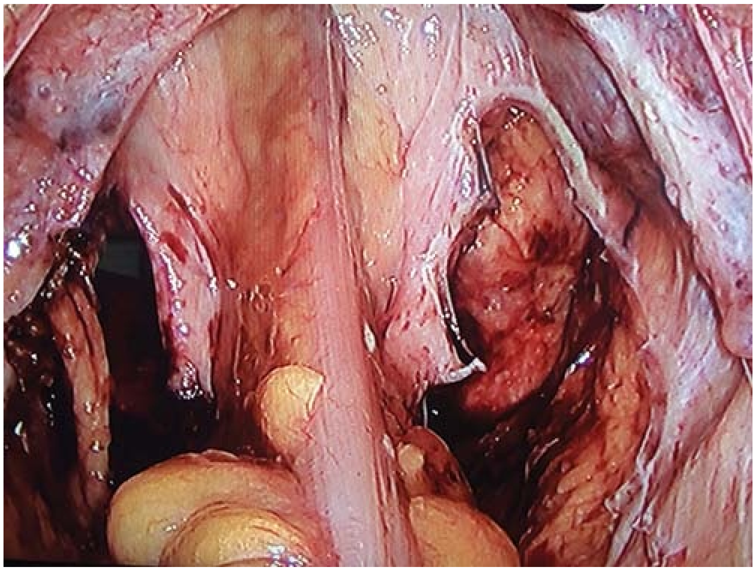


FIGURE 62-2 Laparoscopic view of rectum following full posterior mobilization.

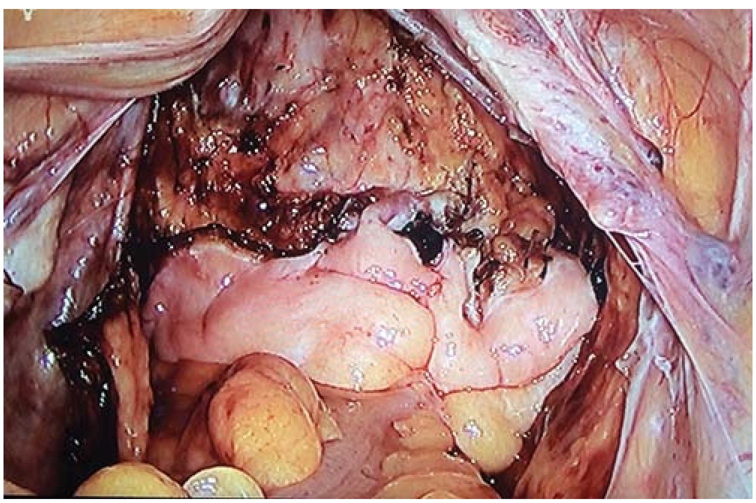
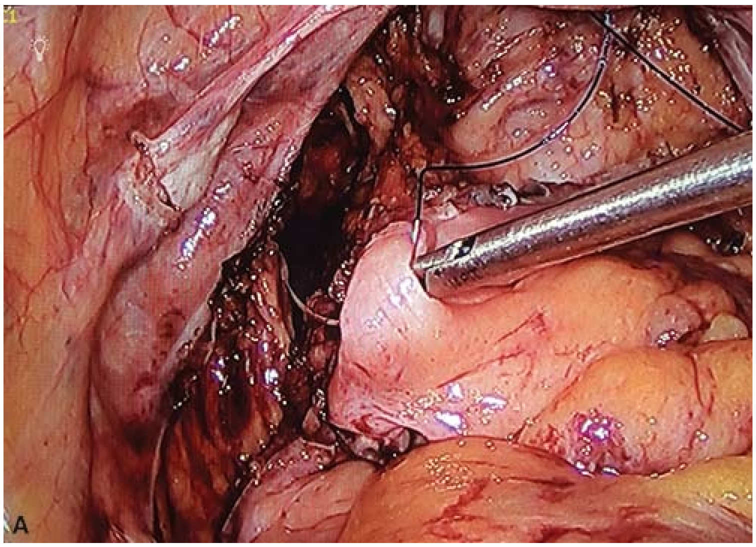
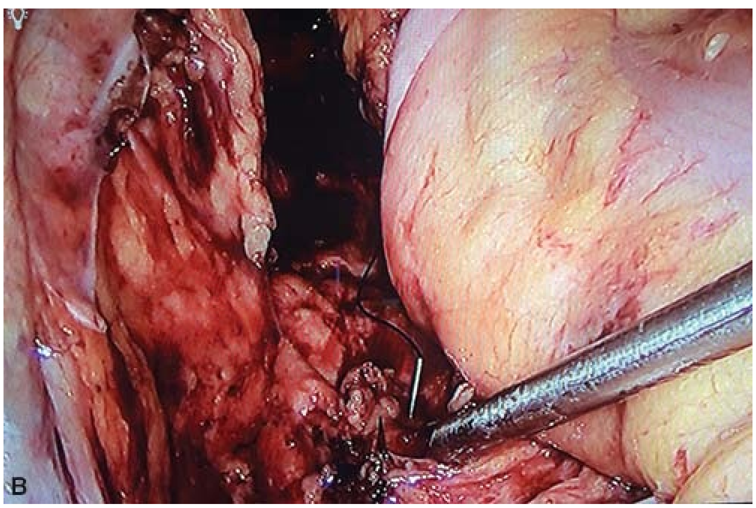


FIGURE 62-3 Laparoscopic view following anterior rectal mobilization.

The rectum is retracted from the pelvis with the hand port and mattress sutures placed from the lateral peritoneal ligament to the presacral fascia overlying the sacral promontory to suspend the rectum out of the pelvis (Fig. 62-4A to C). Sutures are placed at a level on the mid-to-upper rectum such that the rectum will be straightened and retracted out of the pelvis after completion of the rectopexy. Typically, 2-0 nonabsorbable single-strand monofilament or braided filament suture is used. Appropriate fixation to the presacral fascia is of utmost importance for durability of the suture rectopexy. The typical technique includes driving the needle perpendicular to the presacral fascia until the sacrum is encountered, and then slightly withdrawing the needle tip before completing the throw of the needle. Confirm substantial tissue is captured by gently pulling on the suture and observing any movement of the underlying tissue. If done correctly, the needle and the tissue it has captured should have minimal movement. The suture is then driven up through the lateral attachments, creating a mattress stitch, and later tied down with the surgeon's preferred method, ensuring adequate tissue approximation and suspension of the rectum.





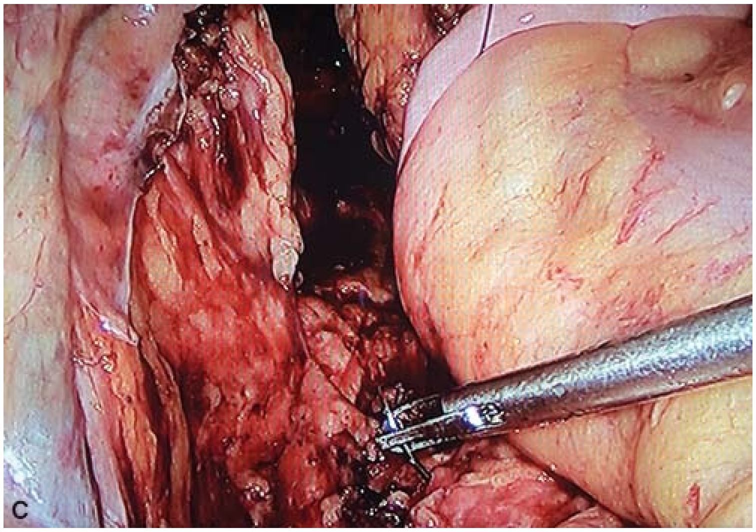


FIGURE 62-4 A. Placement of rectopexy suture into the left lateral rectal peritoneal reflection. B. Placement of rectopexy suture into the periosteum. C. The needle is pulled through the periosteum following suture placement.

After completion of the pelvic dissection and placement of the rectopexy sutures, the sigmoid resection is performed, if planned. Because this procedure is not an oncologic operation, high ligation is not performed on the inferior mesenteric artery, but rather the mesosigmoid is deliberately divided close to the colon wall. The sigmoid is divided at the rectosigmoid junction and extracorporealized through the wound protector of the hand port. The descending colon is then transected at a level to allow adequate suspension of the colon out of the pelvis without tension on the anastomosis. A circular stapling device is used to fashion the colorectal anastomosis in accordance with the surgeon’s preferred technique. After endoscopic inspection of the anastomosis and negative air leak test, the rectopexy sutures are secured (Figs. 62-5 and 62-6). Laparoscopic ligation can be accomplished using either an intracorporeal or extracorporeal knot-tying method. The anastomosis is then reinspected with air leak test including flexible sigmoidoscopy to ensure there is no distortion or narrowing of the lumen (Fig. 62-7). Indocyanine green (ICG) perfusion assessment may be employed.

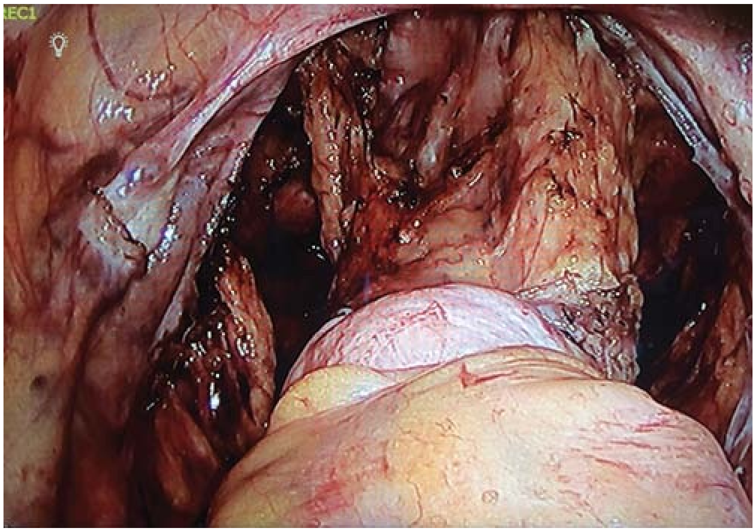


FIGURE 62-5 Laparoscopic view following the tying down of the rectopexy sutures.

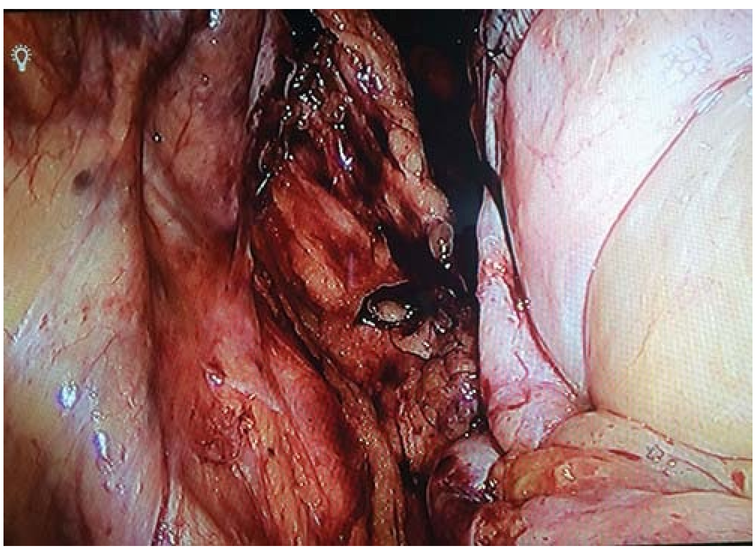


FIGURE 62-6 View of the left lateral rectopexy suture.

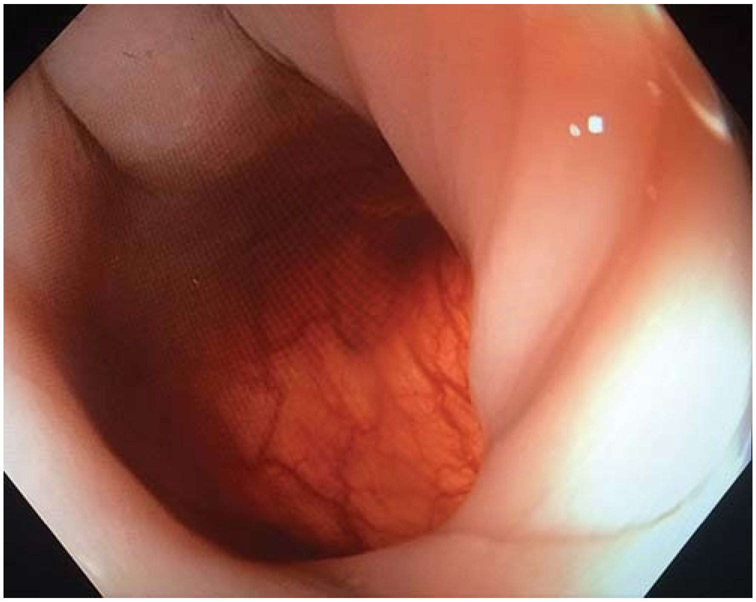


FIGURE 62-7 Endoscopic view of the rectum following the tying of rectopexy sutures.

POSTOPERATIVE MANAGEMENT

Avoiding constipation or frequent stooling/diarrhea are of the utmost importance after this procedure so as to not stress the recently placed rectopexy sutures. A strict bowel regimen is recommended including gentle laxatives, high water intake, and supplemental fiber. This feature is of particular importance when patients are taking narcotic pain medication postoperatively. Dietary fiber, such as raw fruits or vegetables, is immediately postoperatively avoided and slowly reintroduced after 4–6 weeks. Passage of flatus as well as initial bowel movement is recommended before the patient leaves the hospital. This requirement is in contrast to the standard of care for segmental colon resection, after which the authors frequently do not wait for a patient to have a bowel movement. It is important after rectopexy, however, to assure there was not a mechanical obstruction created by the altered rectal angle.

After recovery from surgery, some patients may benefit from pelvic floor physical therapy if their preoperative defecatory dysfunction and/or incontinence persist after reduction of their rectal prolapse. All patients should be encouraged to perform Kegel exercises and to have good toileting habits, such as decreased time on the toilet, avoiding reading or waiting on the toilet for a bowel movement, and avoidance of straining.

COMPLICATIONS

As with any operation it is important to discuss risks and complications of rectopexy with patients before performing the operation. This feature is especially important because constipation may actually be worsened as a result of changing the rectal angle and/or division of the lateral stalks. If a patient's primary complaint is constipation alone and not prolapsing tissue, then this operation may worsen the symptoms without the benefit of reduced external prolapse. For this reason, suture rectopexy with or without resection is not recommended for those patients who only have internal intussusception. Again, these patients may benefit from ventral mesh rectopexy.

Another major concern is recurrence, both with respect to prevention and management of it after it occurs. Recurrence rates are 0–9% after rectopexy without significant difference based on performance of sigmoid resection or laparoscopic versus open approach. As previously mentioned, prevention is of the utmost importance and is centered on medical management of constipation and diarrhea and good toileting habits. Mucosal recurrence can be managed with a perineal approach such as a Delorme procedure or potentially with use of a circular hemorrhoid stapler. Full-thickness recurrence requires repeat repair via the same approach (abdominal vs. perineal) as previously performed if a repeat resection is planned. Sigmoid resection should not be performed if a patient has previously undergone perineal proctectomy (Altemeier procedure) because the vascularity of the remaining colon is compromised and resection may result in a segment of distal bowel that will likely be ischemic owing to the lack of clear blood supply. Therefore, patients who have previously had an Altemeier procedure should either undergo repeat Altemeier with inclusion of prior anastomosis or abdominal rectopexy without resection. Repeat suture rectopexy or ventral mesh rectopexy can be safely performed for full-thickness recurrence regardless of previous operative approach.

Additional complications include those inherent to minimally invasive colorectal surgery and include anastomotic leak and ureteral or hypogastric nerve injury with resulting genitourinary, sexual or defecatory dysfunction, surgical site infection, and incisional hernia.

RESULTS

There are no studies comparing hand-assisted rectopexy to open or laparoscopic rectopexy approaches. However, given similar results of hand-assisted and laparoscopic colorectal surgery in general, results of laparoscopic rectopexy likely translate to hand-assisted rectopexy. Studies have been limited by small samples that are further complicated by the many operative approaches performed for this disease process over the years.

CONCLUSIONS

Hand-assisted abdominal rectopexy is a safe alternative to laparoscopic rectopexy. It can be especially helpful when used during a difficult case or in a reoperative field to try to avoid conversion to laparotomy. It can also be utilized to bridge the learning gap between open and laparoscopic rectopexy to help a surgeon learn advanced laparoscopic skills. The hand-assisted approach may also decrease operative time, which may be useful in patients who would previously have been offered a perineal approach because of their medical comorbidities.

RECOMMENDED REFERENCES AND READINGS

Aalbers AG, Biere SS, van Berge Henegouqen MI, Bemelman WA. Hand-assisted or laparoscopic-assisted approach in colorectal surgery: a systematic review and meta-analysis. *Surg Endosc* 2008;22:1769–80.

Beahrs OH, Theuerkauf JF, Hill JR. Procidentia: surgical treatment. *Dis Colon Rectum* 1972;15:337–46.

Ding JH, Canedo J, Lee SH, Kalaskar SN, Rosen L, Wexner SD. Perineal rectosigmoidectomy for primary and recurrent rectal prolapse: are the results comparable the second time? *Dis Colon Rectum* 2012;55:666–70.

Douard R, Frileux P, Brunel M, Attal E, Tiret E, Parc R. Functional results after the Orr-Loygue transabdominal rectopexy for complete rectal prolapse. *Dis Colon Rectum* 2003;46:1089–96.

El Muhtaseb MS, Bartolo DC, Zayiae D, Salem T. Colonic transit before and after resection rectopexy for full thickness-rectal prolapse. *Tech Coloproctol* 2014;18:273–6.

Eu KW, Seow-Choen F. Functional problems in adult rectal prolapse and controversies in surgical treatment. *Br J Surg* 1997;84:904–11.

Fengler SA, Pearl RK, Prasad ML, *et al.* Management of recurrent rectal prolapse. *Dis Colon Rectum* 1997;40:832–4.

Frykman HM. Abdominal proctopexy and primary sigmoid resection for rectal procidentia. *Am J Surg* 1955;90:780–9.

Glasgow SC, Birnbaum EH, Kodner IJ, Fleshman JW, Dietz DW. Preoperative anal manometry predicts continence after perineal proctectomy for rectal prolapse. *Dis Colon Rectum* 2006;49:1052–8.

Gordon PH. Rectal procidentia. In: Gordon PH, Nivatvongs S, eds. *Principles and Practice of Surgery for the Colon, Rectum and Anus*. New York, NY: Informa Medical, 2007:415–50.

HALS Study Group. Hand-assisted laparoscopic surgery vs standard laparoscopic surgery for colorectal disease. *Surg Endosc* 2000;14:896–901.

Hassan IM, You YN, Cima RR, Larson DW, Dozois EJ, Barnes SA, Pemberton JH. *Surg Endosc* 2008;22:739–43.

Hawkins AT, Olariu AG, Savitt LR, *et al.* Impact of rising grades of internal rectal intussusception on fecal continence and symptoms of constipation. *Dis Colon Rectum* 2016;59:56–61.

Husa A, Sainio P, von Smitten K. Abdominal rectopexy and sigmoid resection (Frykman-Goldberg operation) for rectal prolapse. *Acta Chir Scand* 1988;154:221–4.

Kim DS, Tsang CB, Wong WD, Lowry AC, Goldberg SM, Madoff RD. Complete rectal prolapse: evolution of management and results. *Dis Colon Rectum* 1999;42:460–6.

Lee L, Mappin-Kasirer B, Liberman AS, *et al.* High incidence of symptomatic incisional hernia after midline extraction in laparoscopic colon resection. *Surg Endosc* 2012;26:180–5. doi:10.1007/s00464-012-2311-7.

Madoff RD, Williams JG, Wong WD, Rothenberger DA, Goldberg SM. Long-term functional results of colon resection and rectopexy for overt rectal prolapse. *Am J Gastroenterol* 1992;87:101–4.

Mollen RM, Kuijpers JH, Van Hoek F. Effect of rectal mobilization and lateral sphincter division on colonic and anorectal function. *Dis Colon Rectum* 2000;43:1283–7.

Nunoo-Mensah JW, Efron JE, Young-Fadok TM. Laparoscopic rectopexy. *Surg Endosc* 2007;21:325–6.

Samia H, Lawrence J, Nobel T, Stein S, Champagne BJ, Delaney CP. Extraction site location and incisional hernias after laparoscopic colorectal surgery: should we be avoiding the midline? *Am J Surg* 2013;205:264–8.

Senapati A, Gray RG, Middleton LH, *et al.* PROSPER: a randomized comparison of surgical treatments for rectal prolapse. *Colorectal Dis* 2013;15:858–68.

Speakman CT, Madden MV, Nicholls RJ, Kamm MA. Lateral ligament division during rectopexy causes constipation but prevents recurrence: results of a prospective randomized study. *Br J Surg* 1991;78:1431–3.

Tou S, Brown SR, Nelson RL. Surgery for complete (full-thickness) rectal prolapse in adults [review]. *Cochrane Database Syst Rev* 2015;(11):CD001758.

Varma JS. Autonomic influences on colorectal motility and pelvic surgery. *World J Surg* 1992;16:811–9.

Watts JD, Rothenberger DA, Buls JG, Goldberg SM, Nivatvongs S. The management of procidentia: 30 years experience. *Dis Colon Rectum* 1985;28:96–102.

Chapter 63

Ripstein Procedure

Colleen Donahue, Todd D. Francone, and Rocco Ricciardi

INDICATIONS/CONTRAINDICATIONS

Rectal prolapse, or procidentia, is the full-thickness prolapse of the rectum through the anus resulting from a pelvic floor abnormality. The condition is much more common in older women but can be seen in men or women of any age. Patients tend to have three main complaints: prolapse, mucus per rectum, and bowel dysfunction. Straining is a frequently described symptom, and although rare, some patients describe severe pain when the prolapse occurs. The actual bowel dysfunction varies from incontinence to constipation and can cause substantial concerns for the patient.

Prolapse was originally considered as a sliding hernia through a defect in the pelvic floor with an abnormally deep retrovesical pouch representing the hernia sac. This theory led to the development of many operations aimed at repairing the pelvic floor while ignoring the fundamental anatomy of the rectum. Multiple factors have been associated with an increased risk for rectal prolapse including the elderly, women, vaginal delivery, chronic constipation, cystic fibrosis, dementia, stroke, pelvic floor dysfunction, or anatomic defects. Unlike the original speculation, parity does not appear to be a factor because a large proportion of patients are young and nulliparous. In addition, many patients with prolapse have undergone multiple prior colorectal or gynecologic interventions. In a study by Jurgeleit et al., 50% of patients with rectal prolapse had a prior procedure.

It has been said that there are over 100 operations in use to treat rectal prolapse. In actuality, there are a few popular procedures that are most commonly used but there is no single best approach. There are several reasons for the lack of a gold standard procedure, but the heterogeneity of the patient population may be the most important. The patients are of different ages and sex, have different symptoms, comorbidities, indications for surgery, and functional bowel disorders. In addition to this variability, the procedures sometimes include restoration of the pelvic floor, resection of bowel, suspension of the rectum, sphincter reefing, or any combination of two or more of those concepts.

Ripstein Theory

In 1964, Ripstein described the rectum as a mobile entity that could be easily displaced from the hollow of the sacrum, pushing it forward to create a straight tube that could intussuscept upon itself as pressure was increased. The Ripstein procedure thus aims to restore the normal sacral curve of the rectum using a sling suspension. He developed a design that would fix the rectum to the hollow of the sacrum using a Teflon mesh wrap and suturing it to the presacral fascia.

The Ripstein procedure was historically performed using an open transabdominal approach. Thus, the procedure is contraindicated in elderly patients with significant comorbidities that would preclude them from general anesthesia or an open abdominal surgery. In a review of quality improvement data from the National Surgical Quality Improvement Program, Russell et al., analyzed 1,485 patients who underwent rectal prolapse repair and demonstrated that those with a body mass index (BMI) >25 or American Society of Anesthesiologists (ASA) class 4 had substantially more complications, particularly infectious complications. Others have indicated that those with severe functional disturbances, particularly constipation, should not undergo a Ripstein procedure. This is because the functional outcome after Ripstein repair is unpredictable, with persistence and even worsening constipation. It remains unclear as to the best quality-of-life improving approach for these patients with constipated prolapse.

PREOPERATIVE PLANNING

When considering the Ripstein procedure for repair of rectal prolapse, it is important to realize that it is classically performed as an open transabdominal procedure. Given its infrequent use in today's repertoire for rectal prolapse repair, there are little minimally invasive surgical outcome reports. Although there are severe complications associated with transperineal or transabdominal techniques, an abdominal approach does have substantially more infectious issues. As described, patient factors including age, ASA class, BMI > 25, prealbumin level < 2.5 must be taken into account when selecting patients for abdominal approaches such as Ripstein repair. Patients with multiple medical comorbidities may not tolerate an abdominal procedure or general anesthesia, and therefore some would advocate for transperineal repairs in the frail elderly patient. This recommendation is however historical and good level I evidence to support transperineal approaches over abdominal approaches for rectal prolapse is lacking.

Patients must undergo a complete physical examination with appropriate laboratory tests including a thorough anorectal examination to assess the integrity of the sphincter complex and pelvic floor musculature. The incidence of incontinence in patients who present with rectal prolapse is about 50% and thought to be secondary to stretching of the anal sphincter leading to trauma of the sphincter itself. It is imperative to demonstrate full-thickness rectal prolapse in the office. If patients are unable to demonstrate prolapse on the examination table, they should be asked to sit and strain over the toilet or commode for several minutes. The average prolapse extends beyond 4 cm from the anal verge, and over 30–50% of patients tend to have a lax anal sphincter on digital rectal examination.

A proctosigmoidoscopic examination should be performed on all patients. Women should be assessed for rectocele, enterocele, or other pelvic prolapse, in which combined repair may be required. Approximately 5% of patients have a solitary rectal ulcer and the presence of polyps or obstructing masses should be excluded. Rectal ulcers are thought to be the result of repeated mucosal trauma and resultant ischemia. It can, however, be confused with rectal cancer, which must be biopsied to exclude neoplasia.

Defecography may be useful in patients who are unable to demonstrate full-thickness prolapse in the office. However, the prolapse can often be produced in a more rapid cost-effective manner by having the patient feign evacuation while seated on a toilet. In many instances, patients would present with rectal intussusception that is defined as a circumferential descent of the entire thickness of the rectal wall, which might extend into the anal canal, but not through the anal verge. It was originally thought that internal rectal intussusception was a precursor to prolapse; however, many studies have shown these patients to be asymptomatic, rarely progressing to rectal prolapse. Not surprisingly, these patients have not shown the same functional improvements after repair, including after the Ripstein procedure.

The second most frequent complaint relates to bowel dysfunction, either incontinence or constipation. As mentioned, the incidence of incontinence is quite large in patients with rectal prolapse. The etiology can be unclear, with most instances caused by chronic stretching of the anal sphincter leading to trauma of the sphincter itself. The extent of the impact of rectal prolapse on sphincter function can be difficult to assess, especially in regard to predicting postoperative continence. Surgical treatment in these patients could affect the sphincter by removing the mechanical dilator or rectal distension that causes functional inhibition. Schultz *et al.* reviewed anorectal manometry as a predictor for improved continence after the Ripstein procedure. When maximum resting pressure (MRP) was measured preoperatively, 7 days and 6 months postoperatively, it was found that there was no change at 7 days, but an increase in MRP was seen at 6 months. Although the study demonstrated improved anal continence, the role of anal manometry itself has not been found to have any predictive value in determining which incontinent patients would regain continence.

Many studies have also looked at the incidence of constipation in these patients, with reports suggesting rates ranging from 15% to 65% in patients with rectal prolapse. In these patients, the Ripstein procedure has been shown to make constipation worse by decreasing the number of bowel movements. As such, it has been recommended that patients with rectal prolapse and constipation should not undergo Ripstein repair. However, the procedure may be best chosen for patients with incontinence and for those with an enterocele in addition to rectal prolapse or rectal intussusception.

SURGERY

Secondary data supporting modified Nichols preparation for all colorectal surgical cases have recently been published. It is for these reasons that many surgeons recommend both complete oral cathartic mechanical and oral antibiotic bowel preparation before surgery. All patients should undergo some bowel preparation in the event low anterior resection is indicated and to facilitate intraoperative endoluminal evaluation.

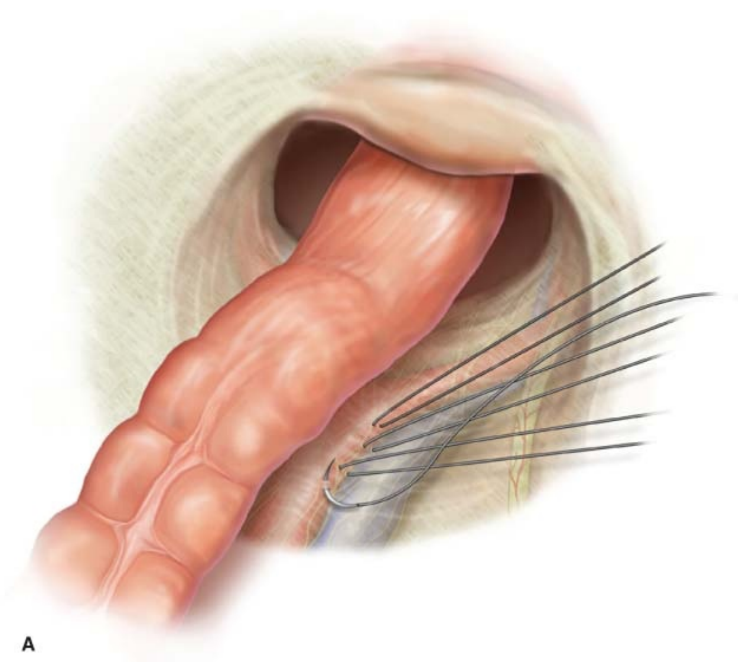
Positioning

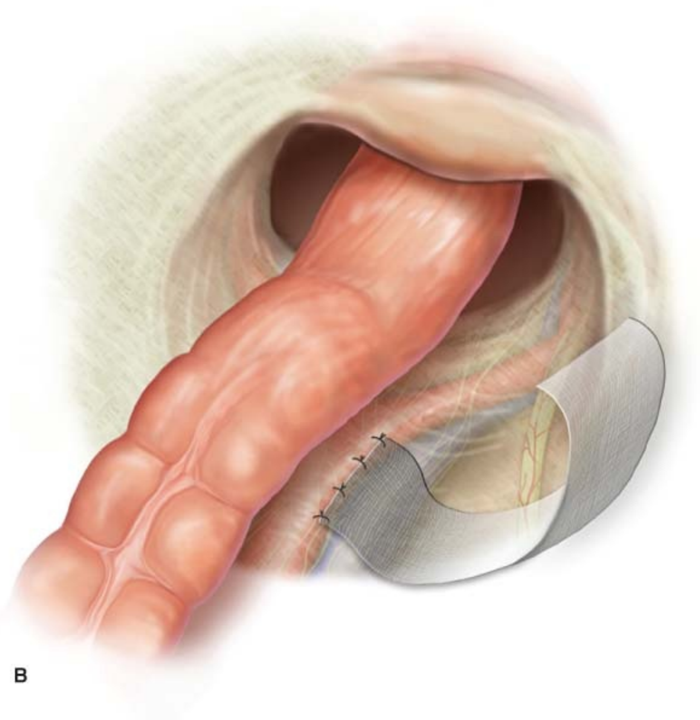
After general anesthesia is induced, the patient is placed in either supine position with a split leg table or in the lithotomy position; a bladder catheter is always placed and bilateral ureteric catheters may be placed at the discretion of the surgeon.

Open Technique

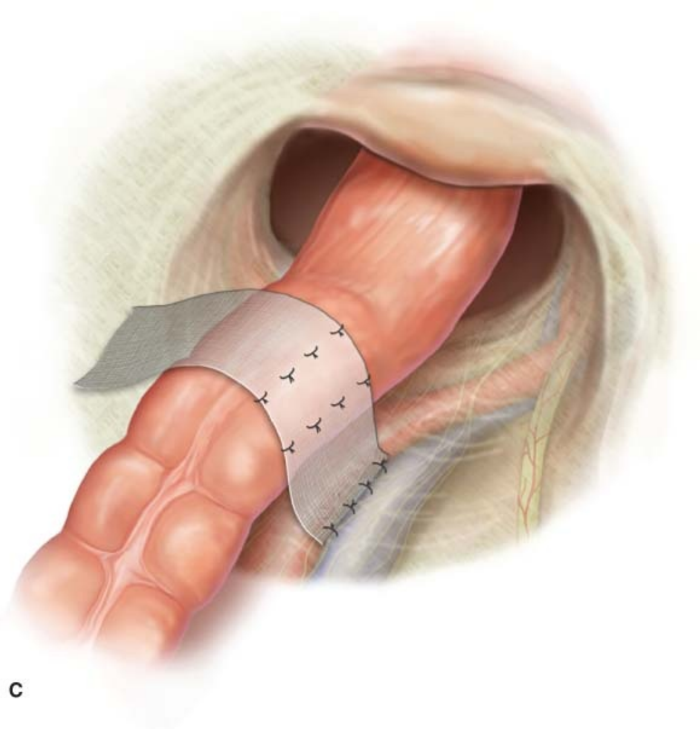
A Pfannenstiel incision permits good visualization and entry into the abdomen. A wound protector is placed, which allows avoiding the use of numerous retractors. The patient is then placed in the Trendelenburg position and packs are placed in the appropriate position to retract the small bowel. The sigmoid colon is then mobilized along the line of Toldt, and the left ureter is identified along with the autonomic nerves. The lateral attachments of the mesosigmoid and mesorectum are released at the sacral promontory. The rectum is lifted in a cephalad approach, allowing the mesorectum to be mobilized along the rectosacral fascia. The retrorectal plane is entered posterior to the superior hemorrhoidal artery, brushing the autonomic nerves away from the rectum. Sharp dissection is used down to the level of the coccyx and pelvic floor to reduce bleeding. Care is taken to avoid injuring the presacral venous plexus, which can lead to considerable issues of hemorrhage.

The lateral ligaments are preserved during rectopexy operations, because the left colon and rectum receive some innervation from nerve fibers that course through the lateral ligaments. However, during times of difficult visualization or difficulty with mesh placement, division of the lateral ligaments can be performed as needed. After the dissection is complete, a 5-cm strip of mesh (Ripstein originally used a T-shaped mesh) is sutured to the sacrum to the right of the midline and then passed over the anterior portion of the rectum and affixed to the sacrum at the left side of the midline. Nonabsorbable sutures secure the mesh to the sacrum. Sutures are affixed 1 cm from the midline on each side of the rectum. Again, it is critical to avoid injuring the presacral venous plexus. To avoid further constipation issues, it is important to ensure that a finger can be inserted between the sacrum and mesorectum. Once the mesh is sutured to the sacrum, the rectum is proximally retracted to fully reduce the prolapse. The mesh is then directly fastened to the rectum using 0 or 2-0 nonabsorbable sutures. Although difficult, sutures are placed to bring the mesh and muscular layers of the rectum together with careful attention paid to not entering the rectal lumen. The mesh is then pulled to the left side and fastened to the rectum and sacrum using nonabsorbable sutures (Fig. 63-1).





B



C

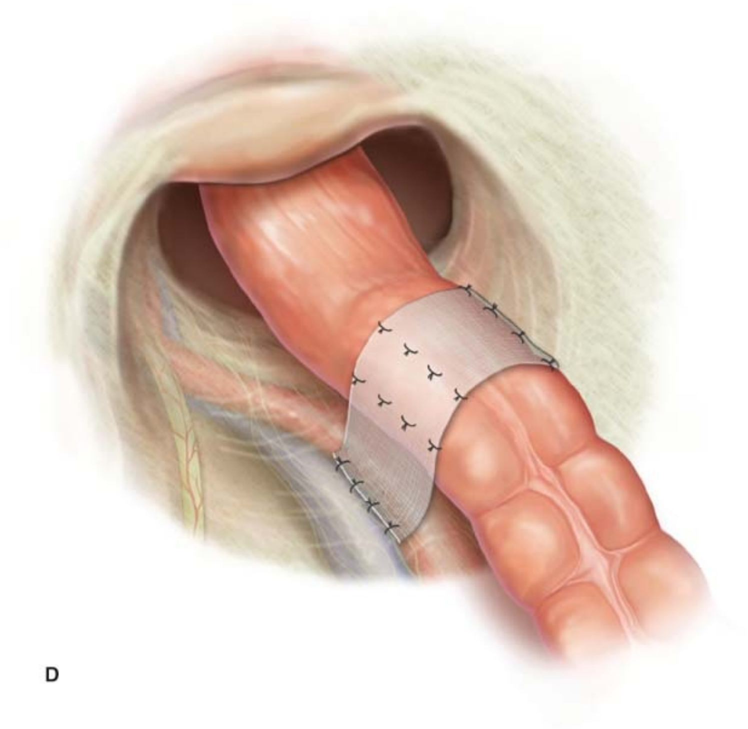


FIGURE 63-1 A. Sutures are affixed to the sacrum to the right of the midline. B. Mesh is affixed to the sacrum to the right of the midline. C. Mesh is affixed to the right side of the rectum using nonabsorbable sutures. D. Mesh is affixed to the left rectum and sacrum using nonabsorbable sutures.

One of the most common causes for recurrence has been technical placement of the mesh, either placed too loose or too tight around the rectum. If the mesh is too tight, stricture, erosion, or obstruction can occur. Owing to these concerns, Ripstein further modified the procedure to reduce the significant incidence of stricture and obstruction secondary to mesh complications. This modification involved placing the mesh in the posterior plane of the rectum, leaving the anterior rectal wall free to distend. The mesh is sutured to the sacrum first using nonabsorbable suture or a hernia tacker. It is then sutured two-thirds or three-quarters of the way around the circumference of the rectum on either side, with care taken to avoid entering the lumen (Fig. 63-2).

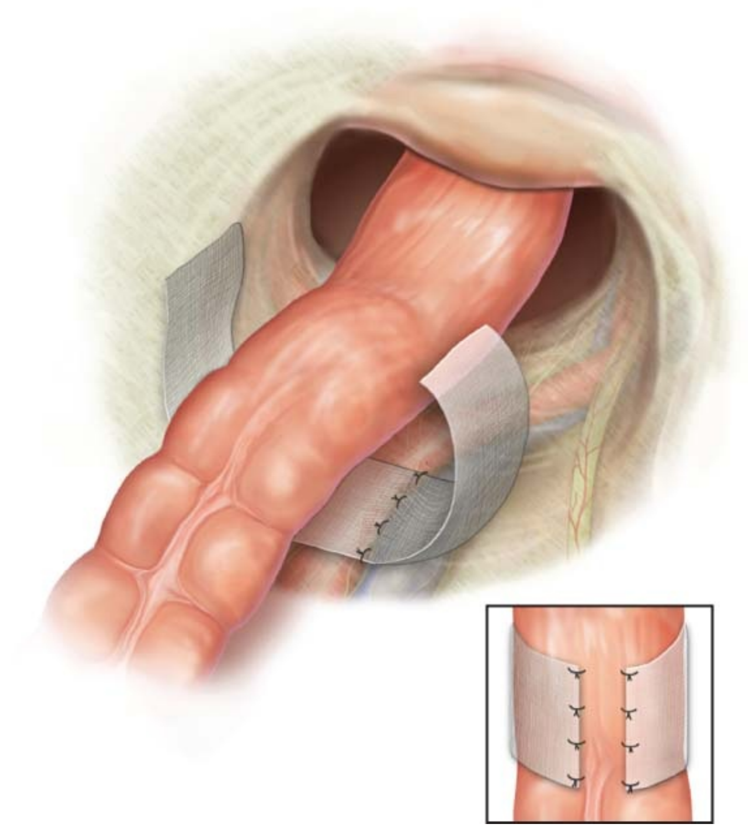


FIGURE 63-2 A modification of the Ripstein procedure leaves a gap in the mesh anteriorly. This is designed to prevent strictures.

Laparoscopic Technique

With the advent of laparoscopic surgery and improvements in instrumentation, an increasing number of endosurgical procedures have become possible, including the Ripstein procedure. Kusminsky *et al.* were the first to describe the laparoscopic approach in an 80-year-old woman who was undergoing concomitant laparoscopic cholecystectomy. During the description of the procedure, at the completion of the cholecystectomy the most lateral 5-mm port was converted to 10 mm, a second 10-mm port was placed in the left flank at the level of the umbilicus, and a third 12-mm port was placed in the suprapubic midline to allow access for the stapling device. The patient is then placed in steep Trendelenburg. Dissection begins with the left colon reflected away from the sidewall, followed by opening of the right parasigmoid peritoneum. The rectum is then separated from the presacral space using dissecting graspers with visualization from both sides of the rectum. Mobilization is continued as far distally as possible. The mesh is inserted through the left port and the promontory of the sacrum is pinpointed visually using tactile feedback. One end of the mesh is fixed to the presacral fascia using several staples with a laparoscopic stapling device. The mesh is then unrolled over the rectum and once again fixed in place with staples. The mesh is then secured to the rectum using intracorporeal sutures or a staple device. Although this operation is technically feasible, there have been no reports of long-term follow-up in these patients using this technique. Henry *et al.* reported a small case series of five patients undergoing a laparoscopic Ripstein procedure using a similar technique as described earlier. These patients were followed up for 10 months without significant issues.

POSTOPERATIVE MANAGEMENT

After surgical repair, a liquid diet is started on postoperative day 1 and the diet slowly advanced as tolerated. The Foley catheter is then removed on postoperative day 1 or 2. All patients are instructed about the potential for incontinence before discharge and oral pain medications with fiber and stool softeners prescribed. As noted by Kusminsky et al., the postoperative course in laparoscopic repairs tended to be shorter with patients being discharged as early as 24 hours.

COMPLICATIONS

Although the Ripstein procedure is associated with a low mortality, ranging from 0% to 2.8%, it does have a considerable morbidity, ranging from 13% to 50%. In a 22-year experience from Lahey Clinic, Roberts *et al.* reported the most common complication to be presacral hemorrhage with an incidence of 8.1%. Vascular control was obtained by tightening the sacral stay sutures as a ligature, similar to the technique described by Ripstein. At times, pelvic packing was required. The high incidence of bleeding complications emphasizes the importance of entering the correct tissue plane during dissection.

The Ripstein procedure has also been criticized for the use of the mesh causing stricture; however, the highest incidence of stricture is reported at 5.6% and as low as 2.2% in the Lahey Clinic experience. Patients who developed strictures tended to have a long history of severe constipation and an even longer history of rectal prolapse. These patients required reoperation with a low anterior resection. This complication may be potentially avoidable by utilizing a posterior wrap as described by Wells. By posterior sling placement, the rectum is allowed to expand, while still anchoring it to the sacrum to prevent intussusception and prolapse. Multiple studies have also suggested the use of a different prosthetic material such as polytetrafluoroethylene or Gore-Tex to allow for ingrowth of the mesh and to minimize inflammation, ultimately preventing delayed stricture secondary to fibrotic reaction. Gordon *et al.* sent out a questionnaire to over 129 surgeons who collectively performed 1,111 Ripstein procedures and noted that the complication rate was highest for surgeons with the least experience, with more structuring complications based on sling placement.

Infection was the third most common morbidity associated with the procedure. As reported by Ricciardi et al., when all transabdominal approaches for rectal prolapse were compared with transperineal, transabdominal approaches were found to have three times the infection rate. These included surgical site infection of 2.6%, sepsis of 2.4%, and organ space infections at 2.0%. If an abscess were to develop after the Ripstein procedure, the mesh would need to be removed through abscess drainage with potentially a diverting colostomy. For this reason and as stated earlier, all patients undergoing the Ripstein procedure should receive prophylactic antibiotics as well as bowel preparation. Patients with multiple comorbidities and high BMI should also be considered for a transperineal approach, given their higher susceptibility to infection. Other complications of the procedure have been reported, but at much lower incidence, including impotence, fistula formation, small intestinal obstruction, and sciatica pain.

OUTCOMES

During the past two decades, the Ripstein procedure has fallen out of favor because of mesh complications and the development of other approaches. The technique has largely been abandoned and replaced with alternative repairs such as the posterior mesh repair (Wells procedure), ventral rectopexy, traditional suture rectopexy, and resection rectopexy. However, the procedure appears to be quite durable with a recurrence rate in the 1.6–12.2% range. In the Lahey Clinic study, Roberts *et al.* reported a recurrence rate of 9.6%, more than 30% secondary to technical factors, either from laxity of the sling, sling being anchored too high in the rectum, or mesh not being secured adequately. Recurrence was also found to be more common in men than in women, approximately 23.5% recurrence, which was nearly three times greater than the recurrence in women. Lescher *et al.* studied the management of late complications from sling repair for rectal prolapse and found that most instances of recurrence were in young men with a mean age of 38. The mesh was typically not secured adequately or was too high in the rectum, likely due to the increased complexity with dissection and suture placement in a narrow male pelvis. The treatment for these patients was to undergo low anterior resection.

The Ripstein procedure has been most successful in patients with rectal prolapse associated with incontinence. In general, continence either remains unchanged or improves after surgery. In particular, after the Ripstein procedure the number of bowel movements decreased and incontinence improved overall, in fact 50–77% improving postoperatively. Schultz *et al.* studied anal manometry both preoperatively, 7 days postoperatively, and 6 months postoperatively. He found that at 6 months postoperatively there was an increase in MRP that was not present at 7 days postoperatively. He concluded that these patients recovered anal sphincter function by essentially removing the mechanical dilator, the prolapse, of the sphincter. Ripstein himself indicated that patulous atonic sphincter improves postoperatively with exercises aimed at restoring anal sphincter tone.

Patients with rectal prolapse associated with baseline constipation either remain the same or, in most instances, become worse. Holmström *et al.* found that 27% of patients had constipation preoperatively, which increased to 43% postoperatively. He postulated that these patients had prolapse secondary to constipation, meaning that the functional disturbance occurred first. Therefore, surgery to correct the rectal prolapse would not correct the underlying physiology of the constipation. Tjandra *et al.* also found persistence of constipation to be more common after surgery, most commonly attributed to sling placement. Similarly, in a gastrointestinal transit study performed by Schultz, significantly more markers were retained in the postoperative period compared with the preoperative period. In these patients, other approaches should be considered first.

CONCLUSIONS

In conclusion, the Ripstein procedure is adequate for patients with rectal prolapse associated with incontinence. It is a procedure of low mortality but significant morbidity; therefore, patient selection is of utmost importance. It is feasible to laparoscopically or robotically perform the Ripstein procedure; however, long-term outcomes have not been published. When performed, posterior mesh placement should be considered because it tends to have better results. The Ripstein procedure should not be performed in patients with multiple medical comorbidities, high BMI, low albumin, and those patients who cannot tolerate a transabdominal procedure well. It should also be performed with some caution in young men because of the higher likelihood of recurrence. Both young men and patients with rectal prolapse associated with constipation should undergo alternative approaches.

RECOMMENDED REFERENCES AND READINGS

Gordon PH, Hoexter B. Complications of the Ripstein procedure. *Dis Colon Rectum* 1978;21(4):277–80.

Henry LG, Cattey RP. Rectal prolapse. *Surg Laparosc Endosc* 1994;4(5):357–60.

Holmström B, Brodén G, Dolk A. Results of the Ripstein operation in the treatment of rectal prolapse and internal rectal procidentia. *Dis Colon Rectum* 1986;29(12):845–8.

Hool GR, Hull TL, Fazio VW. Surgical treatment of recurrent complete rectal prolapse: a thirty-year experience. *Dis Colon Rectum* 1997;40(3):270–2.

Jurgeleit CH, Corman ML, Coller JA, Veidenheimer MC. Procidentia of the rectum. *Dis Colon Rectum* 1975;18(6):464–7.

Kusminsky RE, Tiley EH, Boland JP. Laparoscopic Ripstein procedure. *Surg Laparosc Endosc* 1992;2(4):346–7.

Launer DP, Fazio VW, Weakley FL, Turnhull RB, Jagelman DG, Lavery IC. The Ripstein procedure: a 16-year experience. *Dis Colon Rectum* 1982;25(1):41–45.

Lescher TJ, Corman ML, Coller JA, Veidenheimer MC. Management of late complications of Teflon sling repair for rectal prolapse. *Dis Colon Rectum* 1979;22(7):445–7.

Ricciardi R, Roberts PL, Read TE, Hall JF, Marcello PW, Schoetz DJ. Which operative repair is associated with a higher likelihood of reoperation after rectal prolapse repair? *Am Surg* 2014;80(11):1128–31.

Ripstein CB. Surgical care of massive rectal prolapse. *Dis Colon Rectum* 1965;8:34–38.

Roberts PL, Schoetz DJ, Coller JA, Veidenheimer MC. Ripstein procedure. Lahey Clinic experience: 1963–1985. *Arch Surg* 1988;123(5): 554–7.

Russell MM, Read TE, Roberts PL, *et al.* Complications after rectal prolapse surgery. *Dis Colon Rectum* 2012;55(4):450–8.

Scaglia M, Fasth S, Hallgren T, Nordgren S, Oresland T, Hultén L. Abdominal rectopexy for rectal prolapse. Influence of surgical technique on functional outcome. *Dis Colon Rectum* 1994;37(8):805–13.

Schultz I, Mellgren A, Dolk A, Johansson C, Holmström B. Continence is improved after the Ripstein rectopexy. Different mechanisms in rectal prolapse and rectal intussusception? *Dis Colon Rectum* 1996;39(3):300–6.

Schultz I, Mellgren A, Dolk A, Johansson C, Holmström B. Long-term results and functional outcome after Ripstein rectopexy. *Dis Colon Rectum* 2000;43(1):35–43.

Schultz I, Mellgren A, Oberg M, Dolk A, Holmström B. Whole gut transit is prolonged after Ripstein rectopexy. *Eur J Surg* 1999;165(3):242–7.

Tjandra JJ, Fazio VW, Church JM, Milsom JW, Oakley JR, Lavery IC. Ripstein procedure is an effective treatment for rectal prolapse without constipation. *Dis Colon Rectum* 1993;36(5):501–7.

Chapter 64

Laparoscopic Ventral Mesh Rectopexy

Andre J. L. D’hoore and Albert M. Wolthuis

INTRODUCTION

Rectal prolapse is a full-thickness intussusception of the rectum that protrudes through the anal ring as external prolapse. Untreated rectal prolapse may lead to progressive sphincter damage and eventually fecal incontinence. Deep internal rectal prolapse as a deep intussusception into the anal canal can lead to fecal incontinence and has been linked to obstructed defecation (OD). Surgery for rectal prolapse intends to restore the anatomy and to improve function while avoiding surgery-related morbidity and functional sequellae. Laparoscopic ventral mesh rectopexy (LVR) has gained widespread acceptance, but the type of mesh used (synthetic or biologic) is of timely debate. LVR aims to preserve the rectal ampulla while correcting the leading cause: the rectal intussusception. Furthermore, it corrects a concomitant enterocele and/or rectocele. The dissection is limited to the rectovaginal septum and avoids autonomic nerve damage. More classical types of rectopexy (Ripstein procedure, Wells rectopexy, etc.) require extensive mobilization of the rectal ampulla. Such mobilization may result in autonomic neural damage leading to hindgut inertia and postoperative constipation. Therefore, the functional outcome of an abdominal suture rectopexy with sigmoid resection (Frykman–Goldberg procedure) is better. Rectal prolapse is often associated with a varying degree of middle pelvic compartment prolapse. Insufficiency of the uterosacral ligaments (level I) may lead to enterocele formation and/or vaginal vault prolapse. Structural damage to the rectovaginal septum will lead to a high rectocele (level II). The unique position of the mesh in LVR not only corrects the leading cause of the rectal prolapse (the intussusception) but also reinforces the rectovaginal septum and suspends the middle pelvic compartment (Fig. 64-1). The technique therefore should be tailored to the preoperative findings on defecation proctogram (colpo-cysto-defecography). Surgery for patients with OD and deep internal prolapse remains highly controversial. There is evidence for the role of LVR in patients with internal prolapse and fecal incontinence. Despite the presence of a mesh on the anterior aspect of the rectum, there is no impact on rectal functional volume and compliance. This is in contrast to perineal procedures (Altemeier–Delorme).

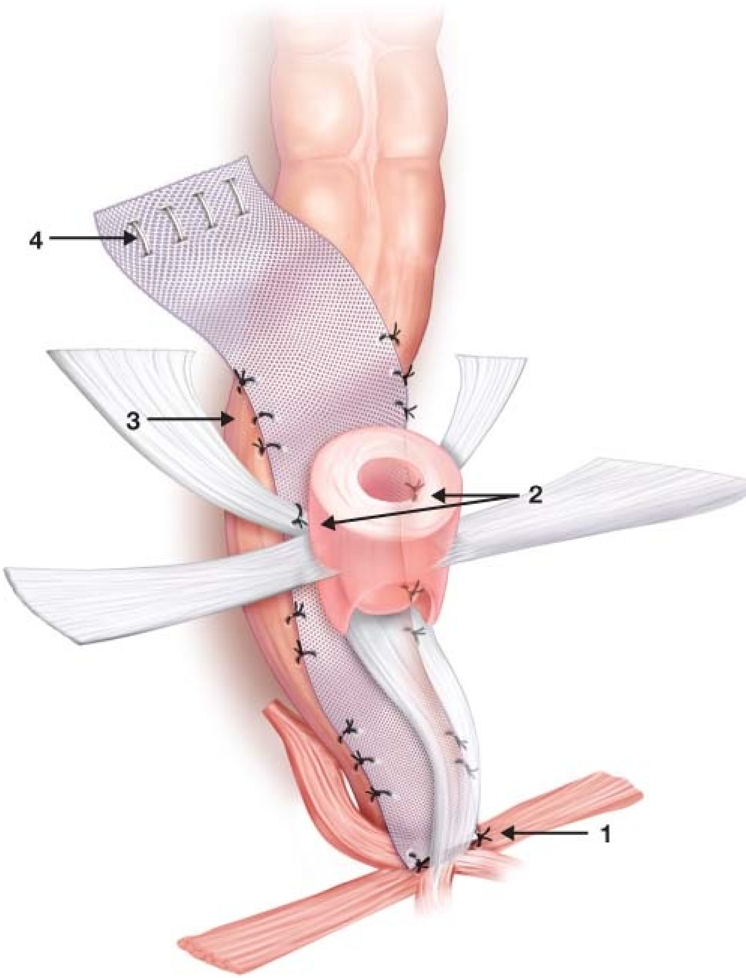


FIGURE 64-1 Laparoscopic ventral mesh recto-colpo-pexy. Position and fixation of the mesh: 1, Deep fixation within the rectovaginal septum reaching the level of the levator ani muscles. This allows a level II and III reinforcement of the middle pelvic compartment. 2, A colpopexy incorporating the uterosacral ligaments to the same mesh suspends level I of the middle pelvic compartment (corrects an enterocele, vaginal vault prolapse). 3, The mesh is fixed to the anterior aspect of the rectum at the level of the intussusception. 4, Fixation of the mesh to the sacral promontory.

PREOPERATIVE PLANNING

In most patients with external rectal prolapse, the clinical findings will be evident. It can be important to visualize the other pelvic compartments. Therefore, a colpo-cysto-defecography or dynamic magnetic resonance scan will be indicated (Fig. 64-2). In patients with fecal incontinence, anal manometry can document residual sphincter function. In patients with OD and internal prolapse, the preoperative functional investigation should be extensive to exclude other causes of pelvic floor dyssynergia that warrant conservative treatment. It is difficult to assess the relative impact of structural (anatomic) prolapse and functional problems that contribute to outlet delay (Fig. 64-3). Preoperative anesthetic consultation is important, especially in the old and frail patient to determine whether the patient is fit for general anesthetic and a laparoscopic approach. The unfit patient should undergo a perineal procedure.

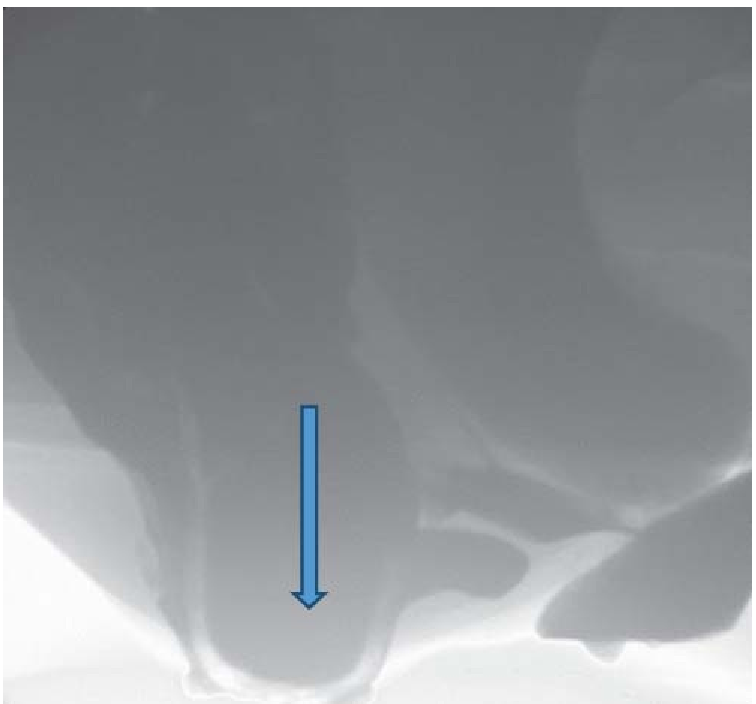


FIGURE 64-2 Defecation proctogram: end of straining. Loops of small bowel descend into the rectovaginal septum and further protrude the intussusception. Note the important dilation of the anal canal. Prolapse is most often most pronounced in the anterior aspect.

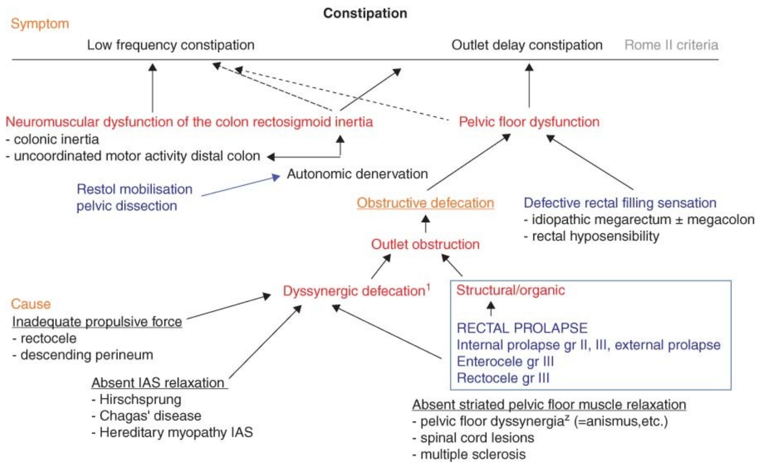


FIGURE 64-3 Outlet delay constipation. Only the anatomic causes can be corrected with prolapse surgery.

PREOPERATIVE PREPARATION

Patients are given a phosphate enema before surgery to empty the rectal ampulla. The rectal ampulla and vagina are rinsed with a Betadine solution in the operating room. Antibiotic prophylaxis is given before the start of the surgical procedure and a urinary catheter is inserted.

Patient Positioning and Trocar Placement

Patients are positioned in a modified Lloyd-Davis position on a moldable bean bag with both the arms adducted. Arms are tucked along the body. Strapping should allow steep Trendelenburg position if needed. An optical trocar is positioned at the umbilical site. A 30-degree optic is preferable to facilitate deep pelvic visualization. Under direct vision, three other trocars (one 12 mm and two 5 mm) are placed. The 5-mm trocars are placed in the right flank and left iliac fossa. The 12-mm trocar is placed in the lower right iliac fossa. Care should be taken not to injure the internal orifice of the inguinal canal and the genitofemoral/ilioinguinal nerve (Fig. 64-4).

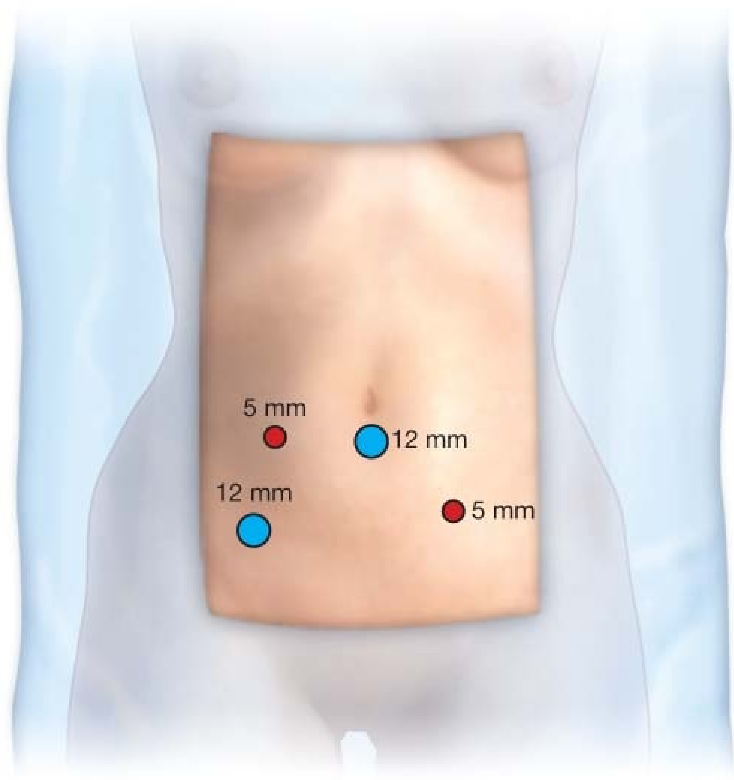


FIGURE 64-4 Trocar position for LVR. Blue dot—12 mm, optic trocar at the umbilicus, right iliac fossa port for mesh introduction and external knotting; red dot—5-mm working trocars.

Anatomic Landmarks

A temporary uterosuspension with transcutaneous suture through the broad ligament (round ligament) can be useful to optimize the view of the pelvis (Fig. 64-5). Of interest are the rectosigmoid colon (⇐), the impression of the sacral promontory (1), the right ureter (2), and the right internal iliac artery (3). The left iliac vein can be close to the sacral promontory and can be injured if the dissection is too medial.

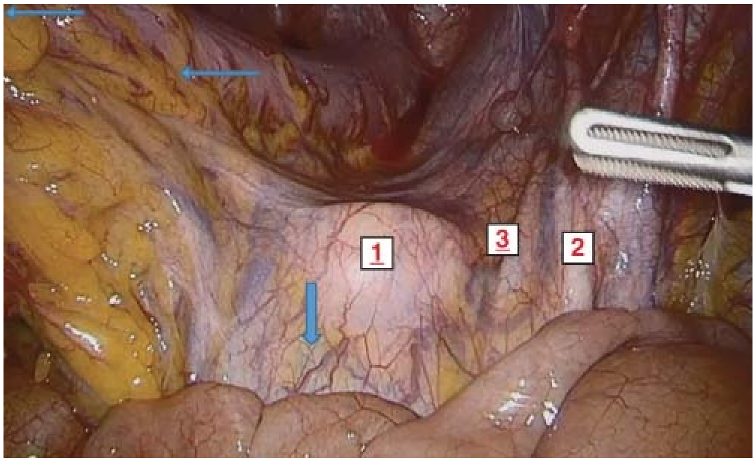


FIGURE 64-5 Anatomic landmarks: Surgeon's view of the pelvis. Gentle elevation and retraction of the rectosgimoid. 1, Sacral promontory; 2, right ureter; 3, right internal iliac artery; small arrow—rectosigmoid junction; broad arrow—impression of the left iliac vein.

Dissection at the Sacral Promontory

Dissection starts over the sacral promontory. Special care is taken to avoid injury to the **right hypogastric nerve** that crosses the pelvic brim at this level (Fig. 64-6). Smaller vessels on the sacral promontory should be controlled by coagulation (monopolar or ultrasonic) and a zone of about 2–3 cm should be freed to allow safe mesh fixation.

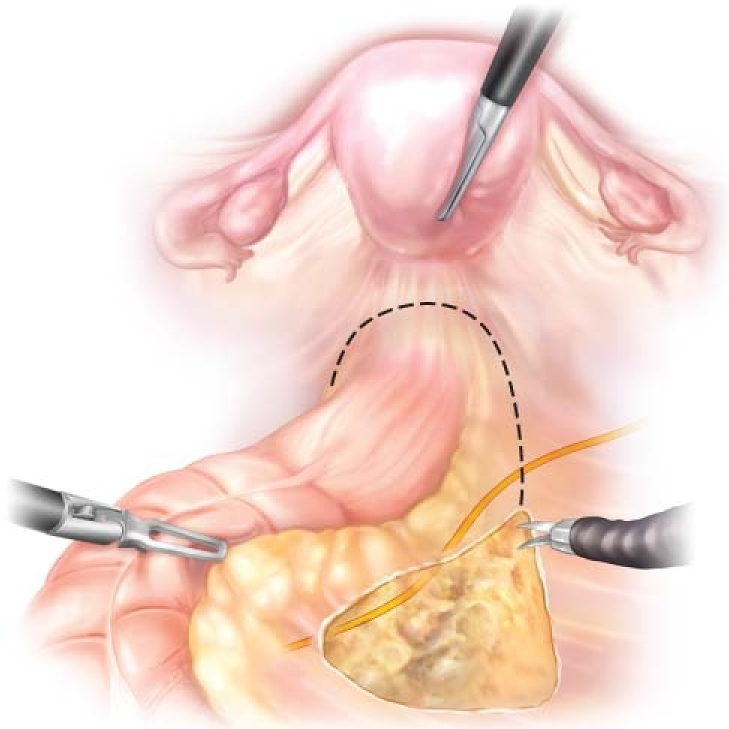


FIGURE 64-6 Dissection at the sacral promontory and line of peritoneal opening. Course of the hypogastric nerve (yellow line).

Bleeding from the left iliac vein should be controlled by localized compression and often indicates conversion to open laparotomy.

Opening of the Pelvic Peritoneum

The peritoneum is opened along the right side of the rectum and extended in an inverted "J" from over the **deepest** part of the pouch of Douglas. The pouch of Douglas should be firmly retracted and opened at its deepest part. This step is essential to facilitate safe opening of the rectovaginal septum (Figs. 64-7 and 64-8).

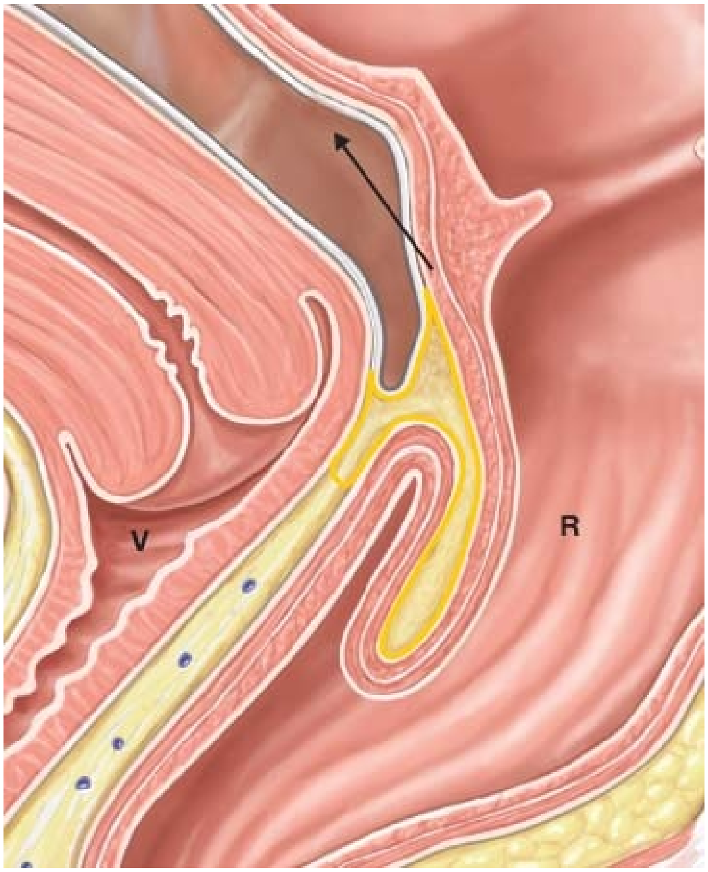


FIGURE 64-7 Sagittal cross section at the level of the pouch of Douglas. Firm retraction of the intussusception will allow incising the deepest part of the pouch of Douglas. V, vagina; R, rectum; yellow line, preperitoneal fat of the pouch of Douglas.

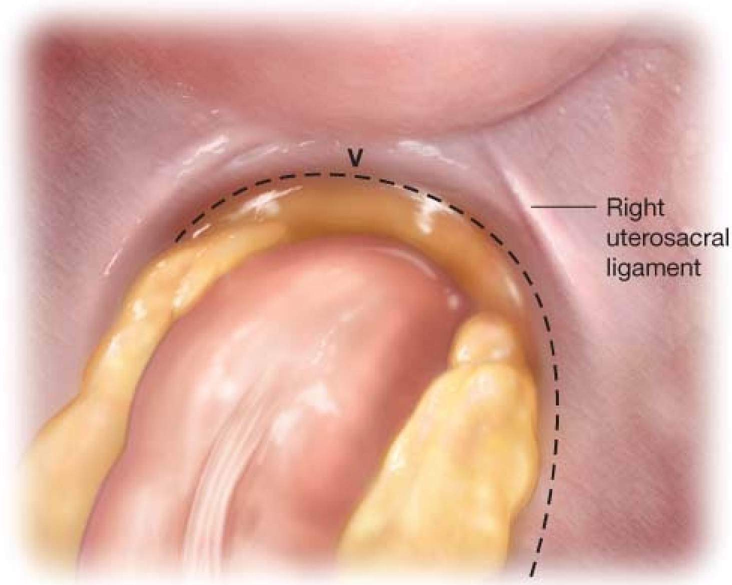


FIGURE 64-8 Surgeon's view of the pouch of Douglas. Line of peritoneal incision. Uterosacral ligaments are identified. V, vaginal vault.

p. 601

p. 602

A right lateral peritoneal flap is created, avoiding damage to the autonomic nerve supply of the rectum. This will allow closure over the mesh at the end of the procedure.

Dissection of the Rectovaginal Septum

The dissection starts by incision of Denonvillier's fascia at 1 cm distance from the vaginal vault and is performed on the anterior muscular aspect of the rectum, leaving all areolar and fibrotic tissue on the posterior side of the vagina. The assistant surgeon will progressively grasp and elevate the posterior side of the vagina and the surgeon will horizontalize the rectum to facilitate this dissection. A flat retractor can be inserted in the vagina to facilitate this maneuver, especially after a previous hysterectomy. Depending on the individual need to correct a concomitant rectocele, a deeper dissection can be performed until the pelvic floor is reached. Occasionally, in the presence of a low rectocele (perineocele), the laparoscopic dissection can be completed with transperineal dissection. *No lateral or posterior dissection is performed, and the risk of autonomic nerve damage should therefore be limited. Occasionally, it will be necessary to resect the "fatty pad" of the pouch of Douglas to allow good mesh fixation. Care should be taken to obtain meticulous hemostasis and to avoid* *injury to the muscular wall of the rectum.* If inadvertently the rectum or the vagina has been injured, this should be sutured and no further mesh should be implanted to avoid mesh erosion and/or infection. The surgeon can decide to perform a suture posterior rectopexy.

p. 602

---

p. 603

Fixation of the Mesh to the Anterior Side of the Rectum

The authors routinely use a nonabsorbable polypropylene strip (4 × 18 cm). The strip will be trimmed to the individual situation. As previously mentioned, different types of mesh can be used. *The mesh should be sutured at the level of the intussusception to the ventral aspect of the rectum* (Fig. 64-9). Recently, absorbable sutures have been used. The authors favor an extracorporeal knot-tying technique using a knot pusher to guide the knot. Deeper suturing will fix the mesh into the rectovaginal septum. Recently, the use of biologic glue facilitates this fixation and significantly reduces the need for suturing in the deepest part of the rectovaginal septum. Care should be taken that the mesh lies flat on the anterior side of the rectum.

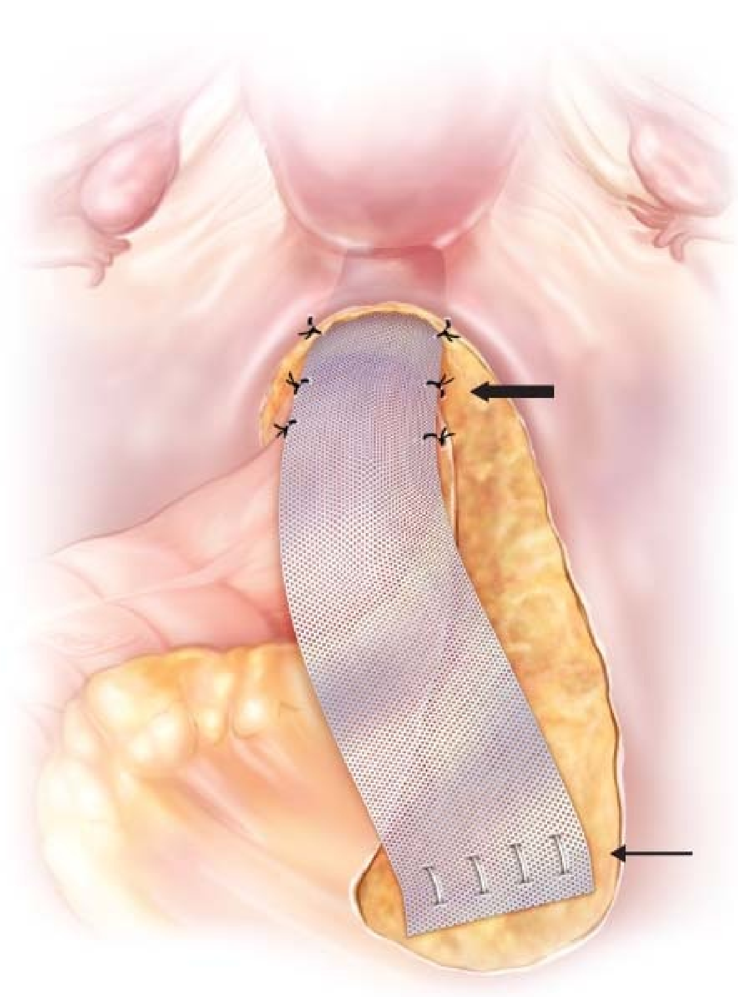


FIGURE 64-9 Fixation of the mesh at the site of the rectal intussusception (broad arrow) and to the sacral promontory (small arrow).

p. 603

---

p. 604

Fixation of the Mesh to the Sacral Promontory

The mesh is then fixed to the sacral promontory using an endoscopic tack applier and, if needed, additional nonabsorbable suture(s). Detachment of the mesh from the sacral promontory will result in recurrent prolapse. The mesh will reduce the prolapse, but no undue traction should be exerted and the rectum should remain in the sacrococcygeal hollow. *Recently, the authors (AW) tunneled the mesh under the hypogastric nerve to avoid nerve entrapment when the mesh is fixed to the sacral promontory.*

Colpopexy

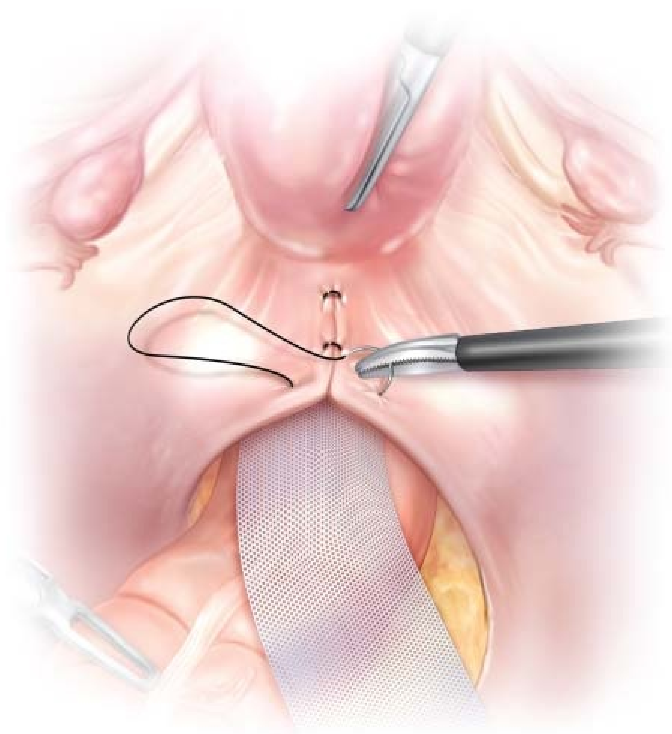
In the presence of an enterocele, a vaginal prolapse or visible insufficiency of the sacrouterine ligament and a colpopexy will be performed to the same mesh. The sutures will incorporate the fibrous part of the cardinal ligament and additional sutures can be placed to further elevate the vaginal vault (Fig. 64-10). If the uterosacral ligaments are intact, no colpopexy should be performed because this would change the natural axis of the vagina and could induce dyspareunia.

FIGURE 64-10 Sagittal view of the unique position of the mesh that allows to perform a rectopexy and colpopexy (⇐).

Peritoneal Closure

Peritoneal closure

After a final control of hemostasis, the peritoneum will be closed over the mesh. This creates an elevated “neo-pouch” of Douglas (Fig. 64-11). No pelvic drain should be placed.



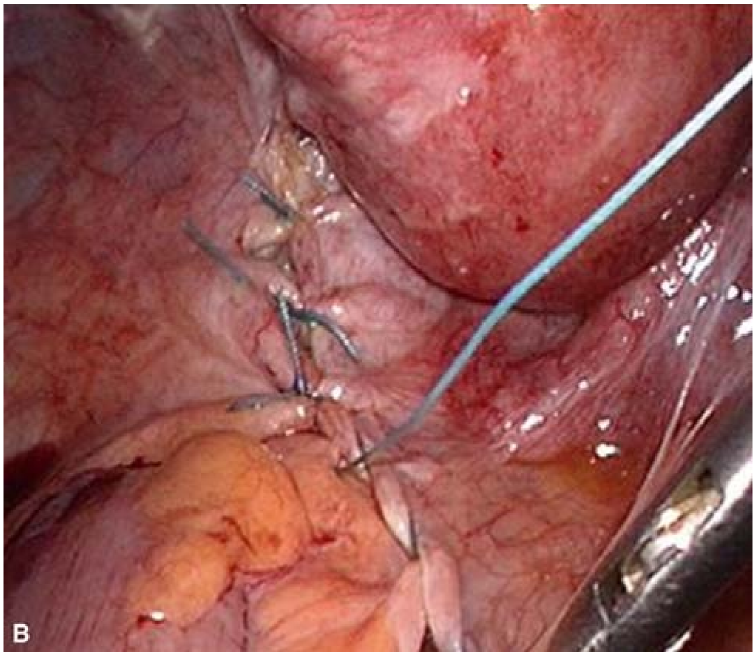


FIGURE 64-11 A. Peritoneal closure over the mesh creating a “neo-pouch” of Douglas. B. Peritoneal closure (laparoscopic view).

The mesh should be completely covered to avoid small bowel fixation to the mesh.

Under direct vision, all laparoscopic ports are removed and 12-mm sites are closed.

POSTOPERATIVE MANAGEMENT

At the end of the operation, the nasogastric and urinary catheter are removed. Early ambulation is advised, and normal diet is resumed as soon as possible. Patients can be discharged on the day of surgery or (usually) after a one-night stay. Fiber supplements are prescribed, and the patient is advised to avoid straining efforts.

OUTCOME

Preoperative complications are fortunately infrequent or rare. Conversion to laparotomy is required in about 3% of patients. The most common reason is the presence of dense adhesions that necessitate open adhesiolysis. Troublesome bleeding is very uncommon. As mentioned, any injury to the rectum or vagina should be sutured and no mesh rectopexy should be performed. *Postoperative morbidity* is minor. Urinary tract infection is the most common morbidity. The procedure has been proved safe in the elderly. Long-term mesh-related morbidity including mesh erosion and mesh-related infection has been noted in about 4% of patients. Furthermore, some cases of septic spondylodiscitis have been described. *Prolapse recurrence* is in concordance with more classical mesh rectopexy techniques and is in the order of 10% at 10-year follow-up. The most common causes for recurrence are undue traction on the posterior or middle pelvic compartment and detachment of the mesh at the sacral promontory fixation. In case of recurrence, a laparoscopic exploration with mesh refixation is indicated. *Functional outcome* shows a significant recovery of fecal continence in a large majority of the patients. Recovery of sphincter function does take time and a reevaluation should be performed only at an interval of 6–12 months. In contrast with more classical mesh rectopexy, new-onset constipation is seldom (<5% of patients). In about 70% of patients, a significant improvement of rectal emptying has been documented. Recovery of function seems to be equal for external and symptomatic internal rectal prolapse. LVR does not correct a descending perineum.

CONCLUSION

LVR is a safe and effective, autonomic nerve-sparing technique to restore rectal prolapse and the concomitant prolapse of the middle pelvic compartment. Fecal continence will recover in most of the patients and rectal emptying improves in about 70% of patients while new-onset constipation is rare.

RECOMMENDED REFERENCES AND READINGS

Consten EC, van Iersel JJ, Verheijen PM, Broeders IA, Wolthuis AM, D'Hoore A. Long-term outcome after laparoscopic ventral mesh rectopexy: an observational study of 919 consecutive patients. *Ann Surg* 2015;262(5):742–7.

D'Hoore A, Cadoni R, Penninckx F. Long-term outcome of laparoscopic ventral rectopexy for total rectal prolapse. *Br J Surg* 2004;91(11):1500–5.

D'Hoore A, Penninckx F. Laparoscopic ventral recto(colpo)pexy for rectal prolapse: surgical technique and outcome for 109 patients. *Surg Endosc* 2006;20(12):1919–23.

Mercer-Jones MA, D'Hoore A, Dixon AR, *et al.* Consensus on ventral rectopexy: report of a panel of experts. *Colorectal Dis* 2014;16(2):82–88.

van Iersel JJ, Paulides TJ, Verheijen PM, Lumley JW, Broeders IA, Consten EC. Current status of laparoscopic and robotic ventral mesh rectopexy for external and internal rectal prolapse. *World J Gastroenterol* 2016;22(21):4977–87.

PART XIV

VENTRAL HERNIA REPAIR

Chapter 65

Abdominal Wall Reconstruction

Daniel J. Park and S. Alexander Earle

Abdominal wall defects and ventral hernias are common complaints that bring patients to seek surgical attention. In addition to primary defects, studies have shown that about 20% of laparotomies will result in incisional hernias. Patients present with a variety of complaints ranging from asymptomatic bulges to obstructive symptoms with significant limitations on quality of life. With 10-year failure rates of primary suture repair well over 60% (and greater than 30% for mesh repair), this is clearly an area for improvement. Recent investigations, as well as innovative techniques and materials, have sought to improve outcomes. We present our approach to the treatment and management of abdominal wall reconstruction.

INDICATIONS/CONTRAINDICATIONS

Patients may complain of an abdominal bulge with or without related pain. They may also have complaints of problems with defecation or urination that may be related to inability to Valsalva effectively because of displacement of the abdominal musculature. Complaints of back pain are also common. Patients may also present in a more urgent or emergent manner, with acute incarceration or strangulation leading to severe pain and obstructive symptoms.

Indications for repair include symptomatic abdominal wall defects, those causing obstructive symptoms or with evidence of ischemia, ulceration of overlying skin, and significant pain. Patients may be asymptomatic as well, but with limitations of the activities of daily life. Many of these patients benefit as well from repair, although their prospective improvement should be balanced against the risk of both the surgical procedure as well as the chances of recurrence.

Absolute contraindications are few, short of those patients who cannot tolerate the surgical procedure from a cardiovascular standpoint. All patients should be evaluated medically to optimize any conditions that may lead to increased complications or recurrence. These include the presence of ascites, obesity, diabetes, and smoking history. A more thorough discussion follows.

PREOPERATIVE PLANNING

Diagnosis can usually be made through a thorough history and physical examination. Often, the defects and any herniating contents are obvious on cursory examination. Imaging with an abdominal computed tomography (CT) can be helpful with more subtle defects, and also in the acute setting, to determine the extent of the defect, presence of multiple defects ("chain of lakes"), and the presence of herniated organs. Evaluation also includes laboratory evaluation and perioperative risk evaluation.

Proper patient selection is crucial in the elective setting, more to optimize potential outcomes rather than to avoid difficult surgery. Even in high-risk patients, repair has been shown to provide a significantly improved quality of life. But as stated before, the high-potential failure rate makes it imperative to identify and address modifiable risk factors preoperatively to provide a lasting and durable repair. These risk factors commonly include ascites, obesity, diabetes, chronic obstructive pulmonary disease (COPD), and smoking. Every attempt should be made to intervene and to optimize comorbidity before surgery.

Patients with ascites are at particular risk of recurrence and wound complications, leading to poor outcomes. Ascites can lead not only to wound complications but also to subsequent bacterial peritonitis as well as significant morbidity and possible mortality. Medical evaluation is imperative, and therapy to manage the ascites is crucial to favorable outcomes.

Obesity has been shown to be associated with increased wound-healing complications, as well as being a cause for recurrence. If asymptomatic, patients should be encouraged to lose weight through lifestyle modifications, including diet and exercise. Weight loss is not always possible because the abdominal wall defect can often make activity and exercise difficult or near impossible for patients. As such, potential benefits of repair, such as improved activities of daily living need to be balanced against potential weight-related complications. Diabetes is a frequent comorbidity that may exist in the obese patient and is also associated with significant wound-healing complications. Comorbidity risk may improve with weight loss and exercise, but medical evaluation should be performed to optimize glycemic control to limit possible complications.

Smoking and the presence of COPD are risk factors affecting both healing and possible recurrence. Smoking cessation is very important because the vasoconstriction secondary to nicotine and other products of smoking can significantly impair wound healing. This caveat is especially true in patients undergoing component separation, where perforators to the skin flaps are disrupted and circulation can be compromised. The added insult of smoking disrupted and circulation can be compromised. The added insult of smoking greatly increases the chances for skin edge ischemia. COPD can increase the chances of recurrence because of the repetitive significant increases in intra-abdominal pressure with coughing.

SURGERY

Techniques

The approach to repairing abdominal wall defects should be similar to those of other reconstructive problems elsewhere in the body. When considering these problems, the idea of the "reconstructive ladder" can be a helpful guiding principle in choosing the appropriate method of reconstruction. The simplest method for repair would involve primary repair of the abdominal wall defect. The goal of any repair is twofold: restoration of a functional abdominal wall by centralizing the rectus muscles, providing more normal vectors of force, in addition to restoring form by eliminating bulging due to hernias.

The first step in all cases is defining the abdominal wall defect. It is often difficult to dissect the hernia sac completely from the surrounding tissues and reduce the contents into the abdomen. These often long-standing defects have a significant amount of surrounding fibrosis and scarring between the sac and the adjacent soft tissue. The safest method involves opening up the hernia sac, reducing the contents after careful lysis of adhesions, and debriding the sac and any scar tissue off of the fascial edges. For patients with prior repair and mesh placement, this can be difficult and time consuming but is worth the effort to provide better tissue to sew to and reduce possibly colonized material left in the wound. The size of the defect and whether the fascial edges can be approximated will determine the reconstructive methods used to close the defect (Table 65-1).

TABLE 65-1 Abdominal Wall Reconstruction Techniques

Technique	Advantages	Disadvantages	Expected recurrence rate	Comments
Primary repair ("standard" suture technique)				

- Familiarity
- Uncomplicated unless there is a large defect

- High failure rate

• Increased wound infection rate	60%	Technique should be abandoned

Primary repair ("short suture" technique)

- Increased wound strength

- Lower wound infection rate
- Lower recurrence rate?

- Unfamiliar technique

• Increased operative time	Unknown, but probably <60%	Should be used for closure of all laparotomy wounds
Prosthetic repair (“inlay” technique; edge of mesh sutured near edge of the defect)		

- Technically simple

• High failure rate • Prosthetic becomes exposed if wound is opened	60%	Technique should be abandoned
Prosthetic repair ("sublay" or intraperitoneal technique)		

- Lower recurrence rate
- Prosthetic not exposed if wound is opened
- Better tolerance of infection even if prosthetic is involved (sublay only)
- Does not require complete closure of midline

• Technically more difficult	5–10%	Sublay technique may require prosthetics designed for intraperitoneal use if posterior layer cannot be closed
Prosthetic repair (“onlay” technique)		

- Technically easier than retromuscular techniques

- Requires complete closure of midline

• Requires skin flaps • Prosthetic becomes exposed if wound is opened	Unknown, probably around 15%	In general, prosthetics designed for intraperitoneal use are not required
Component separation technique	• Able to close midline defects up to 20 cm in width • May be used with the prosthetic technique (retromuscular or onlay)	

- Requires some training

• Increases operative time	• 20–30% if midline is closed using "standard" suturing technique • Probably 10–20% if "short suture" technique is utilized • Probably 10% if utilized with "short suture" technique and a prosthetic	Standard open component separation associated with 20–30% major wound complication rate; endoscopic or may need open techniques to lower wound complication rates by avoiding large skin flaps to disrupt blood supply

Simple Primary Midline Defects

For simple defects with easily approximated fascial edges, primary closure can be attempted. As described previously, simple primary closure is associated with very high recurrence rates and should rarely be attempted except in very small defects. It is our practice to perform primary repair in defects 2–3 cm in diameter or less, using a large, slowly absorbing, monofilament suture in a running manner. There is debate whether the type of suture or particular method of repair, including permanent versus absorbable, monofilament versus braided, interrupted versus continuous affects recurrence rates. Most studies have shown that those factors are unimportant. The most important factor in successful, durable repair is careful tissue handling with precise placement of sutures 5 mm from the fascial edge with 5-mm travel between subsequent sutures. The decision whether to use running or interrupted sutures is surgeon dependent.

Medium-sized Midline Defects

For larger defects with fascial edges that can still be approximated in the midline, we combine primary repair of the fascia with mesh reinforcement. There are several issues that must be considered when deciding on which mesh to use in a particular patient. The materials available for abdominal wall reconstruction are vast, and a brief description is warranted.

Prosthetic materials offer a cost-effective, durable option for mesh material. These patients have a long history of successful, durable repair of abdominal wall defects. The main detriment to their use is the risk of infection. As foreign bodies that do not readily vascularize or integrate, infection can be difficult to eradicate with antibiotics alone and generally will necessitate removal and another repair of the defect. Recurrence also occurs with these materials, with either failure of the mesh or by encapsulation through a foreign body response, causing displacement of the mesh. Failure of the material is thought to occur secondary to the cyclical motions from respiration causing gradual and progressive weakening, and ultimately fracturing of the mesh. Intra-abdominal placement of prosthetic mesh may potentially also lead to fistula formation and major patient morbidity as a result of prolonged wound healing and fluid losses. Most commonly the authors prefer a lightweight or ultra-lightweight polypropylene mesh because these have relatively large pore sizes that encourage tissue ingrowth. Recent work has shown these properties may provide enhanced ability to resist infection, as well as allowing for salvage instead of removal. The decreased bulk may also cause less of a foreign body response.

p. 611

The alternative to these prosthetic mesh materials is biologic materials. There are numerous products from several manufacturers, but the commonality between them all is that they are acellular tissue matrices. Depending on the product, they are derived from human dermis, porcine dermis, porcine small intestine submucosa, or bovine pericardium. The techniques used to sterilize and process the donor materials into a usable product are proprietary, and beyond the scope of this discussion, but lead to products that are acellular with the extracellular matrix of collagen and supporting proteins intact. This acellular scaffold allows for ingrowth of native cells and tissue, leading to greater incorporation than prosthetic materials. Incorporation and ingrowth of blood vessels into acellular matrices allows for greater resilience in the face of infection, as well as enabling their use in contaminated fields that would be a contraindication for synthetic repair.

Larger abdominal defects that can be approximated should be primarily closed as described. In addition, these patients all require reinforcement of the repair with some sort of mesh, whether synthetic or biologic, depending on the circumstances of the case. In addition to the choice of material, the location of reinforcement is also an important consideration. The mesh repair can be performed as an underlay, either intra-abdominally or in a retrorectus manner (Rives-Stoppa repair), or performed as an onlay overlying the suture repair and rectus fascia. An underlay repair is the preferred method, because the intra-abdominal force should distribute along the mesh and protect the repair, as abdominal force should distribute along the mesh and protect the repair, as opposed to an onlay that may be forced away from the repair. The Rives-Stoppa retrorectus repair is a favored approach opposed to the mesh placed in the abdominal cavity because of decreased chances of migration of the mesh and decreased contact with the bowel that may lead to eventual fistualization or perforation. One disadvantage of this approach is the need to secure the material in place with sutures through the full thickness of the rectus muscle and anterior fascia. This may lead to focal ischemia/necrosis of some of the muscle or neuroma formation, which ultimately may impair the recreation of a functional abdominal wall.

Large Abdominal Wall Defects

Many defects that surgeons encounter are unable to be closed in any manner previously mentioned. These large defects with loss of abdominal domain may be due to trauma, long-standing hernias, recurrent hernias, or even abdominal wall resections for malignancy. Again, the main goals of repair and reconstruction are to reestablish the abdominal domain and to recreate a functional abdominal wall. One method of repair is with a bridging piece mesh sutured to the edges of the defect. Fascial edges are debrided to healthy tissue and a sheet of mesh is tensioned and secured with a slowly absorbing monofilament suture. Although this method may return structures to the abdominal cavity, this does not provide a functional wall. In addition, if a biologic material is used, it is prone to stretching and recurrence of abdominal bulging and contour irregularities that may be confused with recurrence and cause significant distress for patients.

An alternative approach to large abdominal wall defects, and the favored approach, is the use of component separation (Fig. 65-1). It allows for the closure of very large defects and effectively aids in the recreation of a functional abdominal wall. By allowing the midline approximation of the rectus muscles, a midline linea alba is formed, which allows the rectus muscles to be held to length and balance the lateral pull of each oblique and transversus complex with the contralateral side. Even when both sides cannot be completely brought to midline, component separation provides maximal coverage of the abdomen with dynamic and muscular tissue to minimize laxity and bulging.

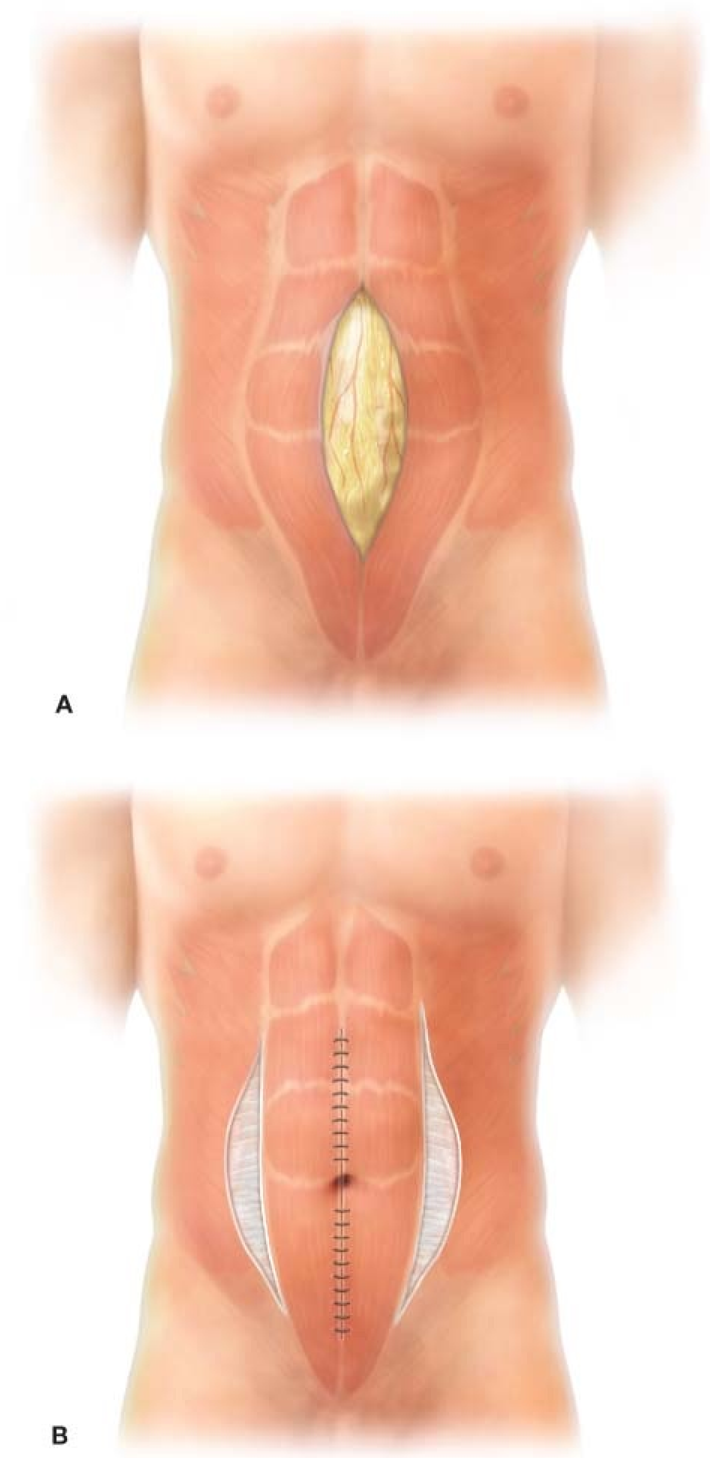


FIGURE 65-1 Image demonstrating component separation repair. A. Ventral hernia. B. After component separation repair with external oblique release.

Component separation starts by widely raising skin and subcutaneous tissue flaps laterally to the anterior or mid-axillary lines. This maneuver aids in the mobilization of the underlying tissues. Next, the linea semilunaris is identified. This can be done by direct palpation; palpation, however, can be difficult in patients with significant scar tissue. One can also use electrocautery to stimulate the anterior abdominal wall to identify the direction of the muscle fibers, delineating between the vertical orientation of the rectus muscles versus the oblique orientation of the external abdominal oblique (EAO) muscles. Once the linea semilunaris is identified, the fascia of the EAO is incised 1–2 cm lateral to that margin (Figs. 65-2 and 65-3). This incision opens the space between the EAO and the internal abdominal oblique (IAO), which is a safe and areolar plane for dissection. Care must be taken to stay in this plane to avoid nerve injury because the nerves of the abdominal wall course between the IAO and transversus abdominis. Release of the EAO can give significant mobilization of the anterior abdominal wall, with 4 cm of upper abdominal advancement, 8 cm of advancement at the level of the umbilicus, and 3 cm of lower abdominal advancement per side. For an additional 2–3 cm, release of the posterior rectus fascia can be performed in combination with release of the EAO (Figs. 65-4 and 65-5). This is done by incising the posterior rectus fascia just lateral to the free edge, and then elevating the rectus muscle from the posterior fascia.

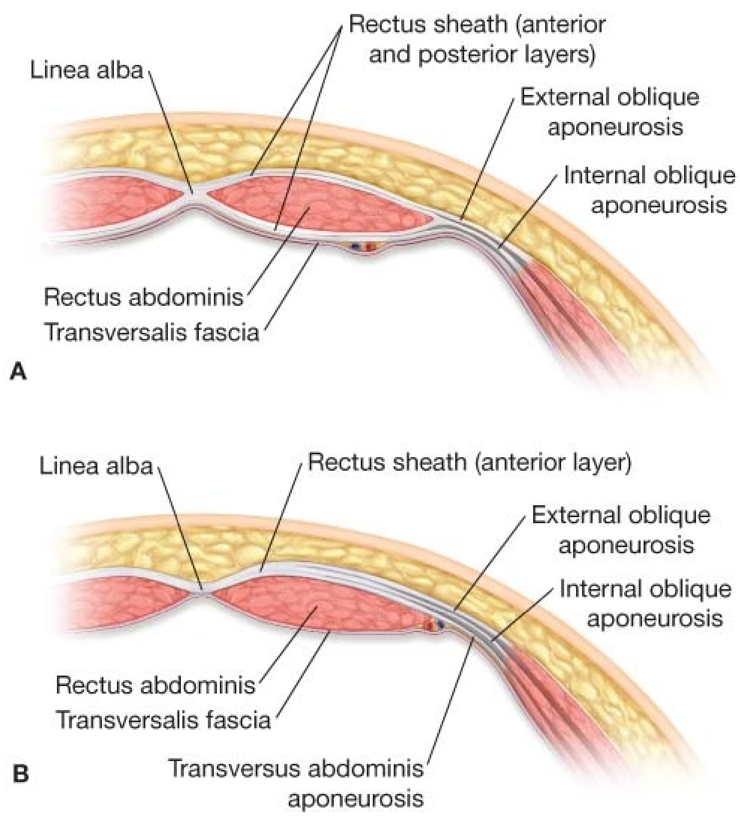


FIGURE 65-2 Layers of the abdominal wall. A.

Above the arcuate line. B. Below the arcuate line.

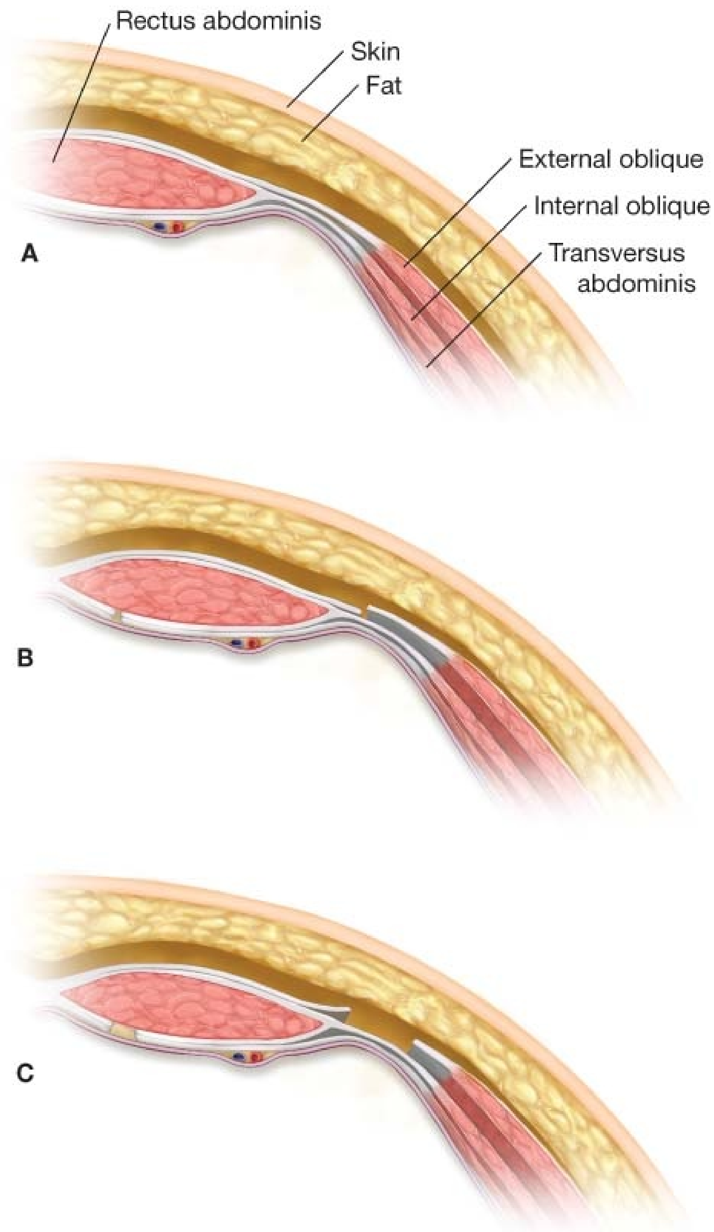


FIGURE 65-3 External abdominal oblique release. A. Subcutaneous flap raised and linea semilunaris identified. B. Fascia of external oblique incised 1-2 cm lateral to linea semilunaris. C. Release of external oblique and mobilization of rectus abdominis muscle flap.

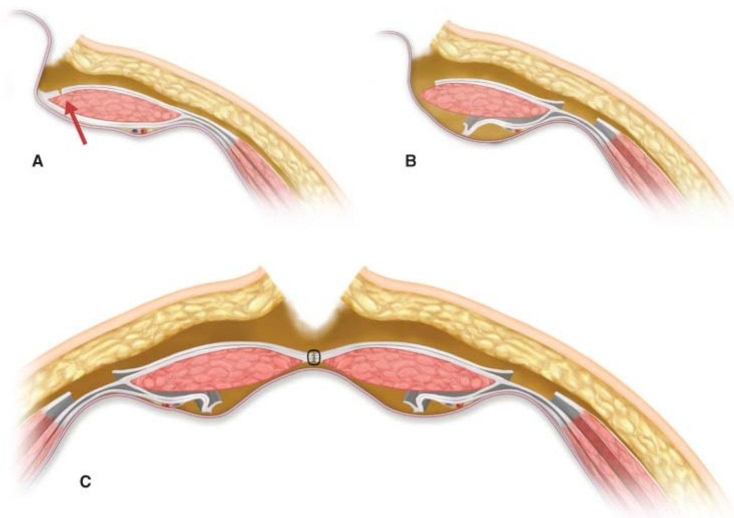


FIGURE 65-4 Posterior rectus release. A. Recuts sheath incision. B. Dissection of rectus sheath off rectus muscle. C. Midline repair after further excursion provided by posterior rectus sheath release.

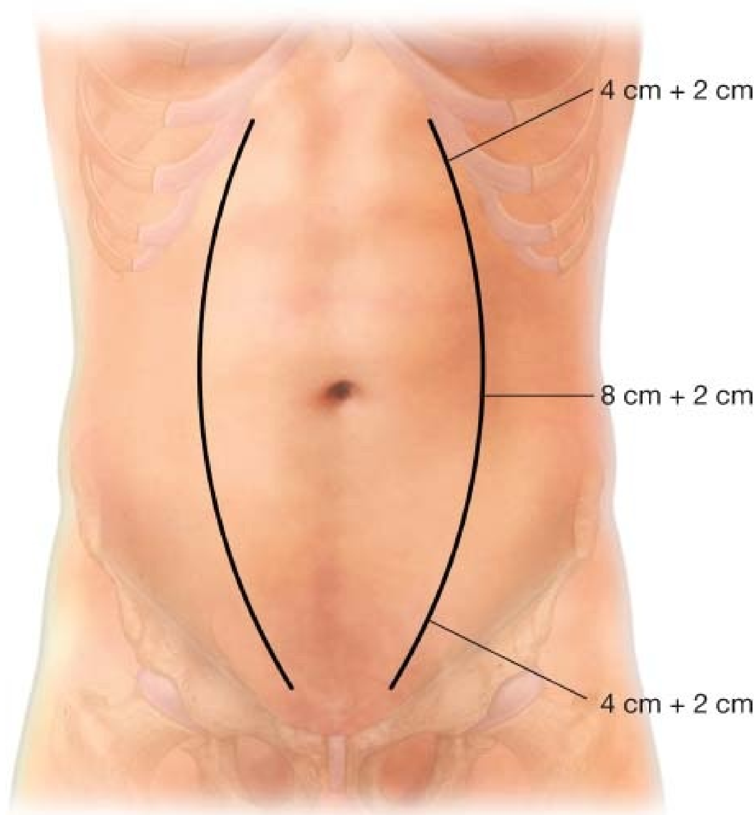


FIGURE 65-5 Amount of advancement from

component separation.

We commonly combine component separation with mesh reinforcement as either an underlay or overlay manner. An underlay can be done in an intraperitoneal or rectrorectus location (Fig. 65-6); whereas in an intra-abdominal location, the mesh should span from oblique edge-to-oblique edge. The mesh should be tensioned to allow easy midline closure. As described earlier, there are disadvantages to an underlay placement, specifically the need for full-thickness sutures to secure the mesh. This can cause neuroma or strangulate included tissue, which may impair abdominal wall function. The authors' favored approach involves an onlay of mesh to reinforce midline closure (Fig. 65-7). Similarly, the mesh spans from free oblique edge to free oblique edge. This can be performed easily and avoids the use of full-thickness sutures. The main disadvantage arises with possible mesh exposure if wound complications arise, which can be mitigated by the use of biologic materials.

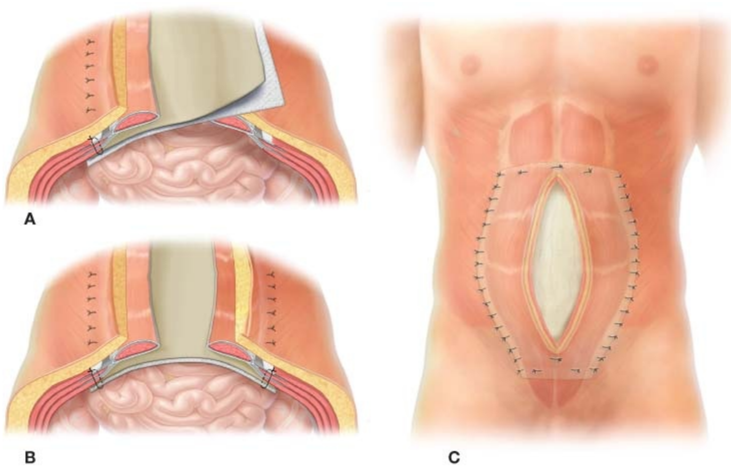


FIGURE 65-6 Component separation with underlay reinforcement. A. Mesh placed intraperitoneal and sutured full-thickness to oblique edge. B. Mesh properly tensed and attached to contralateral oblique edge. C. Combined repair with component separation and mesh underlay.

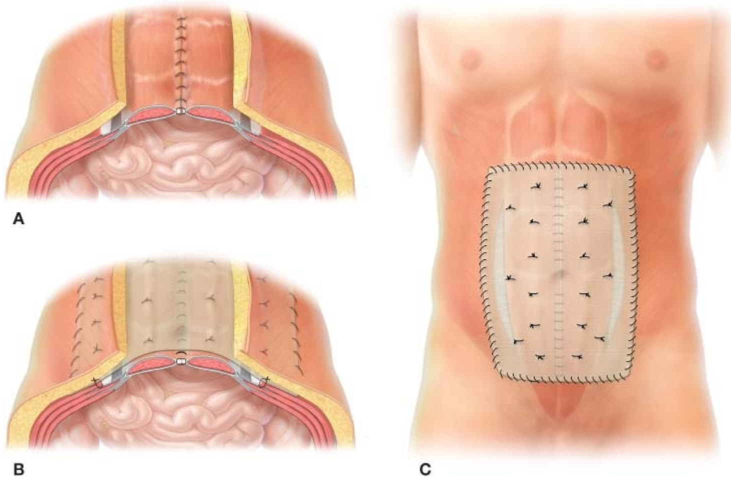


FIGURE 65-7 Component separation with onlay reinforcement. A. Component separation repair with midline closure. B. Onlay mesh sutured from oblique edge to oblique edge. C. Combined repair with component separation and only mesh reinforcement.

POSTOPERATIVE MANAGEMENT

Patients with small defects may be able to be operated on in an outpatient setting. For these smaller reconstructions and repairs performed primarily or with small mesh reinforcement, we do not place drains and the patients are discharged home with an abdominal binder in place. They are restricted to light activity and instructed to avoid lifting greater than 5–10 lb. This continues for 4–6 weeks.

Patients with larger defects, or those undergoing extensive lysis of adhesions or bowel resection, are admitted to the hospital with appropriate deep vein thrombosis prophylaxis. Drains are placed at the time of surgery. Care is taken to ensure adequate pain control and to prevent nausea and emesis that may lead to forceful abdominal contraction and possible disruption of the repair. We avoid the use of abdominal binders in the immediate postoperative period, especially in component separation patients because the circulation to the skin flaps is already diminished and compression may lead to congestion and eventual wound breakdown. However, an abdominal binder will be placed once the patient starts ambulating.

Larger defects necessitate drain placement as drains an important part of the postoperative management to manage possible fluid collections. Seroma is a commonly seen complication that can cause significant morbidity. This can range from discomfort to significant pain, with the potential need for subsequent drainage or other surgical procedures to deal with the fluid collections. Infection of the seroma can be problematic, especially if synthetic mesh prostheses have been used. This may necessitate reoperation and removal of the mesh material. Biologic materials can be more prone to fluid production; however, owing to their ability to incorporate, they may be more resistant to infection.

Patients are discharged home once their pain is adequately controlled and they are tolerating a diet and ambulatory. Drains remain in place until their output is less than 30 ml/day; in patients who have had a biologic matrix placed, this may be several weeks. Patients should be instructed in proper drain care, including frequent stripping of the drains and keeping accurate records of output. Patients are discharged with abdominal binders and encouraged to ambulate but avoid any strenuous activities for 4–6 weeks. They are not to lift anything greater than

5–10 lb during this time period.

COMPLICATIONS

Although abdominal wall reconstruction may provide significant benefit to the patient, like any other procedure it is not without risk. Complications seen after abdominal wall repair include infection, seroma, recurrence, pain, and fistula formation, either early or late. Infections may arise as a superficial wound infection or cellulitis, or present as a large abscess involving the prosthesis if one was placed. Simple superficial infections can initially be treated with antibiotics, but these patients must be closely followed up. If no significant improvement is noted in 24–48 hours, one must be aware and concerned of deeper infection. Infection of synthetic meshes can be problematic, often requiring operative debridement to remove the source of infection. Some recent work has indicated that lightweight or ultra-lightweight, large-pore polypropylene mesh may be more resistant to infection and can be salvaged with a course of antibiotics alone, but there is still debate. Any areas of mesh that do not show incorporation need to be completely excised. If a biologic matrix was used, and is exposed after debridement or drainage, negative pressure wound therapy can be used to manage the wound because the matrix will granulate and be more resistant to infection.

Seroma is a common finding after abdominal wall reconstruction. As discussed earlier, it can cause significant morbidity. Closed-suction drainage is the mainstay of postoperative management and should be removed on a volume-controlled basis. Seromas may cause bulging of the abdominal wall, but concern for recurrence should always be present. Seromas may be associated with a recurrence of previous symptoms, increased pain, a reducible mass, or obstructive symptoms. Repeat CT imaging is helpful in delineating possible recurrence from seroma or postoperative swelling.

RESULTS

Abdominal wall reconstruction is a procedure that has historically been associated with high rates of recurrence. As noted before, closure of a primary laparotomy itself is associated with up to a 20% incisional hernia rate. Primary suture repairs have an unacceptably high rate of recurrence near 60%. Mesh repairs significantly reduce recurrence, with reports of rates between 5% and 30%. The use of component separation has a similar recurrence rate. The effect of underlay placement of mesh compared to onlay techniques is not well elucidated, but the technical advantages and disadvantages have been noted earlier.

CONCLUSIONS

Abdominal wall defects and hernias are extremely common problems causing patients to present to the surgeon's office. These defects and hernias can be seriously debilitating conditions for patients, greatly limiting normal activity and causing significant pain and discomfort. The decision to operate needs to be considered closely because the recurrence rates of repair are high, even in the best of circumstances. Management of comorbidities is crucial to ensure optimal outcomes. Component separation and the use of mesh materials are important tools in the armamentarium of any surgeon who plans to perform abdominal wall reconstruction. Using a systematic approach to the preoperative evaluation, intraoperative approach, and postoperative care, we can aim to provide optimal outcomes in these difficult scenarios.

RECOMMENDED REFERENCES AND READINGS

Albino FP, Patel KM, Nahabedian MY, Sosin M, Attinger CE, Bhanot P. Does mesh location matter in abdominal wall reconstruction? A systematic review of the literature and a summary of recommendations. *Plast Reconstr Surg* 2013;132(5):1295–304.

Althubaiti G, Butler CE. Abdominal wall and chest wall reconstruction. *Plast Reconstr Surg* 2014;133(5):688e–701e.

Burger JW, Luijendijk RW, Hop WC, Halm JA, Verdaasdonk EG, Jeekel J. Long-term follow-up of randomized controlled trial of suture versus mesh repair of incisional hernia. *Ann Surg* 2004;240(4):578–83; discussion 583–5.

Fischer JP, Wink JD, Nelson JA, Kovach SJ. Among 1,706 cases of abdominal wall reconstruction, what factors influence the occurrence of major operative complications? *Surgery* 2014;155(2):311–9.

Ibrahim AM, Vargas CR, Colakoglu S, Nguyen JT, Lin SJ, Lee BT. Properties of meshes used in hernia repair: a comprehensive review of synthetic and biologic meshes. *J Reconstr Microsurg* 2015;31(2):83–94.

Millbourn D, Cengiz Y, Israelsson L. Effect of stitch length on wound complications after closure of midline incisions: a randomized controlled trial. *Arch Surg* 2009;144(11):1056–9.

Pauli EM, Rosen MJ. Open ventral hernia repair with component separation. *Surg Clin North Am* 2013;93(5):1111–33.

Chapter 66

Ventral Hernia: Laparoscopic Ventral Hernia Repair

Samuel Szomstein and Aaron Lee

INDICATIONS/CONTRAINDICATIONS

Ventral hernia is a common complication after an open colorectal procedure. Although there are no universally agreed upon data on the incidence of ventral hernia formation after major abdominal surgery, reported incidence ranges from 11% to 50%. Up to 75% of patients will develop a ventral hernia within 3 years of the index procedure. Ventral hernias can affect patients' quality of life significantly. There are several different ways to treat the condition from conservative management to surgical options, but this chapter focuses on the surgical option, specifically the laparoscopic approach.

Indications for ventral hernia repair in general are discussed in Chapter 65. The aim of this chapter is to discuss the specific pertaining to the laparoscopic repair of ventral hernia. There are several factors that a surgeon should consider when determining a particular technique to repair a ventral hernia. The general rule of thumb when repairing any ventral hernia is to fix it when it is symptomatic; and the symptoms include pain, obstruction, back pain, poor cosmesis, severe disability, incarceration, and/or skin changes.

Although it is not mandatory to fix an asymptomatic incisional hernia, the treating physician should be cognizant of the fact that no hernia will be effectively treated without surgery and that the hernia will progressively increase in size at an unpredictable rate. Some patients will have an unchanging hernia that does not bother them for years, whereas some will notice a rapid increase in size over a few months. This could be explained by the patients' medical conditions, genetics, and baseline activity level. If a patient has poorly controlled chronic obstructive pulmonary disease or asthma, uncontrolled cough can exacerbate the condition at a faster rate than someone who does not have any respiratory conditions. A similar logic applies to patients with severe constipation or benign hypertension hyperplasia. Patients with congenital connective tissue disorders may have accelerated rate of hernia progression. Similarly, more patients will have the same undesirable effect on the hernia as opposed to the more sedentary patients. All these issues need to be considered when the risks benefit assessment is made for the asymptomatic ventral hernias.

The incisional hernia can be repaired either in an elective or emergent setting.

Emergent indications may occur after overlooking sentinel signs such as history of obstruction or incarceration. Laparoscopy can be used in either setting, but the surgeon should be aware of the patient's overall condition and prompt decision should be made to convert to open when the patient shows any signs of intolerance to laparoscopy.

Laparoscopy has shown benefits over laparotomy in terms of shorter length of hospital stay, earlier return to work, and better pain control compared to the open technique. Although it is beneficial, the technique is heavily dependent on the surgeon and equipment. However, it is critical that the technique is utilized by a surgeon who is adequately trained in the technique. There are several different entry techniques available and one may be more optimal than the other, depending on the clinical scenario. The surgeon should feel comfortable using both open and direct entry techniques in the event that one fails. Also, it is important to have all of the necessary components and equipment to perform basic laparoscopic surgery at the facility to ensure the best possible outcome for the patient. Most importantly, adequate discussion needs to happen between the surgeon and the patient about all the risks and benefits of laparoscopic ventral hernia (LVH) and the alternative options.

Contraindications are similar to the ones that are mentioned in chapter 51. It is paramount to understand not only the technical aspect but also the physiologic aspects of the surgery. Contraindications can be divided into absolute and relative, and these are summarized here.

Absolute—Hemodynamic instability, uncorrectable coagulopathy, uncorrectable hypercapnia, inadequately trained surgeons or staff in laparoscopy, lack of equipment

Relative—Multiple previous abdominal surgeries, multiple abdominal wall hernia surgeries, previous mesh placement, recent open abdominal surgery <6 weeks

As shown, patients should be able to tolerate general anesthesia to undergo an LVH procedure. The relative contraindications should be used as a guideline for better patient selection.

PREOPERATIVE PLANNING

A ventral hernia can be diagnosed during physical examination. Certain maneuvers will accentuate the hernia such as examining the patient while he or she is standing up, Valsalva maneuver, or abdominal flexion. Although most incisional hernia can be diagnosed without imaging and there is no rule against obtaining one, the authors are proponents of liberal usage of preoperative computed tomography (CT) scan for several different reasons.

The issue first is the inaccuracy of physical examination in determining the size and content of the hernia. This information is important when discussing the subtle details of the procedure with the patient. The size of the mesh, likelihood of bowel injury, and the level of complexity are examples of topics that can be discussed in full detail with the imaging. Also, the patient’s condition may inhibit surgeons from performing a thorough and accurate physical examination such as when the patient is morbidly obese, has severe arthritis, and is wheel chair bound or bed bound secondary to the patient’s existing medical conditions. There are several different imaging techniques available but the author prefers to use the CT as the primary imaging modality.

Once the ventral hernia is diagnosed, it is important to establish the goal of care from both the hernia and colorectal disease standpoint with the patient. The hernia surgeon needs to determine the acuity and the complexity of the hernia and generate a reasonable plan to address it with the patient in terms of overall goal with the colorectal disease as a part of the equation. It is prudent to coordinate with the colorectal department if the surgeon is being referred for the hernia specifically, to address the hernia concomitantly or deferred until the later date. It is common for patients to have temporary ostomy after a colorectal procedure as a protective measure; and for these patients, it is reasonable to wait until the time of the reversal or even later to address the hernia. Also, it is important to know if the primary surgery is going be done laparoscopically or open because it may change the timing and the level of complexity of subsequent procedure depending on the method of the index procedure. Also, it is critical to coordinate with the colorectal surgeon because the hernia operation will most likely require a mesh, due to the infection risk, it is advisable to defer if a colon resection is planned.

SURGERY

The patient should follow the National Surgical Quality Improvement Program (NSQIP) protocol as far as the venous thromboembolism prophylaxis and perioperative antibiotics are concerned. Patients should receive subcutaneous heparin injection or its equivalent; and during the surgery, a sequential compression device should be placed on the patient's lower extremities. It is the authors' preference prophylactically to use cefazolin as the antibiotic of choice as long as the patient has no allergy to β-lactam-based antibiotics; and if so, other antibiotics should be given according to the NSQIP guideline. Appropriate aspiration precaution should be followed during intubation. Usually, patients at the author's institution have a bladder catheter placed for two reasons; to decompress the bladder in case it is necessary to enter the space of Retzius to place the mesh and to accurately measure the urine output.

Positioning

The patient should be positioned supine with both arms tucked, which allows the surgeon and his/her assistant to operate in the most ergonomically comfortable position. Before the positioning of the patient, it is important that the surgeon communicates with the operating room staff exactly what he/she wants. Also, it is critical to remember to place appropriate padding around the pressure points to prevent any inadvertent ulcer or skin disruption such as the space between the intravenous line and skin, Foley and urethra, below both heels, and so on. The patient is secured with two different straps, one above the knees and one below. Once the patient is positioned and the airway is secured, the entire abdomen from the nipple line to the pubic symphysis is prepped using chlorhexidine prep solution. When draping the patient, it is important to place the sterile towels as wide as possible to place the ports that are necessary to perform the surgery.

Technique

Depending on the location of the hernia and the extent of previous surgeries, different entry techniques can be considered and utilized. If a patient has a large midline incision and previous surgical history that suggests severe peritonitis and is expected to have dense adhesions throughout the abdomen, supraumbilical midline port placement using Hasson technique is a viable option. With reasonable doubt that the patient has minimal adhesion or localized adhesion from the previous history, either right or left midclavicular site can be safely used to enter the peritoneum by a direct visualization trocar technique. The author routinely uses the Optiview technique at the Palmer's point or the right midclavicular site away from the hernia with a 5-mm camera in a 5-mm trocar slip. When the reciprocal side of the Palmar's point is being used, it is prudent to be extra careful when entering the peritoneum because the liver may be in the way and potentially get injured. Then pneumoperitoneum is established using high-flow CO_2 to obtain minimal 15 mm Hg.

Once the pneumoperitoneum is obtained, the 10-mm 30-degree laparoscope is inserted and the full abdomen should be inspected. Necessary dissection should take place to free up any adhesion and reduce the hernia content. The author uses sharp dissection around any bowel and ultrasonic energy device for any omental adhesion. Extra care should be taken when taking down the content because any content in the hernia sac can potentially be injured during the dissection. Preoperative imaging can provide the surgeon with accurate information of the content in the hernia sac before the surgery. The hernia sac should be dissected and reduced as well. Once the hernia sac and its contents are reduced, the hernia size should be measured. There are several ways to measure the hernia, but the author measures it extracorporeally with full desufflation. On the basis of the measurement, the shape and size of the mesh is selected intraoperatively. The author uses a polypropylene-based mesh with hydrogel filament. The author places Prolene stitches at the four corners of the mesh.

Once the size and shape of the mesh are selected, the next step is to close the defect with a unidirectional barbed suture. The author uses the laparoscopic technique to close the defect to increase the coverage of the hernia with the mesh and potential benefit of approximation of the fascia, which are relief of back pain, improvement of respiratory function, and better cosmesis. The port placement is key, especially during this step, because this portion of the procedure is not ergonomically favorable to the surgeon. The surgeon needs to be able to suture looking upward. If the working port is low close to the anterior superior iliac spine (ASIS) or the tucked arm, the surgeon may find it difficult to find the angle to suture. Therefore, it is prudent to place the port at least 10 cm away from the ASIS or the tucked arm. Pushing the hernia externally can help the surgeon by giving a slightly easier to angle to suture. There is no absolute size contraindication to close the defect; the author has successfully closed up to 10 cm without difficulty.

When the hernia defect is reapproximated, the mesh is introduced using a 12-mm port. During this portion, it is critical to roll the mesh so that the polypropylene portion is exposed; otherwise, the hydrogel filament can be damaged during the process. When unrolling the mesh, it is critical to make sure that the hydrogel filament is facing the bowel. Then the stiches are pulled out extracorporeally using a laparoscopic suture needle in the order of caudad, cephalad, far lateral, and closer lateral suture. Then the mesh is tented up to the abdominal wall and it is secured with nonabsorbable tacks circumferentially. Once the mesh is secured, the abdomen is inspected again to confirm hemostasis and to verify that there is no missed injury. The steps are demonstrated in Figures 66-1 to 66-5.

FIGURE 66-1 Typical ventral hernia after the dissection.

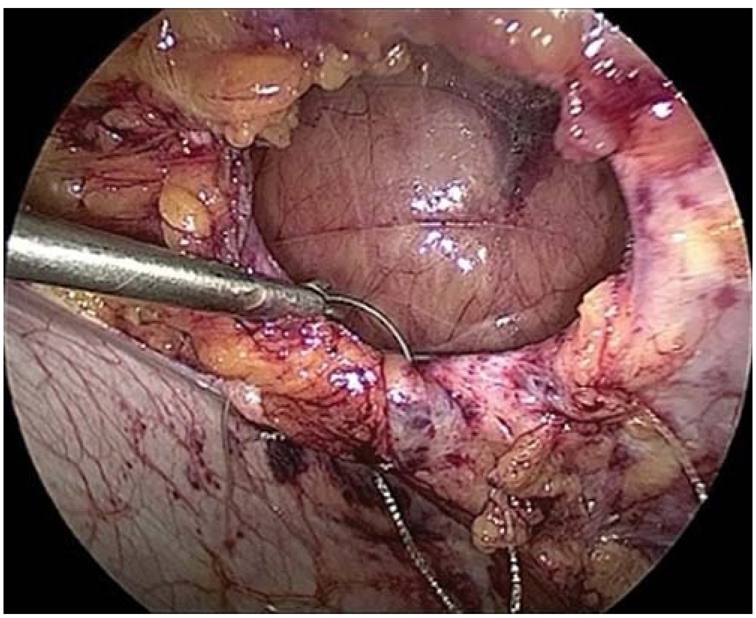


FIGURE 66-2 Primary repair of the hernia with barbed suture.

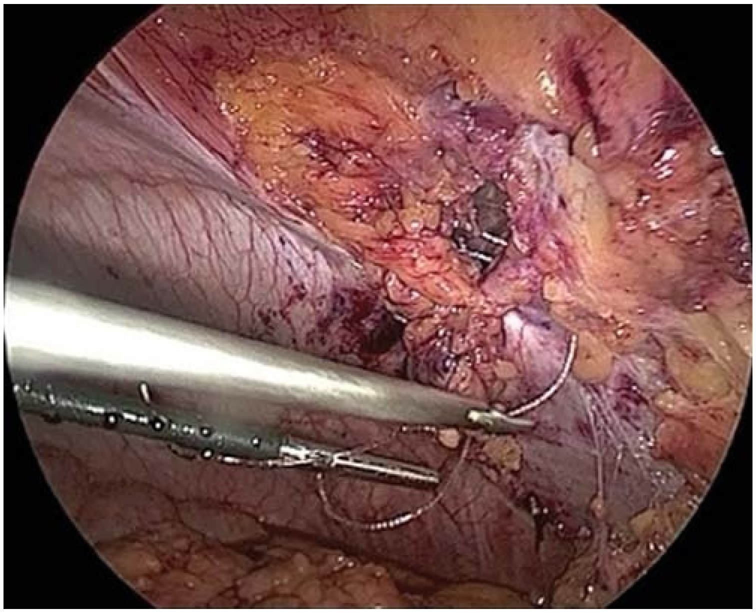


FIGURE 66-3 Continuous running suture to close the defect.

FIGURE 66-4 Anchoring the mesh with sutures.

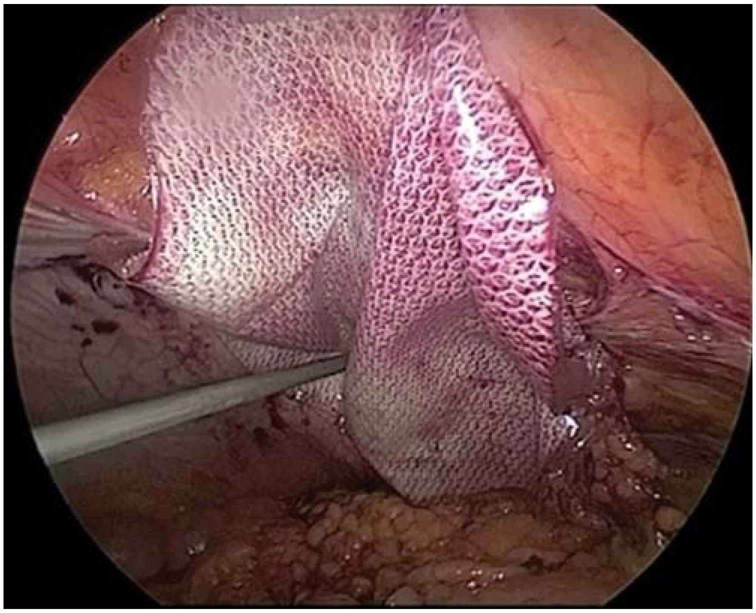


FIGURE 66-5 Securing the mesh with nonabsorbable tacks.

POSTOPERATIVE MANAGEMENT

This procedure can be done safely as an outpatient procedure unless there was an unexpected event during the procedure such as enterotomy, significant hemorrhage, conversion to laparotomy *etc.* The majority of patients can be safely discharged from the postanesthesia care unit in several hours if the patient is able to void and pain is adequately controlled. Sometimes, patients may need to stay overnight as an observation status for better pain control, which seems to be related to the mesh size. The patient is instructed to advance diet as an outpatient basis, starting with a clear liquid diet.

RESULTS

See Table 66-1.

CONCLUSIONS

Incisional hernia is a common complication after any open colorectal procedure. There are several different surgical methods that can be utilized to deal with the hernia including simple suture repair, open onlay, inlay, or underlay mesh repair, laparoscopic repair with mesh with or without fascial closure; and recently robotic repair also has emerged as an option. In the era of laparoscopy, with its clear benefit in terms of less postoperative pain, early recovery, and early return to activity, the author prefers to use the laparoscopic ventral hernia repair with fascial closure and mesh placement.

RECOMMENDED REFERENCES AND READINGS

Agarwal BB, Agarwal S, Gupta MK, Mishra A, Mahajan KC. Laparoscopic ventral hernia meshplasty with "double-breasted" fascial closure of hernia defect: a new technique. *J Laparoendosc Adv Surg Tech A* 2008;18(2):222–9.

Awaiz A, Rahman F, Hossain MB, Khan RM, Memon B, Memon MA. Meta-analysis and systematic review of laparoscopic versus open mesh repair for elective incisional hernia. *Hernia* 2015;19(3):449–63.

Banerjee A, Beck C, Narula VK, *et al.* Laparoscopic ventral hernia repair: does primary repair in addition to placement of mesh decrease recurrence? *Surg Endosc* 2012;26(5):1264–8.

Chelala E, Thoma M, Tatete B, Lemye AC, Dessily M, Alle JL. The suturing concept for laparoscopic mesh fixation in ventral and incisional hernia repair: mid-term analysis of 400 cases. *Surg Endosc* 2007;21(3):391–5.

Clapp ML, Hicks SC, Awad SS, Liang MK. Trans-cutaneous closure of central defects (TCCD) in laparoscopic ventral hernia repairs (LVHR). *World J Surg* 2013;37(1):42–51.

Franklin ME, Gonzalez JJ, Glass JL, Manjarrez A. Laparoscopic ventral hernia repair: an 11-year experience. *Hernia* 2004;8(1):23–27.

Misiakos EP, Patapis P, Zavras N, Tzanetis P, Machairas A. Current trends in laparoscopic ventral hernia repair. *JSLS* 2015;19(3):e2015.00048.

Nguyen D, Szomstein S, Ordonez A, *et al.* Unidirectional barbed sutures as a novel technique for laparoscopic ventral hernia repair. *Surg Endosc* 2016;30(2):764–9.

Nguyen MT, Berger RL, Hicks SC, *et al.* Comparison of outcomes of synthetic mesh vs suture repair of elective primary ventral herniorrhaphy. *JAMA Surg* 2014;149(5):415–21.

Orenstein SB, Dumeer JL, Monteaquodo J, Poi MJ, Novitsky YW. Outcomes of laparoscopic ventral hernia repair with routine defect closure using "shoelacing" technique. *Surg Endosc* 2011;25(5):1452–7.

Palanivelu C, Jani KV, Senthilnathan P, Parthasarathi R, Madhankumar MV, Malladi VK. Laparoscopic sutured closure with mesh reinforcement of incisional hernias. *Hernia* 2007;11(3):223–8.

Regner JL, Mrdutt MM, Munoz-Maldonado Y. Tailoring surgical approach for elective ventral hernia repair based on obesity and National Surgical Quality Improvement Program outcomes. *Am J Surg* 2015;210(6):1024–30.

Vorst AL, Kaoutzanis C, Carbonell AM, Franz MG. Evolution and advances in laparoscopic ventral and incisional hernia repair. *World J Gastrointest Surg* 2015;7(11):293–305.

Zeichen MS, Lujan HJ, Mata WN, *et al.* Closure versus non-closure of hernia defect during laparoscopic ventral hernia repair with mesh. Hernia 2013;17(5):589–96.

Chapter 67

Robotic Ventral Hernia Repair

Emanuele Lo Menzo, Samuel Szomstein and Raul Rosenthal

INDICATIONS/CONTRAINDICATIONS

Ventral hernias occur in 11–50% of laparotomies; however, only 350,000 ventral hernia repairs are performed every year in the United States. The application of robotic techniques to ventral hernia repair is relatively recent. The da Vinci robotic platform (Intuitive Surgical, Inc. Sunnyvale, CA) was approved by the U.S. Food and Drug Administration in the year 2000. Initially, the robot was embraced by specialties in which only single-quadrant operations were performed (urology, gynecology). Only recently have general surgeons developed an interest in the robotic platform, and expanded the indication from single-quadrant operations (cholecystectomy, hiatal hernias, and rectal procedures), to ventral, incisional, and even inguinal hernias.

In general, the indications for robotic ventral hernia repair (RVHR) are similar to the indications for laparoscopic ventral hernia repair (LVHR).

One of the major milestones in the evolution of the technique of ventral hernia repair was reached in the early 1990s when LeBlanc described the laparoscopic approach. Several randomized control trials have demonstrated the major advantages of LVHR over the traditional open counterpart. In fact, LVHR offers minimal soft tissue dissection determining decreased risk of infection and number of overall complications. Other proven advantages of the LVHR are the decreased length of hospital stay and the faster return to work. Furthermore, the possibility of wide mesh overlap of the hernia defect and more complete visualization of the abdominal wall has been linked to lower recurrence rates. Finally, LVHR appears particularly advantageous in obese patients. Although some surgeons have reported decreased postoperative pain, this claim remains a debatable point for both LVHR and RVHR.

However, the steep learning curve of laparoscopy and the often reported longer operating times have contributed to slow unanimous adoption of the laparoscopic technique. The major obstacle in the learning curve had to be attributed to the ability to perform extensive lysis of adhesions in a timely and effective manner and the challenge in manipulating large pieces of meshes in relatively small spaces.

relatively small spaces.

Obviously, the longer operating room (OR) times in the LVHR also translate to higher costs, and hence another reason for the low acceptance of the laparoscopic technique. On the other hand, open repair of ventral hernia allows the freedom to address the skin redundancy and hernia sac, reducing postoperative seromas and, at times, improving the overall cosmesis of the repair.

Recently, to obviate some of the technical shortfalls of LVHR, the proponents of robotic surgery have more widely applied the use of the robotic platform in abdominal wall hernia surgery. The high-definition three-dimensional visualization, the dexterity of the multiple degrees of freedom of the robotic wrists, and the superior ergonomics have been advocated as postulated benefits of the latest application of robotic surgery in general surgery.

Very few contraindications to the use of laparoscopic or robotic technique exist. The contraindications can be divided as anesthesia related and hernia related.

Anesthesia-related contraindications

- Cardiac (i.e., severe coronary artery or valvular disease, congestive heart failure)
- Pulmonary (i.e., severe chronic obstructive pulmonary disease)
- Uncontrolled coagulopathy
- Hemodynamic instability

Hernia related

- Presence of enterocutaneous fistulae
- Mesh erosion
- Significant loss of domain
- History of open abdomen with skin graft closure or large areas of healing by secondary intention.

Although the adhesiolysis might be able to be laparoscopically accomplished, the devascularization of the primary blood supply to the skin graft or granulation tissue from the underlying viscera will lead to abdominal wall necrosis. In this case, the need to remove sizable anterior soft tissue coverage to avoid necrosis obviates the use of laparoscopy or robotic surgery.

The presence of a very large abdominal defect poses the problem of being able to obtain enough mesh overlap in the lateral abdominal wall, but at the same time maintaining room for instrument manipulation and laparoscopic visibility. Also, a relatively recent body of literature has underscored the importance of hernia defect reapproximation to improve abdominal wall function.

PREOPERATIVE PLANNING

A careful evaluation of the patient's comorbidities and the hernia is paramount to achieve a safe and durable repair.

Some of the factors negatively affecting the outcome are as follows:

Obesity (body mass index $\geq$ 30 kg/m^2)

Current tobacco smoking

Diabetes with glycosylated hemoglobin (HbA1C) ≥ 6.5%

Age over 75 years

Malnutrition

Coronary artery disease

The preoperative strategy specific to the type of repair should consider the following factors:

Previous emergency laparotomies

Immunosuppression—chronic steroid use

- Multiple previous repairs
- Location and size of the defect

For this reason, a thorough inspection of the previous abdominal incisions with particular emphasis on the history of previous hernia repairs and history of mesh infections is necessary. Every effort should be made to obtain previous operative reports, to understand the type and location of previous repairs and implanted meshes.

The physical examination should focus on location of the defect (central vs. lateral), proximity to bony confinements that might limit mesh overlap (subxiphoid, suprapubic, flank), presence of skin graft or granulation tissue that might become devitalized once the hernia is reduced, and assessment of potential loss of abdominal domain.

Preoperative imaging studies are helpful for defining the anatomy, especially in the setting of multiple previous repairs. In general, computed tomography scan with oral contrast is considered the gold standard to assess the characteristics of the hernia and guide in the preoperative strategy.

SURGERY

Most practices have moved away from full preoperative oral cathartic mechanical bowel preparation because of the increased chance of dehydration, electrolyte imbalance, and, occasionally, the increased intraoperative bowel dilatation. However, the patient receives a first-generation cephalosporin within 1 hour of the incision. All hair in the field should be clipped. A bladder catheter and a nasogastric tube are inserted to decompress the urinary bladder and the stomach, respectively. For hernias near the symphysis pubis, a three-way catheter can be used to facilitate bladder identification during the process of accessing the preperitoneal plane and exposure of Cooper's ligaments.

Positioning

The patient is positioned supine on the OR table, ideally with both arms tucked (Fig. 67-1). This position will allow both the surgeon and the camera holder to comfortably work from the same side of the patient and protect important pressure points.

FIGURE 67-1 The patient is positioned supine on the operating room table with both arms tucked. The field is prepped widely. Iodine-impregnated drapes can be used.

Technique

Trocar Placement/Adhesiolysis

The access to the abdominal cavity should be away from the hernia defect, to avoid visceral injury and prevent sizable incision directly over the prosthetic mesh. Usually, the abdomen is accessed in the left subcostal area (Palmer's point), or right subcostal area as an alternative, using an optical trocar. When severe adhesions in the upper quadrant are expected, an open Hasson technique is utilized. It is important to keep this first trocar site close to the costal margin and as lateral as possible. This placement will preserve the functionality of the trocar, while maintaining it lateral to the lateral edge of the mesh (Fig. 67-2). However, the insertion of the trocar lateral to the anterior axillary line or with an angle perpendicular to the table might result in insertion into the retroperitoneum, or in colonic injuries. Two additional accessory trocars are then placed as lateral as possible along the lateral abdominal wall. Additional trocars might be necessary on the contralateral side for visualization and fixation of the other side of the mesh. It is important to remember that the operating arms of the robotic platform require 8-mm trocars. Most of the authors who perform RVHR will proceed with the adhesiolysis laparoscopically. However, some of the proponents of RVHR argue that the enhanced 3D visibility and the robotic wrist articulation facilitate this part of the procedure as well. The hernia sac is usually left in place.

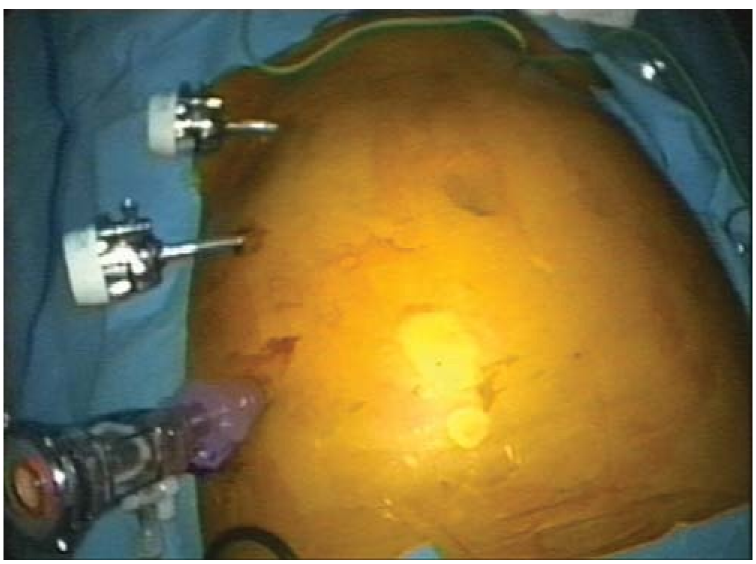
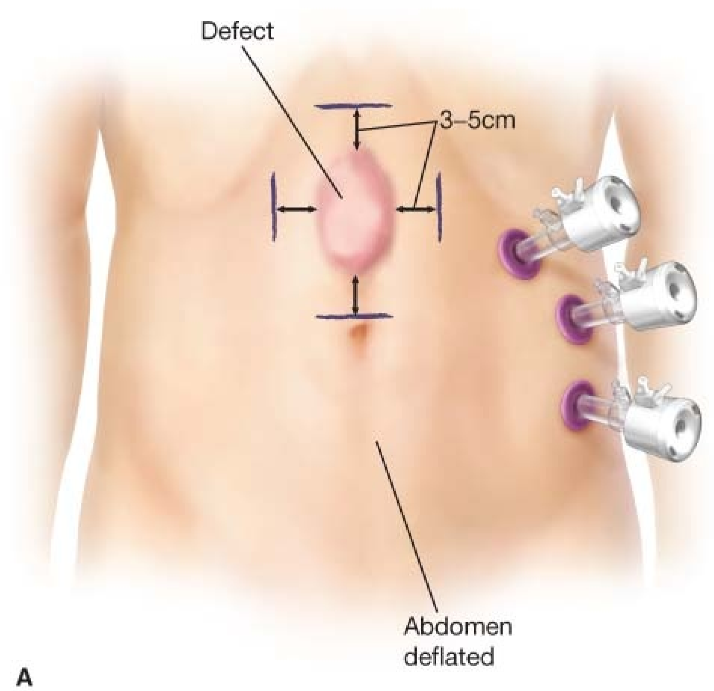


FIGURE 67-2 Lateral placement of trocars to maintain their functionality during the fixation of the mesh.

Hernia Defect Management

The defect is measured either by introducing a ruler in the abdominal cavity or by measuring the corresponding external landmarks (Fig. 67-3). Although the measurement of the defect using an external landmark is faster and more practical, it results in overestimation of the defect itself, particularly in obese individuals, even after completed abdominal desufflation. The goal is to obtain an overlap of the mesh of 3–5 cm in all directions; multiple defects are collectively sized. Also, in cases in which primary fascia closure is planned, the size of the mesh should be based on the extent of the defect before its closure.



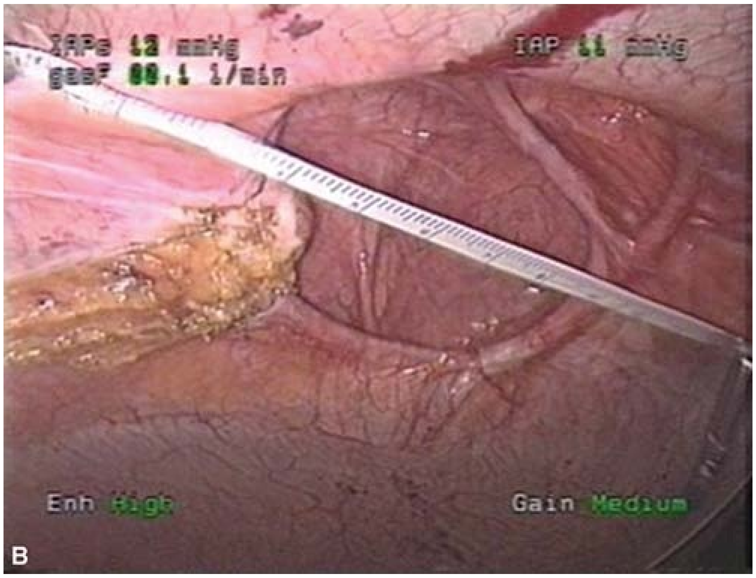


FIGURE 67-3 Measurement of the defect. A. When using external landmarks, the abdomen is completely deflated. B. As an alternative, an intraperitoneal ruler can be used to measure the defect from inside. The latter gives a more accurate estimation.

p. 629

---

p. 630

If not previously used for the adhesiolysis, the robot is now docked, usually from the opposite side of the working trocars at a 45° angle or on the side of the patient (Fig. 67-4). Because the external arms of the robot articulate down during the defect closure and mesh suturing, docking directly over the patient’s head or the pelvis tends to limit arm movements. The new da Vinci robotic platform (Xi) with the different arm design obviates most of these issues.

FIGURE 67-4 The daVinci robotic system is docked on the opposite side of the trocars at a 45-degree angle from the table.

(Source: Media for Medical SARL / Alamy Stock Photo.)

Primary Fascial Closure

The concept of fascial closure before mesh placement is not new. In fact, in the past decade, many expert laparoscopic surgeons have described the value of defect closure, and at times have transitioned to open operations to achieve such closure. As previously mentioned, one of the selling points of RVHR is the ability to easily suture closed small-to-moderate size defects utilizing the aforementioned technical superiorities of the robotic platform (six degree of instrument motion, tremor elimination, #D imaging) (Fig. 67-5). The closure of the defect serves multiple purposes. First, the obliteration of the dead space of the hernia sac seems to reduce the incidence or the extent of symptomatic postoperative seromas, otherwise present in up to 11% of the patient after LVHR. The decreased seroma formation and the recreated linea alba will determine an improved cosmetic result. There is also evidence of decreased recurrence after primary midline closure, maybe because of more surface for mesh overlap because the closed fascia also reduces the possibility of mesh migration and provides a base for mesh ingrowth. The recreation of the linea alba has been demonstrated to improve the function of the abdominal wall based on the more physiologic abdominal wall movements. Surgeons should recognize a note of caution when larger defects are closed without the creation of skin flaps because the overlying skin might wrinkle. Although this unpleasant effect will improve with time, it should be discussed with the patient during the preoperative informed consent.

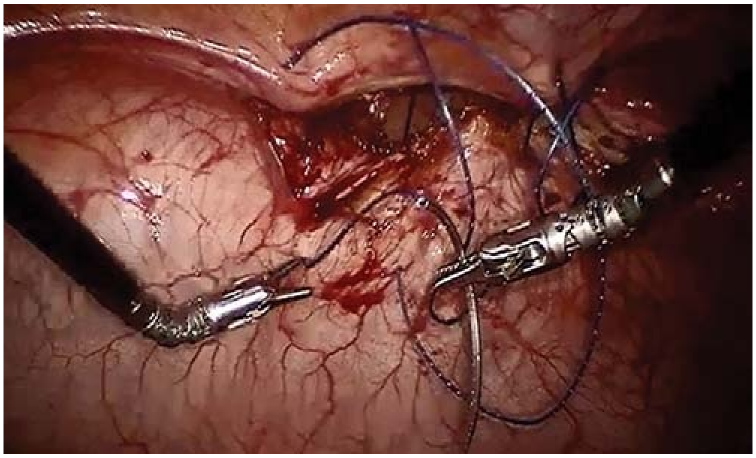


FIGURE 67-5 The degree of wrist articulation allows for comfortable suturing of the abdominal wall (courtesy of Francesco Palazzo, MD).

p. 630

p. 631

The primary fascial closure in our practice is routinely obtained using #2 nonabsorbable barbed sutures. This type of suture allows for constant distribution of the tension along the closure at each passage through the fascia (Fig. 67-6).

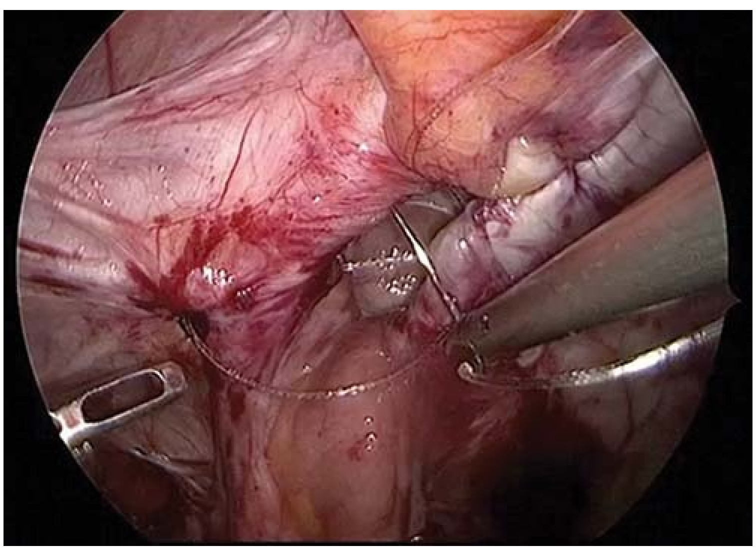


FIGURE 67-6 Laparoscopic closure of a hernia defect using unidirectional barbed suture.

Retrorectus Repair

Retrorectus Repair

This technique, initially described by Rives and Stoppa, presents the advantage of placement of the mesh with ample overlap below the fascia, but not in contact with the viscera. Also, the extensive mobilization of the posterior rectus sheath increases the ability for primary defect closure. The disadvantage of the Rives–Stoppa technique is the need for a more extensive dissection in the retromuscular space. Such dissection is not only more time consuming but also results in the higher potential of seroma formation and wound complications. The retromuscular technique, usually performed with an open approach, has resulted in an increase in wound sepsis. Therefore, some authors have advocated the use of the robotic platform to facilitate this retromuscular dissection, preserving the reduced wound complications typical of the laparoscopic approach.

p. 631

p. 632

The posterior rectus sheath is incised 1 cm lateral to the edge of the defect along the entire length of the defect. Using blunt dissection, the posterior sheath is separated from the rectus muscle (Fig. 67-7). The dissection is extended beyond the limits of the defect to assure adequate mesh overlap (5 cm in each direction). If additional dissection is necessary beyond the semilunar line, the transversus abdominis release (TAR) can be used. This release allows for dissection into the retroperitoneum and could be extended to the psoas muscle if necessary (Fig. 67-8). Dissection of the posterior rectus sheath lateral to the semilunar line without transection of the transversus abdominis will result in damage to the perforator neurovascular bundle. Once the retromuscular space is fully dissected, the mesh is introduced and fixed laterally either by circumferentially suturing or transfascial fixation.

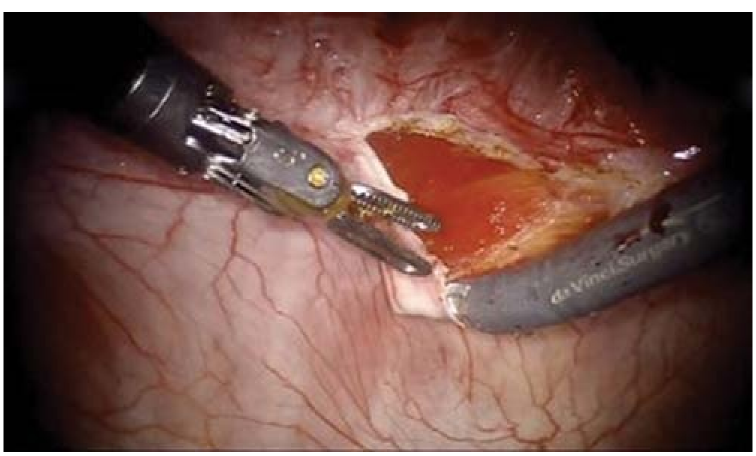


FIGURE 67-7 The posterior rectus sheath is incised 1 cm lateral to the edge of the hernia defect

and then bluntly dissected.

(From Warren JA, Cobb WS, Ewing JA, Carbonell AM. Standard laparoscopic versus robotic retromuscular ventral hernia repair. Surg Endosc 2017;31:324–32.)

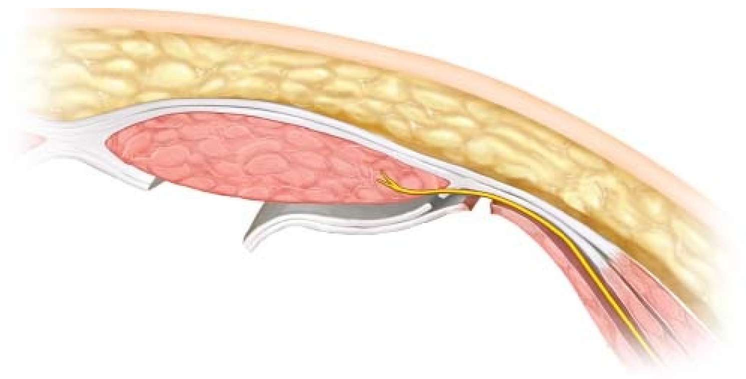


FIGURE 67-8 The transverse abdominis is released just medial to the neurovascular bundle.

p. 632

p. 633

After fixation, the robot has to be re-docked on the opposite side. A similar retromuscular dissection is then performed with or without TAR, and the posterior rectus sheath is closed using a barbed running suture. Inferior to the arcuate line, only the peritoneum is closed. The mesh is then unrolled and laterally secured. The complete closure of the posterior rectus sheath prevents any contact of the mesh with the intra-abdominal viscera. The next step is the closure of the anterior rectus sheath, which is done with nonabsorbable barbed sutures, with the identical technique described in the paragraph on primary fascial closure (Fig. 67-5).

Transabdominal Preperitoneal Technique

The goal of the transabdominal preperitoneal technique is to provide separation of the intra-abdominal mesh from the viscera, without creating large fascial flaps, as in the previously described technique. Peritoneal flaps are developed bilaterally starting just lateral to the edge of the hernia defect. The redundant hernia sac in the middle is also imbricated and utilized as physiologic tissue coverage to the synthetic mesh (Fig. 67-9). Contrary to the previously described retromuscular repair, the lack of fascial dissection does not provide the additional advantage of easier medialization of the midline for primary closure.

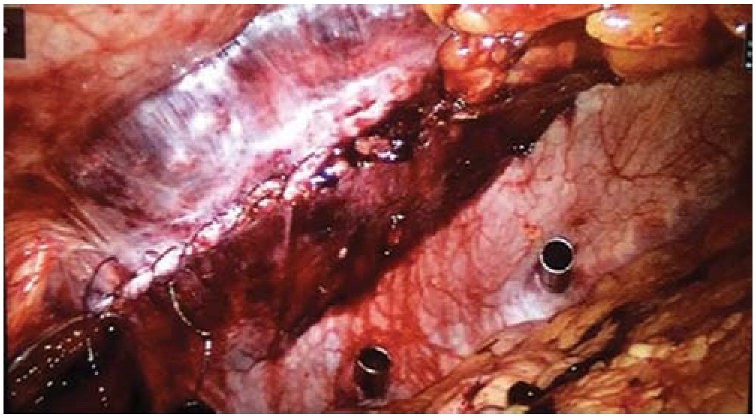


FIGURE 67-9 Intraoperative picture of the mesh completely covered by peritoneum.

(From Sugiyama G, Chivukula S, Chung PJ, Alfonso A. Robot-assisted transabdominal preperitoneal ventral hernia repair. JSLS 2015;19(4).)

Mesh Fixation

Currently, the standard laparoscopic technique of mesh fixation includes both transfascial sutures and tacking devices. Several authors, however, have shown that laparoscopic placement of transfascial sutures can lead to a 2% incidence of postoperative pain lasting more than 8 weeks. Occasionally, these patients even require re-explorations. Also, the common fixation devices have been linked to postoperative pain, adhesions, and bowel obstructions. For these reasons, using the robotic articulating wrists the mesh can be easily sutured to the fascia with a running nonabsorbable suture. Also, the primary closure of the defect, with or without the use of the robotic platform, has encouraged surgeons to forego the use of transfascial sutures and rely only on circumferential tacking of the mesh.

POSTOPERATIVE MANAGEMENT

The postoperative care of the RVHR is similar to that in the laparoscopic technique. The key elements of the postoperative care are as follows:

Postoperative pain. The need for postoperative intravenous (IV) narcotics is dictated by the extent of the dissection and the hernia size. Smaller defects and repairs can be managed in an outpatient setting with oral narcotics. More extensive repairs require hospital admissions for IV narcotics. The addition of the transverse abdominis plane block has been used with good success in limiting the need for narcotics after such operations.

Deep vein thrombosis (DVT) prophylaxis. All patients receive perioperative subcutaneous fractionated or unfractionated heparin, as part of the standard DVT prophylaxis. Also, intermittent compression devices are routinely implemented and patients are mobilized immediately after surgery. Bladder catheters are routinely discontinued within 24 hours or sooner, when utilized.

Seroma prevention and management. Subcutaneous drains are rarely utilized, whereas external elastic compression with abdominal binders is always implemented for the first 2 weeks postoperatively. Asymptomatic seromas are clinically followed up. If they become clinically significant, percutaneous drainage may be undertaken.

Diet management. The diet is quickly advanced, unless reasons for a likely postoperative ileus are present. Stool softeners are routinely prescribed along with the narcotic medication regimen.

Follow-up. Patients are followed up at 2 weeks postoperatively and then at 1, 6, and 12 months. No routine imaging is done, unless concerns for recurrences, prolonged pain, and clinically significant seromas exist.

COMPLICATIONS

Bowel injury. Bowel injury remains one of the most feared complications, especially when recognized late. The incidence has been reported to be around 1%. This seems to be lower than in laparoscopic repairs (8%). The improved visualization (high-definition 3D) and the added instrument dexterity may account for this difference.

Seroma. Although extensive retromuscular dissection allows for separation between the mesh and the viscera, it predisposes to higher incidence of seromas. Seromas have been reported in up to 96% of the cases, although the vast majority are clinically irrelevant.

Wound infection. The use of the robotic platform can minimize this complication (0–1.8% wound infection in the robotic group as compared to 9.5% in the open group). Also, the retromuscular position of the mesh determines a much higher likelihood of mesh salvage (70%) in case of mesh infection, as opposed to the intraperitoneal position (30%).

Recurrence. On the basis of the current literature, no difference in recurrences can be directly attributed to the robotic platform. It seems, however, that the primary closure of the defect in addition to mesh placement might result in a decrease in recurrence rates.

RESULTS

The major advantage of the robotic platform seems to be related to the ability to use laparoscopic techniques in more complex hernias. Also, the increased dexterity achievable with the robot facilitates extensive dissections and primary closure of defects. The primary closure of the defects has been associated with a decrease in postoperative seromas and decreased recurrence.

The fixation of the mesh with circumferential suturing obviates the need for transfascial sutures and tacks, which has been suggested to determine less postoperative pain. Another factor likely involved in decreased pain is the primary closure of the midline. Although unclear how this latter factor contributes to decreased postoperative pain, potential factors include the need for smaller meshes and less fixation as well as the recreation of the linea alba.

Several drawbacks have been attributed to the use of the robot for laparoscopic ventral hernia. The process of docking and undocking of the platform results inevitably in longer intraoperative times. The use of the platform, the need for additional disposable or only partially reusable equipment, and the increased operating time has been shown to increase cost by 34%. Some of this cost might be offset by eliminating more expensive meshes and tacking devices, and by shortening OR time with dedicated teams. In addition, the use of the robot implies a steep learning curve, significant technical expertise, and a dedicated OR team. An additional limitation of this platform includes the difficulty in working in different target regions because of the need for multiple equipment adjustments.

CONCLUSIONS

In conclusion, the use of the robotic platform in minimally invasive ventral hernia is slowly gaining in popularity.

The main potential advantages are the ability to primarily close defects, to fix the mesh with circumferential suturing obviating the need for more painful transfascial sutures and tacks, and the ability to use minimally invasive techniques for more complex hernias requiring more extensive dissection, otherwise not suitable for the laparoscopic technique.

RECOMMENDED REFERENCES AND READINGS

Banerjee A, Beck C, Narula VK, *et al.* Laparoscopic ventral hernia repair: does primary repair in addition to placement of mesh decrease recurrence? *Surg Endosc* 2012;26(5):1264–8.

Beldi G. Technical feasibility of a robotic-assisted ventral hernia repair. *World J Surg* 2012;36(2):453–4.

Carbajo MA, Martín del Olmo JC, Blanco JI, *et al.* Laparoscopic treatment vs open surgery in the solution of major incisional and abdominal wall hernias with mesh. *Surg Endosc* 1999;13(3):250–2.

Gonzalez AM, Romero RJ, Seetharamaiah R, Gallas M, Lamoureux J, Rabaza JR. Laparoscopic ventral hernia repair with primary closure versus no primary closure of the defect: potential benefits of the robotic technology. *Int J Med Robot* 2015;11(2):120–5.

Heniford BT, Park A, Ramshaw BJ, Voeller G. Laparoscopic ventral and incisional hernia repair in 407 patients. *J Am Coll Surg* 2000;190(6):645–50.

Krpata DM, Schmotzer BJ, Flocke S, *et al.* Design and initial implementation of HerQLes: a hernia-related quality-of-life survey to assess abdominal wall function. *J Am Coll Surg* 2012;215(5):635–42.

Liang MK, Holihan JL, Itani K, *et al.* Ventral hernia management: expert consensus guided by systematic review. *Ann Surg* 2017;265:80–9.

Nguyen D, Szomstein S, Ordonez A, *et al.* Unidirectional barbed sutures as a novel technique for laparoscopic ventral hernia repair. *Surg Endosc* 2016;30(2):764–9.

Novitsky YW, Elliott HL, Orenstein SB, Rosen MJ. Transversus abdominis muscle release: a novel approach to posterior component separation during complex abdominal wall reconstruction. *Am J Surg* 2012;204(5):709–16.

Rives J, Pire JC, Flament JB, Convers G. Treatment of large eventrations (apropos of 133 cases) [in French]. *Minerva Chir* 1977;32(11):749–56.

Schluender S, Conrad J, Divino CM, Gurland B. Robot-assisted laparoscopic repair of ventral hernia with intracorporeal suturing. *Surg Endosc* 2003;17(9):1391–5.

Sugiyama G, Chivukula S, Chung PJ, Alfonso A. Robot-assisted transabdominal preperitoneal ventral hernia repair. *JSLS* 2015;19(4).

Tayar C, Karoui M, Cherqui D, Fagniez PL. Robot-assisted laparoscopic mesh repair of incisional hernias with exclusive intracorporeal suturing: a pilot study. *Surg Endosc* 2007;21(10):1786–9.

Vorst AL, Kaoutzanis C, Carbonell AM, Franz MG. Evolution and advances in laparoscopic ventral and incisional hernia repair. *World J Gastrointest Surg* 2015;7(11):293–305.

Warren JA, Cobb WS, Ewing JA, Carbonell AM. Standard laparoscopic versus robotic retromuscular ventral hernia repair. *Surg Endosc* 2017;31:324–32.

Chapter 68

Component Separation Technique

Mark W. Clemens and Charles E. Butler

INTRODUCTION

Ventral hernias may follow laparotomy closures, tumor ablation, congenital anomalies, or trauma to the abdominal wall. Direct suture repair alone of ventral hernia defects results in an extremely high rate of recurrence. Primary fascial coaptation and mesh reinforcement of hernia defects are paramount tenets of abdominal wall reconstruction. No single advancement in surgical technique has made a greater impact on abdominal wall reconstruction outcomes than the development of component separation (CS) described by Ramirez and colleagues in 1990. In wide abdominal defects where fascial approximation is not possible under physiologic tension, CS with musculofascial advancement flaps is critically important to assist in fascial closure. CS maintains the strength and integrity of the abdominal wall while preserving innervated muscle function without tension. This chapter focuses on reliable and effective techniques of CS with an emphasis on patient diagnosis, planning, surgical technique, and complications.

INDICATIONS/CONTRAINDICATIONS

Indications for abdominal wall reconstruction are multifactorial and include tumor ablation, congenital anomalies, and trauma. Proposed risk factors for the development of hernias include tobacco use and a strong family history of hernia, which suggests a genetic predisposition. Studies have suggested that mechanical strain on load-bearing tissues can induce secondary changes in tissue fibroblast function that in turn can result in failure of abdominal wall repairs. The general indications for performing a CS of the abdominal wall include a deficiency of the abdominal wall fascia, which would require a bridged repair without fascial release. Clinical examples include large midline hernias, infected wounds with or without exposed mesh, and patients who have failed previous herniorrhaphy. CS is a fascial release of the external oblique fascia with creation of musculofascial advancement flaps. This procedure creates an autologous flap option for fascia coaptation, which is beneficial particularly in the presence of mesh reinforcement. Relative contraindications include lateral abdominal wall hernias in patients with ostomies directly in line with a planned CS. In these situations, a unilateral CS performed on the contralateral hemi-abdomen may be sufficient to achieve fascial coaptation. It is not possible to perform CS in patients who have lost the anatomy required for such a fascial release, such as complete loss of abdominal domain that can be seen in pancreatic fistulas or necrotizing soft-tissue infections of the anterior abdominal fascia. Radiated tissue is not an absolute contraindication but does have higher rates of wound dehiscence, infection, necrosis, and delayed wound healing. Patients with multiple previous abdominal wall surgeries or unclear reconstructive surgical history and anatomy should be approached cautiously. Violation of the rectus complex such as with elevation of a transverse rectus abdominis muscle flap or vertical rectus abdominis muscle flap does not preclude the use of CS.

PREOPERATIVE PLANNING

Physical examination should be performed to assess the patient's general condition, the abdominal wall integrity, the extent and location of any abdominal wall abnormalities, and the presence of scars that could become an obstacle to raising reliable tissue flaps. Routine laboratory tests and a nutritional assessment are advised. Correct diagnosis of abdominal wall defects is critical to proper management. Preoperative computed tomography (CT) to examine the defect characteristics, abdominal wall anatomy, and vascularity is helpful for surgical planning. CT scans allow for visualization of intra-abdominal organs, and the abdominal wall, three-dimensional data sets, and multiplanar reformation capabilities. CT scans may assist in detecting fluid collections, bowel obstruction, incarceration, strangulation, and traumatic wall hernias. Magnetic resonance imaging also permits the detection of soft tissue defects and abdominal wall hernias, although this modality does not usually offer further sensitivity and therefore may be cost prohibitive. Thromboprophylaxis should be administered on the basis of a patient's particular risk for a thrombosis as evaluated by the Caprini risk assessment tool. Prospective randomized controlled data is unavailable regarding routine antibiotic prophylaxis. Most centers including ours regularly prescribe prophylactic antibiotics intraoperatively for all patients. Bowel preps may be beneficial in patients with anticipated violation of the gastrointestinal tract.

SURGERY

Preoperative/Markings

Patients should be marked in the preoperative holding area, ideally in both recombinant and supine positions for complete evaluation of abdominal wall defects. The pertinent landmarks of the abdominal wall and are recounted. Markings may delineate anatomic boundaries such as the pelvis, midline, and costal margin as well as the fascial extent of any intra-abdominal defects. Once the patient is transported to the operating room, he or she is placed supine on the operating table, sedated, and intubated. Intraoperative intravenous antibiotic component prophylaxis is initiated. The abdomen is widely draped and prepped to expose the patient's flanks and from the pelvis to the mid-sternal area. Patients should receive sequential compression devices for deep vein thrombosis prophylaxis. Patients requiring greater exposure should have room temperatures maintained above 75°F to minimize postoperative infections.

Surgical Technique

Critically important to a hernia repair is the reestablishment of the abdominal domain integrity with complete spacial coaptation. All attempts should be made to avoid a bridged mesh repair because there is a clear trend toward higher recurrence rates compared with when the fascia can be reapproximated over a mesh repair. Understanding all of the approaches for abdominal wall reconstruction and particularly myofascial advancement flaps is critically important to determine the least invasive procedure to provide a long-lasting repair with an excellent functional outcome for the patient. Ramirez and colleagues' description of the surgical technique of CS facilitates medialization of the rectus musculofascia and midline abdominal closure, by releasing the external oblique aponeurosis and posterior rectus sheath bilaterally (Fig. 68-1). Although CS will often allow for midline fascial reapproximation, which is the optimal situation, occasionally this will not be possible for larger hernias. As a result, the myofascial edges will need to be bridged with mesh. Defect size reduction, especially if less than 150 cm^2, will lead to the lowest recurrence rates. There are several other theoretical advantages to reapproximating the linea alba. If one considers the linea alba as the tendinous insertion of the rectus and oblique muscles and borrows from the concepts of tendon repair, then it seems logical that the physiologic tension of the abdominal wall should be restored during ventral incisional hernia repair. Although every attempt to reestablish the midline is advisable, accomplishing that goal is not always feasible, and not all patients can tolerate the intraperitoneal compression required. This can result in intraperitoneal hypertension, pulmonary compromise, or abdominal compartment syndrome. Once the mesh is inserted peripherally the midline fascia will be reapproximated, and the mesh and its inset will bear the majority of the tension.

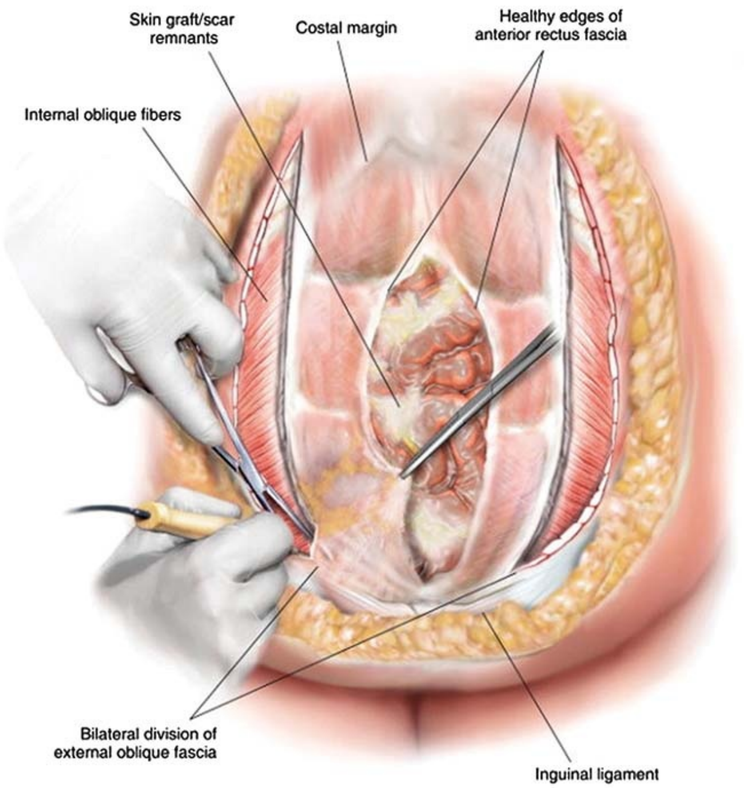


FIGURE 68-1 Open component separation. Subcutaneous flaps are elevated off the anterior rectus sheath to expose the external oblique aponeurosis. The external oblique aponeurosis is released from the inguinal ligament inferiorly to above the costal margin superiorly. This allows exposure of the internal oblique muscle fibers once the external aponeurosis is incised.

(Adapted with permission from, Rosen MJ. Atlas of Abdominal Wall Reconstruction. Elsevier, 2011.)

Open Component Separation

Myofascial advancement techniques, or CS, take advantage of the laminar nature of the abdominal wall and the ability to release one muscular or fascial layer to enable medial advancement of another. The lateral abdominal compartment can be released by open or minimally invasive CS. A minimally invasive CS can be performed in various ways, but all of the techniques (to a certain degree) maintain the blood supply to the skin from the underlying rectus abdominis muscles. In contrast, an open CS is performed by raising large subcutaneous flaps to expose the external oblique fascia (Fig. 68-1). The cutaneous perforators emerging from the anterior rectus sheath are ligated and divided to facilitate exposure of the linea semilunaris in its entirety. These flaps are carried laterally past the linea semilunaris. This subcutaneous dissection itself can provide some medial advancement of the abdominal wall skin. An anatomically precise external oblique aponeurotomy is made 1–2 cm lateral to the linea semilunaris on the lateral aspect of the external oblique aponeurosis from several centimeters above the costal margin to the pubis. It is important to confirm that the incision is not carried through the linea semilunaris because this would result in a full-thickness defect of the lateral abdominal wall, which is very challenging to repair. The external oblique aponeurosis is then bluntly separated in the avascular plane away from the internal oblique aponeurosis to the midaxillary line, allowing the internal oblique and transversus abdominis muscles with the rectus abdominis muscle or fascia to advance medially as a unit. These techniques, when bilaterally performed, can yield up to 20 cm of mobilization in the mid-abdomen.

p. 638

---

p. 639

Once the mesh insertion and fascial closure are performed, the subcutaneous skin flaps are advanced and closed at the midline. To reduce subcutaneous dead space, interrupted quilting sutures should be placed between the Scarpa fascia and musculofascial repair. This technique also decreases shear stress, which is thought to contribute to postoperative seroma formation, and decrease the total drain output, allowing the surgeon to place fewer drains and leave them in for a shorter period. After paramedian skin perfusion is critically assessed, a vertical panniculectomy may be performed so that the skin is reapproximated in the midline without redundancy.

A major limitation of open CS is the wound morbidity associated with the large skin flaps necessary to access the lateral abdominal wall. To avoid this morbidity, several manuscripts have described innovative minimally invasive approaches to CS. These approaches are designed to gain direct access to the lateral abdominal wall without creating large skin flaps, creating dead space, or interrupting the primary blood supply to the central abdominal skin by ligation of the rectus abdominis perforator vessels.

p. 639

---

p. 640

Laparoscopic Component Separation

Laparoscopically, CS is performed through a 1-cm incision below the tip of the 11th rib overlying the external oblique muscle (Fig. 68-2). The external oblique muscle is split in the direction of its fibers, and a standard bilateral inguinal hernia balloon dissector is placed between the external and internal oblique muscles and directed toward the pubis. Three laparoscopic trocars are placed in the space created, and the dissection is carried from the pubis to several centimeters above the costal margin. The linea semilunaris is carefully identified, and the external oblique aponeurosis is incised from beneath the external oblique muscle at least 2 cm lateral to the linea semilunaris. The muscle is released from the pubis to several centimeters above the costal margin. This procedure is bilaterally performed.

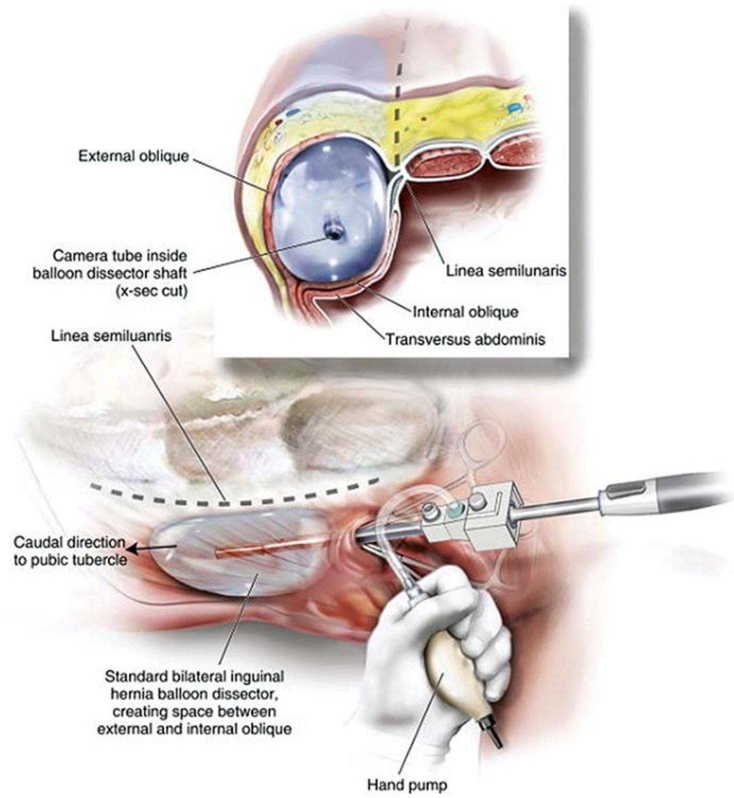


FIGURE 68-2 Endoscopic component separation. Access to the external oblique aponeurosis is achieved through a small incision at the costal margin through which a balloon dissector is placed. The external oblique aponeurosis is then divided from the pubis to above the costal margin. This minimally invasive approach preserves the attachments of the subcutaneous tissue (including myocutaneous perforators) to the anterior rectus sheath throughout its course.

(Adapted with permission from, Rosen MJ. Atlas of Abdominal Wall Reconstruction. Elsevier, 2011.)

Periumbilical Perforator-Sparing Technique

A periumbilical perforator-sparing technique of CS may be performed to preserve the blood supply to the anterior abdominal wall skin near the midline and is based primarily on perforator vessels from the deep inferior epigastric vessels. Cadaver dissections and radiographic studies have confirmed that the majority of these vessels are located within 3 cm of the umbilicus. With preservation of these vessels, ischemic complications involving the subcutaneous flaps are significantly reduced. To avoid injury to the periumbilical perforator vessels, a line is marked no less than 3 cm cephalad and 3 cm caudal to the umbilicus. The periumbilical perforator tunnels are begun at the epigastric and suprapubic regions. Subcutaneous tunnels are created using lighted retractors to identify the external oblique fascia. The superior and inferior tunnels are connected using cautery and retractors while maintaining the subcutaneous attachments of the periumbilical region. The linea semilunaris is identified by palpation, and the external oblique muscle is incised 2 cm lateral to this junction. The aponeurotomy is extended several centimeters above the costal margin and to the pubic tubercle. The external oblique muscle is separated from the internal oblique muscle in an avascular plane toward the posterior axillary line. The periumbilical perforator-sparing approach has several limitations. One of the benefits of minimally invasive CS is to reduce subcutaneous dead space. The periumbilical perforator-sparing technique creates considerable dead space and sacrifices more perforator vessels to the skin than other minimally invasive techniques. When skin mobilization is necessary, adequate advancement occasionally can be difficult to achieve because the midline skin is still invested in the periumbilical region. In addition, the placement of a wide piece of mesh as an underlay can be difficult given the large subcutaneous paddle that is still attached.

Minimally Invasive Component Separation

Butler and colleagues modified the standard open Ramirez-style procedure that further reduces the subcutaneous dead space and maximizes the blood supply to the abdominal skin with rectus perforator preservation. The minimally invasive component separation (MICS) technique is designed to avoid division of the musculocutaneous perforators overlying the rectus sheath and thus maintain perfusion to the paramedian skin. After lysis of adhesions and identification of the fascial edges, bilateral, 3-cm wide, subcutaneous access tunnels are created over the anterior rectus sheath from the midline to the linea semilunaris at the level of the costal margin (Fig. 68-3). Through these access tunnels, the external oblique aponeurosis is vertically incised 1.5 cm lateral to the linea semilunaris. The tip of a metal Yankauer suction handle (Cardinal Health, Dublin, OH), without suction, is inserted through the opening in the avascular plane between the internal and external oblique aponeuroses, separating them at their junction with the rectus sheath. The suction tip is advanced inferiorly to the pubis and superiorly to above the costal margin. Next, lateral dissection between the internal and external oblique muscles is performed to the midaxillary line. Minimal subcutaneous skin flaps are then elevated over the anterior rectus sheath circumferentially to the medial row of rectus abdominis perforator vessels, and a retrorectus or preperitoneal mesh inlay is generally used. If a preperitoneal inset is used, the preperitoneal fat is circumferentially dissected from the posterior sheath to allow the mesh to be inlaid directly against the posterior sheath or rectus abdominis muscle (below the arcuate line). Mesh is inserted to the semilunar line with #1 polypropylene sutures via the horizontal access tunnels and the cranial and caudal aspect of the defect. Next, the myofascial edges are advanced and reapproximated over the mesh with sutures placed through the myofascia and mesh. Interrupted resorbable 3-0 sutures are placed to affix the posterior sheath to the mesh, thereby obliterating dead space and reducing the potential for fluid collection. Closed-suction drainage catheters are placed in each CS donor site area, in the space between the rectus complex closure and mesh, and in the subcutaneous space. The remaining undermined skin flaps are sutured to the myofascia with vertical rows of interrupted resorbable 3-0 quilting sutures to reduce dead space and potential shear between the subcutaneous tissue and myofascia.

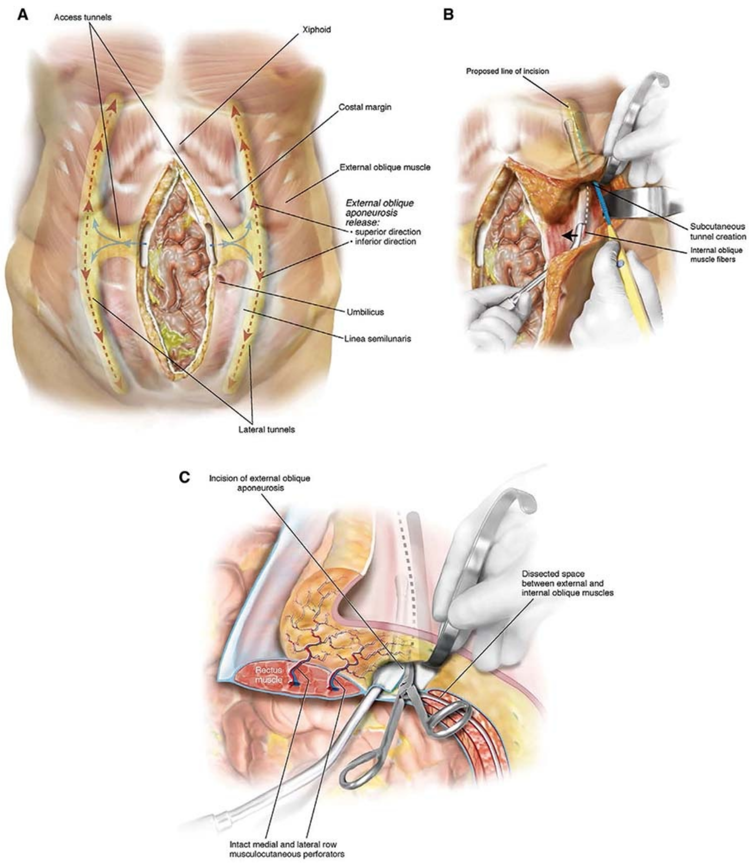


FIGURE 68-3 Minimally invasive component separation (MICS) technique. A. Access to the external oblique aponeurosis is achieved through a small tunnel from the midline to the supraumbilical external oblique aponeurosis. Vertical tunnels are created dorsal and ventral to the planned release site of the external oblique aponeurosis. Periumbilical perforators and the subcutaneous tissue overlying the anterior rectus sheath are left undisturbed. B. The external oblique aponeurosis is then divided from the pubis to above the costal margin. The external oblique aponeurosis in the upper abdomen is released with electrocautery as muscle is transected at, and superior to, the costal margin. C. Scissors are generally used to release the external oblique aponeurosis inferiorly. This MICS approach preserves the attachments of the subcutaneous tissue (including myocutaneous perforators) to the anterior rectus sheath throughout its course.

(Adapted with permission from, Rosen MJ. Atlas of Abdominal Wall Reconstruction. Elsevier, 2011.)

Posterior Technique

A posterior CS is based on the retromuscular Rives–Stoppa approach to ventral hernia repair (Fig. 68-4). Unlike the Ramirez CS focusing on external oblique aponeurosis release, the posterior CS focuses on transversus abdominis aponeurosis release. As previously mentioned, the transversus abdominis aponeurosis actually forms the posterior rectus sheath in the upper two-thirds of the abdomen. By incising this myofascial aponeurosis, the surgeon accesses the preperitoneal space. This provides substantial advancement of both the posterior fascial flap and the anterior myofascial compartment. The initial release is completed by incising the posterior rectus sheath approximately 1 cm lateral to the linea alba and the posterior rectus sheath is separated from the overlying rectus muscle. The transversus abdominis muscle is incised just medial to the intercostal nerves, and the underlying transversalis fascia and peritoneum are identified. This myofascial release is extended the entire length of the posterior rectus sheath. The potential space between the transversus abdominis muscle and the peritoneum is developed as far laterally as necessary, even to the psoas muscle if needed. This plane can be extended superiorly to the costal margin, retrosternally above the xiphoid, and inferiorly into the space of Retzius. The posterior sheath is then completely closed to exclude any mesh from the viscera. An adequately sized piece of mesh is then secured, similar to a standard retromuscular repair, but with greater overlap; finally, the midline is reapproximated.

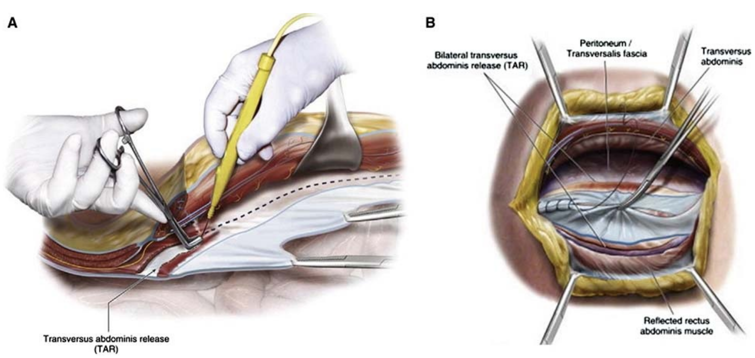


FIGURE 68-4 Posterior component separation. A. The initial release is completed by incising the posterior rectus sheath approximately 1 cm lateral to the linea alba, and the posterior rectus sheath is separated from the overlying rectus abdominis muscle. Dissection is carried to the lateral border of the rectus muscle, and the perforating intercostal nerves are identified, marking the linea semilunaris. B. Next, the transversus abdominis muscle is incised just medial to the intercostal nerves, and the underlying transversalis fascia and peritoneum are identified. This myofascial release is extended the entire length of the posterior rectus sheath. The potential space between the transversus abdominis muscle and the peritoneum is

developed as far laterally as necessary.

(Adapted with permission from, Rosen MJ. Atlas of Abdominal Wall Reconstruction. Elsevier, 2011.)

POSTOPERATIVE MANAGEMENT

In general, patients undergoing abdominal wall reconstruction have prolonged postoperative healing periods due to the dynamic function and mobility of the abdominal musculature. On the basis of specific unique indications, each patient's postoperative care regimen should be individually tailored to allow for sufficient healing of the surgical site. Sequential compression devices and early ambulation should be utilized with low-molecular-weight fractionated heparin administered postoperatively for deep venous thrombosis prophylaxis. Perioperative antibiotics are indicated, and cases with violation of the gastrointestinal tract should be offered broader coverage for anaerobic as well as gram-negative bacteria. For ventral hernia, closed-suction drains are used liberally and are kept in place on average 1–2 weeks until less than 30 ml/day. Patients with abdominal wall reconstruction should refrain from strenuous activities and exercises that isolate the abdominal core for at least 6–12 weeks. Patients may gain comfort from the use on an abdominal binder for 3 months, and then with any expected heavy physical activity thereafter. Routine follow-up includes a physical examination in an outpatient clinic; often performed weekly for 1 month after discharge, then every 3 months for 1 year, and then annually thereafter.

COMPLICATIONS

Infection

Surgical site infections are common after abdominal wall reconstruction. Categorization of the intraoperative level of wound contamination based on the Centers for Disease Control criteria into clean, clean-contaminated, contaminated, and dirty wounds is important to appropriately stratify patients by risk of surgical site infection. The most common infectious organism is *Staphylococcus aureus*, seen in up to 81% of infections; this suggests skin flora contamination during reconstruction. However, gram-negative organisms, such as *Klebsiella* and *Proteus* spp., have been implicated in up to 17% of abdominal wall infections. Culture-directed antibiotics and operative debridement, when indicated, are the mainstay of treatment.

Seroma

Seroma formation can occur following abdominal wall reconstruction, particularly in cases involving large undermined flaps, which create significant dead space. If symptomatic, seromas can be aspirated percutaneously or under ultrasound guidance. In most cases, small seromas will be reabsorbed over time. Resection of a previous hernia sac is important to prevent seroma formation. In open ventral hernia repair, drains are often placed in an attempt to obliterate the dead space caused by the hernia and tissue dissection. Seroma formation is common after abdominal CS and muscle flaps of the trunk owing to extensive tissue dissection, and drains may be necessary for up to 4–6 weeks. Intraoperative techniques, such as quilting sutures, fibrin sealant, and postoperative abdominal binders may help prevent or reduce seroma formation.

RESULTS

Estimated incidences of hernia recurrence have a wide range from 2% to 54%, depending on the type of repair (mesh 2–36% vs. suture repair alone 25–54%), patient comorbidities, and surgical technique. The number of prior attempts of hernia repair is predictive of the relative risk of recurrence. In a study of approximately 10,000 patients, 5-year reoperative rate was 23.8% after a primary repair, 35.3% following a secondary repair, and 38.7% after a tertiary repair. There are few comparative data to suggest the superiority of one myofascial advancement approach over another, and likely each has a role in abdominal wall reconstruction. Open CS often allows tension-free closure of large defects, and recurrence rates as low as 20% have been reported with the use of open CS and mesh reinforcement in large hernias. Recognizing the high recurrence rates with CS alone, several authors have reported series of bioprosthetic or synthetic mesh reinforcement of these repairs; although to date, no randomized controlled trials have demonstrated lower hernia recurrence rates with a specific mesh type. Comparative data have shown laparoscopic CS to result in a lower rate of wound morbidity than open CS. One series reported a significant reduction in wound morbidity with the periumbilical perforator-sparing technique compared with the standard open CS technique (2% vs. 20%; $P < 0.05$). A controlled study demonstrated that patients had significantly fewer wound-healing complications (32% vs. 14%, $P = 0.026$) and skin dehiscences (28% vs. 11%, $P = 0.01$) with MICS than with traditional open CS. These improved wound-healing outcomes are likely due to preservation of the vascularity of the overlying skin flaps and reduction of paramedian dead space—the surgical principles underlying the MICS procedure. In a recent comparative review of open anterior CS with posterior CS for complex abdominal wall reconstruction, Krpata and colleagues reported similar fascial advancement but a 50% reduction in wound morbidity with the posterior approach when compared to an anterior CS.

CONCLUSIONS

Ramirez and colleagues' description of the surgical technique of CS facilitates medialization of the rectus musculofascia, and thus midline abdominal closure by releasing the external oblique aponeuroses. CS with myofascial advancement flaps is a critically important and reliable method for obtaining primary fascial coaptation in large abdominal defects. Strength and integrity of the abdominal wall are preserved as well as muscle vascularity and innervation to provide a long-lasting repair with excellent functional outcomes.

RECOMMENDED REFERENCES AND READINGS

Althubaiti G, Butler CE. Abdominal wall and chest wall reconstruction. *Plast Reconstr Surg* 2014;133(5):688e–701e.

Booth JH, Garvey PB, Baumann DP, *et al.* Primary fascial closure with mesh reinforcement is superior to bridged mesh repair for abdominal wall reconstruction. *J Am Coll Surg* 2013;217(6):999–1009.

Breuing K, Butler CE, Ferzoco S, et al; Ventral Hernia Working Group. Incisional ventral hernias: review of the literature and recommendations regarding the grading and technique of repair. *Surgery* 2010;148(3):544–58.

Butler CE, Bauman DP, Janis JE, Rosen MJ. Abdominal wall reconstruction. *Curr Prob Surg* 2013;50:557–86.

Butler CE, Campbell KT. Minimally invasive component separation with inlay bioprosthetic mesh (MICSIBM) for complex abdominal wall reconstruction. *Plast Reconstr Surg* 2011;128(3):698–709.

Garvey PB, Bailey CM, Baumann DP, Liu J, Butler CE. Violation of the rectus complex is not a contraindication to component separation for abdominal wall reconstruction. *J Am Coll Surg* 2012;214(2):131–9.

Ghali S, Turza KC, Baumann DP, Butler CE. Minimally invasive component separation results in fewer wound-healing complications than open component separation for large ventral hernia repairs. *J Am Coll Surg* 2012;214(6):981–9.

Giordano S, Garvey PB, Baumann DP, Liu J, Butler CE. Primary fascial closure with biologic mesh reinforcement results in lesser complication and recurrence rates than bridged biologic mesh repair for abdominal wall reconstruction: a propensity score analysis. *Surgery* 2017;161:499–508.

Giordano S, Garvey PB, Baumann DP, Liu J, Butler CE. Prior radiotherapy does not affect abdominal wall reconstruction outcomes: evidence from propensity score analysis. *Ann Surg Oncol* 2017;24:816–22.

Itani KM, Hur K, Kim LT, et al; Veterans Affairs Ventral Incisional Hernia Investigators. Comparison of laparoscopic and open repair with mesh for the treatment of ventral incisional hernia: a randomized trial. *Arch Surg* 2010;145(4):322–8; discussion 328.

Mommers EH, Wegdam JA, Nienhuijs SW, de Vries Reilingh TS. How to perform the endoscopically assisted component separation technique (ECS) for large ventral hernia repair. *Hernia* 2016;20(3):441–7.

Morris LM, LeBlanc KA. Components separation technique utilizing an intraperitoneal biologic and an onlay lightweight polypropylene mesh: “a sandwich technique”. *Hernia* 2013;17:45.

Ramirez OM, Ruas E, Dellon AL. “Component separation” method for closure of abdominal-wall defects: an anatomic and clinical study. *Plast Reconstr Surg* 1990;86(3):519–26.

Rosen MJ, Jin J, McGee MF, Williams C, Marks J, Ponsky JL. Laparoscopic component separation in the single-stage treatment of infected abdominal wall prosthetic removal. *Hernia* 2007;11(5):435–40.

Shestak KC, Edington HJ, Johnson RR. The separation of anatomic components technique for the reconstruction of massive midline abdominal wall defects: anatomy, surgical technique, applications, and limitations revisited. *Plast Reconstr Surg* 2000;105(2):731–8.
Slater NJ, Knaapen L, Bökkerink WJ, *et al.* Large contaminated ventral hernia repair using component separation technique with synthetic mesh. *Plast Reconstr Surg* 2015;136(6):796e–805e.

PART XV

SMALL BOWEL STRICTUREPLASTY

Chapter 69

Finney and Jaboulay Strictureplasty

Pamela C. Sivathondan and Bruce D. George

INDICATIONS/CONTRAINDICATIONS

The behavior of Crohn's disease may be considered to be nonstricturing, nonpenetrating (B1), stricturing (B2), or penetrating (B3). About one-third of patients with Crohn's disease will develop stricturing disease. Strictures may be single or multiple, short or long, and may occur at any part of the gastrointestinal tract. The most common sites are the small bowel, especially terminal ileum, and at surgical anastomoses.

Established fibrotic strictures require a mechanical solution. Short strictures may be amenable to endoscopic balloon dilatation. Thienpont *et al.* reported their experience of 237 dilatations in 138 patients. All strictures treated were less than 5 cm and were predominantly at ileocolic anastomoses. Immediate success, judged by the ability to pass an adult colonoscopy through the stricture, was achieved in 97%. Six perforations occurred (2.5% risk per procedure, 4.3% risk per patient). At median follow-up of 5 years, 24% of patients required surgery and 46% repeat dilatation. Forty-four percent of patients remained free of dilatation and surgery after the first dilation.

In broad terms, surgery is indicated for symptomatic strictures not amenable to endoscopic balloon dilatation or when medical/endoscopic therapy has failed. However, further factors need to be considered, ideally within a multidisciplinary team environment:

Degree of certainty that symptoms are due to stricture(s)

Patients with obstructive symptoms and radiologic evidence of a stricture with associated proximal bowel dilatation are most likely to benefit from intervention. Alternatively, patients with nonspecific symptoms or irritable-bowel-like symptoms and lack of proximal bowel dilatation are much less likely to benefit clinically from intervention.

Is the stricture mainly fibrotic or inflammatory?

Conceptually, inflammatory strictures are likely to respond to anti-

Conceptually, inflammatory strictures are likely to respond to anti-inflammatory medical therapy, whereas fibrotic strictures are likely to require mechanical treatment. In practice, most strictures are a mixture of both inflammatory and fibrotic. Assessment of which is dominant depends on a combination of clinical and radiologic features. Strictures occurring early in the natural history of the disease are more likely to be inflammatory. Serum inflammatory markers, erythrocyte sedimentation rate and C-reactive protein, and fecal calprotectin will tend to be raised in inflammatory strictures. Magnetic resonance and computed tomography may demonstrate discriminatory features such as wall thickening with contrast enhancement pointing toward inflammation or lack of such wall enhancement and the “fat halo” sign favoring fibrosis.

The decision to recommend surgery for stricturing disease is ultimately a balance between potential benefits such as relief of symptoms, improved nutrition, and possible reduction of medication and risks including early surgical risks such as anastomotic leakage, stoma, altered symptoms, changed body image and later recurrence and short bowel syndrome.

PREOPERATIVE PLANNING

Once the decision to operate has been made, it is important to preoperatively optimize to reduce the risks of surgery:

- Recent small bowel imaging and colonoscopy
- Reduce risk factors: improve nutrition, reduce/stop steroids, eliminate/reduce sepsis

Multidisciplinary team discussion

For patients with small bowel stricturing disease, a period of clear fluid intake is needed for the 24–48 hours before surgery. Bowel preparation is not required unless there is distal colonic or rectal disease or the need for intraoperative colonoscopy is anticipated. Standard antibiotics and venous thromboprophylaxis should be given.

SURGERY

Initial Assessment

The initial phase of surgery involves careful assessment of the extent of stricturing disease. While most first operations may be laparoscopically undertaken, recurrent disease or cases of extensive small bowel stricturing may require laparotomy.

Most strictures may be detected by the presence of bowel wall thickening, mesenteric fat wrapping, or serosal neovascularization. Subtle strictures can be easily overlooked and balloon characterization of the whole small bowel from duodenum to cecum is recommended. The use of a calibrated Foley catheter inserted via a suitable enterotomy (at a site of planned resection or strictureplasty (SP)) is recommended (Fig. 69-1A and 1B). The length of the small bowel should be measured.

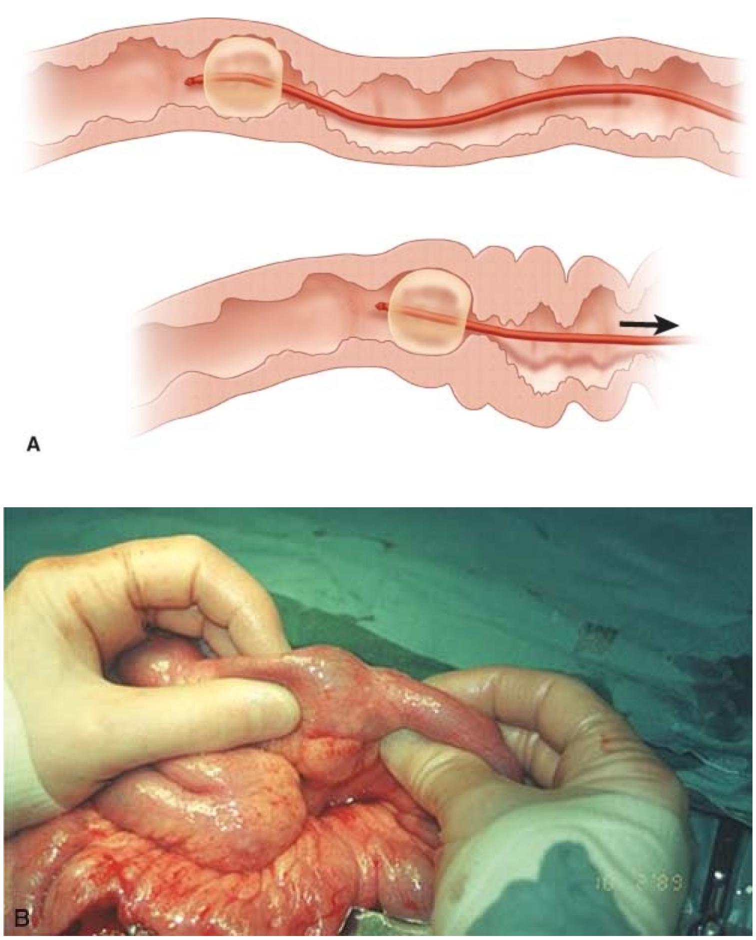


FIGURE 69-1 A. Balloon characterization of the

small bowel. B. Calibrated balloon in the lumen of the small bowel.

Surgical Strategy

Having characterized the whole small bowel, a decision is made regarding the use of resection, single/multiple SPs or a combination of resection and SP. A long-established principle of Crohn's surgery is that bowel length should be preserved if possible. Crohn's disease has a significant risk of recurrence, and repeated resections may ultimately result in short bowel syndrome. The use of minimal rather than radical resections was well established by a large multicenter randomized controlled trial. Some recent data on the significance of microscopic plexitis at resection margins and the potential benefits of more extensive mesenteric resections may challenge this fundamental principle. Meta-analysis of reports of SP indicates that the technique is safe with broadly similar surgical recurrence rates between resection and SP ± resection. However, there are no prospective trials comparing resection with SP and the excellent results of laparoscopic ileocecal/colic resections should be considered.

SP is generally undertaken in patients considered to be at risk for short bowel syndrome. The major groups where SP is appropriate are as follows:

Patients with extensive stricturing disease

Patients with early recurrent stricturing disease after previous surgery and optimum medical therapy

In combination with resectional disease

Contraindications to SP are sepsis, cancer, or dysplasia and severe phlegmonous disease. A fistula at the site of the stricture is a relative but not an absolute contraindication.

The decision to resect or to undertake SP is often a “difficult call” and may benefit from intraoperative discussion with two to three experienced inflammatory bowel disease surgeons.

Types of Strictureplasty

The type of SP depends principally on the length of the stricture.

Short strictures (up to about 10 cm) are generally managed by a Heineke–Mikulicz (H-M) SP.

Intermediate strictures (10–20 cm) may be treated by the Finney or Jaboulay techniques. The Finney technique may also be used for multiple short strictures that are too close together to permit serial H-M SPs.

Longer strictures may be amenable to a Michelassi-type SP.

About 80–90% of strictures are treated by the H-M technique, with only about 10% utilizing the Finney or rarely the Jaboulay technique.

Technical Notes

The Finney and Jaboulay techniques are similar in that the strictured segment is placed in a U-shape, with the middle of the stricture at the apex (Fig. 69-2).

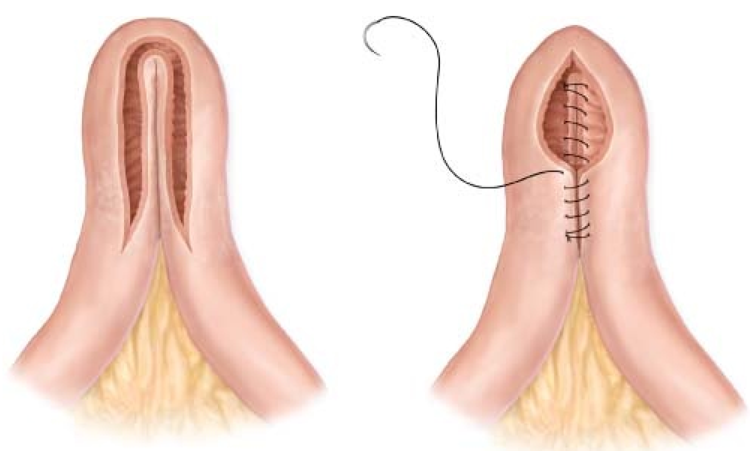


FIGURE 69-2 Finney strictureplasty. From Jones DW and Garrett KA. Strictureplasty and Small Bowel Bypass in Inflammatory Bowel Disease. In: Albo D, ed. Operative Techniques in Colon and Rectal Surgery.

2015, Wolters Kluwer Health, 12, with permission.

In the more commonly used Finney technique, a long enterotomy is made “around the whole U.” The posterior layer is then sutured using a continuous suture, followed by the anterior layer, either in a continuous or interrupted manner according to surgeon preference. The main specific contraindication to this technique is if the bowel is too rigid to be folded comfortably into the U-shape.

In the Jaboulay technique (Fig. 69-3A and B), the strictured segment is again placed in a U-shape. The anti-mesenteric enterotomy, however, does not extend around the apex. Two enterotomies are made on either side of the apex. The posterior and anterior walls are sutured in a manner similar to the Finney technique. The technique is effectively a side-to-side anastomosis close to the apex of the stricture and is rarely undertaken. It is primarily used when a stricture is present in the second part of the duodenum and injury to the Ampulla is high if the Finney SP is preformed.

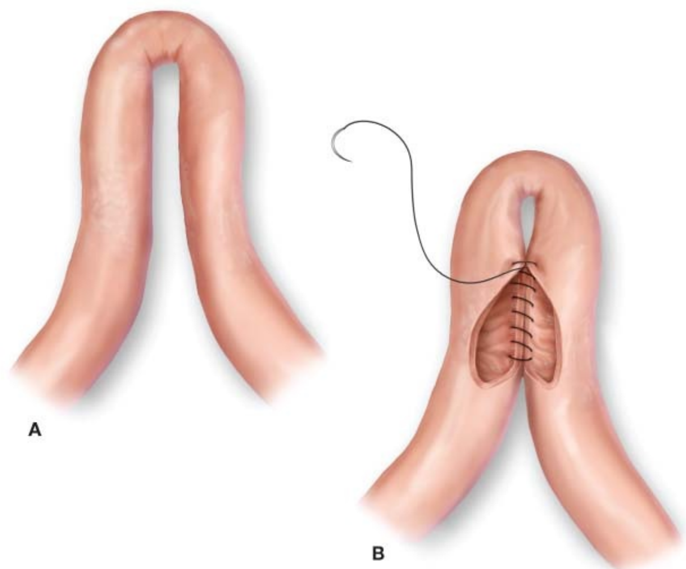


FIGURE 69-3 A. Site of enterotomies in Jaboulay strictureplasty. B. Suturing of Jaboulay strictureplasty.

Final Assessment

At the end of a complex procedure involving one or more SPs it is recommended to check for any leaks using a “bicycle-tyre” test. Our preferred technique is to insufflate CO_2, easily obtainable at low pressure from any laparoscopic stack. The CO_2 is insufflated either via a nasogastric tube, or inserted via a stoma, or via the last suture line to be closed, depending on the precise operative circumstances. Insufflation of CO_2 into the bowel lumen, with saline in the peritoneal cavity allows easy identification of any bubbles. It has the additional advantage of demonstrating free flow along the bowel and is also rapidly absorbed, within 2–4 minutes of insufflation.

POSTOPERATIVE MANAGEMENT

It is the author's practice to recommend no more than 500 ml water in the first 24–48 hours after SP to minimize the risk of postoperative ileus. Standard thromboprophylaxis should be given and there is no requirement for antibiotics postoperatively. Any preoperative parenteral nutrition would normally be continued after surgery.

COMPLICATIONS

Both Finney and Jaboulay techniques tend to leave a large blind limb that may result in postoperative bacterial overgrowth. The associated symptoms of bloating and abdominal pain may be difficult to distinguish from mechanical obstruction, but often respond to antibiotics such as ciprofloxacin or metronidazole.

There is a slight concern about the risk of small bowel tumors developing at SP sites. A few cases have been reported, although this seems to be so rare as to not represent a significant objection to SP. When undertaking SP, some mucosal ulceration is commonly seen on the mesenteric side of the small bowel. Our policy is not to biopsy routinely unless there are any unusual features.

RESULTS

When the technique of SP was first reported, there were concerns that operative morbidity would be high because of suturing in diseased segments of bowel and that recurrence rates would be higher than after resection. Although there are no randomized trials, the evidence does not support these concerns. A meta-analysis of over 3,000 SPs in 1,112 patients reported an overall complication rate of 13% and a 4% rate of leakage/sepsis after jejunoileal SP. These rates are lower than those generally reported after resectional Crohn's surgery.

The recurrence rate requiring surgery in the meta-analysis was 30%, again broadly similar to Crohn's recurrence rates in general. Younger age, shorter disease duration, and short time from previous surgery were identified as risk factors for recurrence. Most studies have not shown any significant differences in recurrence rates between SP and resection or between SP versus SP + resection. Only one study found an earlier recurrence following surgery involving SP compared to resection alone.

An earlier meta-analysis suggested a lower recurrence rate after Finney SP compared to H-M, although a direct comparison of the techniques is not really valid.

CONCLUSIONS

SP is an established technique to preserve bowel length in stricturing Crohn's disease with acceptable short-term morbidity and recurrence rates compared to resectional surgery.

Finney and Jaboulay SPs are techniques appropriate for strictures of intermediate length, (10–20 cm), but represent only about 10% of all SPs undertaken.

RECOMMENDED REFERENCES AND READINGS

Borley NR, Mortensen NJ, Chaudry MA, *et al.* Recurrence after abdominal surgery for Crohn's disease: relationship to disease site and surgical procedure. *Dis Colon Rectum* 2002;45(3):377–83.

Fazio VW, Marchetti F, Church M, *et al.* Effect of resection margins on the recurrence of Crohn's disease in the small bowel. A randomized controlled trial. *Ann Surg* 1996;224(4):563–71; discussion 571–563.

Lee EC, Papaioannou N. Minimal surgery for chronic obstruction in patients with extensive or universal Crohn's disease. *Ann Roy Coll Surg Engl* 1982;64(4):229–33.

Thienpont C, D'Hoore A, Vermeire S, *et al.* Long-term outcome of endoscopic dilatation in patients with Crohn's disease not affected by disease activity or medical therapy. *Gut* 2010;59(3):320–4.

Tichansky D, Cagir B, Yoo E, Marcus SM, Fry RD. Strictureplasty for Crohn's disease: meta-analysis. *Dis Colon Rectum* 2000;43(7):911–9.

Vermeire S, Van Assche G, Rutgeerts P. Classification of inflammatory bowel disease: the old and the new. *Curr Opin Gastroenterol* 2012;28(4):321–6.

Yamamoto T, Fazio VW, Tekkis PP. Safety and efficacy of strictureplasty for Crohn's disease: a systematic review and meta-analysis. *Dis Colon Rect* 2007;50:1968–86.

Chapter 70

Heineke–Mikulicz, Finney, and Michelassi Strictureplasty

Heather Yeo and Fabrizio Michelassi

INDICATIONS/CONTRAINDICATIONS

Surgical decision making is complex in Crohn’s disease because of the recurrent nature of the disease. Many patients require multiple operations throughout their lives for failure of medical management and treatment of symptoms or complications of the disease including sepsis, stricture, bleeding, and cancer. Repeated intestinal resections may leave patients with inadequate intestinal mucosal surface, leading to malabsorption of nutrients, vitamins, and fluids, resulting in malnutrition and chronic dehydration, a condition known as short gut syndrome.

Strictureplasty preserves the intestinal absorptive surface area. It is the treatment of choice, and recommended by both American and European guidelines, for management of patients with symptomatic non-phlegmonous jejunoileo fibrotic strictures. Although the length of the intestine may be reduced by modification of the shape of the bowel, total surface area remains the same in the preserved segment of bowel. Currently, it is not known whether the previously diseased segment regains normal absorptive function after strictureplasty, but studies have demonstrated that endoscopically, radiographically, and histopathologically the appearance of the bowel does normalize after strictureplasty.

Strictureplasty techniques were initially used only for small bowel disease; recently, their use has been extended to duodenal disease as well as recurrent disease or small bowel anastomoses or ileocolic anastomoses. Strictureplasty can be coupled with bowel resections and several strictureplasty techniques can be simultaneously employed to maximize bowel preservation.

Absolute contraindications to strictureplasty include generalized sepsis, cancer, or dysplasia. Severely diseased segments with luminal obliteration or unyielding intestinal wall, and intestinal segments with inflammatory phlegmonous masses are probably best resected. Although fistulous disease or localized sepsis was initially thought to be contraindications, several studies have demonstrated that strictureplasty is safe. The degree of acute inflammation associated with fistulae or sepsis must be limited and the fistulous opening away associated with fistulae or sepsis must be limited and the fistulous opening away from the mesenteric side of the bowel. A critically ill patient should not undergo strictureplasty secondary to the length and complexity of the operation.

PREOPERATIVE PLANNING

Appropriate preoperative evaluation for patients with Crohn's disease includes thorough assessment of extent of disease. Patients may present with a single symptomatic area of disease. Preoperative evaluation of the extent of disease aids in operative planning and in patient preparation in those circumstances when the disease is widespread and complex.

A computed tomography (CT) scan is often the initial imaging study performed to evaluate symptomatic Crohn's disease. CT scan is useful in that it evaluates both intraluminal and extraluminal findings including obstruction, edema, abscess, and fistula. CT enterography or magnetic resonance enterography can provide greater detail on the intraluminal findings of mucosal disease. Endoscopic evaluation, including colonoscopy with ileal intubation, esophagogastroduodenoscopy, push-enteroscopy, and capsule endoscopy can help in assessing the disease. In patients with narrow strictures, a capsule endoscopy is contraindicated because the capsule could be retained proximal to a stenosis and cause obstruction.

Despite the increased accuracy of modern preoperative radiographic and endoscopic imaging, appropriate selection of operative procedures (strictureplasty, resection, bypass, or intestinal diversion) can only be performed after careful intraoperative evaluation and creation of a "road map" at the time of the operative intervention. Therefore, preoperative discussions and informed consent should include all of the possible surgical options.

SURGICAL PROCEDURE

Preparation

The use of preoperative bowel preparation varies depending on the location of the disease. Mechanical bowel preparation is necessary for distal colonic disease, but may be avoided for small bowel and ileocolonic disease. In the presence of chronic obstructive small bowel disease, a preoperative period of clear liquids may be useful to reduce the amount of intraluminal-retained fluid. The authors' and editors' practice is to use a standard oral antibiotic prep for any procedure that may involve colonic resection or repair.

Patients are given appropriate intravenous antibiotic coverage for clean-contaminated or contaminated surgical procedures before incision. Sequential compression devices are used perioperatively for deep venous thrombosis prophylaxis along with administration of subcutaneous low-molecular-weight heparin unless there is a contraindication. Patients receiving steroids should be given appropriate stress dose steroids to help prevent adrenal insufficiency.

Positioning

The patient is usually placed in the supine position on the operating table. If access to the perineum is anticipated, the patient can be placed supine on the operating table and moved to the lithotomy position at the appropriate time. In this case, the patient's hips and buttocks are placed protruding over the break of the operating table to ensure easy access to the perineum once moved to the lithotomy position. Alternatively, the patient can be positioned in the modified lithotomy position for the entire procedure. This latter positioning option is preferred by the editors.

Technique—General Principles

Upon entering the abdomen, a thorough exploration of the abdominal cavity and a careful examination of the entire small and large intestine are mandatory. The total length of intestine should be noted. Any diseased areas should be examined and the length and extent of disease should be recorded. If many areas of disease are found, it can be helpful to mark each one with sutures to facilitate subsequent planning. With a complete "road map" created, an operative strategy is then formulated.

Short isolated segments of stricture are appropriate for Heineke–Mikulicz (less than 7 cm) or Finney (up to 15 cm) strictureplasties. Longer segments or chain of lake formation may be considered for a Michelassi strictureplasty. Several different strictureplasty techniques with or without simultaneous bowel resections may be used in the same patient to maximize intestinal preservation.

Several maneuvers are universally used during strictureplasty to help minimize contamination of the operative field by enteric contents. Use of a wound protector may help prevent contamination of the surgical site. Operative towels or laparotomy pads are placed under the isolated bowel loop to prevent spillage of enteric contents into the abdominal cavity. An atraumatic intestinal clamp is placed several centimeters proximal to the operative segment, where it will not hinder the surgeon, but prevents continued leakage of enteric contents into the operative field. An assistant should be assigned to handle suction following enterotomy.

After opening the disease segment in preparation for a strictureplasty, the mucosa must be inspected. If findings suspicious of cancer or dysplasia are found, a biopsy should be sent immediately to pathology for frozen section: if confirmed, the segment should be resected and strictureplasty aborted.

Meticulous hemostasis of the intestinal wall and overlying mucosa must be achieved. Diseased segments are often quite friable and bleed easily. Suturing of the intestinal wall during the performance of the strictureplasty may help with hemostasis, but any ongoing bleeding should be treated with precise application of electrocautery before starting to fashion the strictureplasty.

Areas distal to the segment of diseased bowel should be intraoperatively examined. When patients have symptomatic proximal disease, strictures distally may be asymptomatic and may not cause bowel dilation. If areas of stenosis are suspected but not evident on inspection, a bladder catheter with a balloon inflated to a 1–2 cm diameter inserted through the enterotomy to be used for the strictureplasty can be used to assess the size of the internal lumen of the suspected sites.

Inspection of the bowel, identification of diseased segments, and mobilization of the intestinal loops may be laparoscopically performed. However, the authors suggest that performance of the actual strictureplasty be done through a limited abdominal incision through which the diseased loop of intestine has been exteriorized. The severely thickened mesentery, extensive and multisite disease, and the disparity between wall thickness of normal and diseased intestine are all challenges that are best confronted through an open approach.

Operative Technique

Heineke–Mikulicz Strictureplasty (In Situ Strictureplasty)

The most commonly performed strictureplasty is the Heineke–Mikulicz strictureplasty. This type of strictureplasty is most appropriate for isolated short segments, no longer than 5–7 cm segments, no longer than 5–7 cm.

After isolation of the diseased segment, two stay sutures are placed on either side of the strictured area at the midpoint. A longitudinal incision is made along the antimesenteric border of the stricture (Fig. 70-1A) and is extended for 2 cm into the normal pliable bowel on either side of the stricture. The longitudinal enterotomy is then closed in a transverse manner (Fig. 70-1B) with either a single-or double-suture layer (Fig. 70-1C). The authors prefer the use of a braided absorbable suture for an internal running stitch followed by interrupted Lembert nonabsorbable sutures for the second layer.

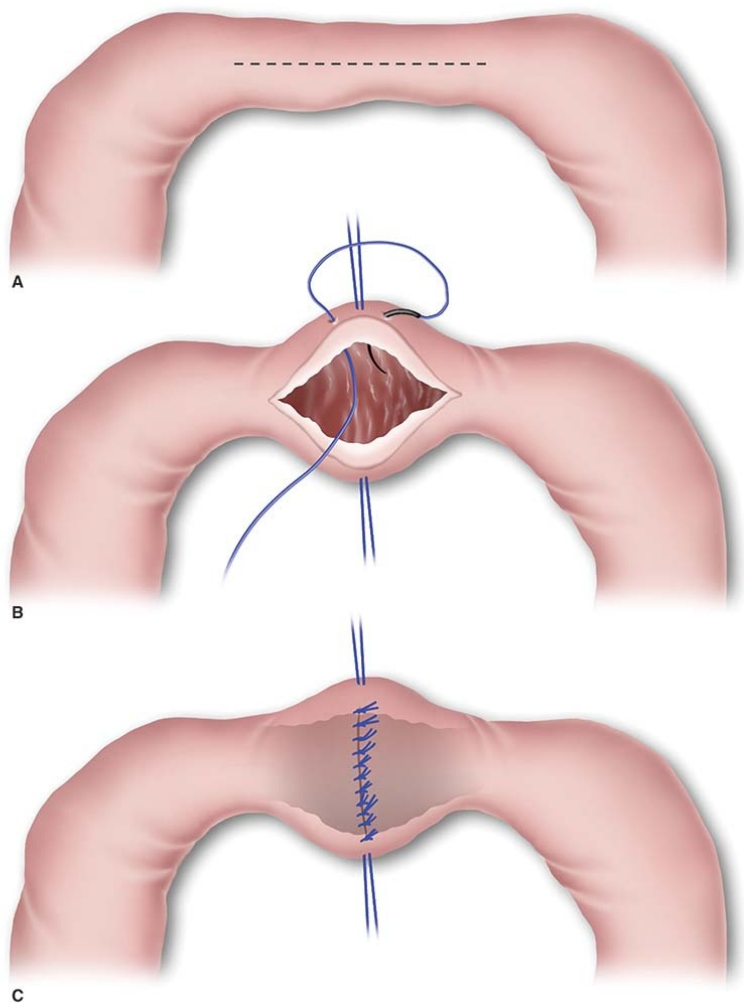


FIGURE 70-1 A. Heineke–Mikulicz strictureplasty. A longitudinal incision is made along the strictured segment of bowel. B. After extending the strictureplasty for 1–2 cm into normal pliable bowel, the longitudinal enterotomy is then closed in a transverse manner. C. Completed Heineke–Mikulicz strictureplasty.

Finney Strictureplasty (Side-to-Side Strictureplasty)

The Finney strictureplasty is appropriate for strictures up to 15 cm in length. The strictured segment is folded onto itself into a U-shape. A row of interrupted seromuscular nonabsorbable sutures is placed between the two arms of the U (Fig. 70-2A) and a longitudinal U-shaped enterotomy is made paralleling the row of sutures. A full-thickness braided absorbable running suture is then placed in a continuous running manner beginning at the apex of the posterior wall of the strictureplasty and continued to approximate the proximal and distal ends of the enterotomy (Fig. 70-2B). This full-thickness suture line is continued anteriorly to close the strictureplasty (Fig. 70-2C). A row of seromuscular Lembert sutures is then placed anteriorly. Strictures longer than 15 cm should not be handled with a Finney strictureplasty that may result in a large lateral intestinal diverticulum, which can be at risk for stasis and bacterial overgrowth, occasionally the cause for a subsequent resection of the strictureplasty.

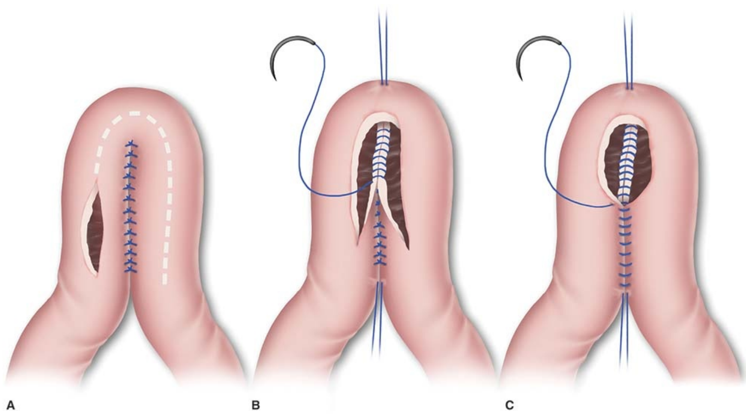


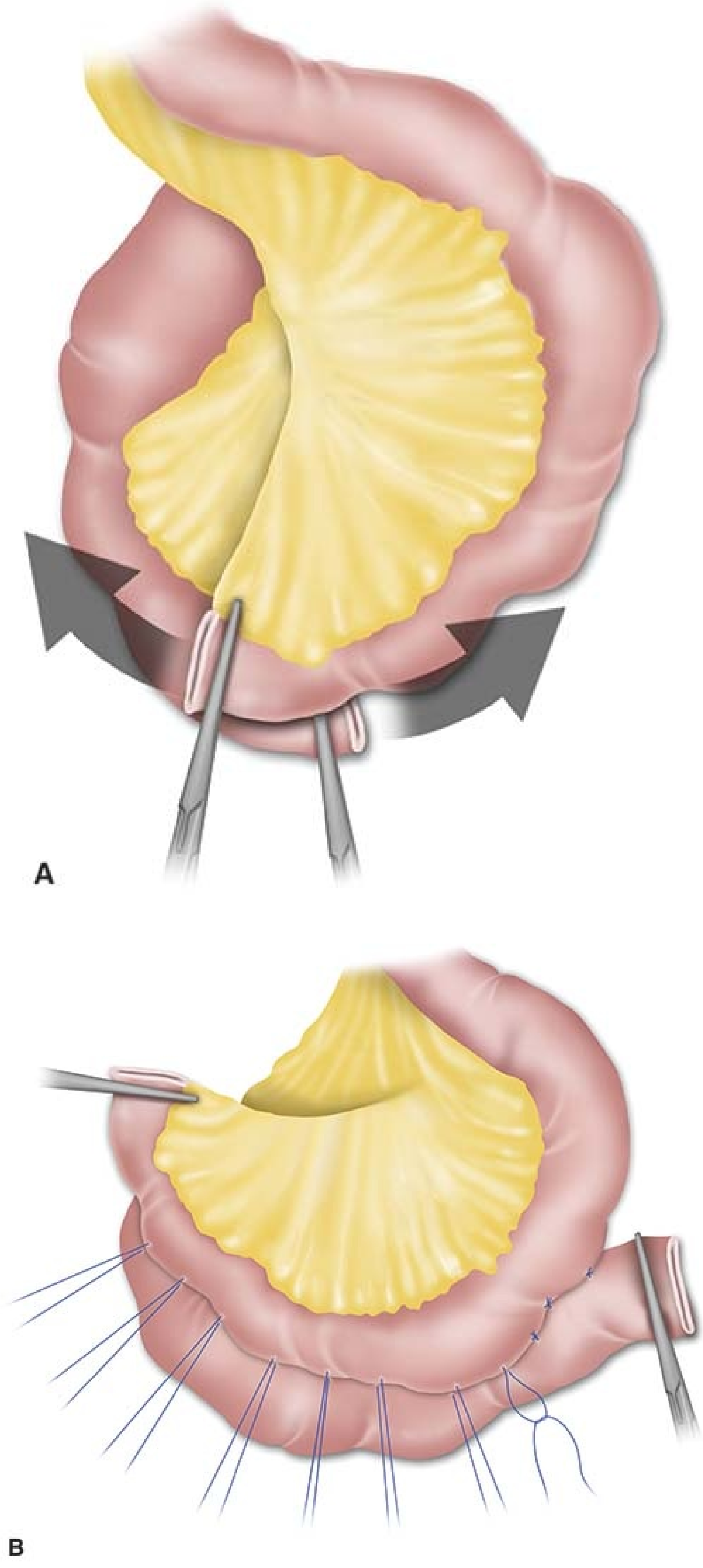
FIGURE 70-2 Finney strictureplasty. A. A row of interrupted sutures is placed between the two loops of the bowel B. A longitudinal enterotomy is created along the antimesenteric border of the strictured segment. C. The enterotomy is then closed using a running suture from the posterior wall of the strictureplasty, than on the anterior wall of the strictureplasty.

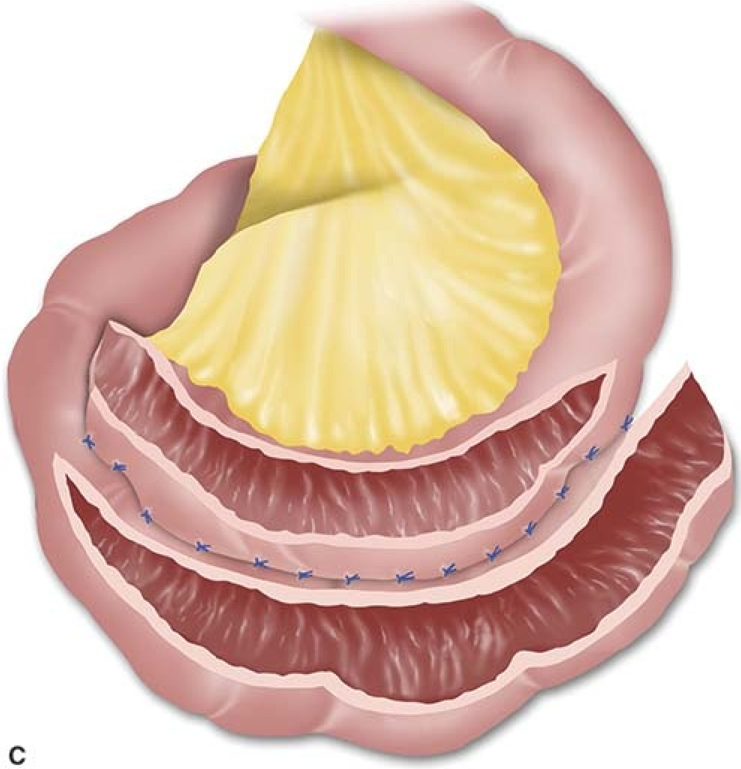
Michelassi Strictureplasty (Side-to-Side Isoperistaltic Strictureplasty)

The side-to-side isoperistaltic strictureplasty (SSIS) was first described in 1996 by the senior author to treat long segments of diseased bowel, and has been performed on segments from 20 to 75 cm in length. In the appropriate patient, the SSIS eliminates the need for large bowel resections or multiple short strictureplasties in close proximity that may create a bulky, awkward repair. The SSIS has the benefit of a more uniform repair without intestinal or mesenteric bulking. Recent data suggest that the SSIS can be used as an alternative for ileocecal resection in extensive terminal ileal Crohn’s, preserving the terminal ileum and cecum.

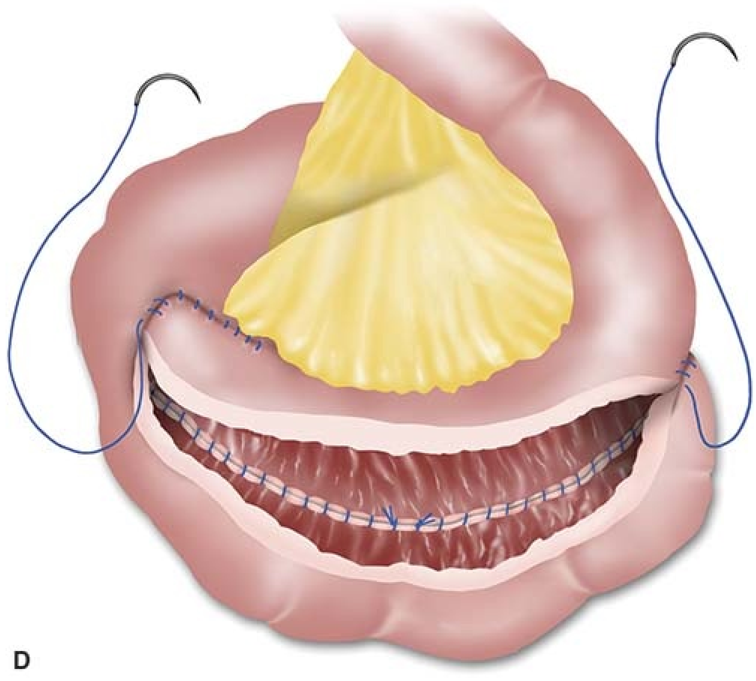
The mesentery of the small bowel loop to undergo an SSIS is divided at its midpoint. The mesentery is often thick with inflammation and lymphadenopathy and may require suture ligation for hemostasis. The midpoint of the small bowel is severed between atraumatic intestinal clamps.

The distal loop of the small intestine is overlaid on the proximal loop in a side-to-side isoperistaltic manner (Fig. 70-3A). The stenotic segments of one loop are aligned with dilated areas of the other loop to balance intestinal diameter and allow for adequate intestinal flow through the strictureplasty. The back wall of the two loops are approximated using a layer of nonabsorbable interrupted seromuscular Lembert sutures extending approximately 1 cm into healthy tissue of the proximal and distal ends (Fig. 70-3B).

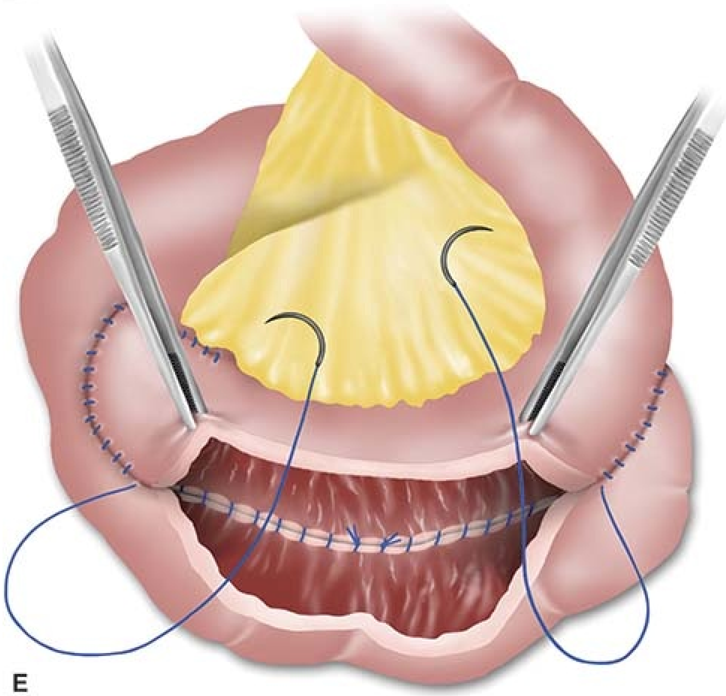

A
B



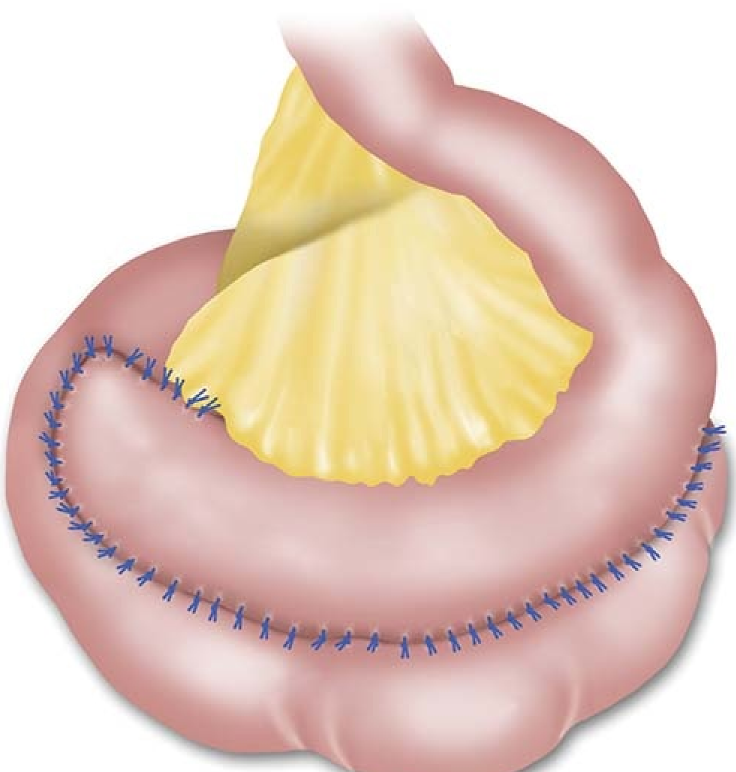
C



D



E



F

FIGURE 70-3 A. Michelassi strictureplasty: the mesentery and bowel wall are transected at the midpoint, the loops of small intestine are overlaid, with dilated segments of the proximal loop aligned with stenotic segments of the distal segment. B. A row of interrupted Lembert sutures is placed along the back row of the segment. C. A longitudinal enterotomy is made on the antimesenteric border. D and E. The ends of the strictureplasty are tapered to prevent creation of diverticula with stasis as the corners of the strictureplasty. The inner layer is completed on the back wall and run medially from the end of the strictureplasty. F. The completed side-to-side isoperistaltic strictureplasty.

A longitudinal enterotomy is performed on both loops, into healthy tissue on proximal and distal ends. The mucosa of the two loops is inspected to evaluate for possible malignancy and meticulous hemostasis is obtained. The ends of each loop of the intestines are gently tapered to avoid blind stumps at the proximal and distal end of the strictureplasty (Fig. 70-3C).

Two full-thickness running 3-0 absorbable suture lines are started on the posterior wall of the strictureplasty. This inner layer is run from the midpoint toward each end and continued on the anterior wall (Fig. 70-3D and E). Following closure of the entire anterior wall, an outer layer of nonabsorbable interrupted Lembert sutures is placed to complete the two-layer side-to-side isoperistaltic enteroenterostomy (Fig. 70-3F).

POSTOPERATIVE MANAGEMENT

Postoperatively, patient management is similar to that for any patient undergoing a bowel resection or anastomosis. Antibiotics are terminated within 24 hours of the operation. Patients on steroids preoperatively should receive appropriate stress dose steroids to prevent adrenal insufficiency after surgery. Early ambulating, pulmonary toilet, and incentive spirometry are encouraged. Diet may be advanced on the basis of clinical judgment. Because of the extent of disease and intestinal manipulation, patients may develop ileus postoperatively and should be monitored for abdominal distension. Consultation with a gastroenterologist familiar with Crohn's disease should be obtained for consideration of maintenance or preventive therapy and timing of treatment.

COMPLICATIONS

The safety of strictureplasty techniques in Crohn's patients was initially questioned. Unlike resection with primary anastomosis where the diseased tissue is removed to grossly normal margins and sutures are placed in healthy bowel, strictureplasties are fashioned in affected bowel and suture lines are placed within scarred and diseased tissue. In addition, many patients with Crohn's disease are on immunosuppressants, parenteral nutrition, or are malnourished. These factors raised concerns for increased rates of perioperative complications. However, strictureplasty has been demonstrated to be safe in appropriately selected patients.

Complications in patients after strictureplasty are similar to those in patients who undergo intestinal resection and include anastomotic dehiscence, suture line hemorrhage, and wound infections. The incidence of anastomotic dehiscence has been measured at 2–4% in large series and the rate of postoperative bleeding in need of blood transfusions occurs in 2–3% of cases. A meta-analysis by Yamamoto *et al.* demonstrated an overall complication rate of 13%. Risk factors for complications included older age, emergency surgery, abscess with intra-abdominal contamination, anemia, and preoperative weight loss.

Results from the authors' series demonstrate an overall complication rate of 12%, with a dehiscence rate of 1.7%. A multicenter trial of SSIS demonstrated complication rates of 5–21% with the incidence of gastrointestinal hemorrhage (2.1%), suture line dehiscence (3.9%), and bowel obstruction (1%) within the range of intestinal resections.

Although considerable concern has been expressed over the risk of adenocarcinoma developing at strictureplasty sites, this remains a rare complication. Adenocarcinoma of the small bowel occurs in less than 2% of gastrointestinal malignancies; and although the risk in Crohn's disease appears to be higher, accurate numbers are difficult to discern. Only four cases of adenocarcinoma at the site of a prior strictureplasty have been described to date in the literature and typically present 2–8 years after the initial operation. Despite the low rate of cancer, the authors still recommend biopsies in any suspicious segments of the intestine during surgery for Crohn's.

RESULTS

A number of studies have demonstrated safety and short-term efficacy of strictureplasty in Crohn's disease, with low morbidity and mortality. In fact, strictureplasty has been shown to have improved outcomes regarding recurrence when compared to segmental resection, with strictureplasty having a lower rate of recurrence.

The realization that Crohn's disease is deliberately left unresected during a strictureplasty has raised concerns of early recurrence. Yet longitudinal studies have demonstrated that this problem is a theoretical one. Yamamoto listed a 3% site-specific recurrence rate in their meta-analysis, and the SSIS multicenter trial had a 7.6% rate of recurrence within the strictureplasty. Interestingly, several studies have reported that on postoperative endoscopic, radiographic, operative, and histopathologic observations, there is evidence of normal appearing mucosa, quiescent disease, loss of fat wrapping, and recovery of submucosal vascular patterns in the majority of patients. Further data are needed to evaluate the possibility of restitution of absorptive function in previously diseased segments of bowel. More recent long-term results of the SSIS technique have also demonstrated good long-term results.

CONCLUSIONS

Strictureplasties alleviate obstructive complications of Crohn's disease and preserve intestinal mucosal surface, thus minimizing the risk of short gut syndrome secondary to repeated resections. Strictureplasty techniques may be used in duodenal disease, short or long segment small bowel disease, and recurrent disease at primary or previous enteroenteric or ileocolonic anastomoses. Relative contraindications to strictureplasty include extremely fibrotic intestinal wall and intestinal fistula. Absolute contraindications are limited to free perforation, critically ill patients, inflammatory masses, and cancer. Strictureplasty can be performed in appropriately selected patients with minimal morbidity when compared to resection. Site-specific recurrence rates appear to be lower in patients who undergo strictureplasty than traditional bowel resection.

RECOMMENDED REFERENCES AND READINGS

Campbell L, Ambe R, Weaver J, Marcus SM, Cagir B. Comparison of conventional and nonconventional strictureplasties in Crohn's disease: a systematic review and meta-analysis. *Dis Colon Rectum* 2012;55(6):714–26.

Fazio VW, Tjandra JJ. Strictureplasty for Crohn's disease with multiple long strictures. *Dis Colon Rectum* 1993;36:71–2.

Hurst RD, Michelassi F. Strictureplasty for Crohn's disease: techniques and long-term results. *World J Surg* 1998;22(4):359–63.

Lee EC, Papaioannou N. Minimal surgery for chronic obstruction in patients with extensive or universal Crohn's disease. *Ann R Coll Surg Engl* 1982;64(4):229–33.

Menon AM, Mirza AH, Moolla S, Morton DG. Adenocarcinoma of the small bowel arising forma previous strictureplasty for Crohn's disease: report of a case. *Dis Colon Rectum* 2007;50:257–9.

Michelassi F, Hurst RD, Melis M, *et al.* Side-to-side isoperistaltic strictureplasty in extensive Crohn's disease. *Ann Surg* 2000;232:401–8.

Michelassi F, Taschieri A, Tonelli F, *et al.* An international, multicenter, prospective, observational study of the side-to-side isoperistaltic strictureplasty in Crohn's disease. *Dis Colon Rectum* 2007;3(50):277–84.

Michelassi F. Side-to-side isoperistaltic strictureplasty for multiple Crohn's strictures. *Dis Colon Rectum* 1996;39(3):345–9.

Milsom JW. Strictureplasty and mechanical dilation in strictured Crohn's disease. In: Michelassi F, Milson JW, eds. *Operative Strategies in Inflammatory Bowel Disease*. New York, NY: Springer-Verlag, 1999:259–67.

Poggioli G, Stocchi L, Laureti S, *et al.* Conservative surgical management of terminal ileitis: side-to-side enterocolic anastomosis. *Dis Colon Rectum* 1997;40:234–9.

Roy P, Kumar D. Strictureplasty. *Br J Surg* 2004;91(11):1428–37.

Sharif H, Alexander-Williams J. The role of strictureplasty in Crohn's disease. *Int Surg* 1992;77:15–8.

Stebbing JF, Jewell DP, Kettlewell MG, Mortensen NJ. Recurrence and reoperation after strictureplasty for obstructive Crohn's disease: long-term results. *Br J Surg* 1995;82:1471–4.

Tjandra JJ, Fazio VW. Strictureplasty for ileocolonic anastomotic strictures in Crohn's disease. *Dis Colon Rectum* 1993;36:1099–104.

de Buck van Overstraeten A, Vermeire S, Vanbeckevoort D, *et al.* Modified side-to-side isoperistaltic strictureplasty over the ileocaecal valve: an alternative for ileocaecal resection in extensive terminal ileal Crohn's disease. *J Crohns Colitis* 2016;10:437–42.

Yamamoto T, Fazio VW, Tekkis PP. Safety and efficacy of strictureplasty in Crohn's disease: a systematic review and meta-analysis. *Dis Colon Rectum* 2007;50:1968–86.

Index

Note: Page numbers followed by “ f ” denote figures; those followed by “ t “ denote tables.

B

C

Colon removal surgery

Colon resection

Colorectal resection

D

E

F

G

H

p. 663

p. 664

I

J

K

L

Laparoscopic rectopexy

M

N

O

P

Parastomal hernia repair

R

Rectal prolapse treatment

Restorative proctocolectomy

Right colectomy

Robotic procedures

S

T

U

V

W