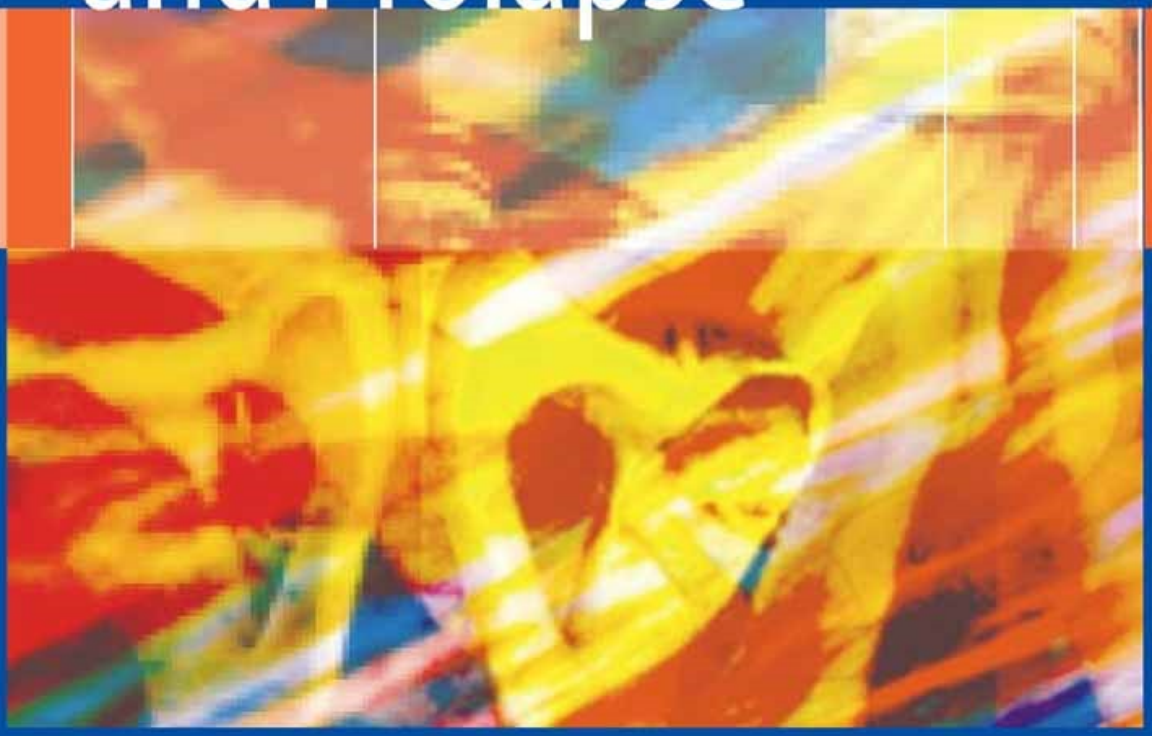
Philippe E. Zimmern • Peggy A. Norton
François Haab • Christopher C.R. Chapple *Editors*

Vaginal Surgery for Incontinence and Prolapse



Springer

Vaginal Surgery for Incontinence and Prolapse

Philippe E. Zimmern, Peggy A. Norton,
François Haab and
Christopher C.R. Chapple (Eds)

Vaginal Surgery for Incontinence and Prolapse

With 120 Figures, including 66 Color Plates

Springer

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Foreword

Imagine the plight of a young woman, some time during the thousands of years before the mid-18th century, who, soon after a difficult childbirth, finds she can no longer keep from leaking urine. She is standing in the chill winter wind, her urine-soaked clothes clinging wet against her thighs as she comforts her crying baby knowing that she faces a life of misery, shame and social ostracism. Or imagine the middle-aged wife of a tenant farmer on the remote central Illinois plain, straining with her husband to lift a heavy log that has fallen on their only milk cow only to feel a deep tearing sensation and discover a large mass protruding between her legs. Gripped by fear, she cannot know what has happened to her or how she will care for her family if she can no longer help with the difficult tasks needed to live.

We must be grateful to the generations of physicians before us who have pioneered treatments and developed preventions for the pelvic floor disorders that have affected women throughout time. Each decade during the last 150 years has brought new insights, new operations, and new medicines to help women who suffer from these debilitating conditions. At first, surgical treatments were so dangerous that they could only be suggested for the most severe of cases, but advances in anesthetic and surgical safety now make them available to the majority of women. Important new medications have been developed and modern obstetrical care has eliminated the obstetrical fistula from the developed world.

Your decision to read this book joins you with other physicians who have sought to inform themselves with the latest knowledge to help women with pelvic organ prolapse, urinary incontinence, and bowel control. It contains the latest insights, clearly outlined and carefully presented by the leading authorities in urology and gynecology. The inclusion of these two perspectives broadens the usefulness of the book as these two specialties see different aspects of the same conditions. In this way they are like the blind men and the elephant. One man, who is holding a leg says that the elephant is like a large tree, one man holding the ear says it is like a giant bird with wings, a third feeling the elephant's side says it is like a wall while the last man, holding the tail, says it is like a rope. Only by taking these observations together does a complete picture emerge.

Together the disciplines of urology and gynecology have a more complete picture than either would provide alone of problems of pelvic floor dysfunction. Urologists, through their extensive experience with patients who suffer from neurological injury understand the neurophysiology of urination at a level not often reached by gynecologists. Obstetrician gynecologists understand the nature of birth-induced problems such as prolapse in a way that urologists often do not appreciate. Both fields have a long history of addressing urinary incontinence, together having amassed a huge literature about this common condition.

The knowledge presented in this book will give you an up-to-date picture of contemporary treatment. The authors are acknowledged authorities who are practicing clinicians with extensive practical experience in managing these problems. Each brings a synthesis of his or her knowledge of the available literature and practical experience in managing patients to the task of making recommendations for your practice. Although

many areas of medicine have become somewhat routine because the direct cause of a disease and its cure are known (for example, treatment of uncomplicated primary urinary tract infection) but the management of urinary incontinence and pelvic organ prolapse remain as much of an art as a science.

Imagine having a group of the world's authorities available to you to assist in managing your patients. This book represents that resource, ready at hand, to improve your knowledge of these common conditions now, and, in the future, to act as a ready reference for new problems as you encounter them.

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Foreword

Vaginal surgery has a great tradition empowered by the tremendous contributions of outstanding surgeons and by the rewarding outcome in terms of patient satisfaction, because the vaginal approach is both efficacious and minimally invasive.

This very focused and timely book on incontinence and prolapse provides a comprehensive review of anatomy, epidemiology, and evaluation of the many conditions which can be effectively treated by vaginal surgery.

Urinary incontinence (either primary or failure cases), pelvic organ prolapse, fecal incontinence, and other vaginal reconstructive procedures (urethral diverticula, bladder neck closure, vesico- and urethro-vaginal fistulae) are described in detail in regards to indications, technique, complications and outcome.

The book is a must for all those who are or wish to be involved in the management of female pelvic floor disorders.

The editors and authors should be congratulated for their effort and unique contribution.

Walter Artibani
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Secretary General of the International Continence Society

Preface

Up to 20 million women in the US have incontinence and up to a third with pelvic organ prolapse will undergo repeat corrective surgery.

Aware of these impressive epidemiologic data, many specialty organizations have started in the last 5 years or so to offer courses in "Vaginal surgery: how to do it". At such a course several years ago, I had the chance to speak with the attendees at the break and found out that most were urologists or gynecologists, few were operating with their counterpart specialty colleagues, and they all wanted to get more knowledge on vaginal surgery to expand their armamentarium and become more self-sufficient in the care of their patients. This was the genesis of this book.

But first, let us ask: Why such a divide? Simply because, up to now, a line has been drawn between urologists dealing mainly with incontinence and gynecologists dealing primarily with prolapse. When a combined urologist–gynecologist team can function well together, patients do not mind being cared for by two "specialists". However, in many practices, these two individuals cannot interact well or one is simply lacking, leaving for example a urologist with no or minimal expertise to deal with a patient suffering from concomitant prolapse and stress urinary incontinence.

This dividing line is rapidly changing, and this book is among the efforts to do so. Other initiatives have already been implemented. In the US, a joint effort from the ABU and ABOG has led to a fellowship training program in "Female Pelvic Floor Medicine and Reconstructive Surgery", with emphasis on equipping trainees with combined knowledge on the surgical options to correct incontinence and prolapse. Large networks involving both urologists and urogynecologists (UITN and PFDN) have recently initiated several multicentric randomized controlled trials to compare surgical techniques to correct these conditions.

The industry is also aware of these emerging domains and has fueled the field with a large array of new products, some with minimal preliminary investigations before being released for human application. For any vaginal surgeon, this influx of new products and surgical techniques is quite overwhelming, although it underscores the recognition of a very large and fairly untapped market and signals the expansion of the field.

Therefore, the goal of this book on *Vaginal Surgery for Incontinence and Prolapse* was to provide an updated and comprehensive reference manual addressing these very focused, yet very common topics. The editors have different training backgrounds and are geographically diverse. Yet, this is their strength as they share not only a vast experience in vaginal surgery but also a deep motivation to render this book useful not only to the less experienced but also to the more seasoned reconstructive surgeon among us.

The book is divided into sections covering vaginal anatomy and physiology, practical guidelines for office evaluation of urinary incontinence, prolapse, and fecal incontinence, and many detailed chapters on reconstructive procedures to correct these three conditions. The challenging topic of "recurrence" is also addressed from the standpoint of vaginal surgery. Other vaginal procedures involving urethral reconstruction, fistula,

diverticulum, bladder neck closure are also expertly reviewed since these entities relate to urinary incontinence as well.

Extirpative surgery (kidney stone, cancer) is on the decline. Reconstructive surgery is on the rise because women live longer and many will suffer from the effect of aging, pregnancies, and hormonal changes. This book will have an immediate appeal to all those involved in training or currently delivering care to women with aging pelvic floor changes because vaginal surgery offers simplicity, minimal intra-operative morbidity, prompt recovery, and very adequate overall patient satisfaction.

The editors remain deeply indebted to the panel of committed experts who dedicated time and effort to bring the readership up to speed with the "established" and the "new" in the field of *Vaginal Surgery for Incontinence and Prolapse*. This book would have never been possible without mutual respect and friendship between all of the contributors, full support of this academic endeavor from our loved ones and families, and certainly the invaluable help and able assistance of Eva Senior, Melissa Morton, and Robert Maged at Springer, and the highly organized skills and dedication of my secretary, Susan Brewer.

Philippe E. Zimmern

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Part I

Anatomy/Epidemiology

1

Vaginal Anatomy for the Pelvic Surgeon

Courtenay Moore and Firouz Daneshgari

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The word *vagina*, derived from the Latin word for "sheath," describes the hollow fibromuscular sheath extending from the vestibule to the cervix. The walls of the vagina are in apposition except at the apex where it is held open by the cervix (1). Vaginograms from normal women show that the vagina takes a slightly S-shaped course, curving at the perineum and cervix with a horizontal plane over the levator plate. Vaginal dimensions based on vaginal casts and radiographic studies show five different vaginal shapes (Figure 1.1) with dimensions ranging from 8.4 to 11.3 cm in length and 2.1 to 5.0 cm in diameter (2,3). The anterior vaginal wall is shorter than the posterior wall given the differences in forniceal length. The anterior vaginal length is approximately 6 to 9 cm in comparison to the posterior vaginal length of 8 to 12 cm (4).

Histology

The normal vaginal wall is 2 to 3 mm thick, consisting of four distinct histologic layers (5). The first layer, the mucosa, is a nonkeratinized stratified squamous epithelium that forms numerous transverse folds or rugae. The epithelium consists of a single layer of basal cells, an actively proliferating lower parabasal layer, and a differentiated superficial layer (6). In premenopausal women epithelial regeneration ranges from 30 days in the basal cell layer to 3 days in the parabasal layer.

Beneath the mucosa is a thin layer of loose connective tissue, the lamina propria. Although the epithelium itself lacks glands, the lymphatics and vascular channels within the lamina propria produce the transudate seen during sexual arousal (5). The muscular layer beneath the lamina propria, the muscularis vaginalis, is made up of spirals of smooth muscle bundles with an outer longitudinal and inner circular smooth muscle layer. This muscular orientation allows for the tremendous vaginal distention seen in childbirth (6). From a surgical standpoint, the layer between the vaginal epithelium and muscularis is known as the pubocervial fascia anteriorly and the rectovaginal fascia posteriorly. Adherent to the muscularis is the adventitia. The adventitia is composed of elastin, collagen, and adipose containing lymphatics, nerves, and blood vessels. The adventitia merges with and becomes an extension of the endopelvic fascia (6).

Anatomic Relationships

The vagina communicates superiorly with the cervical canal and inferiorly with the vaginal vestibule. Anterior to the vagina lies the bladder

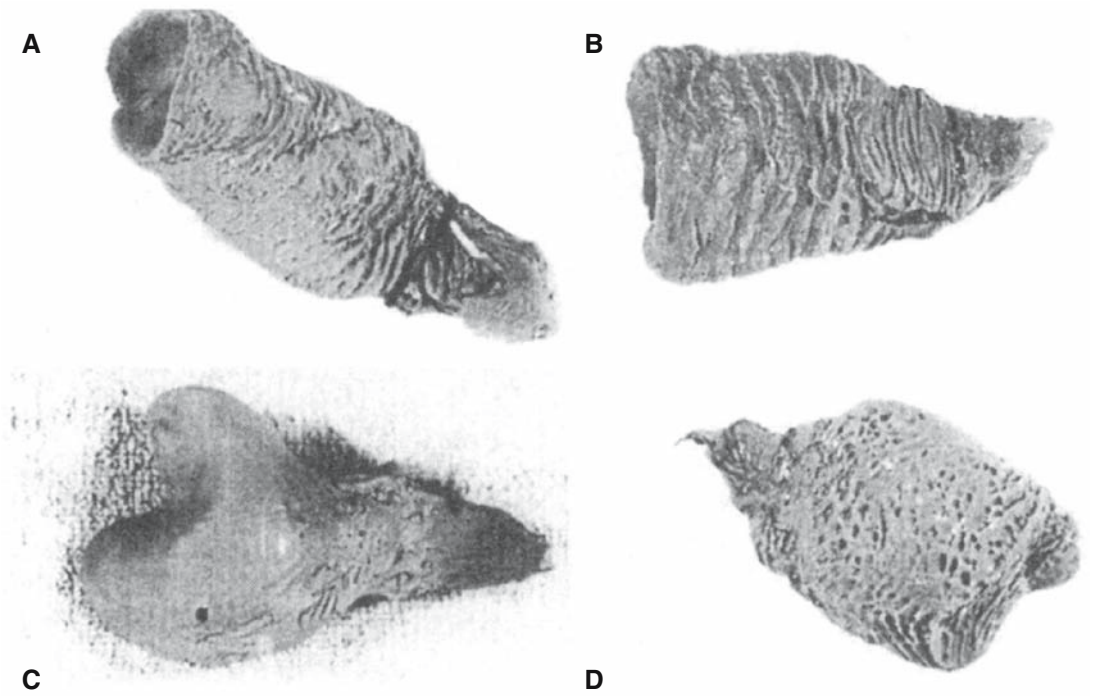

Figure 1.1. Vaginal shapes. A: Parallel sides. B: Conical. C: Heart. D: Slug. (From Pendergrass BP, Reeves CA, Meyer MW, et al. The shape and dimensions of the human vagina as seen in three-dimensional vinyl polysiloxane casts. Gynecol Obstet Invest 1996;42:179, with permission from S. Karger AG, Basel.)

base. Although the urethra is fused to the anterior vagina wall with no intervening adventitial layer, the bladder base is separated from the vagina by the endopelvic fascia (6). The posterior vaginal wall is defined by the pouch of Douglas superiorly and the rectum inferiorly. The vaginal axis is maintained by a combination of muscular and ligamentous support along the length of the vaginal wall (5). This support system is responsible for the cross-sectional H shape of the lumen (4). Laterally, the vaginal adventitia forms strong bands of connective tissue that suspend the vagina, maintaining its orientation within the pelvis (Figure 1.2) (5). Although structures that support the vagina are continuous and interdependent, they can be anatomically divided into three levels based on the segment of vagina (Figure 1.3) (7). The structures that support the cephalic 2 to 3 cm portion of the vagina constitutes level I support (7). This portion of the vagina is suspended from above by the long connective tissue fibers of the paracolpium. These fibers are primarily vertical in orientation and arise broadly from the greater sciatic foramen over the piriformis muscle, the pelvic bones at the sacroiliac articulation, and the lateral sacrum (7). Level I support acts to suspend the vaginal apex to the pelvic sidewall. Damage to level I results in prolapse of the vaginal apex.

Middle-level vaginal support, level II, is located at the bladder base and attaches the vagina laterally and more closely to the pelvic wall. Here the paracolpium is much shorter and acts to anchor the vagina laterally to the arcus tendineus and the fascia of the levator ani muscles (7). The connection between the anterior vaginal wall and the arcus tendineus fascia of the pelvis forms a supportive layer beneath the bladder and corresponds to the pubocervical fascia. The posterior vaginal wall is attached to the superior fascia of the levator ani muscles and forms the rectovaginal fascia. Level II acts to support the vagina laterally, and not suspend it apically like level I. Damage to level II support can lead to a cystocele, urethrocele, or rectocele.

Level III supports the lower portion of the vagina, from the introitus to 3 cm above the hymenal ring (7). Unlike level I and II, level III has no paracolpium separating the vaginal wall from adjacent structures (6). The lack of paracolpium in level III can be explained by the

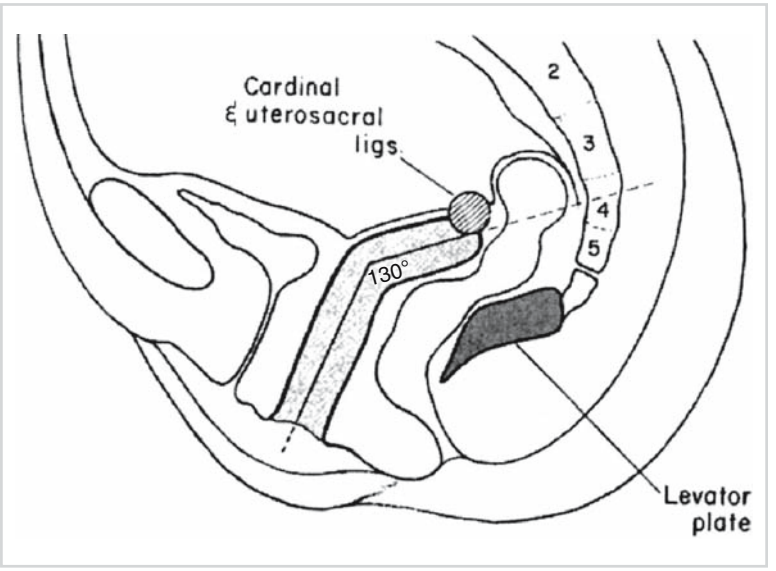

Figure 1.2. Normal vaginal axis in standing position. (From Funt MI, Thompson JD, Birch H. Normal vaginal axis. South Med J 1978;71:1535, with permission from ••.)

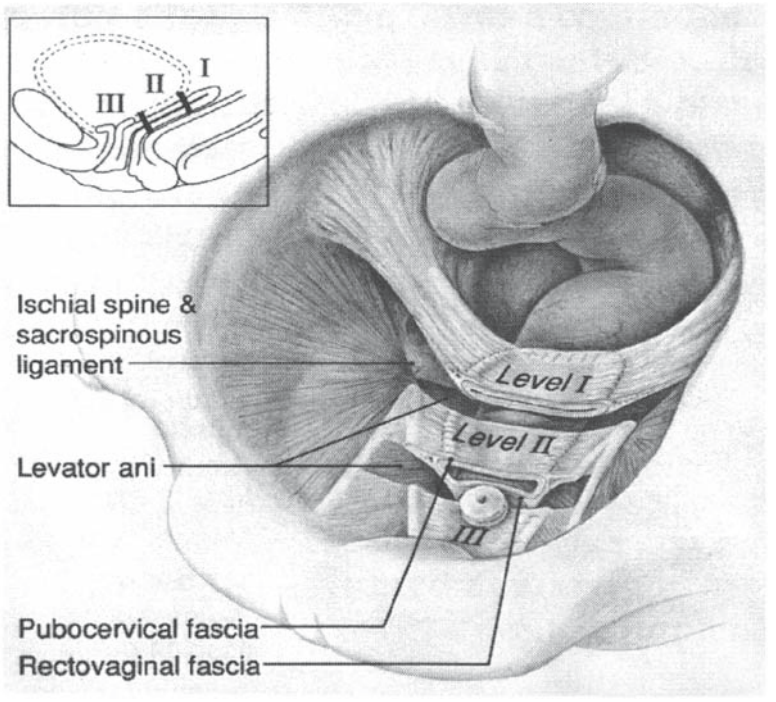

Figure 1.3. Levels of the vagina and its supportive structure after removal of uterus and the bladder. (From DeLancey JOL. Anatomic aspects of vaginal eversion after hysterectomy. Am J Obstet Gynecol 1992;166:1719, with permission from Elsevier.)

embryologic differences between the levels. Level I and II are derived from the müllerian ducts and have attachments similar to those of the uterus and fallopian tubes (6). In contrast, the lower third of the vagina is derived from the urogenital sinus and therefore lacks the paracolpium. Anteriorly, the vagina fuses with the urethra and becomes embedded in the connective tissue of the urogenital diaphragm (5). The vagina fuses with the levator ani laterally and the perineal body posteriorly. Given these attachments, the lower portion of the vagina repre-

sents the most fixed and stationary portion of the vagina (5). Level III support fixes the vagina. Damage to this level results in either a urethrocele or deficient perineal body.

Blood Supply

The vaginal blood supply is best described as a complex and extensive anastomotic network running along the length of the vagina (4). The main blood supply to the vagina is the vaginal artery, which arises either directly from the uterine artery or from a branch of the internal iliac. The vaginal arteries anastomose along the lateral surface of the vagina with the cervical branch of the uterine artery to form the azygous artery. The anterior vagina is also supplied by the vaginal branch of the inferior vesical artery. The caudal vagina is also supplied by a branch from the internal pudendal artery that anastomoses with the middle rectal artery.

The venous drainage of the vagina accompanies the arterial system. The veins form a plexus, the plexus of Santorini. This plexus communicates through the cardinal ligaments with the venous system of the bladder, rectum, and paravaginal tissues, ultimately draining into the internal iliac veins (6).

Lymphatic Drainage

The lymphatic drainage of the vagina is complex and variable with frequent crossover between the left and right pelvis (4). The upper vagina generally drains into the external iliac whereas the middle drains into the internal iliac lymph nodes (1). The posterior vagina drains into the inferior gluteal, sacral, and anorectal nodes and then ultimately into the internal iliac nodes. The distal vagina drains mainly into the superficial inguinal nodes (6).

Nerve Supply

Interestingly, the vagina is not well supplied with nerve endings compared to other skin structures. Nerve endings are regionally distributed with the anterior vaginal to have the greatest concentration (6). There are no sensory corpuscles within the muscularis, tunica propria, or epithelial layer (8).

The vagina is supplied by several parallel nervous systems. There are two main categories of nerves, somatic and visceral or autonomic, both with afferent and efferent fibers. The somatic nerve supply is via the pudendal nerve S2–S4. The afferent fibers of the pudendal nerve are responsible for sensation to the skin and subcutaneous tissue to the distal vagina. The efferent or motor fibers do not play a significant role in the vaginal wall because there is no striated muscle. However, the efferent supply, largely from S2–S4, controls the levator muscles that provide support, and influence function of the lower third of the vagina. Previous studies described the pudendal nerve as innervating the levator ani muscle, but more recent studies have failed to show any contribution from the pudendal nerve (6).

The visceral nerve supply is significant for the upper vagina, musculature, and glands. All pelvic visceral nerve fibers course in the endopelvic fascia beneath the pelvic parietal peritoneum (9). These nerves arise from the inferior hypogastric plexus. The inferior hypogastric plexus is found at the 2 and 10 o'clock positions around the rectum. From the rectum, it extends to the vagina where it forms a dense network on the lateral walls of the middle and proximal vagina. These nerve bundles give rise to the cavernous nerves at the level of the proximal urethra. The inferior hypogastric plexus also gives rise to three other divisions. One division is the uterovaginal plexus. This plexus lies at the base of the broad ligament (10). Fibers from the uterovaginal plexus accompany the vaginal artery and vein to the vagina. Afferent fibers transmit interoceptive, noxious stimuli, from the peritoneum at the pouch of Douglas, and from the cervix and upper third of the vagina to nerve roots S2–S4 (9). This innervation is consistent with the müllerian embryologic origin of these structures (9). Efferent fibers supply smooth muscle and glands.

The autonomic nervous system can be divided into the sympathetic and parasympathetic nervous systems. Sympathetic nerves constrict smooth muscle of the arteries and arterioles. Sympathetic nerve fibers from T1–L2 accompany sacral nerves of the hypogastric plexus. No parasympathetic fibers have been described in association with the pelvic arteries and arterioles (9). The chief importance of vaginal parasympathetic efferent fibers (S2–S4) is to mediate sexual response in the lower portion of the vagina (9).

Parasympathetic fibers are found in the inferior hypogastric plexus and pudendal nerve (9).

From a Surgical Perspective

The dorsal nerve of the clitoris courses beneath the pubic arch diverging laterally toward the puboischial rami (11). Therefore, during pelvic surgery dissection between the ischiopubic rami and crura should be avoided to preserve the dorsal nerve of the clitoris. The proximal course of the cavernous nerve is close to the mid-urethra at the 5 and 7 o'clock positions and joins the vaginal nerve plexus at the 2 and 10 o'clock positions on the anterolateral vagina (Figure 1.4) (11). These branches of the vaginal plexus originate from the inferior hypogastric plexus on the anterolateral sides of the rectum. The presence of such anatomic landmarks indicate that dissection around the urethra should be as lateral as possible. Preservation of the anterior and lateral vaginal walls is crucial for the preservation of the autonomic nerve supply to the urethral sphincter complex. Nerves from the pelvic plexus also travel to the female pelvic viscera through the cardinal and uterosacral ligaments in the company of the vessels. Extensive damage to these structures may contribute to bladder dysfunction after hysterectomy or other similar pelvic surgery.

Visible Human Database

Over the past century, the surgical procedures performed by pelvic surgeons have jumped over a huge evolutionary leap from a limited number of anti-incontinence procedures to hundreds of newer procedures using various technologic advances such as laser, endoscopic devices, laparascopic and robotic surgery, and a large number of reconstructive procedures.

The historical tools for teaching the new procedures for urologists and other surgeons demonstrated the procedure by the pioneer surgeon on a live patient under anesthesia or on cadavers. The live-patient model, by its very nature,

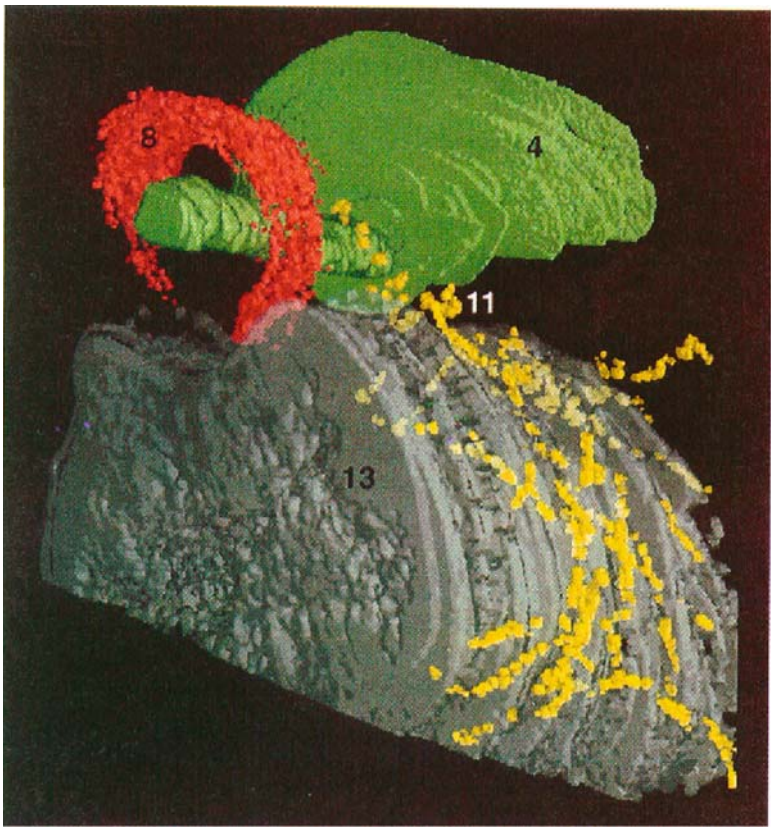

Figure 1.4. Computer regenerated image of the bladder (4), the external sphincter of the urethra (8), the vagina (13) and the visceral nerves around the vaginal wall (11). (From Colleselli K, Stenzl A, Eder R, et al. The female urethral sphincter: a morphologic and topographical study. J Urol 1998;160[1]: 49–54, with permission from the American Urological Association.)

imposes vast limitations on the numbers or variations with which the new procedure could be demonstrated or practiced. The inherent problems with the use of cadavers for teaching surgical procedures are that they lack the "liveliness" of the organ, which prevents effective demonstration of the response of the live body to variations in the steps of the new procedure. In an attempt to overcome the difficulties with traditional anatomic studies and to take advantage of the digital revolution, the National Library of Medicine initiated a program for development of digital databases. As a part of this initiative, the Visible Human Database (VHD) has been developed at the University of Colorado School of Medicine's Center for Human Simulation (CHS), under the directorship of Dr. Victor Spitzer. It is a digital volumetric reconstructed database of the whole human body that has been used all over the world as a resource for human anatomy applications in education, modeling, simulation, training, and morphometrics (Figure 1.5). Some of these applications demonstrate the use of the database in the construction of human simulators for clinical studies (12).

After the initial development of the database, the VHD has been used to generate photorealistic visualization and surgical procedural simulators. For example, the VHD has been used to develop a "virtual dissection" laboratory, a unique tool for the display of stereo three-dimensional (3D) human anatomy dissection. Taking advantage of the digital revolution, the VHD has further been used to build prototype procedural simulators. Using this background, we have started using VHD for reconstruction of the female pelvis for its application in the field of female pelvic medicine and reconstructive surgery (Figures 1.6 and 1.7). An immediate application of such use was to reconstruct sacral

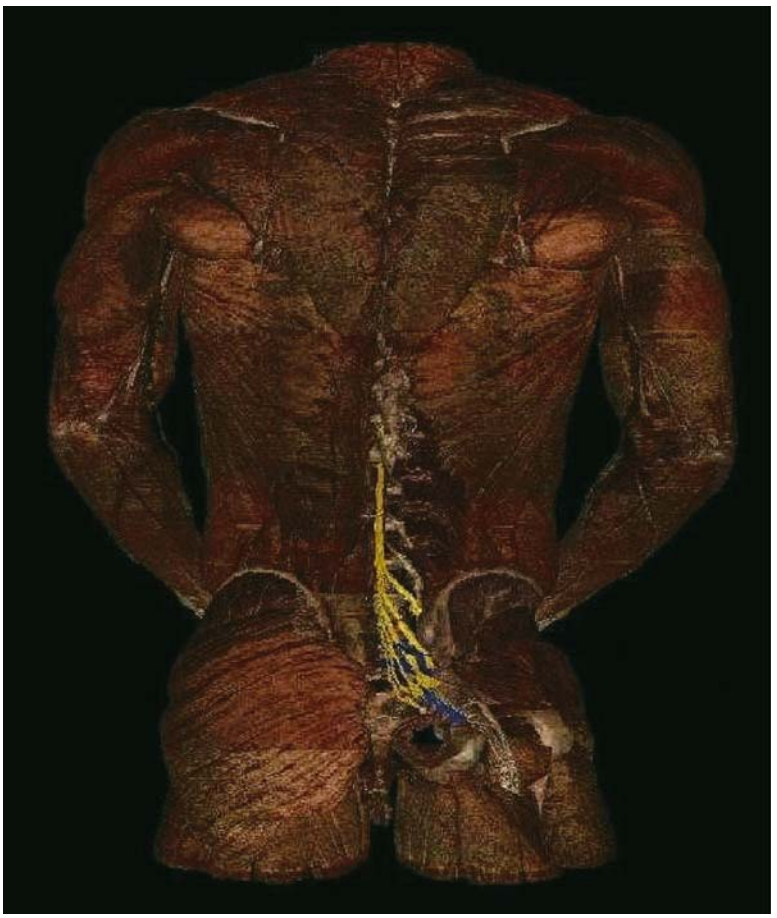

Figure 1.5. A dorsal view of the Visible Human Database demonstrating the exit site and distribution of the lower lumbar nerves. (Courtesy of Victor Spitzer, Ph.D.)

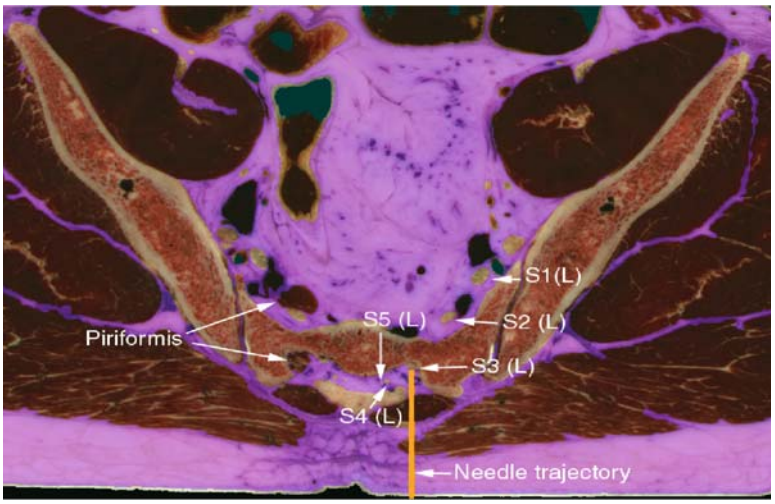

Figure 1.6. Sagittal section of the human pelvis of the VHD, demonstrating the site of penetration of the needle to access the S3 sacral nerve. (Courtesy of Victor Spitzer, Ph.D.)

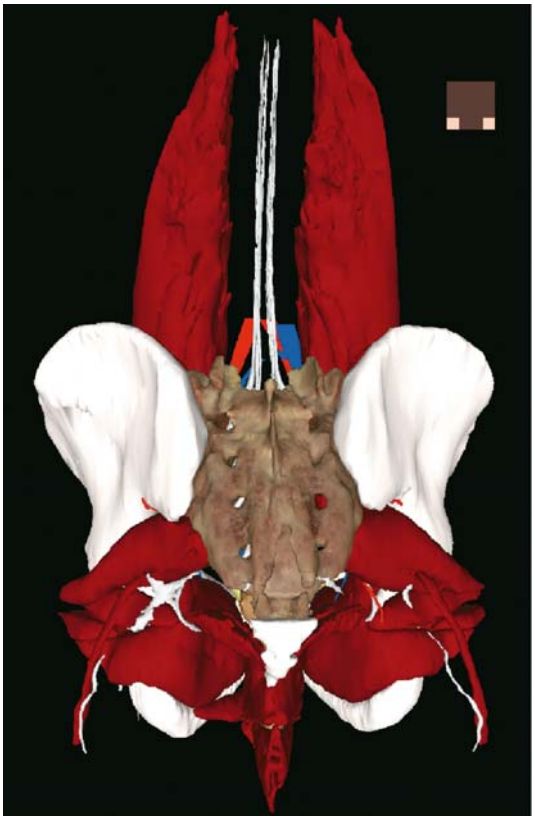

Figure 1.7. Reconstruction of the structures surrounding the sacrum as an educational tool for training of sacral nerve stimulator placement. (Courtesy of Victor Spitzer, Ph.D.)

spine anatomy. The interest for such project was to delineate the anatomic structure of a part of the body that has traditionally been an unfamiliar area for the pelvic surgeons. With increasing use of placement of the sacral neurostimultor, we were interested in building a virtual model for placement of the sacral root neurostimulator that could be developed for the pelvic surgeons.

This application of VHD in the creation of the simulators for surgical procedures reminds us of a similar situation in the airline industry where the simulators of the airplanes are extensively used for training purposes. It is interesting to know that nowadays the simulator of the airplane is often developed prior to the building of the real airplane. The Boeing 777 was such an example.

Further information on the VHD and CHS can be found at www.nlm.nih.gov/research/visible/visible_human and www.uchsc.edu/sm/chs.

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2

Epidemiology of Incontinence and Prolapse

Anne M. Weber and Mark D. Walters

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Because the prevalence of pelvic floor disorders increases with age, the changing demographics of the world's population will result in even more affected women. For example, based on projections from the United States Census Bureau, the number of American women aged 60 and over will almost double between 2000 and 2030. Even absolute population numbers do not fully reflect the real and growing burden of pelvic floor disorders on women as they age. Luber et al (1) estimated that the demand for health care services related to pelvic floor disorders will increase at twice the rate of the population itself.

Prevalence, Incidence, and Remission

Urinary Incontinence

Urinary incontinence is defined by the International Continence Society (ICS) as "the complaint of any involuntary leakage of urine." With such a broad definition, the reported prevalence of urinary incontinence in women varies widely with differences in populations studied, methods of data collection, and specific definitions of disease. Incorrect estimates may result from biases in sample surveys, such as selection and respondent bias. For example, women affected by incontinence may respond more readily to surveys than women without incontinence, thereby overestimating the true prevalence of incontinence. In contrast, it is well known that urinary incontinence (as well as other pelvic floor disorders) is greatly underreported, leading to underestimates of true disease status.

The estimated prevalence of any urinary incontinence (that is, any urine loss during a 12-month period) varies considerably for women. When the continence mechanism is subjected to extreme forces, there is a significant prevalence even in women not traditionally thought to be at risk for urinary incontinence, such as nulliparous elite athletes (e.g., gymnasts, trampolinists) or female paratroopers. Among adult women in the community, the prevalence of any urinary incontinence ranges widely, from 9% to 69%.

Severity of incontinence can be characterized by the frequency of incontinent episodes, quantity of urine lost, or both. When the severity of urine loss is defined as "daily," "weekly," or "most of the time," the reported prevalence covers a much narrower range, from 3% to 17% for community-dwelling women. This estimate

corresponds more closely to the clinical estimate of disease, probably because it identifies women at the more severe end of the spectrum who present for clinical care. The prevalence of urinary incontinence in women in nursing homes is much higher than in community-dwelling women, with most studies reporting prevalence greater than 50%, especially in facilities where residents have more severe functional impairments.

Much less information is available on incidence, progression, or remission, compared to prevalence, for urinary incontinence (and even less for all other pelvic floor disorders). Young and middle-aged women develop urinary incontinence at a lower rate, 3% to 8% per year, than older women. Herzog et al (2) reported a 20% incidence of incontinence per year in women aged 60 years and over. However, Grodstein et al (3) reported a much lower incidence per year of 3.2% for occasional and 1.6% for frequent incontinence in women aged 50 to 75 years. As noted above, these differences point to the difficulty of directly comparing findings across the literature due to the use of different definitions of disease.

Urinary incontinence has traditionally been viewed as chronic and progressive. However, recent findings challenge that view. In a 3-year study of raloxifene for osteoporosis, most women (60%) with incontinence at baseline did not experience a significant change in their symptoms; only 13% worsened and 27% improved. Remission is estimated to occur in 6% to 38% of young and middle-aged women, versus 10% in older women. These estimates include both acute and chronic causes of urinary incontinence. Incontinence due to transient causes such as infection, drug use, and delirium often regresses after treatment. Thus, there is a yearly fluctuation in the development and regression of incontinence among individuals.

Fecal Incontinence

Similar to urinary incontinence, the reported prevalence of fecal incontinence varies by the definition used and the population surveyed. However, unlike urinary incontinence, even the term for the condition itself is problematic. Some clinicians use the term *fecal incontinence* to refer only to loss of stool (liquid or solid) and prefer *anal incontinence* to collectively describe loss of stool or gas; however, many others do not make that distinction and use *fecal incontinence* to refer to loss of any bowel contents, whether gas or stool. For the purposes of this chapter, the term *fecal incontinence* will refer to the involuntary loss of gas and stool (either or both).

There is no consensus as to what constitutes severe or clinically important fecal incontinence. Severity can expressed by the type of loss (gas, liquid stool, or solid stool) or the frequency of incontinent episodes. Clinicians have often assumed a stepwise worsening of symptom impact, in that incontinence to solid stool is worse than liquid stool, which is worse than incontinence to gas. However, more recent work has questioned this assumption, with many patients suffering the greatest impact from loss of liquid stool, as it is more difficult to manage or conceal than loss of solid stool. Even incontinence to gas has a greater impact for some patients than clinically recognized, due to the embarrassing, unpredictable nature of the loss. Several symptom scales combine the two components of type of loss and frequency of incontinent episodes, and express the level of symptoms as a numeric score. Many studies use frequency of incontinent episodes of once a week or more, or loss that requires sanitary protection, to define clinically important fecal incontinence. However, these definitions have not been adequately validated as to the impact of symptoms on patients.

The prevalence of fecal incontinence in the general population ranges from 1.5% to 2.3%. In the elderly, the prevalence is higher, ranging from 3.7% to 18.4%. Women in nursing homes experience fecal incontinence at an even higher rate of at least 30% and up to 63%. Information on the incidence of fecal incontinence is unavailable, as is information on progression from mild or infrequent fecal incontinence to more severe forms. Similarly, remission of fecal incontinence has not been studied.

Pelvic Organ Prolapse

Epidemiologic characteristics of prolapse (i.e., prevalence, incidence, and remission) are even more difficult to determine than those of urinary and fecal incontinence. Symptoms associated with prolapse are nonspecific and the presence of mild to moderate prolapse

cannot be determined reliably by questionnaire assessment without confirmation by physical examination. Although a standardized staging system for prolapse has been accepted by the ICS, there is no consensus as to what level of physical findings defines clinically significant prolapse. Reports of prevalence in the medical literature must be viewed with these limitations in mind.

In studies of women who were not seeking care for prolapse, mild to moderate prolapse (at or above the hymen, stage I or II prolapse by ICS standards) has been found in up to 48% of women. More advanced prolapse (beyond the hymen, stage III or IV) occurs in about 2% of women. Many studies (especially large studies where the study of prolapse was not a primary aim) do not use the standard ICS staging system, again limiting comparisons that can be made across the literature. In 412 women enrolled in the Women's Health Initiative, Handa et al (4) reported an average annual incidence of 9.3 cases of anterior vaginal prolapse (previously known as cystocele), 5.7 cases of posterior vaginal prolapse (previously known as rectocele), and 1.5 cases of uterine prolapse per 100 women per year. In women with at least grade 1 prolapse at baseline, progression occurred in 10.7 cases of anterior vaginal prolapse, 14.8 case of posterior, and 2.0 cases of uterine prolapse per 100 women per year. Interestingly, regression occurred more commonly than incidence or progression, especially from grade 1 to grade 0. Anterior vaginal prolapse regressed from grade 1 to 0 in 23.5 cases per 100 women per year, and from grade 2–3 to 0 in 9.3 cases per 100 women per year. Posterior vaginal prolapse regressed in 25.3 cases and uterine prolapse, in 48 cases per 100 women per year. This serves to emphasize that prolapse is a dynamic condition, and factors related to progression and remission need further study.

Concomitant Pelvic Floor Disorders

It is well known to clinicians that pelvic floor disorders commonly occur together although evidence in the literature has only recently confirmed this. Urinary and fecal incontinence ("double incontinence") coexists in up to 69% of women. Different populations and differing definitions for both types of incontinence are responsible for some of the variation in reported results. Because symptoms of all pelvic floor disorders tend to be underreported by patients, it is incumbent upon clinicians to inquire routinely as to the spectrum of disorders whenever a patient presents with one symptom.

Risk Factors for Pelvic Floor Disorders

Sex

Women are affected by urinary incontinence two to three times more commonly than men. The gender difference is most pronounced among adults younger than 60 years of age because of the very low prevalence of urinary incontinence in younger men. These sex differences are consistent whether the measure is any incontinence, severe incontinence, or irritative bladder symptoms. The symptom of stress incontinence is uncommon in men who have not had prostate surgery, but voiding problems are more common, especially in elderly men, in part caused by prostate conditions.

The comparison of fecal incontinence between men and women depends on the population studied. Many studies show a higher prevalence of fecal incontinence in women than in men, although some studies report similar rates and, in a few studies, men had higher rates than women. Women are uniquely susceptible to damage to fecal continence mechanisms at vaginal childbirth, but how this influences the prevalence and causes of fecal incontinence in women compared to men is unknown. Studies of anorectal function show that, compared to men, women have lower anal squeeze pressures, greater perineal descent, and more evidence of nerve damage to the pelvic muscles and anal sphincters.

Although only women are at risk for pelvic organ prolapse, rectal prolapse affects men and women in approximately equal proportions. Obviously, understanding the pathophysiology of rectal prolapse in men requires an explanation that does not rely on damage incurred at childbirth.

Age

The prevalence of urinary incontinence increases with age, although it is not a linear relationship.

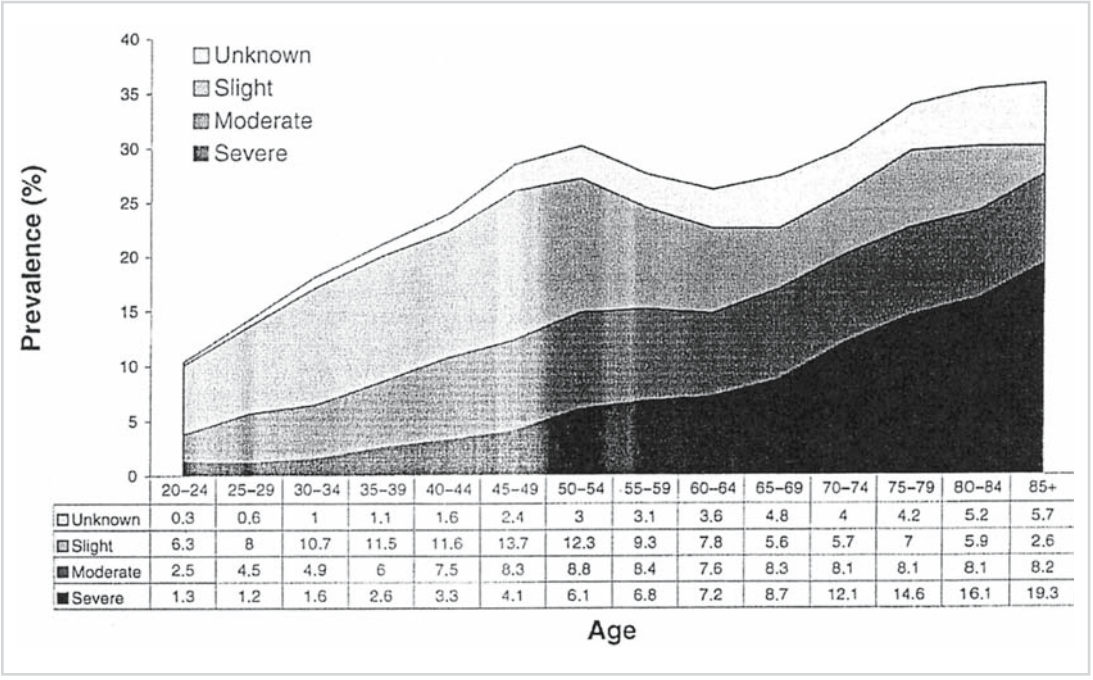
Recent studies show a broad peak in prevalence from 40 to 60 years of age, with a steady increase occurring after ages 65 to 70 (Figure 2.1). The type of incontinence may differ by age, with many studies suggesting a higher prevalence of stress incontinence in younger women, compared to more urge incontinence in older women; however, not all studies confirm this and the prevalence of mixed (stress and urge) incontinence varies widely in different studies.

Most studies of fecal incontinence show increased prevalence with age. In a study of over 10,000 men and women in the United Kingdom, Perry et al (5) reported fecal incontinence in 0.9% of adults aged 40 to 64 years and 2.3% aged 65 and over. Also from the United Kingdom, Crome et al (6) reported that the rate of fecal incontinence roughly doubled by decade of age, from 4.7% in women aged 70 to 79 years, to 10.1% in women aged 80 to 89 years, and 20.3% in women aged 90 to 99. As with urinary function, the effect of age on anorectal function is multifactorial, and the presence of comorbid conditions contributes to worsening symptoms. Incontinence, both urinary and fecal, is strongly associated with cognitive impairment and physical limitations.

Although available data are limited, virtually all studies show that the prevalence of pelvic organ prolapse increases steadily with age. This has been shown in case-control studies, prospective studies, and studies of surgery for prolapse. In the Women's Health Initiative at baseline, uterine prolapse was observed in 14.2% of 16,616 women. Anterior vaginal prolapse was observed in about one third of the study population, regardless of hysterectomy status (32.9% with and 34.3% without hysterectomy); posterior vaginal prolapse was present in about one fifth, similarly unrelated to hysterectomy (18.3% and 18.6%, respectively). For uterine prolapse, regression analyses showed a 16% to 20% increase in the odds ratio (OR) for prolapse associated with each 10-year increase in age. Studies of surgery for prolapse, which are likely to reflect the more severe end of the clinical spectrum of prolapse, consistently show increased rates of surgery by age (until ages 80 and above). Olsen et al (7) reported prolapse surgery rates (per 1000 women per year) of 1.24 for women of ages 50 to 59, 2.28 for ages 60 to 69, and 3.43 for ages 70 to 79.

Race

Racial differences have been reported for some pelvic floor disorders, although it is not yet clear



	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85+
Unknown	0.3	0.6	1	1.1	1.6	2.4	3	3.1	3.6	4.8	4	4.2	5.2	5.7
Slight	6.3	8	10.7	11.5	11.6	13.7	12.3	9.3	7.8	5.6	5.7	7	5.9	2.6
Moderate	2.5	4.5	4.9	6	7.5	8.3	8.8	8.4	7.6	8.3	8.1	8.1	8.1	8.2
Severe	1.3	1.2	1.6	2.6	3.3	4.1	6.1	6.8	7.2	8.7	12.1	14.6	16.1	19.3

Figure 2.1. Prevalence of urinary incontinence by age and severity. (From Hannestad et al [16]. © 2000, with permission from Elsevier.)

whether the differences are biologic or sociocultural (related to health care access or likelihood of seeking health care), or both, or due to other factors. Different levels of risk may be based on genetic or anatomic attributes; lifestyle factors such as diet, exercise, and work habits; or cultural expectations and tolerance of symptoms. Under closer study, populations traditionally thought to enjoy relative protection from pelvic symptoms have a significant prevalence of urinary incontinence and other urinary symptoms, including black, Hispanic, and Asian (Japanese, Chinese) women. There may be differences in the distribution of presenting symptoms or confirmed diagnoses, with some reports suggesting a lower risk for stress incontinence and a higher risk for detrusor overactivity in black or Hispanic women compared to white women. However, these reports are not population-based, which would provide the best estimates of true racial differences.

No reports related to race or ethnicity are available for fecal incontinence.

In many studies of prolapse, the populations are predominantly white, thereby limiting analyses related to race and ethnicity. In studies that do have significant minority representation, there appear to be differences in the occurrence of prolapse by race. In the Women's Health Initiative, black women had a lower risk of prolapse (odds ratio of 0.65 or less), compared to white women. Hispanic women had a higher risk of uterine prolapse and anterior vaginal prolapse (cystocele), with odds ratios of 1.24 and 1.20, respectively; however, the risk of posterior vaginal prolapse (rectocele) was not significantly different compared to white women. In a case-control study of 447 women, Swift et al (8) reported a statistically significant lower risk for prolapse in women of nonwhite race (although the magnitude of the lowered risk was not reported). Racial differences in the structure of the bony pelvis may play a role in determining a woman's risk of prolapse, possibly by influencing the likelihood or extent of injury to pelvic support at childbirth.

Childbirth

Parity is a well-established risk factor for urinary incontinence in young and middle-aged women (up to age 50); however, the effect of childbirth diminishes with age and even disappears in older women. Large randomized trials (the Heart and Estrogen/Progestin Replacement Study [HERS]) and observational studies (the Nurses' Health Study) have shown no or weak effects of parity in older women. Populations, such as nulliparous women, previously thought to be at low risk have significant levels of incontinence when specifically studied. For example, in one study of 149 nulliparous nuns, the prevalence of incontinence was 50%, with two thirds of the incontinent women having stress or mixed symptoms.

Urinary incontinence commonly develops in pregnancy, although the pathophysiology is not well understood. For most women, incontinence in pregnancy resolves after delivery; however, women who have had transient incontinence in pregnancy may be at higher the risk of developing persistent incontinence later in life.

How the type of delivery affects the risk of incontinence is controversial. Early after delivery, within the first 3 to 5 years, the type of delivery has the strongest effect. In one of the few randomized trials of delivery type to address this (although not as a primary aim), the Term Breech Trial found less urinary incontinence in the planned cesarean delivery group (4.5%, relative risk 0.62) compared to the planned vaginal delivery group (7.3%) at 3 months postpartum. Obviously, cesarean delivery does not offer complete protection from the development of incontinence, even shortly after delivery. In addition, because 43% of women in the planned vaginal delivery group actually had cesarean delivery, the results of this study probably underestimate the magnitude of the early difference between cesarean and vaginal delivery.

In a large community-based observational study in Norway of women aged less than 65 years (the Epidemiology of Incontinence in the County of Nord-Trondelag [EPINCONT] study), the prevalence of any incontinence was 10.1% in nulliparous women, compared to 15.9% in women who delivered by cesarean, and 21.0% in women who delivered vaginally. The effect of delivery type diminished with age such that the prevalence of incontinence was similar regardless of type of delivery in the oldest age group of women studied (ages 50 to 64 years). Viktrup (9) showed that incontinence 5 years after the first delivery was not influenced by the type of delivery. A study by Wilson et al (10) showed that the risk of incontinence accumulated with the number of cesarean deliveries; after three or more cesarean deliveries, the prevalence of

incontinence was similar (38.9%) compared to women who delivered vaginally (37.7%).

In the few studies that have directly evaluated anorectal function in pregnancy, no changes have been consistently identified. Few women develop new symptoms of fecal incontinence during pregnancy (in contrast to urinary incontinence), although this has not been well studied. However, fecal incontinence or other symptoms of disordered defecation, especially fecal urgency, develop commonly after vaginal delivery. The risk of fecal incontinence for women delivering vaginally is highest in women who sustain direct anal sphincter damage (third- or fourth-degree perineal laceration). Symptoms of fecal urgency and incontinence to gas occur in up to 50% of women in the early postpartum period; loss to liquid or solid stool is less common but still significant, at 2% to 10%. Subsequent vaginal delivery, particularly if another anal sphincter laceration occurs, is associated with a higher risk of persistent fecal incontinence symptoms. The increased risk of fecal incontinence with anal sphincter damage persists and worsens with time.

Most studies show midline episiotomy as one of the strongest risk factors for anal sphincter damage and, therefore, fecal incontinence. Especially since current methods of surgical repair leave persistent anal sphincter defects in up to 85% of women and are associated with high rates of postpartum symptoms, it is critically important to prevent the initial damage at vaginal delivery. Even cesarean delivery does not protect women completely from the possibility of postpartum anorectal dysfunction. Recent studies have identified new fecal incontinence symptoms even after elective cesarean delivery without labor. At this point, it is unknown whether this reflects changes due to pregnancy, the surgical delivery, or possibly both.

Most (but not all) studies show that parity is linked to the prevalence of prolapse, although the magnitude of the effect varies in different studies. Mant et al (11) reported a strong cumulative effect of parity on the risk of inpatient admission for prolapse. The effect was greatest for the first and second births and less so for three or more births (Figure 2.2). In cross-sectional data from the Women's Health Initiative, Hendrix et al (12) found that the first birth approximately doubled the risk of uterine prolapse and anterior and posterior vaginal prolapse; each additional birth increased the risk by 10% to 21%. In longitudinal data from a subset of women enrolled in the Women's Health Initiative, Handa et al (4) showed that the incidence of anterior vaginal prolapse increased by 31% for each additional pregnancy; similar associations were seen for uterine and posterior vaginal prolapse, although specific data were not reported.

Beyond parity, the type of delivery (i.e., spontaneous versus operative vaginal delivery; vaginal versus abdominal delivery; abdominal delivery with or without labor) and its association with subsequent prolapse has not been well studied. Two case-control studies have identified operative vaginal delivery (either vacuum or forceps) as a risk factor in women undergoing surgery for prolapse or urinary incontinence. However, conclusions regarding the relative effect of different modes of delivery cannot be made at this time, due to limited data.

It is probably premature to change obstetric practice based on the goal of preventing pelvic

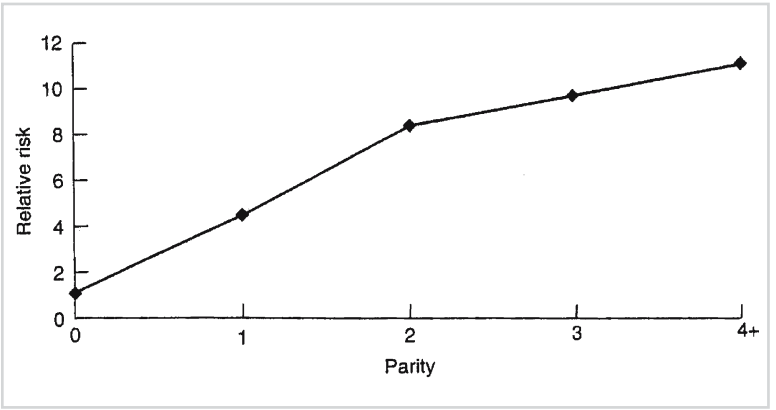


Figure 2.2. Relative risk of inpatient admission for prolapse by parity, adjusted for age and calendar period. (From Mant et al [11], with permission from Blackwell Publishing.)

floor disorders. Even with the limited data currently available, it seems likely that a policy of widespread prophylactic cesarean delivery for all nulliparous women will not, on average, result in lifelong health benefits for mothers or babies. The partial protection afforded by cesarean delivery is quickly offset by higher immediate and long-term maternal and fetal risks. Risks to the mother and baby increase substantially with each successive cesarean delivery, even in otherwise healthy women at low risk for immediate complications of surgical delivery. Ideally, the future holds the potential for identifying women at highest risk to develop pelvic floor disorders (whether by genetic or acquired factors), who may benefit from preventative interventions related to childbirth and other life events. In the future, evidence may support changes in obstetric practice for a carefully selected subgroup of women whose risk of pelvic floor disorders outweighs the risks of serial cesarean delivery.

Menopause and Estrogen

Because of their common embryologic origin, the vagina and urethra have similar epithelial linings. Cytologic changes in the urinary tract are similar to those of vaginal cytology during the menstrual cycle, during pregnancy, and after menopause. The classic estrogen receptor (ER-α) has been identified throughout the pelvis; the second estrogen receptor (ER-β), discovered in 1996, has not been well characterized yet. Estrogen deficiency urogenital atrophy is at least partly responsible for sensory urinary symptoms and decreased resistance to infection often found after menopause. Vaginal estrogen reduces bladder infections in postmenopausal women with recurrent infections, and may improve sensory lower urinary tract symptoms.

Despite some evidence that endogenous estrogen plays a role in maintaining normal urinary function, the effect of exogenous estrogen is less certain. Trials of the pharmacologic use of estrogen for the prevention or treatment of incontinence have not shown strong benefits, and studies of estrogen for other uses (e.g., cardiovascular outcomes) suggest that estrogen worsens or even causes incontinence in some women. In women with incontinence at baseline in HERS, incontinence worsened in more women randomly assigned to estrogen and progestin (39%) compared to placebo (27%). The difference was evident by 4 months of treatment and was observed for both stress and urge incontinence.

Certain selective estrogen receptor modulators (SERMs) carry important risks for pelvic floor disorders. An osteoporosis trial of levormeloxifene was halted before completion due to significant adverse effects on pelvic symptoms. Compared to placebo, there was a fourfold increased incidence of urinary incontinence (17% versus 4%) and a twofold increased incidence or progression of prolapse (9% versus 4%). In contrast, raloxifene had no effect on urinary incontinence over a 3-year period and women on raloxifene were half as likely to have prolapse surgery compared to women on placebo.

Little is known about the potential independent effects of menopause or estrogen status on fecal incontinence. Estrogen receptors have been demonstrated in the external anal sphincter and pelvic muscles. Donnelley et al (13) reported a benefit for postmenopausal women with fecal incontinence treated with estrogen, but overall the effect of hormonal status and estrogen on fecal incontinence has not been well studied.

Except for the studies of SERMs and prolapse, information is very limited on the effect of menopause (independent of age) and estrogen status on the risk of prolapse. In a case-control study of women undergoing surgery for prolapse or incontinence, Moalli et al (14) reported a decreased risk associated with postmenopausal hormone use, although this achieved statistical significance only when the duration of hormone use exceeded 5 years (adjusted odds ratio, 0.1).

Obesity

Obesity has been consistently identified as a strong independent risk factor for urinary incontinence of all types. Incontinence is also associated with an increased waist/hip ratio, which supports the theory that obese women generate higher intraabdominal pressures that overcome the continence mechanism. Weight loss may result in resolution of incontinence without further specific therapy.

Less is known about the relationship between obesity and fecal incontinence. Fornell et al (15) showed elevated relative risks by univariate

analysis in obese women (body mass index [BMI] ≥30 kg/m^2) compared to normal women (BMI <25) for incontinence to gas (relative risk, 1.8), liquid stool (2.5), and solid stool (1.3), although only the risk with liquid stool attained statistical significance. Multivariate analyses were not performed.

Many, but not all, studies of prolapse show a higher risk in overweight and obese women. In cross-sectional data from the Women's Health Initiative, the effect of increased weight was consistent and showed the greatest magnitude in obese women with posterior vaginal prolapse (adjusted odds ratio, 1.75) compared to normal women. In addition, women with "apple" body shapes (waist greater than hip circumference) had a 17% higher risk of anterior and posterior vaginal prolapse, supporting the theory that increased intraabdominal pressure may play a role in prolapse occurrence. Mant et al (11) reported a stronger effect of weight alone (adjusted relative risk, 1.50) compared to BMI (weight and height). Longitudinal data from the Women's Health Initiative showed a strong association between increasing BMI and the development of posterior vaginal prolapse, but not uterine or anterior vaginal prolapse.

Smoking

Smoking has been identified as an independent risk factor for urinary incontinence in several studies, with the strongest effect seen for stress and mixed incontinence in heavy smokers. The pathophysiologic mechanism may include direct effects on the urethra and indirect effects, where smokers generate greater increases in bladder pressure with coughing, thus overwhelming the urethra's ability to maintain a watertight seal.

No information is available on the effect of smoking on fecal incontinence.

Data on smoking and prolapse are contradictory. One study showed no effect of smoking in menopausal women with and without prolapse. In a case-control study of women undergoing surgery for prolapse or incontinence, smoking was associated with a doubled risk. However, in large epidemiologic studies, smoking shows a paradoxical protective effect. In the Women's Health Initiative, the adjusted odds ratio for prolapse in women with current tobacco use ranged from 0.81 to 0.85; the upper limit of the 95% confidence interval approached but did not cross 1, thereby achieving statistical significance. Mant et al (11) reported an adjusted relative risk of 0.78 in women with inpatient admissions for prolapse (although this was not statistically significant, 95% confidence interval of 0.57–1.07). At this point, it is unknown whether these data represent a potential biologic effect, changes in management due to smoking status (i.e., recommending surgery less often), or some other effect.

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Part II

Evaluation

3

Urinary Incontinence

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Urinary incontinence is a benign disease; however, its impact on the patient's quality of life (QoL) is tremendous. The incontinent patient is, most of the time, embarrassed and ashamed, even avoids speaking to her family and friends about her problem. She prefers to isolate herself from some activities that she knows trigger incontinence. She is fearful of being ostracized if discovered.

This embarrassment sometimes goes as far as hiding the problem from her physician. As physicians, we must be attentive to this anxiety and shame, look for these hidden symptoms, and reassure and propose the best treatment for the condition. To achieve this ultimate aim, a very detailed assessment is necessary. This evaluation is mainly clinical. A good interview and a very detailed physical examination usually lead to the right diagnosis, give an idea of the prognosis, allow an appraisal of the impact on QoL, and, when necessary, direct the choice of treatment.

History

Physicians take a patient's history in different ways. Some use a patient self-administered questionnaire. Whatever method is chosen, basic information is needed, such as age, parity, past medical and surgical history with an emphasis on pelvic medical conditions (endometriosis, pelvic pain, pelvic infectious disease), pelvic surgery, hysterectomy, ovariectomy, and trials of conservative treatments (pessary, pelvic floor exercises) of pelvic prolapse and urinary incontinence. Medication history focuses on hormone replacement therapies, medication for incontinence or bladder dysfunction, and any drug having an impact on lower urinary tract dynamics, on renal function, or diuresis.

Symptoms of Incontinence

Most physicians prefer to interview their patients directly to get their history of incontinence and symptoms. Whatever the patients' initial complaint, some symptoms have to be sought (1):

Daytime frequency of urination, also called pollakiuria. A frequency higher than eight times per day is abnormal and has to be differentiated from polyuria.

Urgency, which is a sudden compelling desire to pass urine.

Urge incontinence, which is involuntary leakage accompanied or immediately preceded by urgency. Any urgency is abnormal. The circumstance and frequency of this urgency are important to consider.

Nocturia, which refers to the number of times that the patient has to wake up at night to void. Any nocturia is abnormal.

Stress urinary incontinence (SUI), which is involuntary leakage with effort, exertion, sneezing, or coughing. The patient's perceived amount of leakage is a good indication of the degree of incontinence. Whatever the amount, SUI is always abnormal.

Depending on the findings of one or several of these initially identified symptoms, the questionnaire should address other signs that will help to refine the diagnosis:

Nocturnal enuresis, the loss of urine during sleep.

Nighttime frequency, which includes voiding that occurs after the individual has gone to bed, but before she has gone to sleep. It also includes voiding in the early morning, which prevents the individual from getting back to sleep.

Continuous incontinence—continuous leakage with no relationship to any urgency and/or exertion.

Bladder sensation—a normal sensation is to be aware of bladder filling and to have an increasing sensation up to a strong desire. This sensation can be

- increased when the patient has an early and persistent desire to void,
- reduced when she does not feel a definite desire to void, or
- absent when there is no sensation of bladder filling or desire to void.

Voiding symptoms are also important:

Slow stream, defined as the individual's perception of reduced urine flow usually compared with her previous flow.

Intermittent stream, when urine flow stops and starts on one or more occasions during micturation.

Hesitancy, which is the difficulty in initiating micturation, resulting in a delay in the onset of voiding.

Straining, related to a muscular effort used to initiate, maintain, or improve the urinary stream.

Terminal dribbling, defined as the prolonged, final part of micturation when the flow has slowed to a trickle/dribble.

Postmicturation dribbling, which is an involuntary loss of urine immediately after finishing urination (after rising from the toilet).

Feeling of incomplete emptying.

Taking the history is an important part of the diagnostic process in medicine. It is the privileged time that the physician spends with the patient. Beyond giving a good idea of the pure pathophysiologic process responsible for the complaint, the emotional component of the disease is captured just by the way the patient answers the question. This essential dimension, which precludes analysis of the impact on QoL, is completely overlooked in preset questionnaires, which are more useful in research than in clinical practice.

Symptom Questionnaires

Numerous questionnaires have been proposed to standardize symptom assessment. Ideally, they should not require clinician intervention to be filled out, and cannot be subject to interpretation, but should result in a score.

The simplest and probably the most useful symptom questionnaire is a voiding diary. It usually assesses frequency, volume voided, and incontinence episodes. It has been suggested that a 7-day recording is the best (2), but in clinical practice reliance on a 3-day diary is more usual. However, it cannot distinguish the type of incontinence (3). Other questionnaires are self-administered and evaluate specific symptoms. The Urogenital Distress Inventory (UDI) (4), the UDI6 (5), the Urge-UDI (6), the King's Health Questionnaire (KHQ) (7), and the International Consultation on Incontinence-Questionnaire (ICI-Q) SF (8) are completely validated and highly recommended. The ICI-Q and KHQ measure more than symptoms; they can be used to measure the impact of changes on the QoL of patients suffering from incontinence. For the ICI-Q SF, a recent study showed that similar

results are obtained no matter who administers the questionnaire, be it the patient at the clinic or at home, or the physician (9). To differentiate between stress and urge incontinence, the Medical, Epidemiologic and Social Aspects of Aging (MESA) questionnaire (10) is simple and practical.

Another dimension of incontinence is assessed by the impact of the disease on QoL. The impact on QoL is not directly related to the intensity or frequency of symptoms. Some patients may have a major impact when, for instance, incontinence occurs during intercourse, while others, despite a much more significant leakage episode, may cope well with their handicap and report a much less important impact in their QoL questionnaire.

Generic measures aiming to assess the multidimensional nature of health status are suitable for a broad range of the disease and usually do not contain specific questions on lower urinary tract symptoms. They tend to be relatively insensitive to incontinence (11). As a consequence, their use is not recommended in the context of evaluation of incontinence.

Specific measures of the impact of incontinence on QoL assess female incontinence. Three questionnaires are highly recommended, considering their high level of validation: the Incontinence Impact Questionnaire (IIQ) (12), the KHQ (6), and the Quality of Life in Persons with Urinary Incontinence (I-QoL) (13). The IIQ has been modified for easier use in clinical practice, and the short form, IIQ-7, is generally preferred to the long version (5). It has also been modified for better adaptation to an even more specific part of the disease, urge, which led to Urge-IIQ (6). Finally, the SEAPI-QMM—the acronym for stress-related leak (S), emptying ability (E), anatomy (female) (A), protection (P), inhibition (I), quality of life (Q), mobility (M), and mental status (M)—was completely validated recently (14). A long list of other questionnaires exists (10), but most of them did not reach a complete level of validation and cannot be recommended.

For physicians particularly interested in the assessment of sexual function/satisfaction in relation to incontinence, two questionnaires can be used with a high level of recommendation: the Psychosocial Adjustment of Illness Scale (15) and the Rust and Golombok Inventory of Sexual Satisfaction (16). Finally, QoL in incontinence has also been studied in specific patient groups: incontinence after spinal cord injury (17) and incontinence in multiple sclerosis (18).

Physical Examination

The physical examination must be part of a relatively extensive evaluation that may give an idea of the possible cause of incontinence (e.g., neurogenic condition, cognitive impairment, etc.).

General Examination

The general examination addresses the following areas:

Edema: may contribute to nocturia or nocturnal incontinence.

Neurologic evaluation (motoricity, sensitivity, balance, cranial nerves, reflexes, manual dexterity).

Cognition: simple memory test about very recent or old events.

Abdominal examination for masses, organomegaly, scars, and sensitive or painful areas.

Rectal examination for anal tone, fecal impaction, rectal mass, and anal sensation.

Vaginal Examination

The general technique is the following (also see Chapter 4):

Examination of perineal skin condition

Assessment of genital atrophy, demonstrated by rigidity and decreased introitus and vaginal size often associated with cranial retraction of the urethra, limiting its mobility

Paravaginal muscle tone and sensitivity

Urethral mobility by direct observation of the degree of rotational descent of the urethra during Valsalva maneuver or repeated coughing; mobility can also be measured by the Q-tip test; however, it is observation dependent and also depends on other parameters such as patient position, prolapse, and degree of straining (cough, Valsalva) (19–21)

Urethral discharge or tenderness, suggesting urethral diverticulum or infection of the urethra

Direct observation of urine loss concomitant to repeated coughing

We found the vaginal blade to be very useful in performing this physical examination (Figure 3.1).

This simple physical examination is sufficient in clinical practice. In research, more

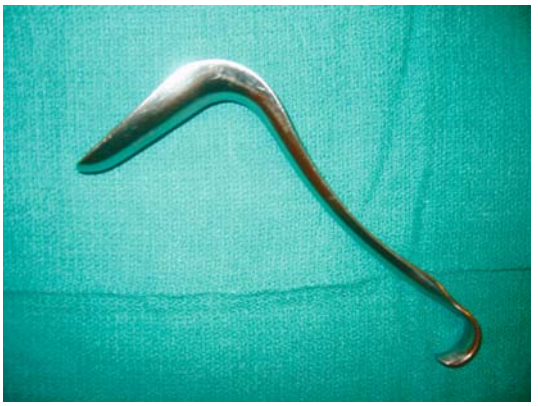


Figure 3.1. Uniblade vaginal valve.

sophisticated evaluation of prolapse, with the pelvic organ prolapse score, for instance, is recommended (22). Its applicability in daily clinical practice is questionable.

At the end of this clinical evaluation, including the interview and the physical examination, it is in most cases easy to classify incontinence as pure urge, pure stress, or mixed. However, this clinical approach alone may be in some cases misleading, and only additional testing allows for an accurate classification. Furthermore, overflow incontinence frequently mimics urge incontinence, and only evaluation of postvoid residual (PVR) can differentiate them.

Estimation of PVR Volume

In clinical practice, in nonspecialized centers, clinical evaluation, including suprapubic area palpation/percussion and vaginal examination, can give a good indication of residual urine volume after micturation. However, accurate measurement can be obtained by either in-and-out catheterization or bladder scanning.

It is difficult to give a value for abnormal PVR since, for instance, some diabetic patients can carry relatively high residuals (300–400 cc) without any symptoms or manifestations. Management of PVR must depend on the individual clinical picture.

Urinalysis

To eliminate possible causes of incontinence, a urine test is mandatory to assess blood (hematuria), sugar (glycosuria), white cells (pyuria), and proteins (proteinuria).

To recap, the initial evaluation of an incontinent woman includes a detailed interview, a physical examination focusing on, but not being exclusive to, pelvic assessment, an appraisal of PVR volume of urine, and urinalysis. Depending on the findings of these assessments, further evaluation may be necessary. However, a pure SUI in a patient who never had a previous procedure done for this condition can be treated without further information. Similarly, for urge incontinence with no atypical findings in the initial evaluation, treatment can be given without further testing. However, in a large number of cases, at least one finding on the initial evaluation indicates that further testing should be done to ascertain the underlying condition before embarking on a treatment.

Optional Testing

Further testing is indicated in these situations:

If the initial evaluation did not lead to a definitive diagnosis (for example, because of a lack of correlation between history and physical examination)

If there are urinalysis abnormalities, e.g., microscopic hematuria, sterile pyuria, proteinuria, etc.

If incontinence occurs in association with a comorbid situation, such as:

- Pelvic irradiation
- A neurological condition
- Abnormal PVR
- A history of previous surgery for incontinence
- Suspicion of vesicovaginal or urethrovaginal fistula
- Recurrent urinary tract infection

More controversial is the systematic indication of further testing (urodynamics, in particular) in patients for whom surgery is considered as a treatment for their incontinence. We suggest urodynamics as a systematic test before any surgery (at least flowmetry and a cystometrogram), but others recommend urodynamics only in the situations mentioned previously.

Among the optional tests, urodynamics are the most frequently requested, but others, such as the Pad test (51), voiding cystogram, pelvic and

abdominal ultrasound, pelvic magnetic resonance imaging (MRI), cystoscopy, electrophysiologic testing (evoked potentials, conduction speed, needle electromyography [EMG], etc.), could be indicated.

Urodynamics Testing

It is not our aim in this chapter to describe in detail all techniques, pitfalls, and results of urodynamics testing, but rather to integrate this information in the very specific context of the evaluation of female urinary incontinence. Urodynamics testing becomes unavoidable in these situations, as revealed on initial testing:

Patients with difficulty voiding (straining, intermittency, hesitancy) or incomplete bladder emptying. In this case, urodynamics are important to try to reveal the cause of obstruction (external sphincter-detrusor dyssynergia) and/or a hypotonic bladder. Flowmetry with concomitant EMG recording, cystometrogram, and pressure flow study are then necessary, ideally by video urodynamics.

Patients with an overactive bladder resistant to simple pharmacologic treatment (anticholinergic medication associated with changes in lifestyle). In this context, the cystometrogram is important to better evaluate possible uninhibited contractions that, by their amplitude and frequency, could reveal an unsuspected neurogenic bladder. Assessment of nonobvious obstruction is also important in this context.

Patients with pure stress or mixed urinary incontinence. If the urge component of the incontinence is dominant, one may also want to exclude a neurogenic cause of bladder instability and possible sphincter weakness. If the stress component is isolated or dominant, urodynamics may be indicated just to reassure the patient and the physician or, in rare cases these days, to decide on a different type of treatment according to outlet resistance. In this context, urethral pressure profile (UPP) or Valsalva leak point pressure (VLPP) is the most important part of urodynamics testing.

A critical review of the urodynamics test results should be done in the context of evaluating incontinence in women.

Measurement of Urine Flow

In this test, the patient, with her bladder comfortably full, is asked to urinate seated in a flowmeter. The recorded parameters during the test are as follows (Figure 3.2A):

Flow rate, which is the volume of urine expelled via the urethra per second

Voided volume, which is the total volume expelled via the urethra

Maximum flow rate (MFR), which is the maximum measured value of the flow rate

Flow time, which is the time over which measurable flow occurs

Average flow rate, which is the volume voided divided by voiding time

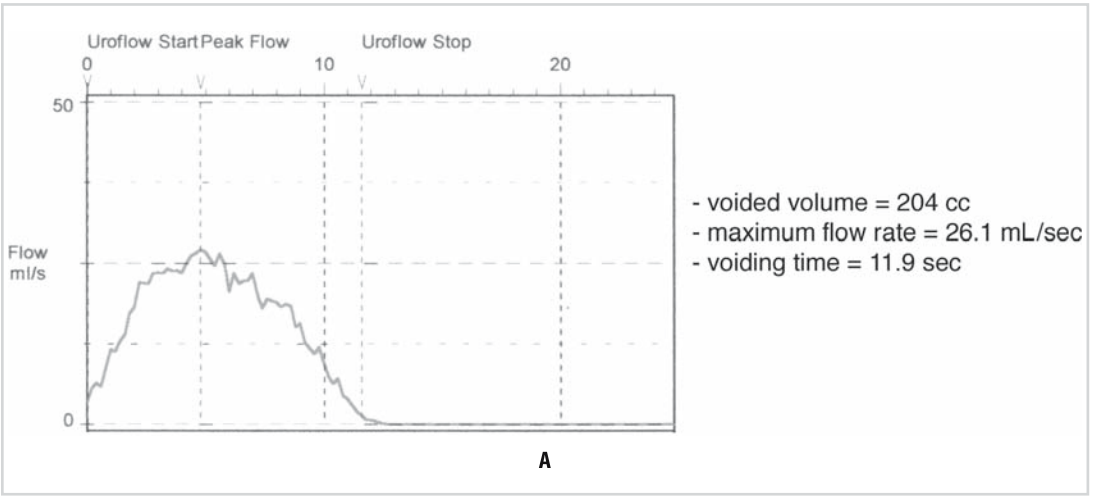
Flowmetry may be very variable, depending on a series of parameters that are considered in evaluating the results:

Voided volume must be within the patient's range. This range can be obtained from the voiding diaries previously recorded by the patient. The use of nomograms may overcome the risk of misinterpreting the flow rate in relation to a given volume (23).

Environment: women are used to voiding in almost total privacy. Such privacy is difficult to find in a urodynamics laboratory. It is therefore highly suggested that the flowmeter be installed in a normal toilet to avoid environment-related psychological disturbance, which may highly affect flowmetry results.

Different type of flows can be obtained during this examination:

1. *Normal flow but with a stiff take off of the flow* is seen mainly in women and may reflect some degree of urgency (Figure 3.2B).
2. *Abnormal flow with continuous flow and an MFR below 15 mL/sec* (Figure 3.3) could be due to either urethral obstruction or decreased detrusor contractions. Urethral calibration and pressure flow studies are important for the diagnosis in these cases. This is important in the context of surgical treatment of incontinence where patients are exposed to a higher risk of postoperative retention.
3. *Abnormal interrupted flow* (Figure 3.4) usually indicates detrusor sphincter dyssynergia with intermittent contraction/relaxation of



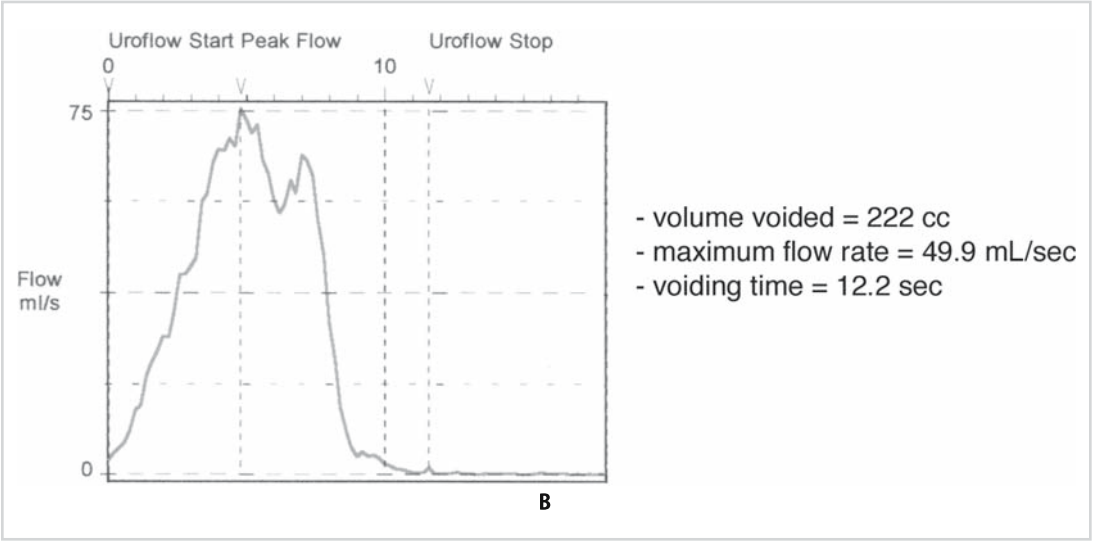


Figure 3.2. A: Normal flowmetry. B: Normal flowmetry with a stiff take-off of the flow, possibly an indication of urgency.

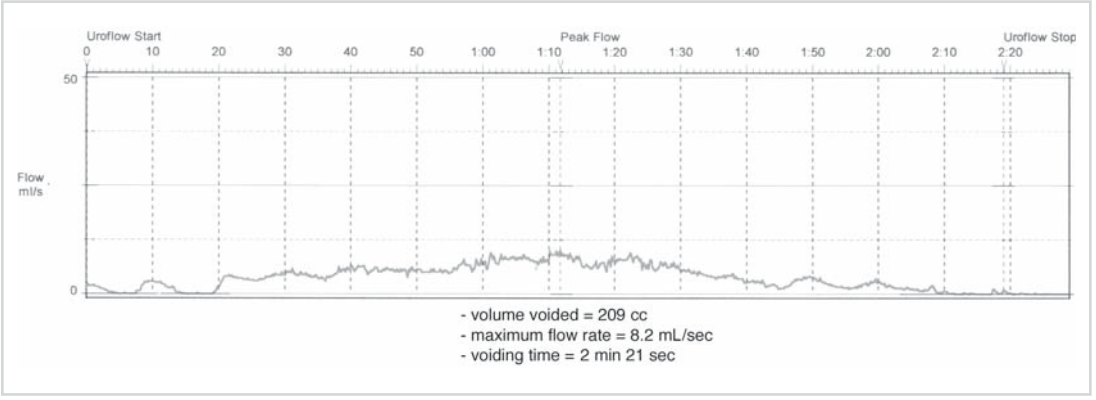


Figure 3.3. "Obstructive" flowmetry may reflect an obstruction or a weak detrusor contraction.

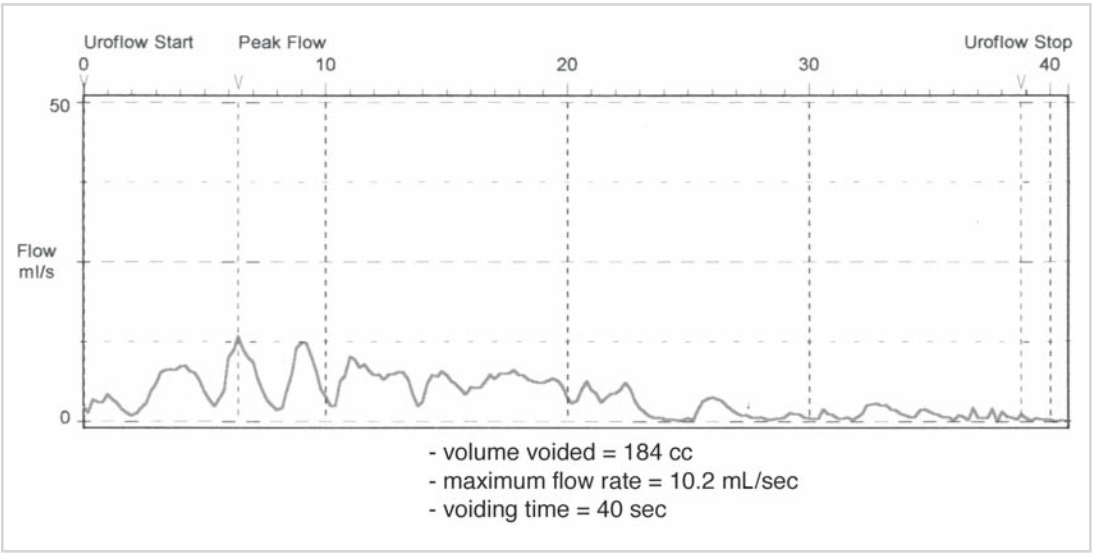


Figure 3.4. Flowmetry: intermittent flow.

the sphincter during voiding. Concomitant EMG and video urodynamics are useful tools to confirm the diagnosis. However, before these tests, we have to be sure that flowmetry has been performed in appropriate conditions, since stress is the most frequent cause of detrusor-sphincter dyssynergia.

Cystometry

Cystometry measures the pressure-volume relationship of the bladder. These measurements facilitate the evaluation of detrusor function during storage (filling phase) and during voiding. During the voiding phase, cystometry also measures detrusor reaction to urethral function. This important urodynamics test aims to reproduce patient symptoms, to reveal asymptomatic bladder dysfunction, and to reflect bladder function changes after a given treatment. Several parameters will be recorded:

During filling:

Detrusor pressure before filling

First desire to void (B_1)

Maximum bladder capacity (cystometric capacity)

Detrusor pressure at the end of filling

The presence of uninhibited contractions

Bladder compliance

During voiding:

Detrusor voiding pressure; the flow rate is usually recorded simultaneously to define the relationship between flow and voiding pressure, allowing differentiation between obstruction and hypotonic bladder

Cystometry results are assessed in the context of incontinence:

1. *Urinary incontinence (stress or mixed) with normal cystometry*: It is usual to have normal cystometry (bladder capacity around 400 cc, B_1 around 150 cc, no uninhibited contractions, normal compliance) associated with SUI or mixed incontinence. It is considered a good prognostic factor for the success of surgery.
2. *Urinary incontinence (stress or mixed) with abnormal cystometry*: Uninhibited contractions are sometimes present on the cystometrogram of patients complaining of stress or mixed incontinence. When these contractions occur at the end of filling of a bladder of normal capacity and/or normal compliance, they are difficult to interpret, but are not a contraindication for surgery. However, the presence of frequent, high-amplitude contractions should represent a contraindication to simple urethropexy and should lead to an investigation to rule out neurogenic bladder.

3. *Urge incontinence with normal cystometry*: Sensory urge is frequent and usually associated with normal cystometry or a stable bladder, with only a slight decrease in bladder capacity and an early first desire to void. Anticholinergics are unlikely to be efficient in this type of overactive bladder.
4. *Urge incontinence with abnormal cystometry* (Figure 3.5): Detrusor uninhibited contractions and/or loss of compliance usually lead to urge incontinence. In these conditions, neurogenic bladder must be highly suspected, and proper evaluation ordered.

Pressure Flow Study

The relationship between flow and detrusor pressure has not been well studied in women. Most of the literature reports on males, and the nomograms developed for men may not be applicable to women. However, even if a very precise diagnosis of obstruction or strength of detrusor contractions is difficult to establish, the presence of a "weak" detrusor is important to consider as a risk factor, for retention after surgery or anticholinergic treatment.

Urethral Evaluation

In SUI, urethral function deficiency appears to be the *primary mechanism*. This urethral dysfunction results from the interaction of muscles, fascia, mucosa, and vasculature. The assessment and quantification of this function are probably important to choose the best treatment or combination of treatments. However, the test that will have a good correlation with other clinical and urodynamic parameters is still to be described.

Currently, two tests are primarily used, both of them aiming to measure the sphincteric reaction to the effort (cough or Valsalva maneuver: UPP and VLPP. A real controversy over their reliability arose when high variations of their results were reported (24–28). Parameters that can influence the results are as follows:

In UPP: the type of catheter used, the type and rate of infused media, the speed of retraction of the catheter, the degree of stress of the patient, the severity of patient's incontinence

In VLPP: the position of the patient, the type of catheter used, the degree of bladder fullness, the accuracy of abdominal pressure recording

The Standardization Committee of the International Continence Society (ICS) has defined the parameters in usual practice and has recommended several measurements to increase the degree of accuracy (29). Several book chapters and articles on urodynamics concur on the limited value of UPP in the assessment of urethral function in clinical practice, but do not support its use to determine treatment (30–37).

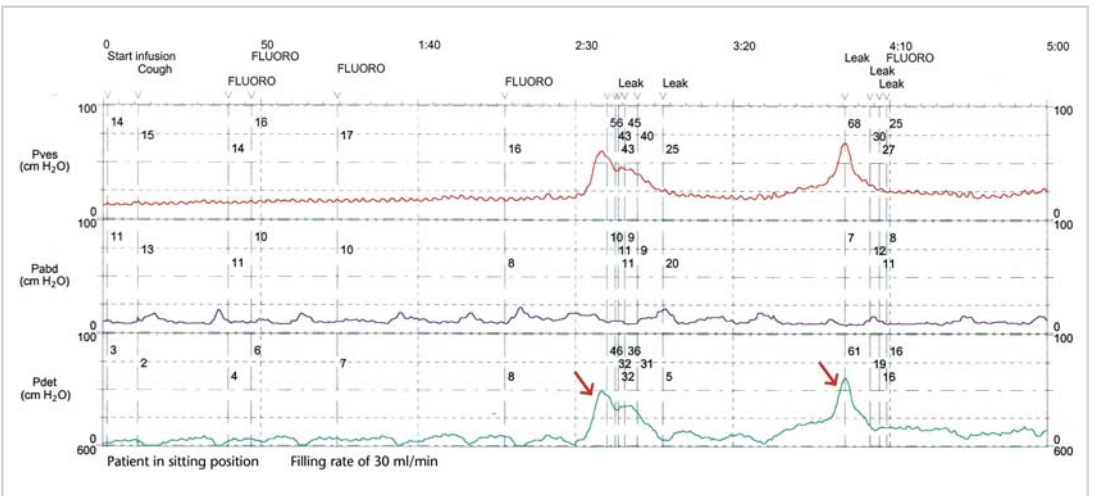


Figure 3.5. Cystometrogram: uninhibited bladder contractions during filling (arrows indicate detrusor contraction).

On the other hand, VLPP appears to achieve better accuracy and better correlation with other urodynamic parameters as far as a standardized method is concerned (16,37). However, it is reasonable to suggest that each urodynamics laboratory follow ICS recommendations regarding the techniques of these tests and define its own normal (or cut-off) values according to its own specific technical method.

Other Optional Testing

Cystoscopy

It would be interesting to perform cystoscopy in patients who have had previous surgery and present obstruction symptoms or irritative symptoms. But cystoscopy is not the best test to assess obstruction, and physical examination combined with urodynamics assessment is often enough to confirm the diagnosis. However, visual inspection of the urethra could be helpful, before performing urethrolysis, for instance.

In the face of irritative symptoms, cystoscopy is probably more indicated to rule out an associated disease, or a possible consequence of the surgery, like a missed bladder perforation leaving an intravesical thread (often the origin of intravesical calcifications) or an intravesical eroded tape. Most of the time, these rare events are associated with microscopic hematuria, which would have been discovered on urinalysis and which, by itself, represents an indication for cystoscopy.

Pad Weighing Test

Usually, patient interviews and physical examinations give a very wrong idea of the amount of urine lost during daily activities. The pad weighing test has been developed with that aim. It is the best and only instrument to measure the importance of incontinence, but it does not discriminate between urge and stress incontinence. This is one of its main limitations.

Qualitative pad tests using either a dye (phenazopyridine 200 mg daily) (38) or distal urethral electrical conductance (39) have been proposed. These qualitative tests are mainly very helpful for small amounts of leakage. Quantitative pad tests are used much more often in clinical practice and research. They consist of weighing the pads after different time intervals, with or without provocative exercises. Different protocols have been described in the literature, from short ones (a few minutes to 2 hours) to long ones (12 hours to several days). Several reports compare these different tests and the environment where they are performed (12,40–45). Details of these tests are summarized in two articles (46,47).

In clinical practice, the real value of a pad weighing test is controversial. It is very useful if doubt exists about the origin of a very discrete (but sometimes very bothersome) incontinence by allowing differentiation between urine leakage and vaginal discharge. It is a good argument in favor of the diagnosis of stress incontinence when the test is done with standardized exercises and under supervision. When such testing is performed, a known volume in the bladder is mandatory to validate the result.

In research, it is beyond doubt that at present the 24-hour pad test has good reproducibility, and is relatively easy to conduct without supervision.

Pelvic MRI

Pelvic static and dynamic MRI appears to be used increasingly in the assessment of pelvic prolapse (48–50). It seems more sensitive than a good pelvic examination or other imaging modalities. However, according to our knowledge, no literature supports its superiority. Pelvic MRI is not helpful in the evaluation of urinary incontinence when it is not associated with prolapse.

Advanced Neurologic Evaluation

When neurologic symptoms are associated with incontinence and go beyond the necessary initial clinical urologic examination, some tests could be instrumental in establishing the link between the neurologic and urologic condition:

Evoked potentials
Spine and/or brain MRI
Needle EMG

Conclusion

Evaluation of incontinence has to be conducted rationally to select the best approach for the

patient. This essential step in the diagnostic process is mainly based on a good interview, which could be complementary to a preset, self-administered questionnaire, but which could not be fully replaced by it. The interview facilitates the establishment of a relationship between the symptoms and the degree of impairment of patient QoL as well as patient goals and expectations of a treatment. Physical examination completes this evaluation, and indicates the appropriate treatment. Urodynamics testing may be helpful in some patients when the initial clinical evaluation is not conclusive, when it is a recurrence of incontinence, or when a neurologic condition is associated or suspected.

We tend to spend less time with our patients than physicians did a few decades ago. This is probably acceptable for some diseases, but not for incontinence. Evaluation of incontinence is still based on clinical assessment, which is probably what makes the condition so fascinating.

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4

Prolapse

William Andre Silva and Mickey M. Karram

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There is currently no consensus on how much evaluation is required or needed when surgically managing women with pelvic organ prolapse. However, most would agree that optimal treatment is contingent upon a thorough assessment of historical and physical exam findings and an understanding of the relationship between pelvic prolapse and coexisting functional derangements. This assessment very commonly requires ancillary testing in the hope of objectifying the cause of the associated functional derangements (Figure 4.1).

History

Mechanical Symptoms

Complaints of pelvic pressure and tissue protrusion are often reported by the patient. Lower back and sacral pain may be caused by the tension placed on the uterosacral ligaments in patients with uterine prolapse, whereas pelvic pain may be produced by stretching of the peritoneum adjacent to the prolapsed organ. Because back and pelvic pain have numerous nongynecologic, multifactorial causes, a trial of pessary use may be valuable in investigating the relative contribution of prolapse to this symptom.

In some instances, vaginal atrophy may cause pressure symptoms even in the absence of any significant prolapse, especially in the presence of previous vaginal repairs.

Urinary Incontinence

More than 40% of women with urethral sphincter incompetence will have a significant cystocele (1). A complaint of stress incontinence associated with the appearance of a

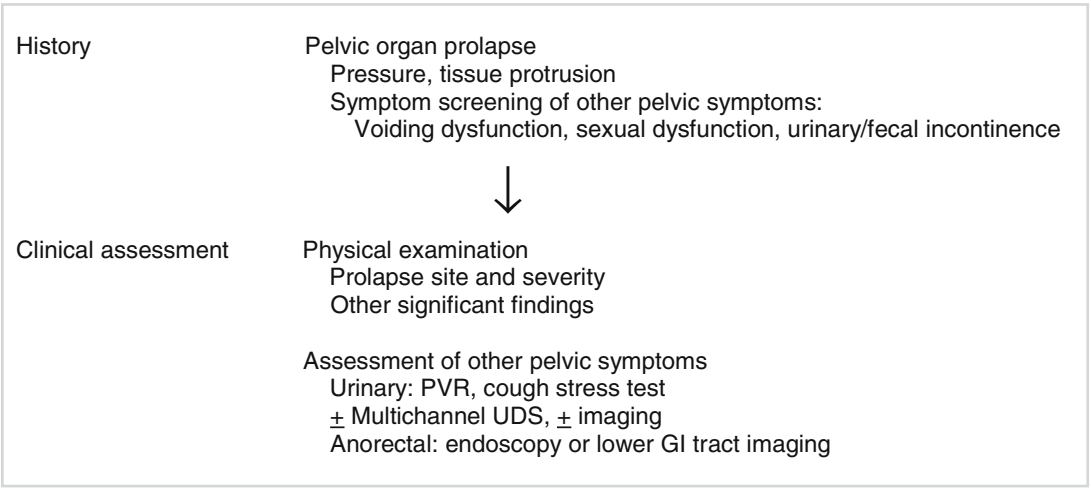


Figure 4.1. Evaluation of pelvic organ prolapse. PVR, postvoiding residual; UDS, Urodynamic study.

mild or moderate cystocele, however, is not specific for diagnosing genuine stress incontinence (2,3).

Occult or latent incontinence is urethral sphincteric incompetence masked by the presence of pelvic prolapse (4). Not infrequently, incontinent women may note the decrease or disappearance of stress incontinence episodes as the degree of prolapse worsens. The office demonstration of the sign of occult stress incontinence is facilitated by the use of a speculum or pessary to reduce the prolapse while a stress maneuver is performed. Its presence may influence management options given to the patient. However, the method to reduce vaginal prolapse to evaluate latent incontinence is not universally agreed upon or standardized at this time.

Voiding Dysfunction

Urinary frequency, urgency, and nocturia may accompany the presence of pelvic prolapse (5). Through an unknown mechanism, urge incontinence may develop in women with advanced pelvic organ prolapse secondary to detrusor instability. Seventeen percent to 85% of patients experience improvement or remission of bladder instability after reconstructive pelvic surgery (6). In addition, age is a strong risk factor for detrusor instability, urogenital atrophy, increased urine output secondary to nocturnal mobilization of body fluid, and sleep disorders, all of which contribute to the symptoms of urgency and frequency. One study found that women with mild cystoceles had a 20% incidence of detrusor instability, and the incidence increased to 52% in those with moderate to severe cystoceles (7).

Patients with severe prolapse may develop obstructive voiding symptoms as a result of urethral kinking that is worsened during straining effort (8). For instance, a moderate or severe cystocele may promote urethral compression and kinking, pressure dissipation, and an increase in maximum urethral closure pressures (9,10). Bergman et al (9) studied 67 patients with urethral pressure profiles at rest and straining, pre- and postreduction and found 24 (36%) had pressure transmission ratios less than 1; 17 (71%) of these 24 patients had latent stress incontinence. Similar decreases in pressure transmission ratios and maximum urethral closure pressures are seen after reduction of grade 2 apical prolapse (11), whereas only reduction of grade 3 posterior vaginal wall defects shows similar urodynamic results (12). Urodynamic parameters including maximum flow rates and postvoid residual volumes have been shown to improve after surgical treatment of the prolapse (13,14). Prolapse severity does not necessarily correlate with the magnitude of voiding dysfunction, as some with mild prolapse may exhibit obstructive urodynamic patterns (15).

Bowel Dysfunction

A large rectocele may cause incomplete bowel evacuation and tenesmus, leading some physicians to splint or manually reduce the posterior vaginal segment or perineum to assist in defecation. Patients may describe stool becoming trapped in the rectocele pocket itself. Constipation and straining may worsen the symptoms and lead to left lower quadrant abdominal pain if impaction occurs.

The prevalence of fecal incontinence increases to 17% in populations with pelvic organ prolapse and urinary incontinence (16) compared to 2% to 3% in the general population (17,18). The most common mechanisms are an incompetent sphincteric mechanism (secondary to a structural defect or pudendal nerve damage) and overflow incontinence.

Sexual Dysfunction

Sexual function consists of a complex interaction of biologic, psychological, and social factors that affect both the patient and her partner. Various studies have described the presence of sexual problems in patients who present with pelvic organ prolapse and urinary incontinence (19,20). However, most studies on this topic have been limited, failing to account for various factors and other confounding variables including patient age (21,22).

Several studies have attempted to correlate symptomatology, bothersomeness, and degree of pelvic organ prolapse. Mouritsen and Larsen (23) studied 110 patients with a median age of 66.5 years. Mechanical symptoms including pelvic heaviness, introital lump, vaginal pain, and low back pain were found to be the most troublesome (70%). Of the 55% of the patients who were not sexually active, reasons cited were prolapse (18%), dyspareunia (50%), and decreased libido (20%). In the 45% who were sexually active, 57% experienced mechanical symptoms or psychological problems secondary to prolapse, and 35% experienced dyspareunia or dryness. The authors concluded that pelvic symptoms were frequent and not well correlated to specific compartments or prolapse severity. Ellerkmann et al (24) found that 69% of sexually active patients with symptomatic pelvic prolapse experienced dyspareunia. Factors that adversely affected coital frequency included dyspareunia (57%), fecal incontinence (15%), urinary incontinence (27%), prolapse (28%), spousal limitation (37%), and pelvic pain (41%). Effect on sexual activity was moderately associated with worsening prolapse in all three compartments with the apical compartment being most pronounced. Barber et al (25) studied 348 women, 316 of whom had urinary incontinence of greater than one episode per week and 32 had pelvic organ prolapse (Pelvic Organ Prolapse Quantification stage III or IV). One third of pelvic organ prolapse patients felt their sexual ability to be significantly more affected than the other groups (stress urinary incontinence 13%, detrusor instability 7%, mixed incontinence 2%). As a result of prolapse surgery, fewer women with prolapse were likely to report that their symptoms affected their ability to have sexual relations compared with baseline (33% preoperative versus 0% postoperative). However, overall sexual satisfaction was the same at baseline and at 6 months, thus appearing to be independent of diagnosis of or therapy for urinary incontinence or prolapse.

Relationship Between Structure and Function

A complex relationship between anatomic descent of pelvic organs and physiologic function exists and often the two do not correlate well with one another. This is especially evident as it pertains to the anterior segment. Advanced prolapse of the anterior segment may have no associated functional derangement, may coexist with stress incontinence, or may coexist with significant voiding dysfunction (15). This wide array of functional derangement in what appears to be the same anatomic picture in various patients is at this time unexplainable. In a randomized control trial by Weber et al (26), 10 of 33 patients (30%) who were randomly assigned to the standard anterior colporrhaphy group had satisfactory or optimal anatomic results, compared with 11 of 26 patients (42%) with standard plus mesh and with 11 of 24 patients (46%) with "ultralateral" anterior colporrhaphy. However, the severity of symptoms that were related to prolapse improved markedly despite the relatively low rates of anatomic cure compared to previous uncontrolled studies. In addition, there is much debate as to whether anatomic repair of a paravaginal defect leads to

any improvement in function, and outcome data on paravaginal defect repair (including quality of life and sexual function) is lacking.

Past Medical and Surgical History

Chronic increases in intraabdominal pressure due to obesity, chronic cough (chronic obstructive pulmonary disease [COPD], asthma), chronic constipation, and occupational conditions (job requiring heavy lifting) have been associated with the subsequent formation of pelvic organ prolapse (27). A past history of neurologic disorders such as spina bifida and connective tissue disorders are other predisposing factors.

Any history of previous pelvic organ prolapse surgery should be elicited. A previous history of colposuspension and needle suspension may lead to enterocele formation by altering the vaginal axis vertically. Various studies have suggested that sacrospinous ligament fixation increases the risk of anterior vaginal wall prolapse by causing vaginal retroversion (28–31). Sze and Karram (28) reviewed 1062 cases of sacrospinous ligament vault suspension and reported an 8% incidence of anterior vaginal wall prolapse. A previous hysterectomy in which the cuff or cul-de-sac was managed suboptimally may further predispose a patient to apical prolapse. In a case-control study by Swift et al (32), a history of hysterectomy and previous surgery for pelvic organ prolapse were found to be the strongest predictors of severe pelvic prolapse.

Past Obstetrical History

Numerous studies have suggested that vaginal delivery of a term infant is the greatest risk factor for the future pelvic organ prolapse (32–36). The history should include an inquiry regarding parity, labor duration, delivery mode, and largest birth weight, although recall may be limited.

Physical Examination

General and Neurologic

The general examination as it pertains to pelvic organ prolapse involves an assessment of mobility and mental state, which may affect compliance with any proposed treatment. A screening neurologic examination is important to rule out neurologic disease. Acquired and congenital neurologic lesions can predispose to pelvic prolapse. An increased prevalence of neurologic disease such as spina bifida occulta has been noted to occur in young patients with pelvic prolapse (37).

A focused assessment of lower extremity motor strength, tone, reflexes, movement, gait, and sensation is important. One side should be compared to the other. A motor exam consists of evaluating the strength of hip flexion (S2-S3), plantar flexion of the foot (S1-S2), and abduction of the toes (S3).

Tone can be assessed though passive motion of the muscle groups. Upper motor neuron lesions produce a spastic increase in muscle tone associated with hyperreflexia, clonus, and a Babinski sign. Lower motor neuron lesions produce decreased tone, hyporeflexia, atrophy, and fasciculations. Light touch and pain sensation along the S2–S4 dermatomes can be tested using a small piece of gauze and a safety pin. If sensation is abnormal, the examiner should work proximally until a sensory level can be determined (Figure 4.2).

Anal tone can be assessed during a digital rectal exam. Sacral spinal reflexes can be evaluated with the bulbocavernosus and anal wink reflexes. Gentle tapping of the clitoris or touch of the skin lateral to the anus should cause reflex contraction of the anal sphincter. Alternately, a voluntary cough should elicit the same response. Approximately 10% of the normal population will have a response too faint to perceive (38).

Pelvic Examination

The pelvic exam is initially performed with the patient in the supine lithotomy position. A general inspection of the vulva and vagina should find any evidence of atrophy, excoriation, bleeding, or ulceration.

Classification Systems Used to Describe the Severity of Pelvic Organ Prolapse

A reproducible, standardized system of quantitatively describing pelvic organ prolapse has eluded gynecologists for many years, which

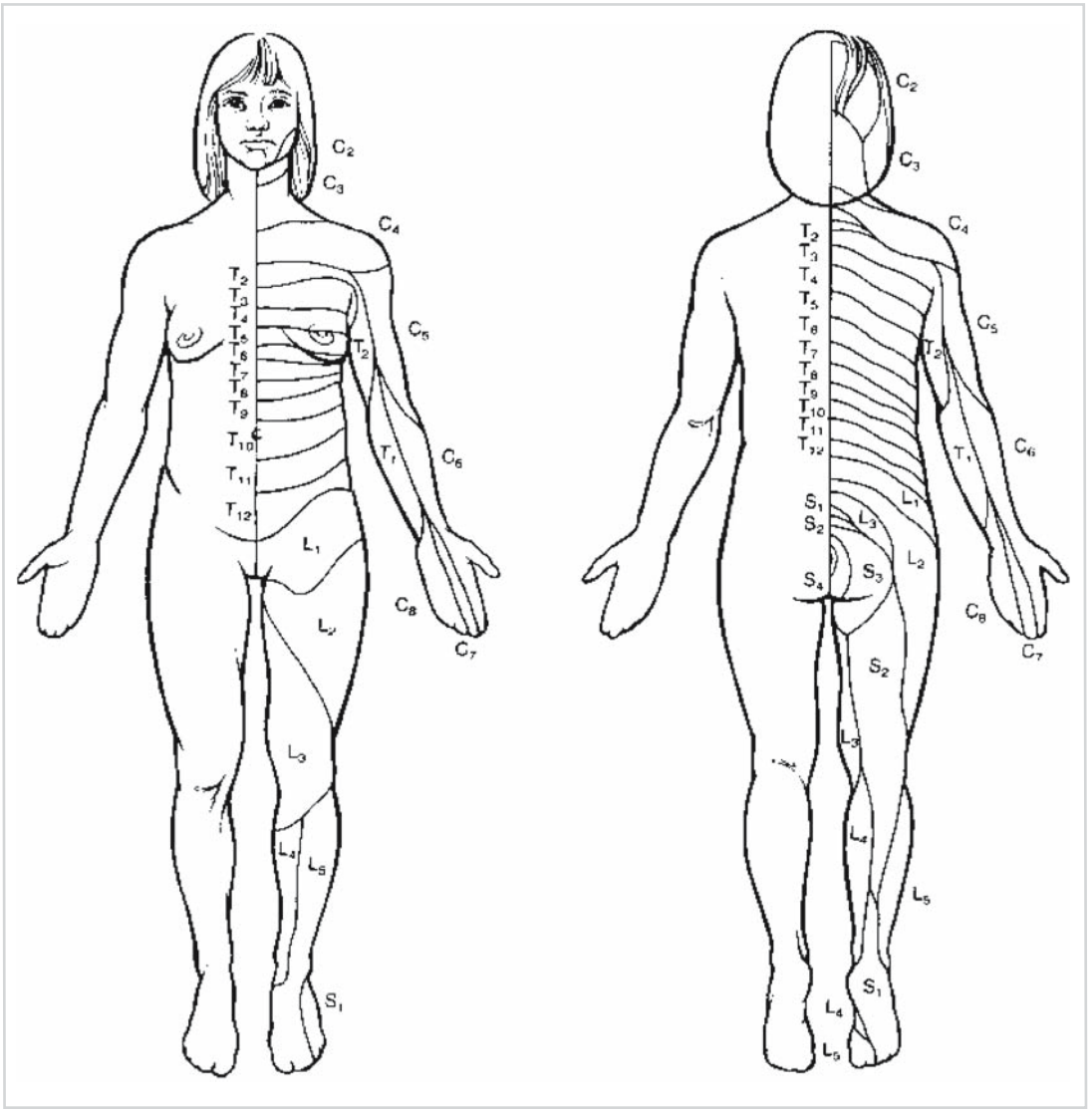


Figure 4.2. Dermatome distribution for sensory testing. (Modified from Gabbe SG, Niebyl JR, Simpson JL. Obstetrics: Normal and Problem Pregnancies, 4th ed. Philadelphia: Churchill Livingstone, 2002. © 2002, with permission from Elsevier.)

previously hampered attempts in communicating severity of prolapse between practitioners and comparing treatment outcomes in research settings. Various grading systems were proposed in the latter half of the 20th century including ones proposed by Porges (39) and Beecham (40) (Figure 4.3). One system developed by Baden and Walker (41) has been used in the modern literature. Termed the "halfway system," urethroceles, cystoceles, uterine prolapse, culdoceles, and rectoceles are graded on a four-point scale as normal (grade 0), halfway to the hymen (grade 1), to the hymen (grade 2), halfway past the hymen (grade 3), and maximum descensus (grade 4). The advantages of this system are ease of use, easy comprehension, and acceptable interobserver variability (41). However, the need for a more exact measurement of prolapse existed to facilitate a more precise description of treatment outcome.

The current standardized system used for prolapse assessment is termed the pelvic organ prolapse quantification (POPQ) system, and was described by Bump et al (42) in 1996. The POPQ

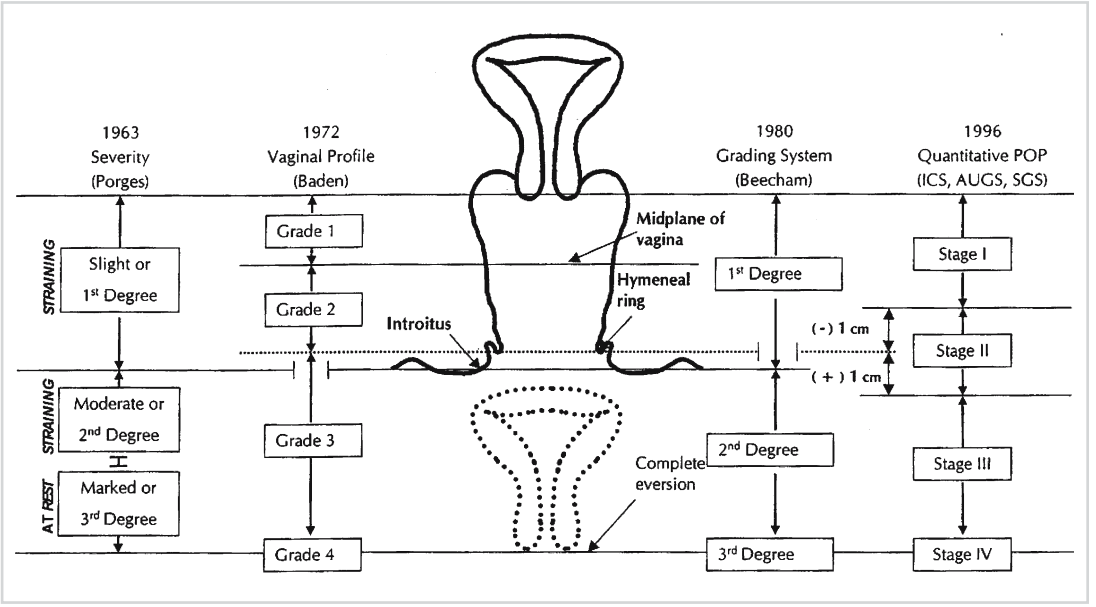


Figure 4.3. Comparison of various grading systems of pelvic organ prolapse. (From Theofrastous JP, Swift SE. The clinical evaluation of pelvic floor dysfunction. Obstet Gynecol Clin North Am 1998;25(4):790, © 1998, with permission from Elsevier.)

is a descriptive system that contains a series of site-specific measurements of a patient's anterior, apical, and posterior pelvic organ support. This nomenclature has replaced the respective terms cystocele, enterocele, and rectocele, as it is often uncertain which specific structures are contributing to prolapse at each segment. Prolapse is measured in centimeters relative to the hymeneal ring in relation to six defined points (Figure 4.4). Points proximal to the hymen are denoted as negative and points distal, positive. The other landmarks that complete the examination are the genital hiatus, perineal body, and total vaginal length.

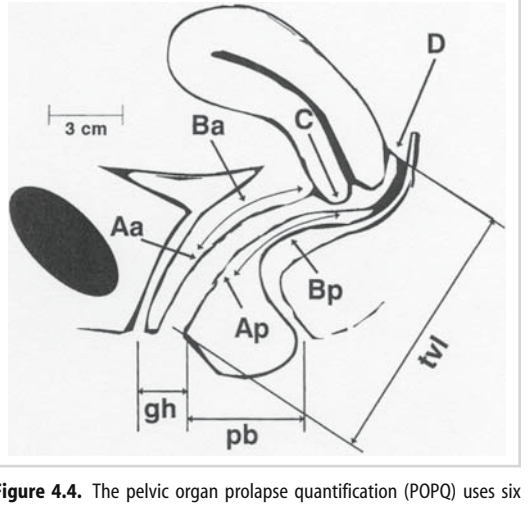


Figure 4.4. The pelvic organ prolapse quantification (POPQ) uses six points (Aa, Ba, C, D, Ap, and Bp) and three other landmarks (gh, pb, tvl). (From Bump et al. (42) © 1996, with permission from Elsevier.)

Anterior Segment

Prolapse of the anterior vagina remains as one of the most challenging problems for the pelvic floor surgeon. It is a common condition, especially in patients with coexisting urinary incontinence. Thiede (43) found 56% of patients with genuine stress incontinence and 39% of patients with detrusor instability had a moderate to severe cystocele.

Depressing a retractor or the bottom blade of a Sims or Graves speculum along the posterior vagina will allow visualization of the anterior vaginal segment. The degree of prolapse is noted during forceful straining or vigorous coughing (Figure 4.5). In the POPQ system, the anterior segment includes two points in reference to the plane of the hymen. Point Aa corresponds to a point 3 cm proximal to the external urethral meatus in the midline of the anterior segment.

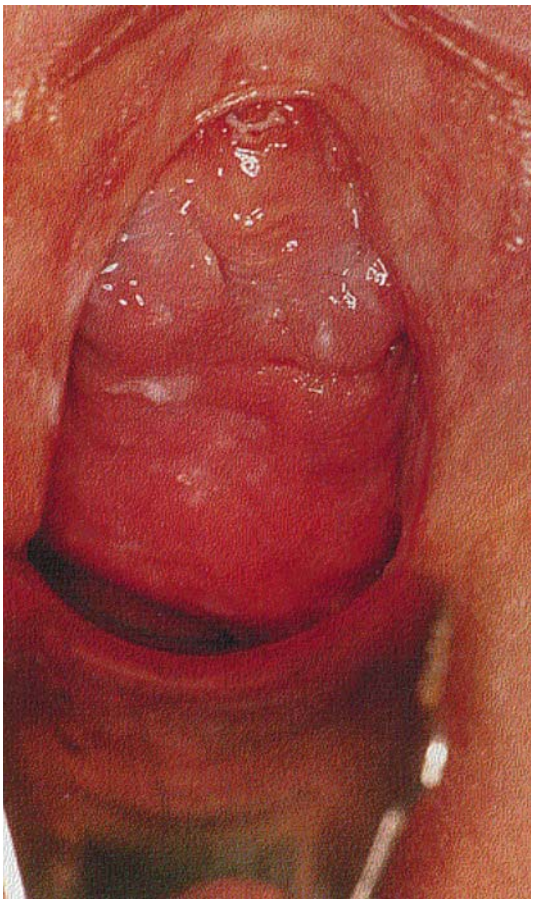


Figure 4.5. The anterior vaginal wall showing the urethrovaginal crease. Note that the vagina over the bladder base shows minimal rugae, which is more consistent with a midline defect. (From Baggish MS, Karram MM. Atlas of Pelvic Anatomy and Gynecologic Surgery. Philadelphia: WB Saunders, 2001:381. © 2001, with permission from Elsevier.)

Possible values range from −3 to +3 cm from the hymeneal ring. Point Ba represents the most distal portion of the anterior vaginal wall. The minimum value is −3 in the absence of any anterior wall prolapse. In the presence of complete vaginal eversion, the maximum value equals the value of C.

Central defects, paravaginal defects, or a combination of the two (Figure 4.6) may be assessed with the help of a ring forceps. A pure central defect is noted as a midline anterior vaginal wall protrusion, often with the absence of vaginal rugae along its surface and with preservation of the lateral sulci. Paravaginal defects can be diagnosed by supporting the vaginal sulci with the forcep rings in contact with the ischial spines to their normal position at the level of the arcus tendineus fascia pelvis. This maneuver restores anterior support in the presence of paravaginal defects without any central defects. Unilateral defects can be diagnosed by elevating each sulcus individually with a closed ring forceps. Pure paravaginal defects are often associated with preservation of the vaginal rugae (Figure 4.7). A combination of central and paravaginal defects may be present when only partial reduction of the anterior vaginal wall prolapse is noted with the above maneuver.

Barber et al (44) studied the accuracy of clinical assessment of paravaginal defects in women with anterior vaginal wall prolapse. They found sensitivities and negative predictive values of clinical examination to predict paravaginal defects to be high (94% and 91% for right-sided defects and 90% and 88% for left-sided defects) but specificities and positive predictive values to be low (54% and 65% for right-sided defects and 50% and 57% for left-sided defects). The accuracy was found to be decreased in those with previous retropubic surgery. A similar, prospective study by Segal et al (45) found the standard clinical exam used to preoperatively detect a paravaginal defect was a poor predictor for the gold standard intraoperative identification of pubocervical detachment from the arcus tendineus fascia pelvis. The presence of ruggae and the stage of anterior vaginal wall prolapse were not useful predictors for paravaginal defects.

Apical Segment

Apical support defects have traditionally referred to uterine prolapse (Figure 4.8), enteroceles (Figure 4.9), and vaginal vault prolapse, although high cystoceles and high rectoceles can exist. A sigmoidocele occurs when a redundant segment of sigmoid colon extends caudally into the cul-de-sac. It is usually not detected on physical examination; proctography or magnetic resonance imaging MRI is usually required to detect it preoperatively.

The examination of apical defects in the lithotomy position can be aided with the use of a Sims or Graves speculum. During a forceful strain or cough, the unsplit speculum is slowly withdrawn to determine if the vaginal vault or uterus descends. The patient can be reexamined in the standing position if assessment in the lithotomy position is inadequate.

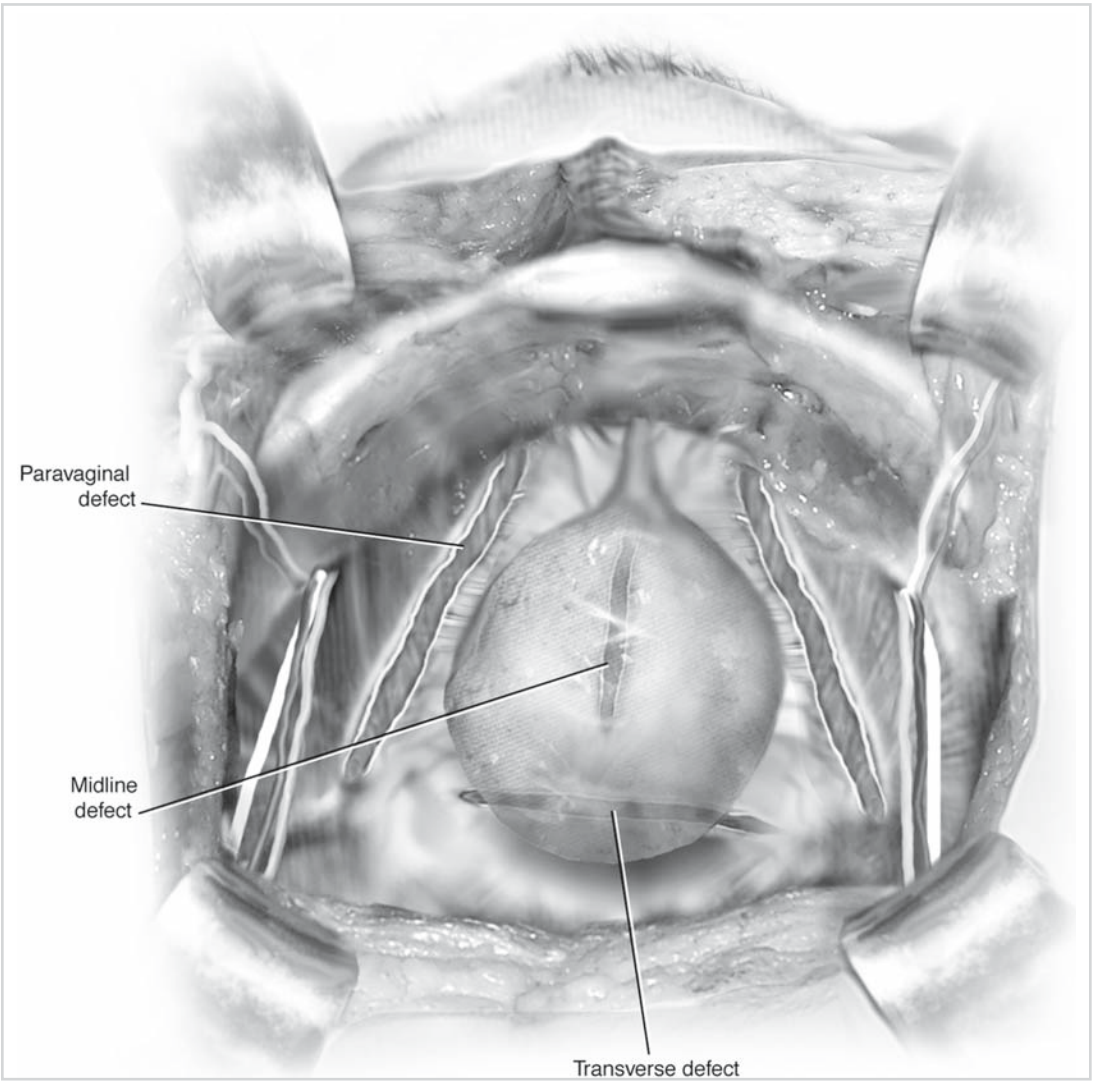


Figure 4.6. Three different defects can result in anterior vaginal wall prolapse. Lateral or paravaginal defects occur when there is a separation of the pubocervical fascia from the arcus tendineus fascia pelvis, midline defects occur secondary to attenuation of fascia supporting the bladder base, and transverse defects occur when the pubocervical fascia separates from the cervix or vaginal cuff. (From Baggish MS, Karram MM. Atlas of Pelvic Anatomy and Gynecologic Surgery. Philadelphia: WB Saunders, 2001:381. © 2001, with permission from Elsevier.)

In the POPQ system, the apical segment is denoted by point C (in hysterectomized women) and points C and D (in the presence of a uterus). Point C corresponds to the most distal portion of the vaginal cuff (after total hysterectomy) or most distal edge of the cervix. Point D is measured only in patients with an intact cervix and corresponds to the location of the posterior fornix. It denotes the level at which the posterior cervix is attached to the uterosacral ligament complex and helps to contrast cervical elongation with true suspensory failure.

Enteroceles usually occur in combination with vaginal vault prolapse and may also be present with a rectocele. It may be difficult to differentiate a small enterocele from a rectocele. However, these defects can often be confirmed by noting a thickening or pulsation of the rectovaginal wall during a rectovaginal examination. The enterocele may also be seen as a distinct apical bulge in relation to the more distal rectocele, which may be divided by a transverse groove. In severe enteroceles, the presence of peristalsis may be noted.

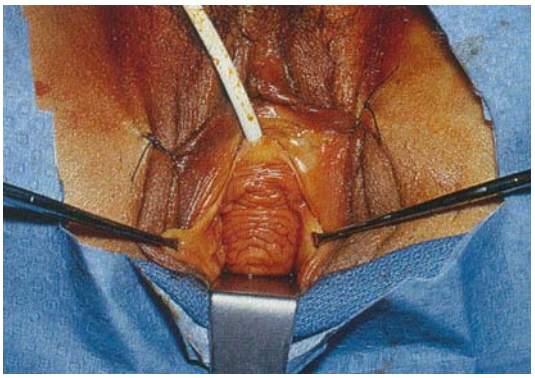


Figure 4.7. The anterior vaginal wall with rugae, which is more consistent with a paravaginal defect. (From Baggish MS, Karram MM. Atlas of Pelvic Anatomy and Gynecologic Surgery. Philadelphia: WB Saunders, 2001:381. © 2001, with permission from Elsevier.)

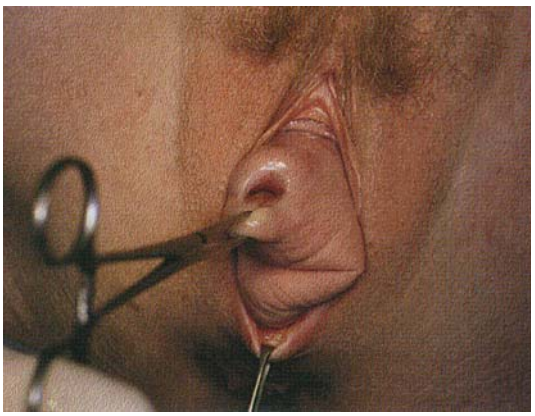


Figure 4.8. Complete uterine prolapse with a large enterocele. (From Baggish MS, Karram MM. Atlas of Pelvic Anatomy and Gynecologic Surgery. Philadelphia: WB Saunders, 2001:402. © 2001, with permission from Elsevier.)

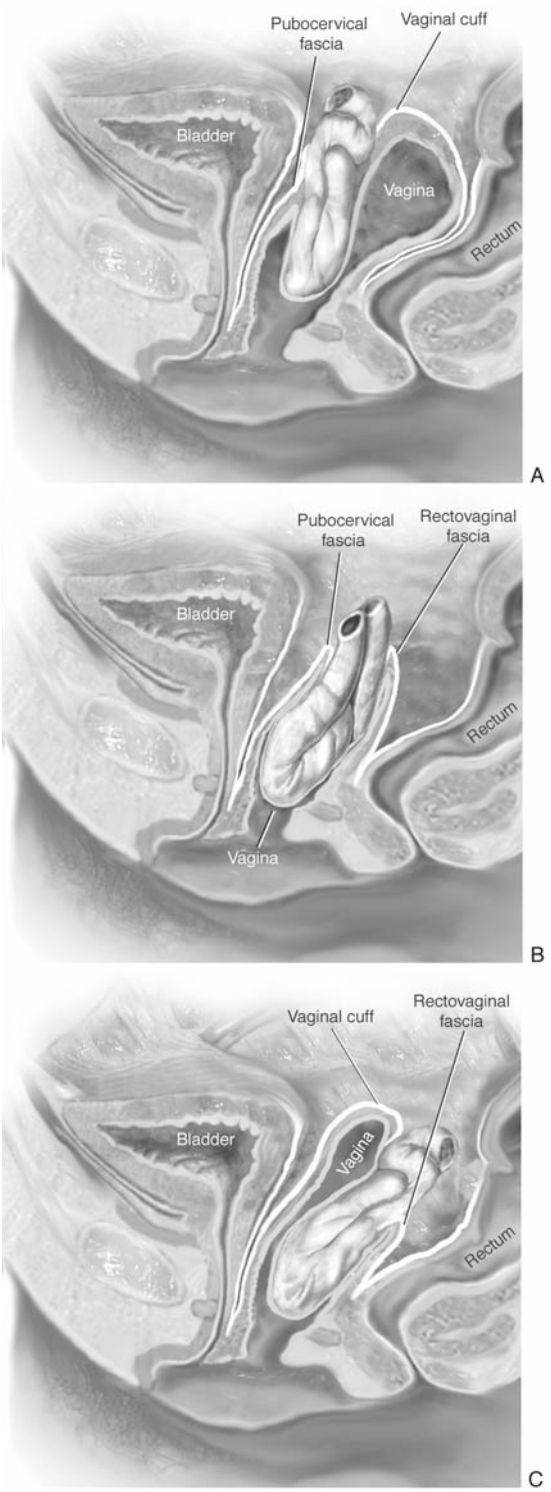


Figure 4.9. Cross section of pelvic floor showing various anatomic locations of enteroceles. A: Anterior enterocele—defect in the pubocervical fascia near its attachment to the vaginal apex. The peritoneal sac with its contents protrudes to the vaginal opening. B: Apical enterocele—defect at the vaginal apex. The peritoneal sac protrudes between the pubocervical fascia anterior and the rectovaginal fascia posterior. C: Posterior enterocele—defect posterior to the vaginal cuff. The peritoneal sac protrudes through the defect in the rectovaginal fascia. (From Baggish MS, Karram MM. Atlas of Pelvic Anatomy and Gynecologic Surgery. Philadelphia: WB Saunders, 2001:398. © 2001, with permission from Elsevier.)

Posterior Segment

Posterior vaginal wall prolapse is common and results from defects in the underlying rectovaginal septum, often as a result of childbirth. Richardson et al (46) proposed that these defects are usually isolated breaks that can be repaired directly in a "site-specific" fashion.

A rectocele is detected by observing the bulge in the posterior vaginal wall during maximum Valsalva maneuver or cough. The use of the split blade of a Sims or Graves speculum to support the anterior segment can aid in visualization. A rectocele can be confirmed with a rectal examination during which anterior displacement of the vaginal wall adjacent to the rectum is noted (Figure 4.10).

In the POPQ system, the posterior segment includes analogous points ascribed to the anterior segment. Point Ba corresponds to a point 3 cm proximal to the hymen in the midline of the posterior segment. Possible values range from –3 to +3 cm from the hymeneal ring. Point Bp represents the most distal portion of the posterior vaginal wall. The minimum value is –3 in the absence of any posterior wall prolapse. In the presence of complete vaginal eversion, the maximum value equals the value of C.

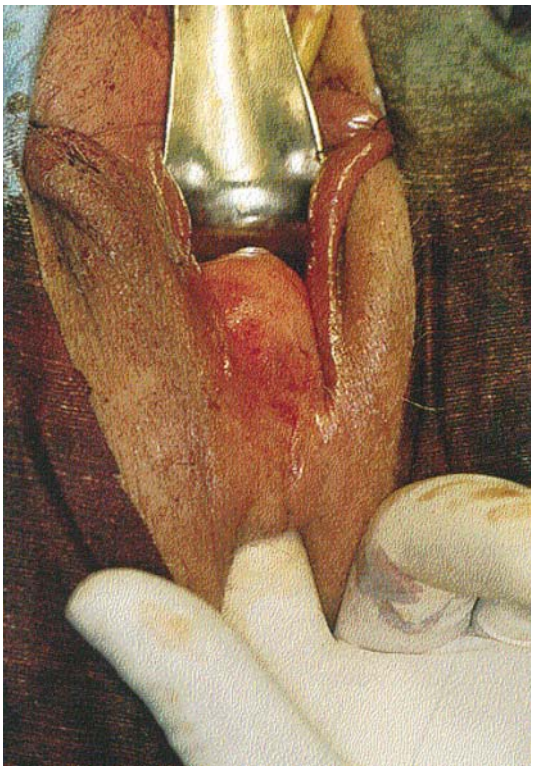


Figure 4.10. A distal rectocele with attenuated perineum. (From Baggish MS, Karram MM. Atlas of Pelvic Anatomy and Gynecologic Surgery, Philadelphia: WB Saunders, 2001:408. © 2001, with permission from Elsevier.)

Richardson et al (46) described site-specific defects in the rectovaginal septum that occur in various locations including the superior, inferior, right, left and midline areas. These defects are often noted at time of surgical intervention (47). One study has suggested that locating defects during clinical evaluation of the posterior vaginal wall is often inaccurate when compared to surgical assessment at the time of a defect-specific repair (48).

Perineum

The structural integrity of the perineal body should be assessed. The perineum may be noted to bulge and widen during maximum Valsalva effort. A lax perineal body may be associated with a large, gaping introitus.

The three final measurements in the POPQ system include the length of the genital hiatus, perineal body, and total vaginal length. The genital hiatus (gh) is measured from the midexternal urethral meatus to the posterior midline hymen, and the perineal body (pb) is measured from the posterior margin of the genital hiatus to the midanal opening. Total vaginal length is the greatest vaginal depth as measured without the patient straining.

Anorectum

Examination of the anal sphincter may demonstrate the "dove-tail" sign in the region of the sphincteric laceration (49). Any scarring should be noted. Uniform circular contraction of the anal sphincter should be demonstrated during maximal pelvic floor contraction. In the rectal examination, the tone of the anal sphincter can be assessed during a maximal contraction. Any suspected defects in the muscle, decrease in contraction strength, and easy fatigability should be noted.

Other Aspects of the POPQ System

The nine POPQ measurements can be conveniently recorded in a grid and line diagram (Figure 4.11). Examples of complete vaginal ever-

sion, predominant anterior vaginal wall prolapse, and predominant posterior vaginal wall prolapse are shown in Figures 4.12 and 4.13.

Pelvic prolapse can be staged according to the extent of the most severely prolapsed segment after a complete quantitative assessment (Figure 4.14). Although the staging system is arbitrary, the International Continence Society (ICS) committee has expressed a need for staging to allow comparisons of patient populations, correlation of symptoms with prolapse severity and follow-up of treatment outcomes.

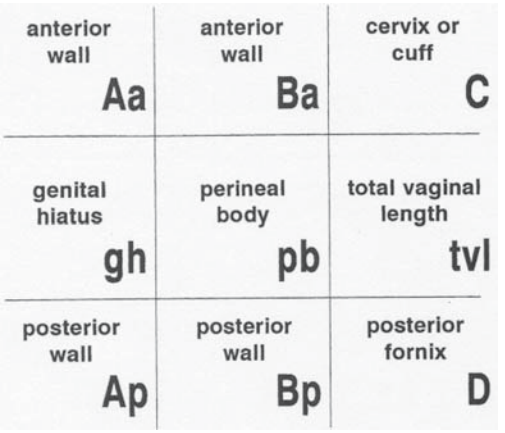


Figure 4.11. Grid-and-line diagram to record POPQ values. (From Bump et al. (42). © 1996, with permission from Elsevier.)

Owing to the unknown effects of the technique variability on POPQ assessment, the approved ICS document has suggested that a full description of the technique must be included. The method of producing maximal prolapse (i.e., Valsalva or cough) and confirmation of its full development should be documented. The latter can be defined by noting the tightness of the vaginal wall at straining, by eliciting no further prolapse with traction on the prolapse, by patient confirmation that the prolapse is at the most severe level experienced at home, and by producing no further prolapse when assessed in various examination positions.

Other examination details that should be fully documented include the type of examination table or chair; the type of vaginal specula, retractors, or tractors; the content of the rectum; patient position; and fullness of the bladder (42).

Previous studies have shown that patient position affects the degree of pelvic organ prolapse noted on examination. Barber et al (50) determined that the degree of prolapse found in the dorsal lithotomy position correlated well with a 45-degree upright assessment in a birthing chair; however, a greater degree of prolapse was noted in the upright examination. In addition, Visco et al (51) noted a greater degree of prolapse in the standing position as compared to the supine lithotomy orientation. Swift and Herring (52) compared POPQ values in the standing and lithotomy positions. They concluded that there was no statistically significant difference between

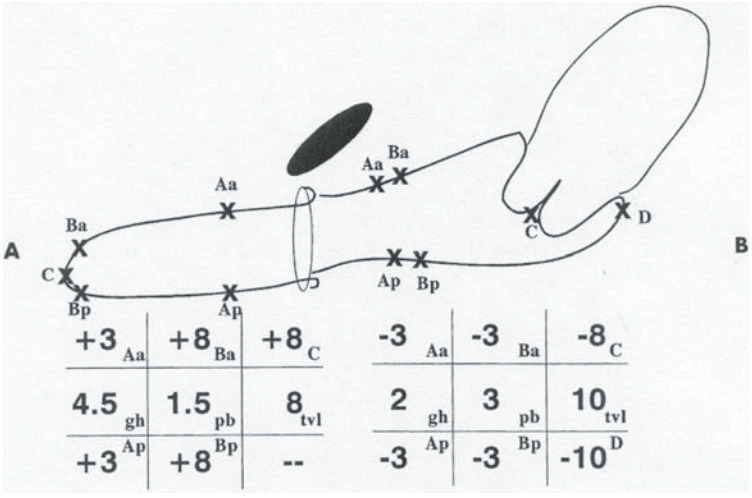


Figure 4.12. Grid-and-line diagram of complete eversion of vagina. (From Bump et al. (42). © 1996, with permission from Elsevier.)

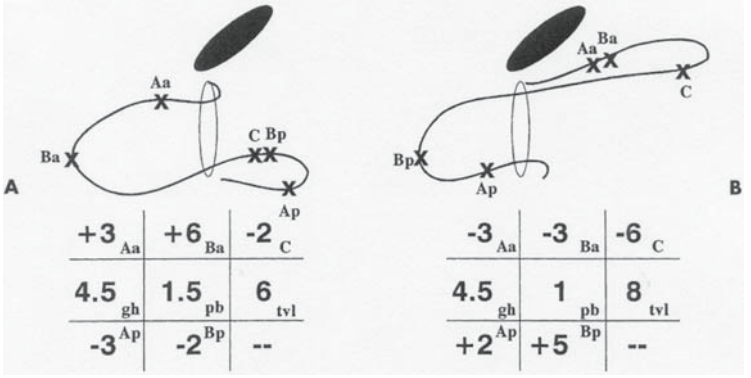


Figure 4.13. Grid-and-line diagram. A: Predominant anterior support defect. B: Predominant posterior support defect. (From Bump et al. (42). © 1996, with permission from Elsevier.)

STAGES OF PELVIC ORGAN PROLAPSE

Stage 0	No prolapse is demonstrated. Points Aa, Ap, Ba, and Bp are all at –3 cm and either point C or D is between –TVL (total vaginal length) cm and –(TVL-2) cm (i.e., the quantitation value for point C or D is ≤–[TVL-2] cm).
Stage I	The criteria for stage 0 are not met, but the most distal portion of the prolapse is >1 cm above the level of the hymen (i.e., its quantitation value is <–1 cm).
Stage II	The most distal portion of the prolapse is ≤1 cm proximal to or distal to the plane of the hymen (i.e., its quantitation value is ≥–1 cm but ≤+1 cm).
Stage III	The most distal portion of the prolapse is >1 cm below the plane of the hymen but protrudes no further than 2 cm less than the total vaginal length in centimeters (i.e., its quantitation value is >+1 cm but <+[TVL-2] cm).
Stage IV	Essentially, complete eversion of the total length of the lower genital tract is demonstrated. The distal portion of the prolapse protrudes to at least (TVL-2) cm (i.e., its quantitation value is ≥+[TVL-2] cm). In most instances, the leading edge of stage IV prolapse is the cervix or vaginal cuff scar.

Figure 4.14. POPQ staging. (From Bump et al. (42). © 1996, with permission from Elsevier.)

the stage or any of the measured POPQ points in the dorsal lithotomy and standing positions. It has been suggested that the standing position does not provide the same degree of pelvic tilt provided by a birthing chair, which allows greater hip flexion and more closely resembles the orientation of the McRoberts maneuver used for shoulder dystocia in labor and delivery.

The effects of bladder fullness and patient positioning on prolapse assessment have recently been studied. When comparing the various examination conditions involving a full or empty bladder in the supine and standing positions, the largest difference was noted in the full/supine vs. empty/standing assessments and were more likely to be upstaged by POPQ stages I or II (53). [Silva 2004].

Other additional techniques used during the POPQ examination that should be fully characterized include the use of a rectovaginal exam to differentiate a traction and pulsion enterocele, Q-tip testing, measurement of the transverse diameter of the genital hiatus, measurement of vaginal volume, examination of rectal prolapse, and endoscopic or imaging procedures. Currently, the effect of anesthesia and unconsciousness on POPQ assessment is unknown.

Two studies have shown good reproducibility of the POPQ measurements (54,55). In a study by Hall et al (54), seven examiners (including two attending faculty members, three urogynecology fellows, and two third-year residents) were randomly paired to perform POPQ examinations on 48 subjects. The examiners were each blinded to the results of the other examination. The study showed that correlations for each of the POPQ measurements were highly significant and staging was highly reproducible.

The POPQ system will likely gain increased acceptance by gynecologists and pelvic floor specialists over time. However, issues regarding its complexity to teach and learn have been raised (56,57). In a study by Steele et al (58) the POPQ system was shown to be effectively taught to Ob-Gyn residents and medical students by means of a public-domain video presentation. Another concern centers around the incompleteness of the POPQ system in fully characterizing pelvic floor findings (56). Various deficiencies of the POPQ system include the lack of grading of lateral wall defects, the lack of grading or assessing urethral mobility, and the lack of measuring cervical length and perineal descent. Scotti et al (56) have proposed a revised New York classification system to address some of these issues and have indicated that it is similar enough to the POPQ system to be easily converted to and integrated with the POPQ reporting system.

Role of Urodynamics

Urodynamic testing may provide objective information regarding the etiology of any lower urinary tract dysfunction that coexists with pelvic organ prolapse. It may be useful in diagnosing occult incontinence in a patient with advanced pelvic organ prolapse. Other potential indications include incomplete emptying with abnormal postvoid residuals, a history of mixed incontinence or failed antiincontinence surgery, and a lack of improvement after trial of empiric therapy. However, there is currently no consensus on whether or not urodynamic studies are routinely indicated prior to surgery for pelvic organ prolapse. A more complete discussion on urodynamic testing is beyond the scope of this chapter.

Role of Imaging

Significant strides in the area of prolapse evaluation have occurred in the last decade, largely as a result of advanced technology in the field of radiology. However, the results of imaging studies are only useful when used in combination with other information, especially history, symptomatology, and physical examination, and should not be used alone to make treatment decisions. Potential uses of radiologic investigation include those situations in which (1) symptomatology and physical findings do not correlate, (2) the pelvic anatomy is unusual or altered owing to previous pelvic surgery or a congenital defect, and (3) the patient is unable to exert maximal straining during pelvic examination.

Dynamic Cystoproctography

The use of contrast media in pelvic fluoroscopy allows the various prolapsed organs to be opacified and seen in real time. Traditionally, it has mainly been used in the study of anorectal dysfunction as evacuation proctography, which is also known as defecography. However, the addition of a cystogram to this modality allows further information to be gained during the assessment (59).

The equipment required includes a thick barium paste, a radiolucent toilet, and video equipment. Images are taken at rest, during straining effort, during evacuation, and postevacuation.

Currently, there are no universally accepted radiologic criteria for defining pelvic organ prolapse (60). However, prolapse is usually radiologically defined in reference to the pubococcygeal line, which is a line extending from the inferior pubic ramus to the sacrococcygeal junction (61). This line is reproducible and includes the attachment sites for the levator muscle.

A cystocele (Figure 4.15) is seen as an extension of the bladder below the pubococcygeal line. Similar information obtained with dynamic cystoproctography is seen in cystourethrography. This includes the presence of funneling (beaking) of the bladder neck suggestive of, but not diagnostic of, an incompetent urethral sphincter (62), and measurement of the urethrovesical angle.

A rectocele is seen radiologically as an anterior rectal bulge (Figure 4.16) (63–66). It is usually measured as the depth in relation to a line extended upward through the anterior anal wall. The cutoff value has not been universally agreed upon, but some authors consider a depth of greater than 3 cm to be abnormal (as many asymptomatic women will be found to have a small rectocele 2 cm or less in depth) (67,68). Proctography will also note the finding of postevacuation barium trapping, which may help to explain any evacuation dysfunction (69). During testing, patients can be taught how to apply manual pressure in the vagina to obtain relief from the symptoms associated with incomplete

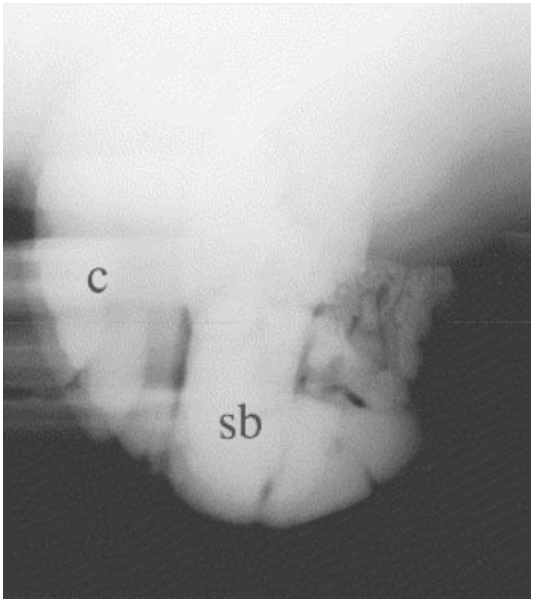


Figure 4.15. Cystocele and enterocele as seen on dynamic cystoproctography. A cystocele (c) is noted to be low lying in the pelvis. An enterocele (sb) is also seen on the right. (From Kelvin FM, Maglinte DDT. Dynamic evaluation of female pelvic organ prolapse by extended proctography. Radiol Clin North Am 2003;41(2):395–407. © 2003, with permission from Elsevier.)

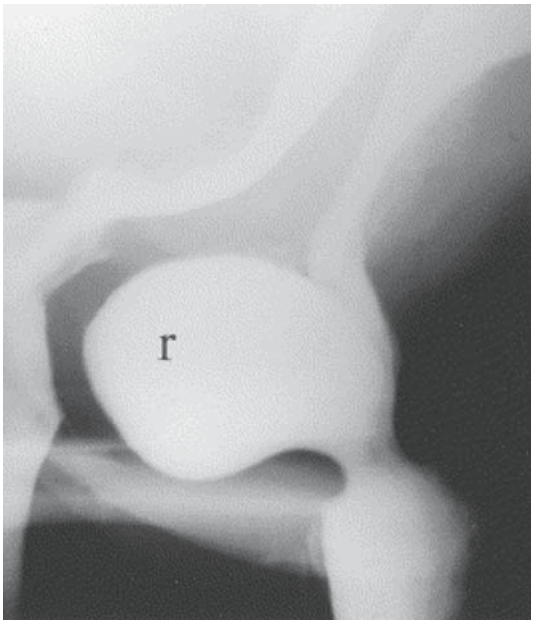


Figure 4.16. A rectocele (r) with the classic "hockey puck" appearance is shown to be trapping radiocontrast media after the evacuation phase. (From Kelvin FM, Maglinte DDT. Dynamic evaluation of female pelvic organ prolapse by extended proctography. Radiol Clin North Am 2003;41(2):395–407. © 2003, with permission from Elsevier.)

emptying. Proctography may suggest the diagnosis of anismus, which may be the main contributor to a patient's bowel dysfunction rather than a rectocele (70). This has important implications because anismus is treated with biofeedback therapy rather than with surgery.

An enterocele is noted as a herniation of the small bowel into the cul-de-sac and into the vagina, the rectovaginal space, or both. The vagina and small bowel in the pelvis need to be opacified to obtain this diagnosis. They are most evident after evacuation, as a full rectum may obscure its visualization (Figure 4.17). Sigmoidoceles are noted in approximately 5% of proctograms (Figure 4.18) (71). However, there still

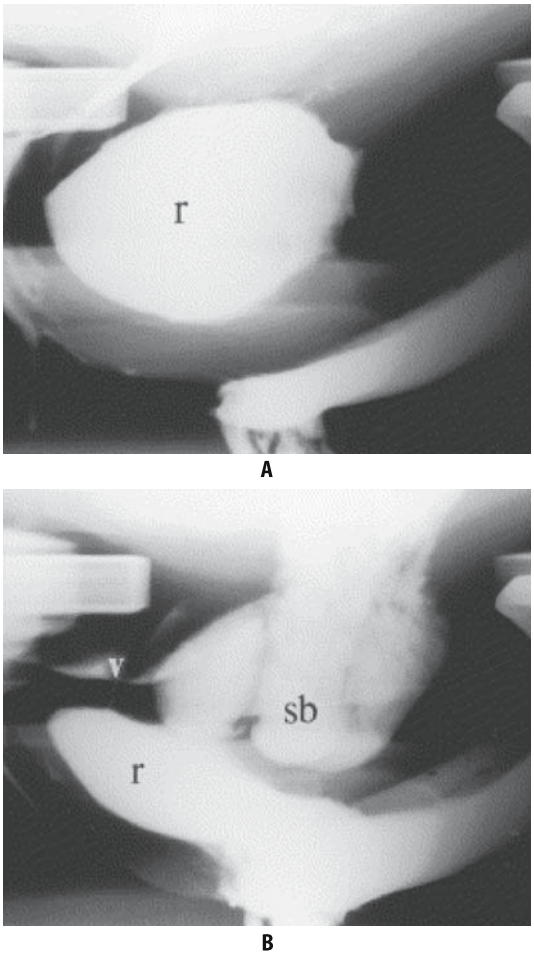


Figure 4.17. A: A full rectum (r) is partially obscuring complete visualization of the enterocele. B: The enterocele (sb) is then noted to push contrast out of the rectocele, resulting in a better view of the enterocele. (From Kelvin FM, Maglinte DDT. Dynamic evaluation of female pelvic organ prolapse by extended proctography. Radiol Clin North Am 2003;41(2):395–407. © 2003, with permission from Elsevier.)

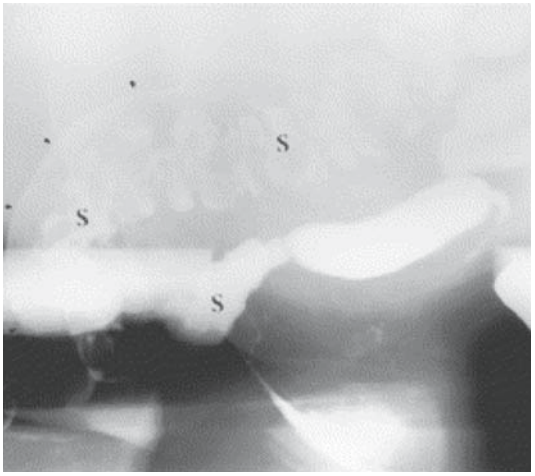


Figure 4.18. This sigmoidocele (S) is only evident preoperatively on dynamic cystoproctography and cannot be diagnosed solely on physical examination. (From Kelvin FM, Maglinte DDT. Dynamic evaluation of female pelvic organ prolapse by extended proctography. Radiol Clin North Am 2003;41(2):395–407. © 2003, with permission from Elsevier.)

may be false negatives with proctography owing to insufficient filling of contrast media into the sigmoid. This finding is important in that a patient may require sigmoid resection or sigmoidopexy as treatment. Vaginal vault prolapse can also be assessed on postevacuation studies.

Compared with physical examination, evacuation cystoproctograpy will detect many enteroceles and sigmoidoceles not seen on pelvic exam (63). Studies have shown that enteroceles are only identified approximately 50% of the time on physical examination, which is less than the rates of identifying rectoceles and cystoceles (64,71,72). This has been attributed to the failure of the patient to strain maximally during a pelvic exam, an impediment that is removed during the evacuation phase of cystoproctography. One study by Altringer et al (64) found that patient diagnosis was changed in 75% of cases after dynamic cystoproctography. Another benefit is that fluoroscopy will identify the specific organs involved in the prolapse. However, it is difficult to correlate the degree of prolapse seen on imaging with that seen on physical examination as each has two separate reference points, the pubococcygeal line and hymen, respectively (73).

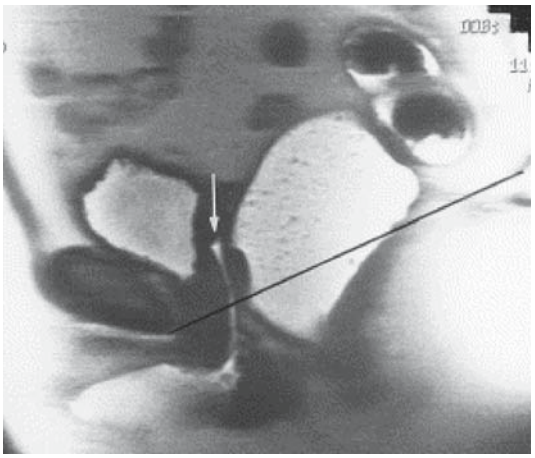
MRI

Magnetic resonance imaging was first introduced as a diagnostic modality for pelvic organ prolapse by Yang et al (61). It has many advantages over dynamic cystoproctography: (1) it is able to contrast soft tissue structures well; (2) it provides images in numerous different planes; (3) it can examine subtle pelvic floor changes, such as superior rectovaginal defects, paravaginal defects, and uterine defects; (4) it can assess pelvic floor musculature; (4) bony landmarks are easier to identify; (5) no catheterization is necessary; and (6) the patient is not exposed to ionizing radiation. The main limitation is the supine position usually employed by this modality.

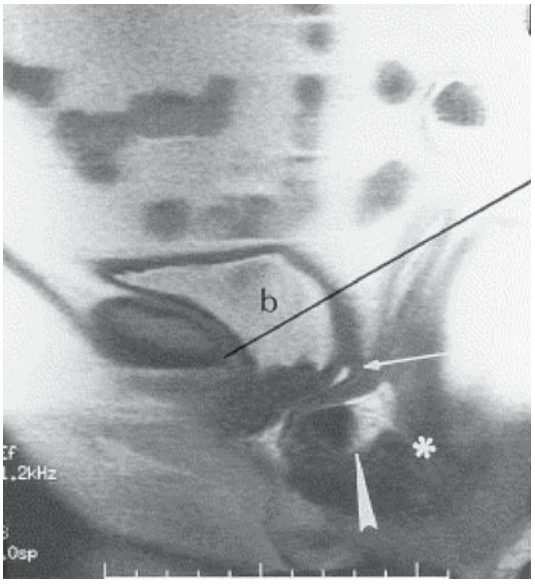
As with dynamic proctocystography, the pubococcygeal line is used as the reference point radiographically (Figure 4.19). Pelvic organ prolapse is seen as an extension of the pelvic organ below the pubococcygeal line, and can be measured in the same way as with dynamic proctocystography. It also shares some of the same advantages, including identifying prolapse not noted on physical exam. One study showed that the surgical plan was altered in 41% of cases after MRI and fluoroscopy were employed (74). Tunn et al (75) found that rectoceles and enteroceles were easily identifiable with MRI in patients with posthysterectomy vault prolapse.

There is evidence that MRI is equivalent or superior to proctocystography if evacuation studies are performed during the MRI study, also allowing for an upright assessment to occur (73,76). MRI defecography also allows the diagnosis of anismus and intussusception. In addition, paravaginal defects can be detected on MRI as a loss of the typical H shape of the vagina owing to deficiencies in the lateral supports (Figure 4.20); however this finding may also be noted in normal women (77–80). Another advantage is that the cervix and vaginal vault are often easier to see on MRI than with fluoroscopy due to leakage of vaginal contrast in the latter (Figure 4.21). Fluoroscopy may not detect enteroceles in 20% of cases in which small portions of peritoneal fat enter the rectovaginal space (76). However, owing to greater soft tissue contrast with MRI, the various tissue components can be seen with relative clarity.

Disadvantages of MRI include (1) limited access to a vertical configuration magnet, (2) increased relative cost to fluoroscopy, (3) less physiological modality than fluoroscopy if performed supine and without evacuation studies, and (4) lack of available MRI time due to demands from other specialties.

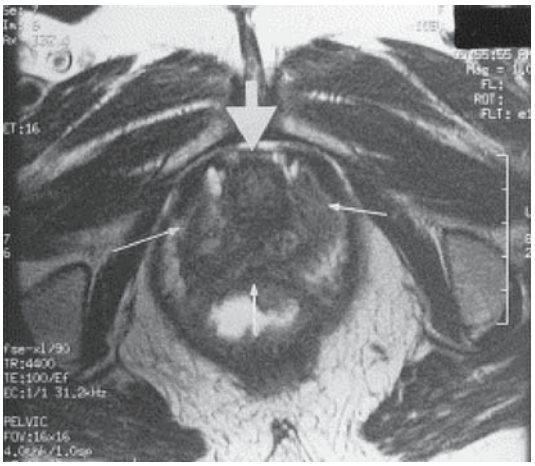


A



B

Figure 4.19. A: The pubococcygeal line (arrow) used as a reference point radiographically is drawn from the inferior pubic symphysis to the sacrococcygeal junction. B: Compared to the normal exam in A, this image shows prolapse of the bladder (b) and vaginal vault (long arrow) below the pubococcygeal line, compatible with a cystocele and vaginal vault prolapse. A rectocele is also seen as an anterior bulge (arrowhead) in relation to the anal canal (asterisk). (From Pannu HK. Dynamic MR imaging of female organ prolapse. Radiol Clin North Am 2003;41(2):409–423. © 2003, with permission from Elsevier.)



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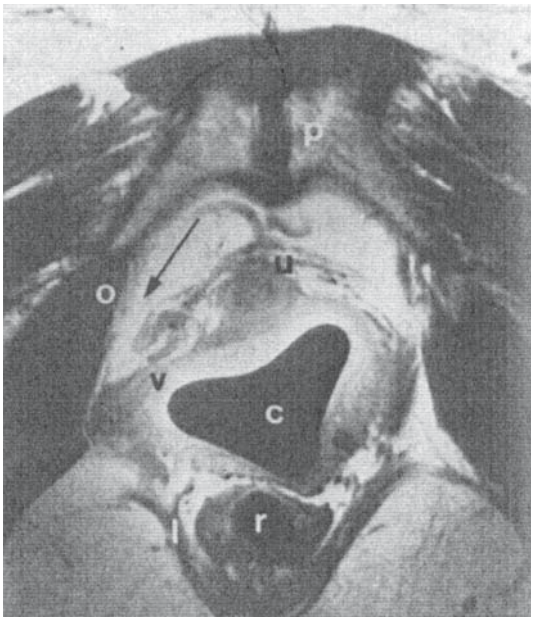
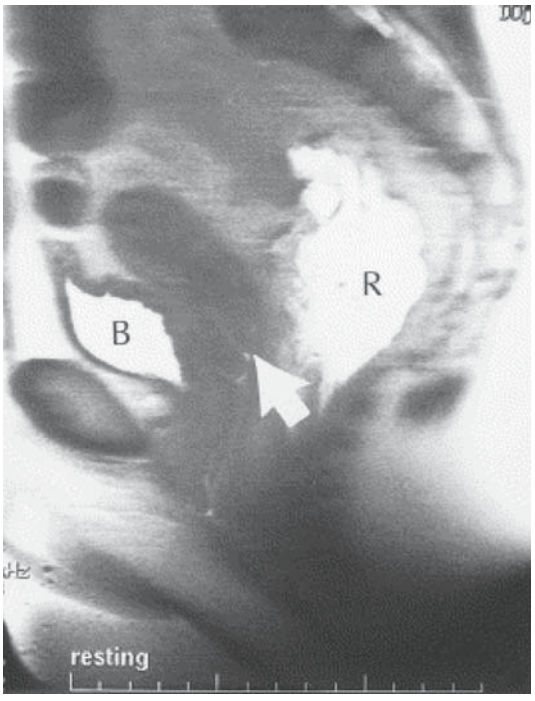


B

Figure 4.20. A: Typical H configuration of the vagina (long arrows) is seen in this MRI image. B: A paravaginal detachment (arrow). (From Pannu HK. Dynamic MR imaging of female organ prolapse. Radiol Clin North Am 2003;41(2):409–423. © 2003, with permission from Elsevier.)



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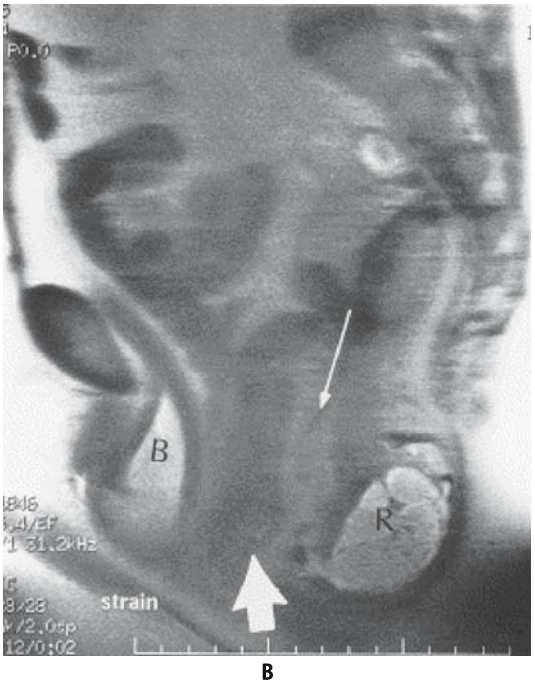

B

Figure 4.21. Cystocele, cervical prolapse with enterocele, and perineal descent. A: Normal resting image. B: Compared to A, this study was performed during defecation and shows a cystocele (B), a prolapsed cervix (long arrow), a widened rectovaginal space (thick arrow), and a low-lying rectum (R). (From Pannu HK. Dynamic MR imaging of female organ prolapse. Radiol Clin North Am 2003;41(2):409–423. © 2003, with permission from Elsevier.)

Other Modalities

Transperineal ultrasound has been described to assess dynamic function of the pelvic floor (81). Dynamic anorectal endosonography has also been described and may detect the presence of enteroceles (82). The role of these alternate modalities has not been fully elucidated and needs further study.

Conclusion

A thorough pelvic assessment is necessary prior to any planning regarding surgical or nonsurgical intervention for pelvic organ prolapse. Patient history will direct the physician to look for appropriate findings on physical examination. The Pelvic Organ Prolapse Quantification system is gaining wider acceptance with physicians involved in the care of women with pelvic floor disorders as it has been shown to be valid and reproducible, and it facilitates effective communication of treatment outcomes among clinicians and researchers. Several studies have shown that physical examination may not be accurate in diagnosing certain pelvic floor defects such as paravaginal defects whose clinical relevance has yet to be fully elucidated. The use of pelvic floor imaging may complement the clinical assessment of the pelvic floor, but its use needs to be further studied and defined prior to advocating its routine use. Ultimately the goal of the evaluation is to fully appreciate the extent of the prolapse and to relate that to any visceral or sexual dysfunction that may coexist.

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5

Fecal Incontinence

Sharon G. Gregorcyk

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Fecal continence is a complex function with multiple factors contributing to normal continence: anatomic integrity, function, innervation, compliance, capacity, sensation, and stool characteristics. The evaluation of fecal incontinence can also be complex, with a variety of investigations aimed at the different components of continence. A thorough evaluation is necessary to identify the type of incontinence and its etiology so that the correct treatment can be selected.

History

A directed history and physical examination are essential in evaluating a patient with fecal incontinence and help guide the selection of studies to be performed. As this is a sensitive topic, very pointed questions must be asked, as the patient may not volunteer specifics. The history starts with defining the patient's incontinence and its severity. The physician must determine if the patient's incontinence is to gas, liquid, and/or solid stool, and the volume of stool lost. The patient who has minor seepage and otherwise full control over her stool is approached differently than the patient with complete incontinence. While recording the number of episodes of incontinence will assist with determining the severity of the patient's incontinence, one must keep in mind that some patients adapt their entire life to being near a bathroom so that they may avoid an episode of incontinence. Other changes in lifestyle may include the use of pads and carrying a change of underwear. Factors such as these must be taken into account.

A variety of scoring systems exist and are aimed at objectively quantifying a patient's incontinence. Most scoring systems include the type of incontinence (solid, liquid, gas), frequency of episodes, lifestyle alteration, and use of pads. Table 5.1 demonstrates a common scoring system utilized. All of the scoring systems have limitations. Adding a quality of life assessment questionnaire improves upon these limitations as it takes more into account the effect the patient's incontinence has on her daily life (see appendix). Since these two tools do not change one's management of the patient, they are not routinely used by all physicians. However, these tools bring an objectivity to the evaluation, which is important in comparing results of procedures in the literature.

The patient should be questioned about urgency or any change in her bowel habits, which

Table 5.1. Incontinence scoring system (30)

Type of incontinence	Never	Rarely	Sometimes	Usually	Always
Solid	0	1	2	3	4
Liquid	0	1	2	3	4
Gas	0	1	2	3	4
Pad usage	0	1	2	3	4
Lifestyle alteration	0	1	2	3	4

The score may range from 0 (perfect continence) to 20 (complete incontinence).
Rarely, less than once per month; *sometimes*, less than once per week, once or more per month; *usually*, less than once per day, once or more per week; *always*, once per day or more.

might indicate a problem such as a colitis or irritable bowel syndrome. Even with an intact functioning sphincter mechanism, continence may be difficult when a large watery stool is presented with extreme urgency. Dietary and medication history should be recorded as well as any past medical history. Some systemic disorders such as diabetes, alcoholism, and connective tissue diseases can predispose a woman to incontinence with or without mitigating factors. An obstetric history is very important. The number of vaginal deliveries, episiotomies, obstetric tears, and use of forceps with delivery have all been associated with fecal incontinence. A history of pelvic or anal surgery should be documented as well. The patient should also be asked if she has urinary incontinence, as a significant number of patients are afflicted with this problem as well.

Physical Examination

Although a complete physical examination should be performed, the emphasis is placed on the perineum and digital rectal examination. For the experienced surgeon, the history and physical exam alone may be all that is necessary to develop a therapeutic plan in some patients. Inspection of the perineum is first performed. Important findings to note include a patulous anus, loss of perineal body, scarring (Figure 5.1), perineal soiling, muscular defect, dermatitis, or a mucosa ectropion. Asking the patient to bear down might help the physician identify a prolapsing hemorrhoid or complete rectal prolapse. Straining also is necessary in order to evaluate the presence of perineal descent, an enterocele, or a cystocele.

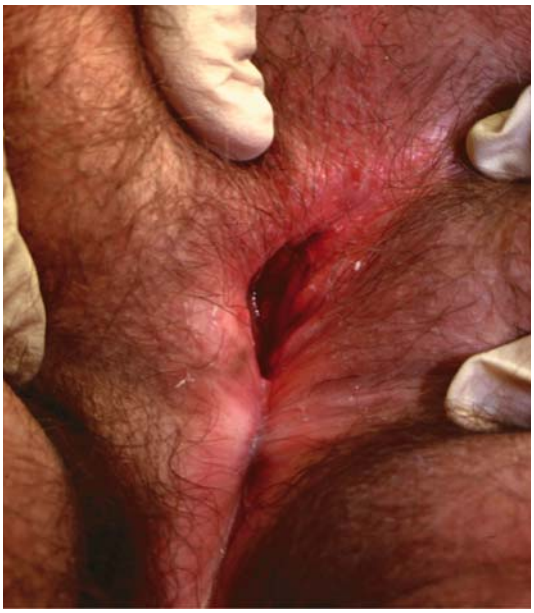


Figure 5.1. Gapping anus and scarred perineum on physical exam.

Sensation can be assessed by touch or with a Q-Tip, and the presence or absence of the anocutaneous reflex, also known as an anal wink, should be noted. This reflex is a transient contraction of the external sphincter in response to the stimulation of the perianal skin and suggests an intact innervation via the pudendal nerve. The digital rectal examination should start within the anal canal where one can assess both the resting tone and the patient's squeeze. A more aggressive digital examination proximally can then be performed to rule out a mass within the rectum or a fecal impaction. Inserting a finger into the vagina during the rectal examination is helpful in evaluating the rectovaginal septum, as well as the anterior sphincter. In the office, a proctosigmoidoscopy can be performed to evaluate for inflammatory or neoplastic conditions.

Special Physiologic Testing

Once the history and physical examination have been completed, the physician may have sufficient information to plan treatment. In 11% to 51% of cases (1), the history and physical exam alone are adequate for the evaluation of fecal incontinence. An example is the patient with incontinence who has suffered an obstetric injury and who upon examination has good

tone and squeeze pressures with a palpable anterior defect. This patient can be directly counseled with regard to a surgical repair versus attempts at biofeedback. Although further physiologic testing for this patient may be of benefit for objective documentation, it is not necessary to plan the patient's treatment. Other patients are not so easily diagnosed and further information is necessary. A variety of investigative tools exist to evaluate fecal incontinence, with no one testing modality providing all the information needed with regard to all of the components of continence.

Anal Manometry

Anal manometry is typically performed by placing a four- or eight-channel catheter with radial ports into the anal canal and measuring the pressures at rest and with the patient squeezing. The rectal-anal inhibitory reflex (RAIR), rectal sensation, compliance, and capacity are also measured. Normal values are listed in Table 5.2.

Although digital examination assesses the resting and squeeze pressures, anal manometry is a reliable and reproducible way to quantify the pressures (2–5). This information can be useful for documentation purposes and may be used for comparison after treatment. For the patient with an isolated external sphincter injury, one would expect a normal resting tone with decreased squeeze pressure, whereas a patient with an isolated internal sphincter injury such as from a sphincterotomy would have a decreased resting pressure and normal squeeze. A decreased resting pressure and squeeze pressure (Figure 5.2) may be seen in a combined sphincter injury or with a neurogenic etiology.

The RAIR is the relaxation of the proximal internal anal sphincter in response to rectal distention such as when a substance is presented to the rectum. This reflex allows for sampling of the substance to discern if it is gas, liquid, or solid. The RAIR is measured by inflating a balloon into the rectum with 10 cc or more of air and observing for a decrease in the pressure to 15% below the baseline. The RAIR is absent in Hirschsprung's and Chagas' disease and is commonly absent with rectal prolapse.

Rectal sensation can be measured at the time of manometry or separately, as it simply involves inflating a balloon placed in the rectum. Resection of the rectum, inflammation, or radiation proctitis may result in a lower compliance with less volume required to cause a rise in the rectal pressure. As the pressure rises above that of the sphincters, incontinence may result. Compliance is calculated by taking the difference in pressure between the initial rectal sensation and rectal fullness and dividing that into the volume of fluid necessary to achieve that difference (2).

Although the measurements from anal manometry can be helpful, they do not by themselves determine the etiology of a patient's incontinence. The measurements do not even indicate if a patient is incontinent or to what degree. A patient can have abnormal values and be continent or normal values and be incontinent. In a study by McHugh and Diamant (6), almost 40% of patients with fecal incontinence had normal resting and squeeze pressures on anal manometry. Thus, it is important to balance the results from anal manometry with the history and physical exam.

Table 5.2. Normal parameters for anal manometry

Parameters	Normal
Resting pressure	40–70 mmHg
Squeeze pressure	100–180 mmHg
Rectal-anal inhibitory reflex	Present
Sensory threshold	10–30 cc
Rectal capacity	100–250 cc
Rectal compliance	3–15 ccH_2O/mmHg

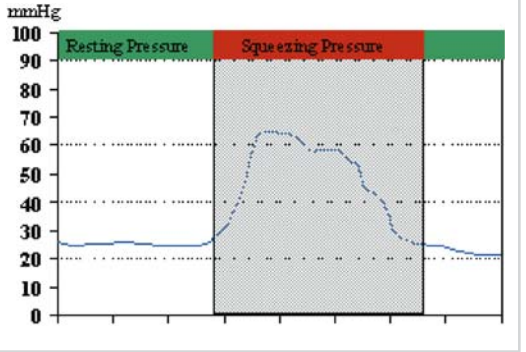


Figure 5.2. Anal manometry with low resting and squeeze pressures.

Electromyography

Anal sphincter electromyography (EMG) records the electrical activity of the striated

muscles of the anorectum (7). This electrical activity may be recorded with surface electrodes, concentric needle electrodes, or single-fiber needle electrodes. Measurements from the EMG provides information about the innervation and functional state of the motor units within a muscle. Pudendal nerve terminal motor latency (PNTML) is a type of surface EMG that is addressed separately in the next section. Besides PNTML, surface EMG is utilized with biofeedback therapy. It is a simple, well-tolerated method of EMG but it is imprecise and limited in value.

Concentric needle EMG and single-fiber needle EMG are much more precise than surface EMG. In general, the measurements from needle EMG can delineate muscle that has undergone denervation and reinnervation. Thus it can be used to map injuries to the muscle as well as evaluate for neurogenic conditions. The single-fiber needle EMG is the most accurate and measures action potentials from individual muscle fibers from which the fiber density is calculated. Fiber density is a sensitive way to detect and quantitate rearrangement of the muscle fiber in the motor unit. Needle EMG has significant drawbacks including the expense of the equipment, pain associated with inserting the needles (8), and the difficulty of doing the exam itself, which is quite time-consuming. The utility of needle EMG with fecal incontinence is controversial, and its routine use is not advocated owing to poor patient compliance and limited additional value provided.

Pudendal Nerve Terminal Motor Latency

The pudendal nerve innervates the external anal sphincter and puborectalis. Injury to this nerve is one of the possible etiologies of incontinence. Pudendal nerve terminal motor latency (PNTML) is the measurement of the nerve conduction velocity in the terminal part of the pudendal nerve (9). The device for measuring the PNTML consists of a stimulating electrode that is positioned at the tip of the index finger and a recording electrode located at the base of the finger (Figure 5.3). The pudendal nerve is stimulated at Alcock's canal, resulting in contraction of the sphincter muscles. The technique requires extensive practice and may not be possible in the obese or muscular patient owing to anatomic factors. The time from the stimulation to movement of the muscle is measured. A normal PNTML value is 2.0 ± 0.2 ms. Prolonged PNTML may be seen in patients with neurogenic fecal incontinence, perineal descent, and rectal prolapse. Of note, PNTML also increases with age.

Pudendal nerve terminal motor latency is primarily used in fecal incontinence to predict outcomes of surgical therapy. Its use, however, in predicting outcomes is controversial, with some studies supporting poorer outcomes in patients with prolonged latency and other studies showing no difference (Table 5.3). Even patients with bilateral pudendal neuropathy may benefit from surgical repair, with Nikiteas et al (10) demonstrating a 60% success rate for overlapping sphincteroplasty in patients with bilateral prolonged PNTML. Patient selection is important, as a success rate that high would not be expected in the patient with a gapping anus and minimal muscle movement. As with all the testing modalities, PNTML, when used, should

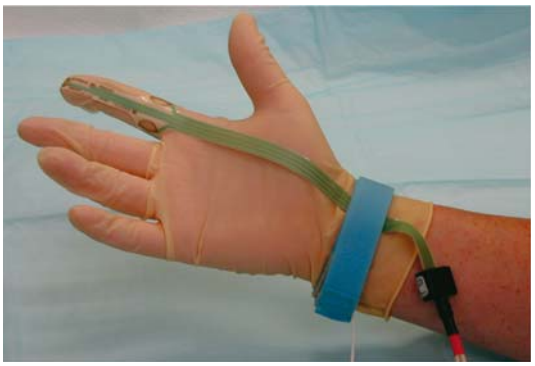


Figure 5.3. Pudendal nerve stimulating device.

Table 5.3. Results of sphincteroplasty based on pudendal nerve function

First author	Year	*n*	Patients without neuropathy (% success)	Patients with neuropathy (% success)	*p* value
Londono-Schimmer (31)	1994	94	55	30	<.001
Sitzler (32)	1996	31	67	70	NS
Gilliland (33)	1997	100	63	10	<.01
Young (34)	1998	56	90	78	NS
Karoui (35)	2000	28	32	56	NS

NS, nonsignificant.

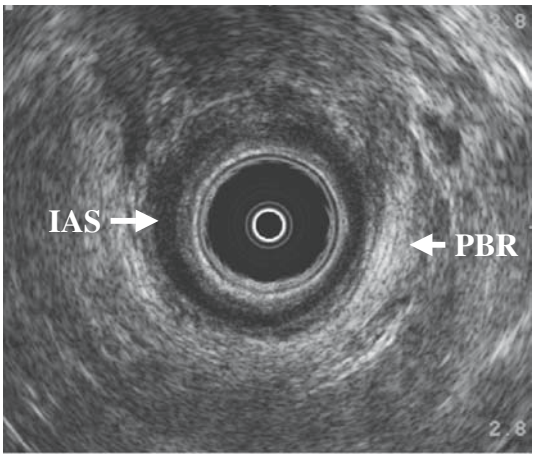
be only one piece of the puzzle and not a sole deciding factor.

Endoanal Ultrasound

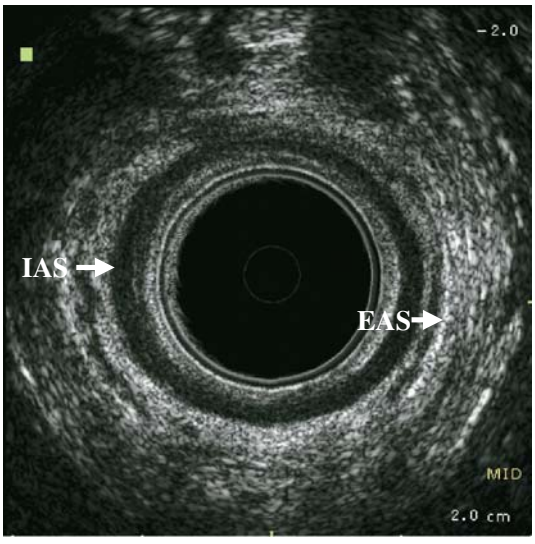
Endoanal ultrasound provides direct imaging of the internal and external anal sphincters as well as the puborectalis. A radial probe with a high-frequency transducer such as a 10-mHz device is used to obtain 360-degree images of the anal canal. Endoanal ultrasound is very accurate at assessing the structural integrity of the sphincters (11–13). Defects, scarring, thinning of sphincters, and other local pathology can be visualized. The procedure is very well tolerated and is more accurate than EMG or anal manometry (8,14,15). In fact, Sultan et al (16) compared the accuracy of detecting anal sphincter defects using clinical exam, anal manometry, EMG, and endoanal ultrasound. The results were 50%, 75%, 75%, and 100%, respectively. The accuracy, however, does depend on the experience of the sonographer.

One must have intimate knowledge of the anatomy to accurately interpret the ultrasound. The external sphincter has mixed echogenicity and extends further distally than the hypoechoic band of internal sphincter. Proximally, one sees the horseshoe-shaped puborectalis (Figure 5.4A), which can be mistaken for an anterior sphincter defect. As the probe is withdrawn into the mid-anal canal, both the internal and external sphincters are best visualized and should be intact rings (Figure 5.4B). By inserting a finger into the vagina, the distance between the probe and finger is measured, with a normal value being 1.0 to 1.5 cm. A thinner muscle implies a defect or scar. Defects in the external sphincter muscle are seen as an interruption in the parallel mixed echogenic layer (Figure 5.5). The intervening scar tissue appears as an amorphous texture usually with low reflectiveness.

Endoanal ultrasound is safe, inexpensive, and well tolerated. These factors combined with its accuracy make it the procedure of choice in defining the anatomy of the internal and external anal sphincters. Although a sphincter defect may be present, it does not necessarily mean that the patient is incontinent, or if the patient is incontinent, it does not necessarily mean that the defect is the principal cause of the patient's incontinence. Karoui et al (17) demonstrated sphincter defects in 335 incontinent patients and in 43% of 115 continent patients. Hence, clinical correlation is essential.



A



B

Figure 5.4. A: Normal upper anal canal. Top of picture is anterior and shows the open horseshoe shape that can be misdiagnosed as a defect. IAS, internal anal sphincter; PBR, puborectalis muscle. **B:** Normal anal sphincters at mid-anal canal on endoanal ultrasound. IAS, internal anal sphincter; EAS, external anal sphincter.

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) with an endoanal coil is a radiographic technique that can be used to image the sphincter muscles. The external sphincter muscle and pelvic floor muscles are well demonstrated on MRI. Even

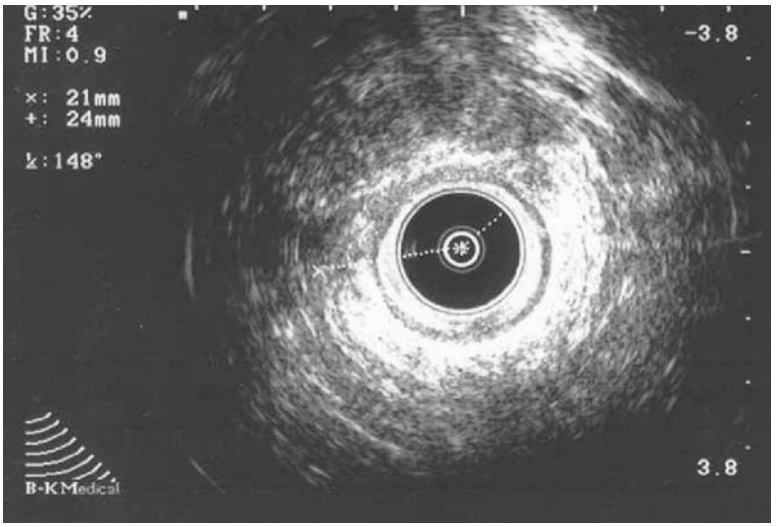


Figure 5.5. Anterior sphincter defect (top of picture and marked with dotted lines) demonstrated on endoanal ultrasound.

external sphincter muscle atrophy can be detected with MRI, whereas this is difficult to do on endoanal ultrasound (18,19). The ability of MRI to detect fat gives it this advantage. As the external sphincter atrophies, the striated muscle is replaced with fat. Magnetic resonance imaging is less effective in evaluating the internal sphincter. Endoanal ultrasound provides superior imaging of the internal anal sphincter with regard to defects and atrophy (20).

Multiple studies have compared endoanal MRI to endoanal ultrasound, with some finding that MRI is superior (21), others finding that ultrasound is superior (22), and still others finding that the two techniques are equivalent (23). All the studies, however, agree that endoanal ultrasound is less expensive, more widely available, and faster than MRI. Thus endoanal ultrasound should be the initial imaging modality for fecal incontinence, reserving MRI for cases where one might need to assess for atrophy of the external sphincter or weakness of the pelvic floor.

Cinedefecography

Cinedefecography is a radiographic procedure that images the dynamics of defecation (24–28). The patient's rectum is filled with a barium mixture that has the consistency of stool. The vagina and small bowel are opacified as well. With the patient on a radiolucent commode, a fluoroscopic videotape is made capturing the patient during rest, squeeze, push, evacuation, and postevacuation. This exam is able to demonstrate rectoceles, perineal descent, spastic pelvic floor, intussusception, rectal prolapse, enteroceles, and leakage of contrast. Most of these findings, however, are more beneficial in evaluating the patient with constipation suspected of having obstructed defecation (28). Overall cinedefecography is of limited value in studying the patient with fecal incontinence and thus is not routinely used (29).

Conclusion

The evaluation of fecal incontinence is a complex process and should be tailored to the individual patient. The history and physical exam alone may be adequate in some patients, but many patients require more extensive investigation. Some institutions use all the investigations at their disposal for every patient, but the utility of that approach is mainly for purposes of documentation and publication. Still anorectal physiological testing and endoanal ultrasound are valuable tools that can help in guiding one's management of a patient with fecal incontinence. In addition to being used in the patient's initial evaluation, these tests may also be used in monitoring the patient's progress and determining in an objective manner what has been altered in the course of treatment. The decision of which tests to utilize and when is based on the physician's clinical

evaluation and judgment. One must remember that these tests are only tools, and correlation to the patient's history and physical exam is always necessary.

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Appendix: Fecal Incontinence Quality of Life Scale (36)

Q1: In general, would you say your health is:

1 Excellent
2 Very Good
3 Good
4 Fair
5 Poor

Q2: For each of the items, please indicate how much of the time the issue is a concern for you *due to accidental bowel leakage*. (If it is a concern for you for reasons other than accidental bowel leakage, then check the box "Not Apply.")

	Most of the time	Some of the time	A little of the time	None of the time	Not apply
Q2. Due to accidental bowel leakage:					
a. I am afraid to go out.					
b. I avoid visiting friends.					
c. I avoid staying overnight away from home.					
d. It is difficult for me to get out and do things like going to a movie or to church.					
e. I cut down on how much I eat before I go out.					
f. Whenever I am away from home, I try to stay near a restroom as much as possible.					
g. It is important to plan my schedule (daily activities) around my bowel pattern.					
h. I avoid traveling.					
i. I worry about not being able to get to the toilet in time.					
j. I feel I have no control over my bowels.					
k. I can't hold my bowel movement long enough to get to the bathroom.					
l. I leak stool without even knowing it.					
m. I try to prevent bowel accidents by staying very near a bathroom.					

Q3: Due to accidental bowel leakage, indicate the extent to which you AGREE or DISAGREE with each of the following items. (If it is a concern for you for reasons other than accidental bowel leakage, then check the box "Not apply.")

	Strongly agree	Somewhat agree	Somewhat disagree	Strongly disagree	Not apply
Q3. Due to accidental bowel leakage:					
a. I feel ashamed.					
b. I cannot do many things I want to do.					
c. I worry about bowel accidents.					
d. I feel depressed.					
e. I worry about others smelling stool on me.					
f. I feel like I am not a healthy person.					
g. I enjoy life less.					
h. I have sex less often than I would like to.					
i. I feel different from other people.					
j. The possibility of bowel accidents is always on my mind.					
k. I am afraid to have sex.					
l. I avoid traveling by plane or train.					
m. I avoid going out to eat.					
n. Whenever I go someplace new, I specifically locate where the bathrooms are.					

Q4: During the past month, have you felt so sad, discouraged, hopeless, or had so many problems that you wondered if anything was worthwhile?

1. Extremely so, to the point that I have just about given up
2. Very much so
3. Quite a bit
4. Some—enough to bother me
5. A little bit
6. Not at all

Scales range from 1 to 5, with a 1 indicating a lower functional status of quality of life. Scale scores are the average (mean) response to all items in the scale (e.g., add the responses to all questions in a scale together and then divide by the number of items in the scale. "Not apply" is coded as a missing value in the analysis for all questions.)

Scale 1. Lifestyle (ten items): Q2a, Q2b, Q2c, Q2d, Q2e, Q2fg, Q2h, Q3b, Q3l, Q3m

Scale 2. Coping/behavior (nine items): Q2f, Q2i, Q2j, Q2k, Q2m, Q3d, Q3h, Q3j, Q3n

Scale 3. Depression/self-perception (seven items): Q1, Q3d, Q3f, Q3g, Q3i, Q3k, Q4 (question 1 is reverse coded.)

Scale 4. Embarrassment (three items): Q2l, Q3a, Q3e

6

Neurophysiologic Testing

Kimberly Kenton

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Electrodiagnostic testing of the pelvic floor is becoming increasingly common in clinical pelvic medicine and pelvic floor research. Along with history, physical exam, and urodynamics, neurophysiologic testing can help in the diagnosis of certain pelvic floor disorders and to determine if a central or peripheral neurologic problems exists. Electrodiagnostic testing is also emerging in studies investigating the etiology of pelvic floor disorders. Therefore, a basic understanding of the principles and techniques used in electrodiagnostic medicine are essential for reconstructive pelvic surgeons.

This chapter introduces the most common electrodiagnostic techniques used in women with pelvic floor disorders, including pudendal and perineal nerve conduction studies, sacral reflex testing, and surface and concentric needle electromyography. It describes the technique, advantages, and disadvantages of the technique, and how the technique can be applied clinically. A brief review of neurophysiology is presented to provide a basis for understanding the pathophysiology that leads to nerve and muscle disorders and how the electrodiagnostic studies work.

Electrophysiologic Testing

Skeletal muscles are activated by electrical impulses (action potentials), which can be generated along myelinated and unmyelinated axons. In unmyelinated axons, action potential propagation occurs by each small area of nerve undergoing depolarization activating its neighbor in a continuous fashion. Many nerve cell axons are covered myelin, which improves impulse conduction by increasing speed of current movement down the inside of the membrane. The myelin acts as an insulator, allowing the action potential generated at one node to "jump" to the next node significantly increasing the velocity of action potential propagation. The amount of myelin surrounding a nerve and the distance between the nodes of Ranvier are directly proportional to the nerves diameter and conduction velocity. A large myelinated nerve conducts more quickly than small unmyelinated nerves. Large,

Table 6.1. Classification of nerve fibers

Sensory and motor fibers	Sensory fibers	Diameter (nm)	Velocity (m/s)	Function
A α	Ia	10–20	50–120	*Motor:* alpha motor neurons *Sensory:* muscle spindle afferents
A α	Ib	10–20	50–120	*Sensory:* Golgi tendon organs, touch and pressure
A-β	II	4–12	25–70	*Motor:* neurons to intra/extrafusal muscle fibers *Sensory:* secondary muscle spindle afferents, touch, vibratory, and pressure receptors
A-γ		2–8	10–50	*Motor:* gamma motor neurons to intrafusal muscle fibers
A-δ	III	1–5	3–30	*Sensory:* small, lightly myelinated; touch, pain, and temperature
B		1–3	3–15	*Motor:* small, unmyelinated preganglionic autonomic fibers
C	IV	1	2	*Motor:* all postganglionic autonomic fibers *Sensory:* pain and temperature

myelinated motor axons conduct action potentials, and then branch out into a few terminal branches, which attach to a single muscle fiber. Axonal and demyelinating neuropathies can decrease the distance between nodes and slow nerve conduction velocity, which can be recorded clinically during electrodiagnostic testing. Table 6.1 lists nerve fiber classifications.

Nerve Conduction Studies

A nerve conduction study is the introduction of an action potential in the peripheral nervous system and the subsequent recording of the neural impulse at some location distant to the site of stimulation. Nerve conduction studies measure the velocity of action potential propagation and the magnitude of the response, thereby allowing one to make clinical judgments about the health of a particular nerve. Depending on the type of nerve stimulated and where the recording electrodes are placed, one can measure three different types of responses: pure sensory nerve action potentials, compound nerve action potentials from mixed sensory and motor nerves, and pure motor nerve evaluations by measuring compound muscle action potentials (CMAPs).

Compound muscle action potentials have been traditionally used to evaluate neuropathies in women with pelvic floor disorders. Nerve conduction studies facilitate identifying precise neural injuries or more generalized neuropathic injuries along portions of the peripheral nervous system. As with all electrodiagnostic tests, it is important to have a thorough understanding of peripheral neuromuscular anatomy prior to performing nerve conduction studies.

Stimulating

When performing nerve conduction studies, a stimulus is given at a predefined site using a surface or monopolar needle electrode. Most pelvic floor electromyographers use surface electrodes to stimulate, reserving needle electrodes for nerves that are hard to stimulate with surface electrodes because of excess fat or edema. The magnitude of stimulus used in routine nerve conduction studies is referred to as the *supramaximal stimulus*. The supramaximal stimulus is approximately 20% to 30% above the stimulus, which does not produce any further increase in CMAP response because all the nerve fibers to the muscle are being depolarized. The larger, myelinated axons are depolarized first, and then at supramaximal stimulation, the smaller, myelinated axons are depolarized.

Recording

After stimulating the nerve, it is necessary to record the response. Surface or monopolar needle electrodes can be used. When recording a muscle response, three electrodes are necessary: an active, a reference, and a ground. The active electrode should be placed directly over the muscle being studied, and the reference electrode should be placed some distance from the muscle.

Compound Muscle Action Potential

A CMAP is the biphasic waveform obtained from stimulating a nerve proximal to a muscle

and recording the potential directly over the muscle. A CMAP, or M response, is a summation of all the muscle fibers that are depolarized by a single stimulated nerve. Several parameters recorded from the CMAP are useful in electrodiagnostic testing (Figure 6.1). Onset latency is the time from nerve stimulation to the initial upward deflection of the CMAP. *Onset latency* reflects neural activation at the cathode, propagation of the action potential along the nerve, and transmission at the neuromuscular junction. Therefore, an abnormality at any of these sites can result in prolonged latency. Latency measures only the large, heavily myelinated, fastest conducting axons in a nerve. If a nerve has lost many axons, but a few myelinated axons remain intact, the onset latency will be normal. When the latency is prolonged, one can assume significant loss of neuromuscular function. However, if only a few axons conduct the nerve impulse at a normal velocity, the latency can be normal despite significant neural injury. Therefore, latency is not a sensitive measure of nerve injury. *Amplitude* is measured from baseline to the maximum point of the waveform. Amplitude reflects the total number of axons and muscle fibers being tested and provides an estimate of the amount of functioning tissue. It is less reliable than latency because the distance between the electrode and muscle influences it. *Area* is the space under the portion of the waveform above baseline and provides the most direct estimate of functioning tissue. Compound muscle action potential *duration* is typically measured from the onset latency to where it crosses the baseline. Duration and shape of the waveform measure the temporal dispersion of all the individual fibers. *Nerve conduction velocity* is the rate an action potential propagates along the stimulated nerve. It is calculated by dividing the length of nerve over which the action potential travels by the time required to travel the distance. However, in motor nerve conduction studies the latencies between two different sites of stimulation are subtracted from one another to account for the delay at the neuromuscular junction. Nerve conduction velocities are difficult to obtain on the pudendal nerve owing to the nerve's anatomic course and the inability to stimulate at two well-defined sites.

Nerve conduction velocities are affected by the diameter of the nerve (large nerves conduct more quickly), temperature (cooler temperatures increase latency and amplitude), and age (age greater than 60 years decreases nerve conduction velocity and amplitude). Therefore, delayed nerve conduction velocities in these instances may not be abnormal.

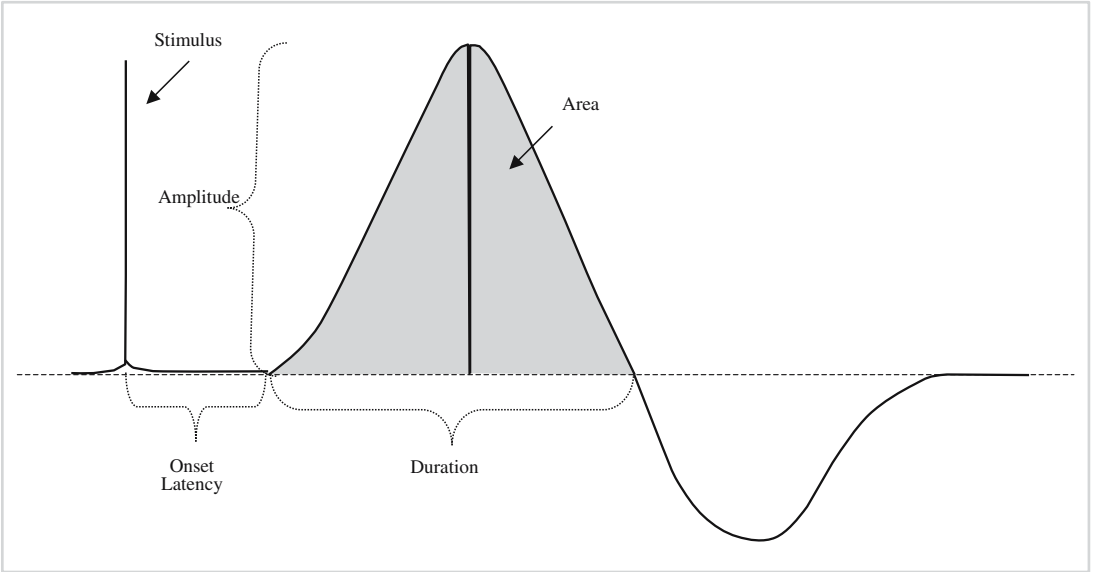

Figure 6.1. Compound muscle action potential (CMAP).

Pudendal Nerve Conduction Studies

The pudendal nerve branches, after exiting Alcock's canal, form three terminal branches: the inferior hemorrhoidal, the perineal, and the dorsal nerve to the clitoris. The inferior hemorrhoidal and perineal branches contain efferent fibers to the external anal sphincter and urethral sphincter, respectively, which can be measured using nerve conduction techniques.

Pudendal nerve conduction studies are the most commonly reported electrodiagnostic tests done on the pelvic floor. First described by Kiff and Swash (1) in 1984 to study patients with fecal incontinence, they have been used to investigate the role of pudendal neuropathy in stress urinary incontinence and pelvic organ prolapse (2–6). A St. Mark's electrode (Figure 6.2) consists of a stimulating cathode and anode and two recording electrodes, which can be attached to a gloved index finger. The stimulating electrodes are located at the tip of the index finger and the recording electrodes at the base. The pudendal nerve is then stimulated at the level of the ischial spine. If stimulation is applied transrectally, the recording electrodes are located at the external anal sphincter. In women, it is preferable to stimulate the pudendal nerve using a transvaginal approach with surface electrodes placed over the external anal sphincter at the 3 and 9 o'clock positions with the patient in dorsal lithotomy. Normative data using this technique in 42 continent women have been established (Table 6.2). Older age, more vaginal deliveries, and a wide genital hiatus were associated with longer pudendal and perineal nerve terminal motor latencies (7). These data are consistent with normative data determined in other electrodiagnostic laboratories (8).

Perineal Nerve Conduction Studies

The amplitude and latency of fibers to the urethral sphincter can be measured at the same time that pudendal nerve conduction studies are being done. Ring electrodes consisting of two pieces of platinum wire wound onto a small cylinder are available, which slip onto the end of a Foley catheter (Figure 6.3). When the electrode is placed 1 cm distal to the Foley balloon and the balloon is secured at the level of the urethrovesical junction, the electrode can record neuromuscular activity from the striated urethral sphincter. Stimulating the pudendal nerve at the ischial spine and recording from the urethral sphincter and external anal sphincter simultaneously facilitate recording the CMAP from the pudendal (inferior hemorrhoidal) and perineal branches. Normal values

Table 6.2. Normative pudendal and perineal nerve conduction parameters

	Latency (ms)	Amplitude (μV)
Pudendal	1.94 (1.55–2.54)	101 (20–260)
Perineal	2.18 (1.84–3.33)	63 (14–199)

From Olsen et al. (7).

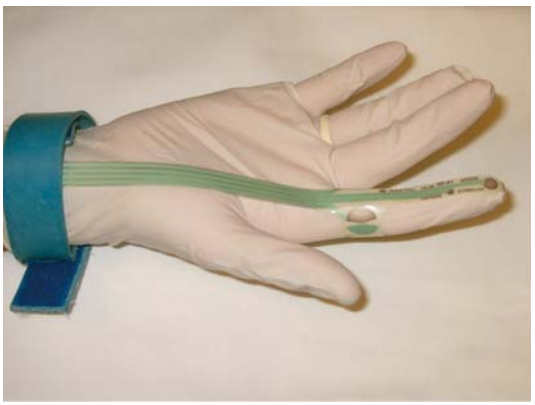

Figure 6.2. St. Mark's electrode.

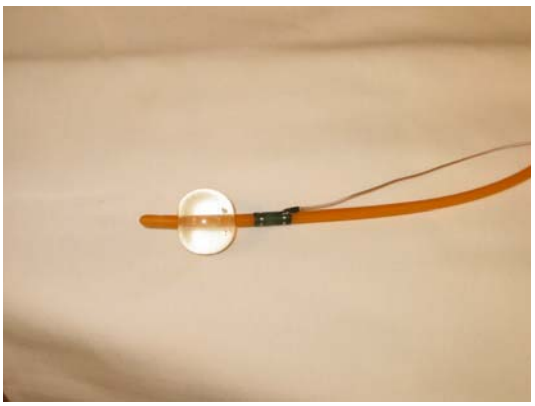

Figure 6.3. Ring electrode on Foley catheter.

for perineal latencies and amplitudes are listed in Table 6.2.

Clinical Applications

Pudendal and perineal nerve conduction studies established the link between pudendal neuropathy and stress urinary incontinence and fecal incontinence (2–6). Prolonged terminal motor latencies have also been shown after vaginal incontinence and prolapse surgery (26,27), suggesting that some anterior vaginal wall dissection leads to distal pudendal nerve injury.

Pudendal nerve terminal motor latencies are most frequently reported in case series of women undergoing anal sphincteroplasty. Authors have attempted to predict surgical outcomes based on normal versus abnormal pudendal nerve function, with varying results (9–11). One hundred subjects underwent anterior overlapping anal sphincteroplasty after pudendal nerve testing. Sixty-two percent of subjects with normal pudendal nerve terminal motor latencies had "successful" outcomes versus only 17% of subjects with unilateral or bilateral pudendal nerve terminal motor latencies (10). Other authors have reported good postoperative success in patients with prolonged pudendal nerve terminal motor latencies (9).

The clinical usefulness of pudendal and perineal nerve terminal motor latencies is hotly debated. They should not be used in isolation from other electrodiagnostic tests when evaluating pelvic floor injuries. Generally, EMG follows nerve conduction studies since EMG is more sensitive for detecting neuropathic injury.

Sacral Reflex Testing

Stimulation of certain pelvic floor structures results in reflex contractions of pelvic floor skeletal muscles. Techniques to test these reflexes in the pelvic floor are used to measure efferent and afferent nerve activity, as well as neurotransmission through the pelvic plexus and sacral nerve routes. Reflexes from the urethra and bladder travel through visceral afferent pathways through autonomic nerves to the sacral cord and are then carried through the pudendal nerve to the external anal sphincter.

Table 6.3. Normative sacral reflex latencies cutoffs

Reflex	Sensory threshold (mA)	Latency (ms)
Urethral anal	8	82
Bladder anal	37	85
Clitoral anal	9	55

Urethral Anal Reflex

Urethral anal reflexes were first described by Bradley et al (12), who used the ring electrode mounted on a Foley catheter to stimulate while recording from electrodes over the anal sphincter (3 and 9 o'clock positions—dorsal lithotomy). This reflex involves afferent fibers from the urethra, which synapse in the conus medullaris and travel through pudendal efferents to the external anal sphincter. Injuries to the pelvic plexus or cauda equina frequently result in absence of the urethral anal reflex. If the patient is unable to sense the stimulus, but the reflex is intact, she likely has an injury in the sensory cortex or ascending spinal cord. Abnormal urethral anal reflexes with preserved bladder anal reflexes are common after multiple urethral surgeries. Responses with latencies greater than 100 ms are voluntary and not considered reflex responses. Amplitudes of the responses are not used clinically, but are currently being assessed in research protocols. Normal values for women can be found in Table 6.3 (13).

Bladder Anal Reflex

This reflex is performed similarly to the urethral anal reflex, except the site of stimulation is the bladder. Abnormal bladder anal reflexes with preserved urethral anal reflex latencies suggest denervation injury to the bladder wall. This can be seen in women with urinary retention or voiding problems owing to overdistention injuries.

Clitoral Anal Reflex

Surface electrodes are placed paraclitorally to stimulate while recording is done at the surface electrodes placed over the external anal sphincter. This reflex passes through the pudendal afferents to the spinal cord back through pudendal efferent fibers to the anal sphincter. These roots are often affected in cauda equina disease

but are not affected in conditions that disrupt the pelvic plexus.

Clinical Applications

Anything that affects the pelvic plexus can potentially disrupt the urethral and bladder anal reflexes. This can be seen in peripheral neuropathies with significant autonomic components and after radical pelvic surgery or radiation. The clitoral anal reflex should be preserved because the course of this branch is not involved.

Pudendal neuropathy typically results in prolonged or absent clitoral anal reflex with preservation of the urethral and bladder anal reflexes. The afferent limb of the pathway through the pelvic plexus is less affected and is a temporally longer portion of the pathway. Lesions in the conus medullaris and cauda equina frequently produce abnormalities in all sacral reflexes.

Suppression of the urethral anal reflex by actively trying to void is a measure of upper motor neuron function (14). If a patient is unable to suppress the response during voiding, she may have a lesion in the suprasacral spinal cord.

Electromyography

Electromyography (EMG) is the recording and study of electrical activity from striated muscles and can be used to distinguish between normal, denervated, denervated and reinnervated, and myopathic muscle. The electrical activity can be recorded using surface or needle electrodes and then displayed on the oscilloscope screen of an electrodiagnostic instrument. Voluntary electrical activity is recorded as motor unit action potentials (MUAPs), which represent the summation of activity from multiple motor units. Motor units are composed of a single anterior horn cell, its axon, and all the skeletal muscle fibers it serves.

A variety of electrode types are used for EMG. Each has different properties and capabilities. The most common electrodes used in the pelvic floor are surface and concentric needle electrodes (CNE).

Surface Electrodes

Surface electrodes are placed on the skin over the muscle being evaluated and can be used to evaluate patterns of muscle activity. Surface electrodes record a summation of electrical activity from the muscle, but cannot distinguish individual MUAPs, and therefore cannot be used to diagnose or quantify neuropathy or myopathy. They are easier to use and less painful than needle electrodes, but provide less reliable information owing to signal distortion by intervening skin, subcutaneous tissue, and volume conduction from other muscles.

Surface electrodes are commonly used during urodynamic studies to assess striated urethral sphincter activity. Electrodes are placed on either side of the perineal body or anal sphincter, and neuromuscular activity is recorded during the cystometry and voiding portions of the study. An increase in activity is normally seen during filling with an absence activity during voiding or episodes of detrusor overactivity. This setup records neuromuscular activity of multiple pelvic floor muscles, not just the striated urethral sphincter, making it difficult to differentiate which muscle is contributing to the signal. A recent study comparing perineal surface to urethral CNE during urodynamics demonstrated that needle tracings were consistently more interpretable than surface recordings (15). Needle tracings demonstrated urethral relaxation with voiding 79% of the time, whereas surface recordings demonstrated urethral relaxation only 28% of the time.

Concentric Needle Electrodes (CNE)

Electromyographers consider EMG the gold standard for studying peripheral striated neuromuscular disease. Needle electrodes are inserted directly into the muscle, providing an accurate portrayal of the electrical signals to diagnose neuropathy or myopathy. The main advantage of CNE is the ability to quantify neuromuscular function. The small recording area at the beveled tip of a CNE differentiates activity from approximately 20 nearby muscle fibers. The wire or active electrode is referenced to the needle shaft, reducing the activity recorded from nearby muscles. Concentric needle electrodes have the advantages of being able to record EMG activity with little interference from other muscles, a predictable recording surface, and the absence of a separate reference electrode.

Three types of activity can be recorded with CNE: insertional, spontaneous, and MUAPs.

Insertional activity is the electrical activity detected by the CNE as it passes through the muscle at rest. When the electrode is in healthy muscle, the insertional activity returns to baseline in 300 ms. Decreased insertional activity indicates that the electrode is not in muscle or the muscle has undergone severe atrophy and replacement by electrically inactive tissue. This is commonly seen in the anal sphincter at the 12 o'clock position in women with long-standing anal sphincter disruptions.

Spontaneous activity is persistent electrical activity after the CNE is inserted and results from marked membrane instability of the muscle or neuron innervating it. Unlike most skeletal muscles, which are electrically silent at rest, the pelvic floor muscles have baseline tonic electrical activity, making it more difficult to detect spontaneous activity. The most common form of spontaneous activity is the presence of positive sharp waves or fibrillation potentials. Fibrillation potentials are action potentials of single muscle fibers that have been denervated. The density of the fibrillation potentials is a rough estimate of the number of denervated muscle fibers. Fibrillation potentials develop within 1 to 3 weeks after the loss of innervation. The final type of spontaneous activity reported in pelvic floor muscles is complex repetitive discharges. Complex repetitive discharges are high-frequency, abrupt onset and offset waveforms associated with neuropathy and voiding dysfunction in women. Fowler's syndrome, first described in 2003, is the triad of urinary retention, urethral complex repetitive discharges, and polycystic ovaries in young women (16). Retention in this group of patients is thought to be due to "overactivity" of the striated urethral sphincter resulting from direct spread of electrical excitation from muscle fiber to muscle fiber.

Motor unit action potential analysis in the sphincters can be done at rest and with voluntary activity. Figure 6.4 shows a normal MUAP. Nerve injury results in characteristic changes in MUAP parameters of duration, amplitude, and polyphasia. After nerve injury, a muscle fiber can be reinnervated by regrowth of the original axon or a nearby axon. If a nearby axon reaches the denervated muscle fiber, it will supply more muscle fibers, creating a more complex MUAP. The new complex waveform tends to be polyphasic (number of times a MUAP crosses the baseline). New axons are initially not well myelinated and conduct impulses more slowly; as a result, newly reinnervated muscle has long duration MUAPs. The MUAPs have larger amplitudes because one motor unit is supplying more muscle fibers.

Motor unit action potential analysis can be done using one of three techniques: manual MUAP, individual MUAP, and computerized multi-MUAP programs. A study comparing the techniques in the anal sphincter demonstrated that individual MUAP and multi-MUAP analyses were most sensitive for differentiating neuropathic from normal muscle (17). Mean quantitative parameters from the three techniques are different, so normative data from one technique cannot be used for another (17).

Motor unit recruitment refers to the pattern in which motor units are recruited by the spinal cord. Muscles increase force by increasing the frequency and number of individual motor units are firing. Therefore, as voluntary effort is

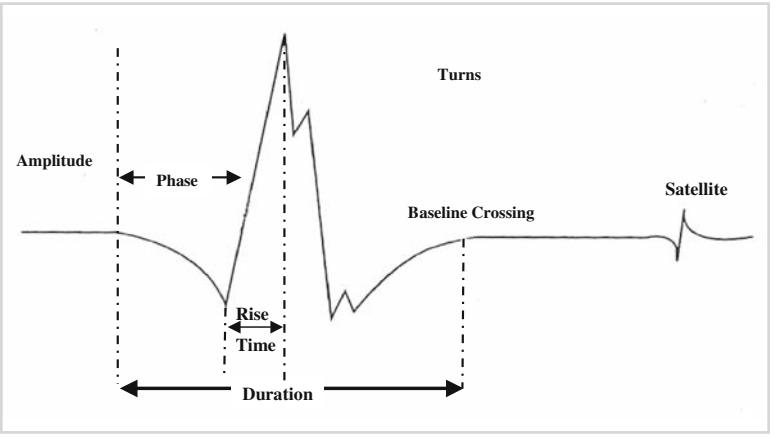

Figure 6.4. Motor unit action potential.

increased, an increased number and frequency of MUAPs should be seen. At maximum effort, so many motor units are firing that individual MUAPs cannot be distinguished, resulting in an interference pattern. Computerized software programs are available to measure interference patterns as well.

Urethral EMG

Concentric needle EMG of the striated urethral sphincter is done with the woman in the dorsal lithotomy position. Anesthetic cream can be applied to the external urethral meatus 10 minutes prior to the study to optimize patient comfort. The CNE is inserted 5 mm above the external urethral meatus. The striated urethral sphincter is located at the mid-urethra, 1.5 cm from the external urethral meatus.

External Anal Sphincter

Needle exam of the anal sphincter is also done with the patient in dorsal lithotomy after application of anesthetic cream. The external anal sphincter can be located with a digital rectal exam and the CNE inserted parallel to the muscle at 3 and 9 o'clock. Twenty MUAPs should be examined from each site.

Clinical Applications

Concentric needle EMG has been used in pelvic floor muscles to confirm the association between pelvic nerve injury, and vaginal delivery, stress incontinence, and fecal incontinence. Significant changes in MUAP morphology have been reported after vaginal childbirth by multiple authors (18–20). Needle EMG of the levator ani and external anal sphincter muscles has shown electromyographic evidence of denervation with reinnervation in women with stress urinary incontinence and pelvic organ prolapse (20,21). Two studies have used quantitative CNE of the urethral sphincter in women undergoing incontinence surgery (22–24). Fisher et al (23) demonstrated more advanced neuropathic changes in women with persistent stress urinary incontinence. Kenton et al (24) studied 89 women undergoing Burch urethropexy with CNE and found significant differences in EMG parameters of women with successful incontinence surgery, suggesting that these women had better innervation of their urethral sphincters. Specific EMG criteria were established, which could predict surgical success 100% of the time.

Gregory et al (19) recently reported quantitative CNE data from the anal sphincter of 23 nulliparous and 28 vaginally parous women. Motor unit action potentials from the 23 nulliparas had significantly higher amplitudes, longer durations, and more phases, providing further evidence that vaginal childbirth results in pudendal neuropathy.

Concentric needle EMG of the anal sphincter can also be used to map the anal sphincter prior to surgical repair. The exam should include the anterior quadrant in addition to the 3 and 9 o'clock positions. This will provide information about where the muscle is intact/disrupted and about whether the muscle has sustained denervation or denervation/reinnervation injury.

Some normative CNE MUAP parameters have been reported for the external anal sphincter and levator ani (20,25). No normative data exist for the striated urethral sphincter.

Conclusions

Electrodiagnostic testing has both clinical and research applications in pelvic floor disorders. Clinical evidence suggests that certain types of reconstructive surgery may impact pelvic floor innervation. Zivkovic et al (26) measured perineal nerve terminal motor latencies before and after vaginal reconstructive surgery and found significantly prolonged terminal motor latencies in women who underwent vaginal needle suspension procedures. Similarly, Benson and McClellan (27) found significantly prolonged pudendal and perineal nerve terminal motor latencies in 27 women undergoing vaginal prolapse repair, while the terminal motor latencies of 21 women undergoing abdominal prolapse repair were not different. The authors then compared postoperative perineal terminal motor latencies of the women with optimal and suboptimal prolapse repairs. Pudendal neuropathy was significantly more common in the women with suboptimal repairs. In a well-done randomized controlled trial of abdominal versus vaginal reconstructive surgery, Benson (13) found superior anatomic results of prolapse repair in the abdominal group. Another ran-

domized controlled trial also demonstrated anatomic superiority of the abdominal approach (29). These data suggest that vaginal reconstructive surgery results in denervation of the pelvic floor musculature, which may impact anatomic success of the surgery. There is also increasing data that preoperative pelvic floor denervation may impact surgical outcomes, particularly for continence procedures. Two studies demonstrated a relationship between urethral sphincter neuropathy and outcome of continence surgery (23,24).

Much of our current understanding of the etiology of pelvic floor disorders has come from both nerve conduction studies and EMG of the pelvic floor muscles in women with stress incontinence, fecal incontinence, and pelvic organ prolapse. We understand that surgery can impact pelvic innervation, and electrodiagnosis has also confirmed the relationship between vaginal childbirth and pudendal neuropathy. The degree of denervation and pelvic floor injury can be measured and therefore studied. Such measurements have some correlation with clinical outcomes, but further research refining techniques and establishing normative electrodiagnostic parameters for the urethral sphincter anal sphincter, and levator ani are imperative (25,30,31). No normative data exist for the striated urethral sphincter.

Pelvic floor electrodiagnostic studies may aid in the clinical diagnosis of some pelvic floor disorders and help to predict outcomes of incontinence surgery. However, confirmatory studies are necessary. Clinicians who wish to add electrodiagnosis to their clinical evaluation of patients with pelvic floor disorders should have proper training in nerve conduction studies and EMG or work in a multidisciplinary setting with a neurologist or physiatrist trained in electrodiagnosis.

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7

Outcome Measures for Assessing Efficacy of Incontinence Procedures

Adam G. Baseman and Gary E. Lemack

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Standard treatment for stress urinary incontinence (SUI) in women has evolved over the last few decades. The development of effective surgical modalities and the recent explosion in the availability of minimally invasive treatment options have altered the playing field, and have provided a wider range of treatment options for women with SUI. With these alternatives come the opportunity and the responsibility to assess how successful these treatments are. The area of outcome assessment itself has evolved over the last several years, becoming more structured in the approach to defining treatment success. This process is particularly important for treatments aimed at SUI, where an improvement in the quality of life is the ultimate goal, and for which success can be defined in a number of different ways. Indeed, it may be impossible to identify a single parameter that can be used to define success in every patient undergoing treatment for SUI. This chapter explores current methods to analyze outcome of SUI treatment.

Difficulties in Assessing Treatment Outcome

Defining treatment success for SUI remains a contentious issue. One of the first considerations is whether to rely on purely objective outcome measures confirming the absence of SUI, for example the absence of urodynamically demonstrable SUI following treatment of SUI. Advocates of this argument would contend that since one is treating a particular disease state, then the absence of that disease state confirms successful outcome. It is perhaps the most pure form of assessing success.

There are several problems with this approach, however. First, our ability to detect SUI may not be sufficiently reliable. For example, what might be present one day on

urodynamic testing (or pad test, stress test, etc.) may be absent the next, even if a patient reports ongoing SUI. The absence of the SUI in an office setting does not rule out the presence of symptomatic SUI while at home. Furthermore, what is considered a successful outcome to one patient may be a disastrous failure to another; one pad per day leakage in a 50-year-old golfer may not be acceptable, whereas an improvement from six to three pads per day in an 80-year-old sedentary woman who is now able to get out of the house may be considered quite an accomplishment. In contrast, a woman who is cured of leakage by objective testing who develops de novo urge incontinence might be considered a success by an objective assessment of SUI, but would hardly be considered a treatment success.

From the other viewpoint, relying solely on subjective measures (such as quality of life questions) does not answer the obvious question of whether the condition was responsible for the reduced quality of life. It certainly seems unwise to widely recommend an operation to treat SUI that does not objectively accomplish its goals merely because subjective assessments are improved. Perhaps less invasive strategies could accomplish the same goal.

Obviously, defining success depends on the questions asked and the manner in which they are asked. But this itself is a complicated issue. First, to whom should assessment questions be asked? Should patients be asked directly, or does the best assessment come from the treating physicians? And who should ask the questions? Most surgical series rely on physician assessment, but such assessment can be biased. Second, what question should be asked? Should the questions be condition-specific or more global? Third, how should questions be asked? Should assessment rely solely on response to validated questionnaires without direct interaction with the patient to avoid any influence of the caregiver on the response? Fourth, when should assessment questions be asked? Most authorities advocate waiting at least 1 year before assessing efficacy and durability. But perhaps data need to be accumulated earlier, particularly regarding adverse outcomes. Finally, do assessment questions need to be asked at all? And are objective measures, such as pad tests, physical exam findings, radiologic studies, and urodynamics, more reliable, reproducible, and defendable than subjective assessments?

Symptom Assessment

Effect of Study Methodology

Assessing both the severity and bothersomeness of urinary incontinence is critical in determining treatment success. Similarly, utilizing condition-specific quality of life measures can be a useful means of determining the overall impact of SUI. Many are available, and which to use is not clear. What is clear is that relying solely on physician reports of success can result in tremendous bias. Higher success rates are found in series relying on retrospective chart review, and study methodology can greatly affect success rates for surgical intervention on patients with SUI. Disparate outcomes were found between physician reports (via chart review) and questionnaires administered by a third party for both pubovaginal slings and transvaginal bladder neck suspension. Govier and colleagues (1) found 78% of 32 women had no leakage following pubovaginal sling on retrospective chart review, yet in an independent telephone survey only 33% stated they experienced no leakage. Sirls et al (2) used chart review and patient questionnaire to assess surgical results of 102 patients who underwent transvaginal bladder neck suspension for SUI. Although physician records indicated that 91% of the patients did not use pads, questionnaire data revealed that only 47% endorsed not using pads. Rodriguez and colleagues (3) recently noted a significant difference in lower urinary tract (LUT) questionnaire score when completed by a physician (after an interview with the patient) in comparison to an identical questionnaire completed by the patient. Others have also noted a distinct difference between what physicians and patients consider successful treatment of urinary incontinence (4). All of these findings highlight the importance of relying on patient report rather than physician interpretation when it comes to a subjective assessment of urinary symptoms.

Incontinence Questionnaires

Questionnaires are easily administered, can be completed independent of a physician visit or interaction, and, because most are based on a grading system, are responsive to change. A

variety of questions can be used to address the whole spectrum of lower urinary tract complaints. Questions can be designed to explore the extent and impact of irritative, obstructive, or stress components of patients' presentation, and results may more accurately represent patients' perception of their problem when quality of life questions are included. Questionnaires normally go through a rigorous process, both in questionnaire development (using patient focus groups and health care personnel) and in statistical validation. Additionally, these instruments should be sensitive enough to detect effects of surgical or medical intervention on patient symptomatology.

Several questionnaires have been used to evaluate patients with SUI—some assessing bothersomeness, and others assessing the impact of urinary symptoms on quality of life (Table 7.1). The Incontinence Impact Questionnaire (IIQ) consists of 30 questions examining the effect of incontinence on physical activity, travel, relationships, and emotional health (5). Questions are answered on a scale from zero (not affected at all) to three (affected greatly). The Urogenital Distress Inventory (UDI), developed by the same group, consists of 19 questions dealing with irritative, obstructive, and stress symptoms. Questions are graded identically as in the IIQ. Shorter forms of both questionnaires have been designed by finding question subsets to approximate scores of the complete questionnaires. A seven-question version of the IIQ, the IIQ-7, excellently correlates with the full version, and similar results were demonstrated with a six-question version of the UDI, the UDI-6 (6).

Criterion validity (how well questionnaires correlate with established methods of evaluation) has been demonstrated for different questionnaires with regard to voiding diaries, pad tests, and urodynamic studies. Uebersax et al (6) found significant correlation between answers on the IIQ-7 and UDI-6 and results from voiding diaries and pad tests, which validates use of these easily administered questionnaires. Hagen and colleagues (7) noted significant sensitivity to change postintervention for SUI in both the UDI and IIQ, indicating their reliability in assessing outcome. A recent reanalysis of the UDI and IIQ identified new subscales within each (five in each), which enhanced the reliability and clinical utility of the questionnaires (8).

Relationship between responses on the UDI-6 and urodynamic findings has also been studied. High response to the stress symptom question was found in 85% of patients with urodynamically demonstrated SUI (correlation coefficient of 0.51, $p < .001$) (9). Less strong correlation was found between urge-related leakage and the urodynamic indication of incontinence secondary to detrusor overactivity. These findings support the role of a validated questionnaire in evaluating patients with lower urinary tract symptoms and in more rigidly defining who may require pretreatment invasive testing such as urodynamics.

Several other validated questionnaires have been used to evaluate outcome following treatment for incontinence. Raz and Erickson (10)

Table 7.1. Commonly used validated questionnaires for assessing incontinence in women

Questionnaire name	Year	No. of items	Comments
SEAPI QMM (10)	1992	15	Also incorporates data from physical exam, radiology studies, urodynamics
Incontinence Impact Questionnaire (IIQ) (5)	1994	30	Assessment of impact of incontinence on daily activities in women
IIQ-7 (6)	1995	7	Shortened version
Urogenital Distress Inventory (UDI) (5)	1994	19	Assessment of the prevalence of urinary symptoms in women
UDI-6 (6)	1995	6	Shortened version
Bristol Female Lower Urinary Tract Symptom Questionnaire (12)	1996	34	Assessment of bothersomeness of urinary symptoms in women as well as impact of quality of life, and direct impact on sexual function
King's Health Questionnaire (15)	1997	21	Assessment of impact of incontinence on daily activities and quality of life; also validated for use in males and females with symptoms of overactive bladder
Incontinence Quality of Life Instrument (IQOL) (16)	1999	22	Assesses impact of urinary symptoms on physical activities and emotional health
Leicester Impact Scale (19)	2004	21	Assesses impact of urinary pattern on daily activities and emotional health

suggest an incontinence classification system, the SEAPI QMM, to standardize the evaluation of incontinent patients. This system utilizes a 15-item questionnaire that examines the effect of incontinence on work, relationships, recreation, financial situation, and emotional satisfaction. Results are incorporated with data from the physical and medical history, urodynamic examination, and radiologic evaluation. A drawback is that this questionnaire may be somewhat impractical since not all patients will undergo all of these modes of evaluation pre- and postoperatively, though a recent reevaluation of this questionnaire has demonstrated its utility in clinical practice for both men and women (11).

The Bristol Female Lower Urinary Tract Symptoms questionnaire is commonly used. It consists of 34 questions covering urinary incontinence, voiding and storage phases of micturition, quality of life issues, and sexual function (12). The range of issues covered by the Bristol questionnaire enables it to be used to examine the prevalence of nocturnal enuresis as well as urinary incontinence in a general population (13,14). Other commonly used LUT questionnaires include the King's Health questionnaire (15), the International Consultation on Incontinence Questionnaire (ICIQ) (16), the MESA questionnaire (17), the Incontinence Quality of Life Instrument (I-QOL) (18), and the Leicester Impact Scale (19). Other questionnaires to evaluate possible side effects resulting from treatment for SUI, such as sexual dysfunction, have also been designed. In particular, the development of a sexual inventory questionnaire to assess sexual symptoms in women with LUT dysfunction has also been developed (20).

The importance of using questionnaires in outcomes analysis is highlighted by the inclusion of a questionnaire response in assessing outcome of two recent randomized surgical trials for treating SUI. In Europe, a randomized trial comparing transvaginal tape (TVT) versus Burch colposuspension incorporated the Bristol questionnaire as a secondary outcome measure (21), and in the United States the National Institutes of Health–sponsored Urinary Incontinence Treatment Network (UITN) trial, comparing pubovaginal sling versus Burch, has incorporated the MESA (22). Indeed, in the UITN trial only patients without self-reported symptoms of SUI (in addition to other factors) can be considered surgical successes.

Objective Measures to Assess Volume/Frequency of Urine Loss

Pad Tests

During a perineal pad test, urine loss is quantified by placing some type of absorbent pad at the vaginal introitus for a specified length of time, either during a course of regimented exercises or during routine activity, and the change in pad weight is recorded after completion. The attractiveness of the pad test lies in its objectivity and its potential to directly evaluate that which brought the patient to surgery, namely urinary incontinence. Pad tests have been shown to have good correlation with patients symptomatology (23,24), although distinguishing the type of urinary incontinence (urge versus stress) based on pad test results has not been possible (25,26).

Caldwell (27) reported the first clinical use of a pad test to evaluate for urinary incontinence, though no assessment of reliability was made. An attempt to standardize the methodology of the pad test was published several years later (28). This study compared the gain in pad weight during a 1-hour test—performing activities that would usually cause urine to leak—between women with SUI and those without. The study did not mention the activities continent women were asked to perform or the exact amount of urine in the bladder ("comfortably full"). The mean gain in pad weight among controls was 0.26 g per hour versus 12.2 g in the SUI group.

Further modifications of the pad test were made by more rigidly quantifying the bladder volume, the duration of the test, and the activities performed. In 1984, Klarskov and Hald (29) instructed patients (all with lower urinary tract symptoms) to drink 500 mL of fluid prior to a 60-minute test, during which they were told to perform a standardized activity program (e.g., walking, stair climbing, deep knee bends, hand washing). Though no control group was used, the authors found the degree of urine loss in the same patient highly reproducible in repeated studies. Others more rigidly define bladder volume by determining cystometric capacity before testing, and then filling the bladder to 75% capacity (30). These investigators employed a rigorous 15-minute test, which might not be appropriate for certain patients, particularly the aged. Others advocate less bladder filling (31),

but the issue of bladder volume may have been settled by Jakobsen and colleagues (32), who compared 50% to 75% bladder filling during a repeated provocative pad tests. They found no significant difference in the median change of pad weight between the two volumes, though the median leakage in the 75% fill group was significantly higher on the repeat study compared to the first. Interestingly, diuresis during the 40-minute pad test was significantly greater with the bladder filled to 50%, which made the volumes voided at the end of the study relatively similar and may explain why the changes in pad weight were also quite similar.

The utility of the pad test in comparing outcomes depends on standardization of the many parameters of the test (Table 7.2). The advantages of an in-office evaluation include establishment of uniform conditions including a common starting bladder volume, length of the test, and the types of activity performed during the test's duration. Compliance with test protocols may be assessed or ensured by office staff, and immediate assessment of the pad becomes possible, minimizing concerns relating to evaporation. The International Continence Society has recommended a standardized 1-hour in-office pad test (33). Despite these recommendations released over 10 years ago, only a small number of published studies utilizing pad tests for outcome assessments for incontinence have followed these guidelines (34), limiting the ability to make valid comparisons between outcome reports. Additionally, the reliability of the 1-hour test has been called into question with recent research showing poor test-retest reliability (35). Others have questioned its ability to reproduce the activities that normally incite urine leak, and the feasibility of taking 60 minutes of office time to perform such a test.

In light of such concerns, pad tests of longer duration performed in the patients' home environment have been advocated by many clinicians and investigators. Advantages include the patients conducting their normal activities rather than provocative measures that may not be representative of their regular experiences, and a diminished importance of the initial bladder volume as the patients will likely cycle through all stages of fullness during the test duration. A pad test of 48 hours duration has been advocated by Versi and colleagues (36), who noted excellent test-retest reliability and acceptable compliance and reproducibility using a 48-hour pad test in which patients were instructed to conduct normal activity that resulted in incontinence. Although the reproducibility of the 48-hour test was slightly better than the first 24 hours alone, the authors suggested that the improved compliance that might be expected with a shorter test outweighs any marginal benefit. A similar conclusion was reached by Groutz and colleagues (37), who compared 24-, 48-, and 72-hour pad tests and determined that a 24-hour pad test resulted in optimal patient compliance with exceptional reliability. Matharu and colleagues (26) evaluated both the 1- and 24-hour pad tests in the same study cohort and concluded that the 24-hour test was more clinically useful. A recent study to evaluate the participation of patients in performing home pad testing as a means of outcome assessment following incontinence surgery found only half of the study population willing to complete the protocol, highlighting the need to minimize the testing period (38).

One frequently raised issue is the correct interpretation of a positive pad test; for example, how much change in pad weight is acceptable?

Table 7.2. Commonly used pad tests for assessing incontinence in women

Test duration	Starting bladder volume	Activities during test duration	Weight gain cutoff for positive test
<1-hour in-office test (20 minutes) (87)	One-half cystometrically determined volume	Stair climbing (100 steps), coughing (10 times), running (1 minute), jumping (1 minute), washing hands (1 minute)	≥1 g
1-hour in-office test (88)	Test to be started without voiding (500-cc fluid load prior to starting test)	Walking and stair climbing (30 minutes, one flight up and down), standing up (10 times), coughing (10 times), running (1 minute), bending (5 times), washing hands (1 minute)	≥1 g
24-hour home test (85)	Any starting volume	Normal everyday activities (patient specific)	≥2 g
48-hour home test (89)	Any starting volume	Normal everyday activities (patient specific)	≥7 g

Weight loss (evaporation) and gain (perspiration, vaginal secretions) are to be expected, particularly during longer tests. Nygaard and Zmolek (39) approached this topic during a study of 14 asymptomatic (continent) volunteers who underwent a vigorous exercise pad test. Subjects were given pyridium before the test so their urine would be stained. Mean gain in pad weight was 3.19 g over the 40-minute period, and nearly all volunteers demonstrated pyridium staining at least once, though none were aware of any leakage. Tests in the same patients varied little, though a wide variation existed between these presumably similar continent volunteers. Based on their findings, these authors suggest a pad test is useful if each patient serves as her own control (i.e., before and after treatment) but is not useful to differentiate between continent and incontinent women. Furthermore, the addition of pyridium and vigorous exercise appear to overestimate the degree of leakage (40). Values for the 24-hour pad test in continent populations have also been evaluated (41). No impact on pad weight change was found to be owing to hormonal status or exercise habits. Median pad weight gain over 24 hours was reported as 0.3 g. Other authors found a 24-hour home pad test incapable of distinguishing incontinent (mean pad weight gain of 3.3 g) from continent (3.1 g) women in a random sample of menopausal women (42). These authors and others also note that the pad test may underestimate the subjective report of incontinence. These data suggest the usefulness of the pad test as a screening tool is limited.

Further confounding the issue of interpretation of the pad test is that of mechanical sensitivity, for example, how the pads are weighed. While high-precision scientific balances with resolution to 0.001 g and a standard error of 0.001 g are available, many commonly used scales (e.g., kitchen models) have resolution to only 0.1 oz (2.83 g) and a similar standard error. Most studies do not report on the exact model of balance used and its readability and expected reproducibility. A minimum standard for balances used to assess weight change during pad testing should be established to allow for easier cross-study comparisons.

In practice, a pad test must be individualized. For incontinence that cannot be demonstrated despite a thorough interrogation, a 24-hour pad test may be quite useful. The pad test may be most helpful, however, as an outcome tool because intraindividual reproducibility seems its most reliable asset. Repeating a pad test, regardless of duration or specific regimen, after intervention for incontinence may be one of the most accurate means of assessing efficacy currently available, though clearly, its inability to distinguish the type of incontinence may limit its usefulness as a sole outcome measure.

Voiding Diaries

Voiding (micturition) diaries are used to record the volume and frequency of voids, as well as leakage episodes. Some also estimate the timing and volume of fluid intake. The duration of voiding diaries varies considerably; some last as long as 14 days. Although diaries cannot estimate the quantity of urine loss or the bothersomeness associated with urine loss, they can often, in contrast to a perineal pad test, distinguish (based on patients' symptoms) between urge and stress incontinence. They also assess frequency of urine loss, which is often the target of therapy. More importantly perhaps, the diary may be able to demonstrate to patients how behavioral modification alone can alter voiding habits (43,44). Both traditional paper diaries and electronic diaries that simplify data entry and processing have been used (45).

Wyman and colleagues (46) were among the first to objectively investigate the merits of a prolonged voiding diary as a means of assessing incontinent women. Fifty women complaining of incontinence were asked to complete a 2-week diary, recording the frequency of daytime and nighttime micturition and incontinence episodes. Urodynamics were carried out after the recording. Test-retest analysis revealed that diurnal and nocturnal micturition frequencies and the number of micturition episodes were highly reproducible from one week to the next. Interestingly, women with detrusor overactivity were less able to consistently report their leakage episodes than women with sphincteric incontinence, likely owing to the unpredictability of urge incontinence episodes. Overall, the authors suggest that the voiding diary is useful and reproducible in evaluating urinary incontinence in symptomatic women. Although the optimal duration of the diary is not specifically discussed, the authors seem to agree with Robb (47), who suggests that a minimum 3-day diary is required.

Good test-retest reliability with 7-day voiding diaries has been shown with regard to the frequency of micturition, episodes of incontinence, incontinence-associated symptoms (urge- or stress-related), and urinary urgency (48). Three- and 4-day diaries have similar reliability with regard to these parameters. Investigators have reported that 4- and 7-day diaries recording voiding frequency and volumes are statistically indistinguishable (49).

A question distinct from test-retest reliability relates to the length of time required to detect any effect of intervention with a voiding diary. Utilizing mathematical modeling, 7-day voiding diaries are long enough to reasonably detect changes in either stress- or urge-related incontinent episodes (50). This time course is dependent on the initial frequency of the outcome variable being evaluated, with a lower number of episodes requiring a longer voiding diary period in order to detect significant changes owing to intervention.

One confounding aspect regarding utilization of voiding diaries for outcomes assessment is that the very act of keeping track of voiding symptomatology can affect those symptoms. This behavioral modification owing to increased focusing on and awareness of urinary issues is referred to as "self-monitoring" (51). This effect has been shown to occur early, though it can dissipate after 3 days. The impact of self-monitoring is most strongly felt on shorter-term diaries and should be considered when interpreting these data.

Voiding diaries have been established as the standard outcome tool in evaluating new medical therapy for incontinence, particularly for measuring effectiveness in treating symptoms of overactive bladder (OAB). Nearly all studies of new pharmaceutical agents for OAB incorporate a voiding diary, since the main outcome measures (i.e., voiding frequency, urge-leakage episodes) can be readily obtained from a micturition diary (52,53). The role of diaries in evaluating treatment for SUI has also been addressed (54), but without some assessment of bother associated with leakage, the results of leakage frequency that can be gleaned from a voiding diary might tell only part of the story. The largest role for voiding diaries in outcome assessment may be in combination with other methods of evaluation. In this regard, scoring systems that incorporate results from voiding diaries with symptom questionnaires and pad tests have been proposed and used to evaluate surgical interventions for incontinence (55).

Physiologic Assessment: Urodynamic Testing

Uses of Urodynamic Testing

Urodynamic testing is ideally suited to assess objective outcome following incontinence surgery because it can assess success as well as failure. Specifically, urodynamic testing can evaluate for the finding that prompted the intervention (i.e., by testing leak point pressures or urethral pressure profiles for SUI), but it can also evaluate for possible (sometimes asymptomatic) sequelae of the intervention, such as detrusor overactivity, altered voiding dynamics, and elevated postvoid residuals. However, because urodynamic testing is more expensive than other noninvasive measures, it may not be a practical method. Since many referral centers have standardized urodynamic protocols and therefore generate comparable data, it may be most useful as a research tool to assess both the etiology of successes and sources of failures in treating SUI.

Accuracy of Urodynamic Testing

It is important to stress that urodynamic measurements of voiding parameters are evaluating a different entity than the normal daily voiding experience. The lack of correlation between some reported symptom scales and urodynamic findings (56) is not entirely surprising, as it may be explained by the differences between a patient's normal spontaneous voids and those performed in the milieu of the urodynamic laboratory. Similarly, these changes may elucidate the poor correlation between validated quality of life instruments and urodynamic findings (57). Deviation from an individual's normal voiding experience to that which is represented on the urodynamic tracing may be due to the instrumentation required by the study, the laboratory environment, the presence of observers, nonphysiologic filling velocities, or other alterations. This does not mean that these objective measurements are any less valuable, but that it is critical that they are considered in

their appropriate context. For example, since alterations have been shown to exist between free and intubated flow rates (58), comparison of postoperative free flow rates to preoperative intubated flow rates should not be considered a reliable or meaningful outcomes assessment.

Assessing Treatment Success

Urodynamics have proven quite useful in understanding mechanisms of success. In a nonrandomized study of 327 women who underwent surgery for incontinence, Tamussino and colleagues (59) performed urodynamics before and 5 years after either anterior colporrhaphy (AC), AC with needle suspension, or Burch colposuspension. They found that the efficacy of surgical therapy depends not only on the procedure chosen and urodynamic changes effected, but also on the preoperative severity of the incontinence. For example, colposuspension was significantly more likely to increase the pressure transmission ratio (PTR) across the urethra than an anterior colporrhaphy and much more likely to cure incontinence. Klutke and colleagues (60) noted that patients cured of incontinence following colposuspension were more likely to have a higher mean urethral resistance following surgery (0.099) than those who failed (0.041), which suggests that enhanced resistance rather than anatomic restoration is the key to surgical success. Similarly, Bump and colleagues (61) noted that patients with low PTRs (<90%) were much more likely, 6 weeks and 6 months after bladder neck surgery for incontinence (Burch or vaginal suspensions), to remain incontinent than those with appropriate (90–110%) or high (>110%) PTR. This alteration in PTR has been shown to be durable over long-term follow-up (62). In contrast, urethral axis angle did not correlate with success of the operation. Elevated levels of urethral resistance have been found in patients following tension-free vaginal tape procedures (63). These data support the hypothesis that an element of dynamic urethral obstruction may be the most important factor in the success of anti-incontinence operations.

Assessing Adverse Outcomes

But when is urethral obstruction excessive? Urodynamics taken after a procedure also allow surgeons to determine when obstruction may alter both voiding dynamics and resting bladder function. Bump et al's (61) study demonstrated that when the PTR was too high (>110%), patients were significantly more likely to have detrusor overactivity and voiding dysfunction. Nearly all studies that investigate pressure flow relationships during voiding after anti-incontinence operations note increased detrusor pressure at maximum flow. In fact, increased voiding pressures have been noted after modified Pereyra bladder neck suspension (64), Stamey procedures (65), Burch colposuspension (66), pubovaginal sling (67), and tension-free vaginal tape (68), though in most cases, clinical symptoms were not apparent. Urodynamics can also assess for development and resolution of detrusor overactivity following anti-incontinence procedures (69,70), which is a factor that must be considered given that the likelihood of new-onset urgency and the resolution of urge symptoms are important aspects of informed consent.

As with the other methods of outcomes assessment discussed, the information generated by multichannel urodynamics should not be viewed in a vacuum. Evaluation of these studies in light of the patient's symptom complex must be performed to ensure correct interpretation. One outcome assessment study found that of patients with urodynamically demonstrated sphincteric incontinence following surgery, only 50% were symptomatic (71). Given that anti-incontinence surgery is undertaken to correct urinary incontinence, it would not seem accurate to classify these patients as failures in the absence of reported incontinent episodes solely because of low leak point pressures. It is important to keep this in mind when interpreting study results that only report urodynamic data on "failures," as alterations or persistent abnormalities in voiding parameters may exist in "successfully" treated populations.

Objective Measures to Assess Anatomic Changes Following Treatment

Radiologic Studies

There are several reasons to consider anatomic assessment of the bladder and/or urethra as an outcome measure after an intervention for

incontinence. Historically, surgical correction of incontinence was based on the principle of restoring the urethra to a more anatomically correct position, as this was thought to restore physiologic pressure transmission to the urethra during times of increased intraabdominal pressure. Whether this is the mechanism by which some surgical approaches produce continence is debatable, but restoring the urethra to an intrapelvic position and reducing urethral hypermobility (UH) remains a goal of some approaches. Additionally, development of secondary cystoceles has been noted following certain suspension procedures in which no support of the more proximal anterior vaginal wall was applied.

Although physical examination alone offers some insight into urethral mobility and anterior vaginal wall descent, its accuracy and interexaminer reliability remain uncertain. For this reason, radiologic studies may offer a more objective assessment. The standing cystogram has been utilized to assess for anterior vaginal descent following suspension procedures (72). It is also a reliable means to assess urethral mobility with increases in intraabdominal pressure and changes in urethral angle following anti-incontinence procedures (73). Vaginal ultrasonography has been used to assess for anatomic changes in the position of the bladder neck following colposuspension (74).

Q-Tip Test

During a Q-tip test, the urethral angle is assessed by placing a cotton swab in the urethra to the level of the bladder neck and then measuring deflection from the horizontal at rest and with straining. This simple test can be conducted in the office and without more invasive or costly testing, and it seems a fairly reliable indicator of urethral mobility associated with straining maneuvers (75). However, some investigators question its accuracy and overall value. For example, like any assessment of urethral position, the presence of hypermobility alone does not necessarily indicate SUI. That is, the specificity of this test for predicting SUI is quite low (76), and using specific cutoff values (such as 30- to 35-degree deflection with straining) to differentiate incontinent women is unreliable (77). Thus, although a properly performed Q-tip test gives reasonably accurate assessment of urethral position, its current role in evaluating incontinent patients and the outcome of procedures aimed at treating incontinence is questionable.

Stress Test

Several authors have reported on the use of a provocative stress test to assess for urinary incontinence during pelvic examination. The technique for performing the stress test has differed, generally based on the degree of bladder filling, which has varied from empty (incontinence assessed 20 minutes after catheterization) (78) to 200 cc (79) or higher (80). In general, the observation of leakage at the urethral meatus during performance of either a Valsalva maneuver or cough is considered a positive test. Most studies have shown excellent correlation with urodynamic parameters used to measure urethral function (such as low Valsalva leak point pressures) indicating intrinsic sphincteric dysfunction (ISD). Positive predictive values (for predicting ISD) of greater than 95% have been reported, though the finding of stress-induced leakage does not rule out the possibility of coexisting detrusor overactivity. Of potentially greater interest is the finding of negative predictive values of 80% to 90%, indicating that women without leakage during stress testing are unlikely to have ISD in most instances (81). The supine stress test is a useful clinical tool in patients with severe ISD without features of mixed incontinence.

Recent Trends

A multidimensional approach to defining cure for incontinence has been advocated by most professional organizations dealing with this issue, including the ICS (82), the Society for Urodynamics and Female Urology (83), and the World Health Organization International Consultation on Incontinence (84). Recent large-scale, multiinstitutional randomized trials comparing incontinence treatments have adopted this approach, including both the National Institutes of Health (NIH) Urinary Incontinence Network trial comparing Burch colposuspension versus pubovaginal sling (22) and the United Kingdom–based trial of TVT versus Burch (21). In the former, a strict

definition of cure incorporating both subjective and objective outcome measures is being utilized, whereas in the latter, the primary outcome was a 1-hour pad test, though secondary outcomes included subjective measures of success.

Others have utilized a similar approach to defining treatment success. Groutz and colleagues (85) combined a questionnaire as a subjective assessment with a 24-hour pad test and voiding diary to assess success of a pubovaginal sling operation, and, predictably, the cure rate using this rigid approach was lower than historically quoted values. It seems clear that a rigid system such as this may provide more realistic outcome data for most women, though it may underestimate success in women who have dramatic improvement albeit with some persistent leakage. Although overall, it is true that most patients may perceive questionnaire results as the most important outcome following incontinence procedures (86), surveying multiple domains, including both subjective and objective measures, seems to be the most reliable means of assuring continued improvement in the therapies we offer patients.

Conclusion

To improve treatment for women with incontinence, it is imperative to do further studies to enhance current assessment practices. Outcome assessment has evolved over the past few decades and must continue to do so. This is particularly true for a disease entity such as incontinence, for which the desired goal is enhanced lifestyle rather than enhanced survival. For this reason, worsening a patient's symptoms or creating new, unexpected symptoms are not acceptable outcomes. Therefore, assessing other domains potentially affected, such as sexual function, and also investigating for the development of new urinary symptoms must be incorporated into standard outcome assessment in addition to an analysis of the cure of urinary leakage. Existing tools can be modified, and new ones should emerge to evaluate these other domains.

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Part III

Surgery for Urinary Incontinence

8

Transvaginal Surgery for Stress Urinary Incontinence Owing to Urethral Hypermobility

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Ideally, the choice of surgery for stress urinary incontinence should be determined by the underlying pathophysiology. Generally, the diagnosis is refined to either urethral hypermobility (UHM) or intrinsic sphincteric dysfunction (ISD) based on history, questionnaires, physical exam, and various special tests including assessment of urethral mobility (Q-tip test or lateral cystogram), stress test, pad test, and video or nonvideo urodynamic studies. Unfortunately, there is no gold standard test or algorithm to allow diagnostic precision in every case, and the diagnosis is usually arrived at based on various combinations of the above investigations along with clinical acumen and experience. Nonetheless, the importance of arriving at the correct diagnosis lies in its role in determining the appropriate surgical intervention. Although this principle of practice has been challenged more and more in recent years (1,2), traditionally, UHM is treated with one of the bladder neck suspensions (BNSs) and ISD with one of the sling procedures, urethral bulking agents, or artificial urinary sphincter. For UHM, once the diagnosis is made, one must decide on the appropriate BNS, for which there exist two main types based on surgical approach: retropubic or transvaginal. Differences in efficacy aside, the decision to proceed with one approach or the other should be driven by any associated pathology requiring concomitant surgical repair. For example, if concomitant vaginal repair of a symptomatic rectocele is undertaken, then a transvaginal anti-incontinence procedure is appropriate. Conversely, if an abdominal hysterectomy is required, then a retropubic approach is logical.

There are many advantages of a vaginal approach to anti-incontinence surgery (Table 8.1). The ability to perform a vaginal procedure to target UHM not only provides the surgeon the flexibility to minimize surgical incisions when concomitant procedures are performed, but also eliminates a larger, more painful abdominal incision required in retropubic procedures. This may be an important issue in the frail, older patient in whom any restriction in postoperative mobility owing to incisional pain could prove significant. The option of a transvaginal approach is also useful in patients in whom an abdominal

incision may provide less than optimal exposure, such as in a severely obese patient, or when there is a need to avoid incising near a femoral–femoral bypass graft or over a prior abdominoplasty or hernia repair. Conversely, an abdominal approach may be necessary when the dorsal lithotomy position is contraindicated as in severe scoliosis, osteoarthritis, or lower extremity contractures. Ultimately, however, the approach taken often is dictated by surgeon experience and preference, regardless of the specific advantages or disadvantages to the patient.

A number of transvaginal needle suspensions and vaginal wall "slings" have been described over the years since the earliest description by Pereyra (3) in 1959. At that time, the goal was to devise a transvaginal procedure capable of replicating results of the retropubic bladder neck suspensions developed 10 years prior (Table 8.2). Although many of these procedures have undergone modifications to improve efficacy and simplify surgical technique, in principle they all remain similar in that the goal is to support the bladder neck using suture tied over the rectus sheath. This chapter describes the operative techniques and outcomes of these various procedures as well as the rationale for their development. A detailed description of the evolution and technique of the anterior vaginal wall suspension (AVWS) will synthesize some of the ideas born from the development of and experience with earlier techniques.

Table 8.1. Advantages of the vaginal approach compared to the abdominal approach for incontinence surgery

1. Ability to perform concomitant transvaginal procedures through a single incision/approach, such as other prolapse and hysterectomy
2. Optimization of operative exposure in obese patients
3. Reduction of postoperative morbidity
   Pain
   Mobility
   Total recovery time
4. Facilitate surgery in unusual circumstances, such as femoral–femoral vascular bypass graft and to avoid incising prior abdominoplasty

Table 8.2. History of the development of bladder neck suspension (BNS) procedures for incontinence

1880s	Hypermobility of the bladder neck and proximal urethra is recognized to be associated with incontinence, while elevation/fixation of these structures is shown to improve continence.
1914	Howard Kelly describes the Kelly plication, which is later modified to the anterior colporrhaphy, whereby midline plication of the pubocervical fascia elevates the bladder neck and improves continence. Poor long-term cure rates, however, prompt development of BNS procedures.
1949	The Marshall-Marchetti-Krantz (MMK) procedure is the first retropubic BNS described to "restore the bladder neck to a high retropubic position." Complications of urethral obstruction and osteitis pubis prompt development of the Burch BNS.
1960	Burch modifies the MKK by placing sutures more laterally in the paravaginal tissue resulting in a lower incidence of urethral obstruction while providing the advantage of concomitantly repairing any low-grade cystocele.
1959	Pereyra describes first transvaginal BNS utilizing a trocar and wire sutures.
1973	Stamey introduces the use of cystoscopy to ensure atraumatic and anatomically correct placement of sutures during BNS. A Dacron pledget is used to prevent suture pull-through.
1978	Introduction of the double-pronged ligature carrier by Cobb and Ragde decreases the number needle passes required and ensures a consistent fascial bridge over which suspension sutures can be tied.
1981	Raz modifies the Pereyra BNS and describes the "Raz needle suspension." An inverted-U incision facilitates more lateral dissection away from the urethra, thereby avoiding outlet obstruction, and simplifying entry into the retropubic space. This also allows placement of sutures through the urethropelvic ligament under direct vision and facilitates freeing of the bladder neck and proximal urethra from adhesions or scar.
1987	Gittes describes the no-incision technique BNS and emphasizes the potential for performing these procedures under local anesthesia in an outpatient setting.
1989–1996	Raz modifies the needle suspension to describe the "vaginal wall sling" using an in situ patch of vaginal epithelium suspended by four sutures.
1996	The four-corner anterior vaginal wall suspension is described by Raz with the goal of supporting the entire vaginal wall, including correction of minimal to moderate cystocele.
1997	Modifications of the four-corner anterior vaginal wall suspension by Leach and Zimmern result in the four-corner BNS for correction of SUI with mild to moderate cystocele.

Indications for Transvaginal Bladder Neck Suspension Procedures

A transvaginal bladder neck suspension procedure is indicated in a patient with stress urinary incontinence owing to urethral hypermobility (i.e., anatomic stress incontinence) who has failed a trial of conservative measures. In addition to a basic history and physical exam, the severity of incontinence can be gauged using a number of subjective and objective measures. These include validated questionnaires, voiding diaries, stress tests, pad tests, urodynamic studies with Valsalva leak point pressure measurements and/or urethral pressure profilometry, and outcome scores. Specific attention should be paid to the impact of incontinence on quality of life, and this "bothersomeness" factor should weigh heavily in the decision to proceed to surgery. Although controversial, mixed urinary incontinence is not a contraindication to bladder neck suspension, provided urethral hypermobility has been demonstrated and a trial of pharmacologic therapy has been undertaken. Patients do need to be advised, however, regarding the risk of persistent urge incontinence and possible need for continued pharmacologic therapy postoperatively. Stress incontinence owing to intrinsic sphincteric deficiency is not generally well managed with suspension procedures, as adequate urethral coaptation cannot be achieved without the risk of compromising voiding function.

Patient Preparation

Informed consent should be obtained by providing the patient with a detailed description of the procedure and its risks and benefits. This discussion should address expected cure rates, recurrence rates, and risks of persistent or de novo urgency, urge incontinence, voiding dysfunction, secondary prolapse, and dyspareunia. In addition to the general complications of anesthesia and surgery, the risks of specific complications such as injury to the bladder, urethra or ureter, and vaginal fistula should be mentioned. Hospital admission following an uncomplicated transvaginal bladder neck suspension without concomitant procedure(s) generally varies from same-day discharge to 48 hours. Full recovery typically requires 2 to 3 months during which time activities are limited, in particular heavy lifting, straining, and sexual activity. Analgesia requirements are usually minimal, requiring at most a mild oral narcotic with an antiinflammatory agent.

Infection risk is minimized by confirming a negative urine culture preoperatively and administration of perioperative antibiotics (usually a first-generation cephalosporin or ampicillin plus gentamicin). A vaginal douche and a limited bowel preparation with an enema are recommended the night prior to surgery.

Anesthesia, Patient Positioning, and Instrumentation

Transvaginal bladder neck suspension procedures may be performed under general, regional (epidural or spinal), or, rarely, local anesthesia. Patients are positioned in the dorsal lithotomy position using either candy-cane or adjustable stirrups, with care taken to pad pressure points appropriately and avoid exaggerated joint flexion and extension to minimize the risk of soft tissue and nerve injury. Compression stockings and pneumatic compression devices are important to minimize the risk of deep vein thrombosis with lithotomy position.

Essential instrumentation for vaginal surgery for incontinence is not extensive. Optimization of exposure is achieved by the use of a self-retaining vaginal ring retractor (e.g., Scott, Lone Star Medical Products, Stafford, Texas; Turner-Warwick Retractor, London, UK), weighted vaginal speculum, and, occasionally, a headlight. A double- or single-pronged ligature carrier (e.g., Raz, Stamey, or Pereyra needle) is required for suture passage. If a suprapubic catheter is required, this can be placed with either a curved Lowsley (4) or a punch suprapubic tube set.

Pereyra Suspension

Pereyra (3) described the first transvaginal bladder neck suspension in 1959. This procedure introduced the idea of passing suture material through the retropubic space using a long trocar-ligature carrier, thus eliminating the larger incision and retropubic dissection required for the Marshall-Marchetti-Krantz and Burch suspensions. The original procedure utilized stainless steel wire, which was passed

through a suprapubic incision to the vagina where it was passed back through the same suprapubic incision on the contralateral side, leaving the wire encircling the vaginal wall. The wire was tied over the rectus fascia and removed later in a separate procedure. Cystoscopy was not utilized. Although a 90% (28/31) success rate at a mean follow-up of 14 months was reported initially, longer follow-up revealed a large proportion of failures related to pull-through of the wire sutures.

Several modifications using different suture material and vaginal incisions were subsequently described. In 1967, Pereyra and Lebherz (5) reported a modification using No. 1 chromic catgut sutures, a midline vaginal wall incision, and a concomitant Kelly-type placation. A cure rate of 94% was reported in 210 patients with follow-up of 12 to 24 months. Similarly good results, however, could not be reproduced by others including Crist et al (6) and Kursh et al (7), who reported cure rates of 54% and 44%, respectively.

The procedure known as the modified Pereyra (8,9) is the result of even further modifications described in 1978. These included detachment of the endopelvic fascia from the pubic rami to improve mobilization of the bladder neck and proximal urethra such that the pubourethral ligaments could be exposed and included during suture placement. An 85% cure rate and 7% improved rate in 82 patients was reported for a follow-up of 4 to 6 years.

When Raz (10) described his modification of the Pereyra suspension in 1981, one of the key features was an inverted-U anterior vaginal wall incision that facilitated more lateral dissection away from the urethra and simplified entry into the retropubic space. Unlike the original Pereyra procedure, the Raz needle suspension used non-absorbable monofilament suspension sutures (No. 1 polypropylene) and routine cystoscopy. The initial report in 1981 described a 96% cure rate in 100 patients. Similarly promising results were reported in 1992 for a cohort of 206 patients with a mean follow-up of 15 months and success rate of 90% (cure or rare stress incontinence not requiring pads) (11). In 1988, Leach (12) described bone fixation of the suspension sutures, a modification aimed at reducing suprapubic discomfort postoperatively.

More contemporary reviews of outcomes after the Pereyra suspension have utilized patient questionnaires, and, not unexpectedly, these have yielded less impressive results. Trockman and coworkers (13) reported long-term results after modified Pereyra suspension in 177 patients with a mean follow-up of 9.8 years. Although questionnaire analysis revealed poor results with rates of 20% for no incontinence of any type and 49% for cure of stress incontinence, it is important to recognize that the definitions used were very strict and data were collected over the phone without opportunity for physical exam or urodynamic studies. Others have reported similarly poor cure rates after modified Pereyra suspension based on outcomes analysis; cure rates for stress incontinence of 51% at a median of 3.5 years was reported by Kelly et al (14) and 47% at a mean of 2.1 years by Korman et al (15). Sirls et al (16) compared retrospective chart-based review with questionnaire-based outcomes after modified Pereyra suspension and found 72% cure and 89% improved rates based on chart review compared to 47% cure and 64% improved based on questionnaire analysis.

Stamey Endoscopic Needle Suspension

The Stamey bladder neck suspension, initially described in 1973 (17), was designed to be a less morbid and technically simpler procedure compared to the Pereyra suspension. Stamey introduced the routine use of cystoscopy to ensure atraumatic and anatomically correct placement of the suspension sutures at the bladder neck. To reduce the risk of suture pull-through, a novel technique was used in which Dacron pledgets (1-cm-length tube of 5-mm Dacron arterial graft) were placed to support the No. 2 monofilament suspension sutures in the periurethral tissues. Similar to previously described transvaginal bladder neck suspensions, sutures were transferred from the vagina using blind passage of a blunt needle (straight, 15 or 30 degrees). Unlike the modified Pereyra procedure, the retropubic space was not developed, resulting in a "less invasive" procedure. Although the original description of the procedure mandated "considerable tension" on the tied suspension sutures, subsequent descriptions have used minimal or no suture tension to minimize the risk of urethral obstruction (18,19).

In 1980, Stamey (20) reported a cure rate of 90% in 203 patients with follow-up from 6 months to 4 years. Others have reported cure

rates of 53% to 82% based on retrospective chart reviews (21–25) whereas questionnaire-based cure rates were significantly less at 40%. (16) As expected, similar to observations on the Pereyra procedure, longer-term follow-up combined with questionnaire outcomes analysis revealed less optimistic results; O'Sullivan et al (26) reported on 28 women with at least 5 years' follow-up and only 18% were dry, whereas in 251 patients with mean follow-up of 42 months, Knispel et al (27) reported a 39% cure rate. The most frequent complication was postoperative urgency at a rate of 70% in a series of Stamey suspensions reported by Clemens et al (28). Wang (29) reported a significant rate of urodynamically demonstrated outlet obstruction in these patients. Less common complications included suture abscess (12%), urinary retention (7%), and chronic suprapubic pain (10%) (25).

A variation of the Stamey procedure is the Gittes "no-incision" transvaginal needle suspension, first described by Gittes and Loughlin (30) in 1987. The procedure is similar to the Stamey operation, except that (1) no vaginal incision is made, and (2) the Dacron pledget is not used. These modifications were intended to make the procedure less invasive and eliminate the infectious risk of Dacron bolsters. The suspension sutures are placed on a free needle and passed through the full thickness of the anterior vaginal wall before suprapubic transfer, with the expectation that the monofilament suture will pull through the vaginal wall and subcutaneous tissues when placed under tension. Overall success rates of 84% were reported in 1990 by Loughlin et al (31) for an 8-year experience in 125 patients. Others, however, have not been able to replicate these results, with success rates as low as 44% at 14 months' follow-up (32). Elkabir and Mee (33) reported on a series of 87 patients with median follow-up of 46 months; of 55 patients who responded to a mailed questionnaire, 24% reported no leakage and 27% reported improvement, with most failures occurring within 2 years.

Bone-Anchored Bladder Neck Suspension

The bone-anchored bladder neck suspension (BABNS) utilizes pubic bone fixation in place of rectus suprafascial fixation of the suspension sutures. The primary goal of this modification was to provide a fixed anchoring point to, theoretically, prevent Valsalva-induced tension on the suspension sutures and subsequent suture pull-through. Although bone anchors were originally described for suprapubic placement (Duratak, Davis and Geck, St. Louis, MO; Vesica, Microvasive/Boston Scientific Corp., Natick, MA), vaginal bone anchoring devices are also now available (In-Fast System, Influence Medical Technologies Ltd., San Francisco, CA). In addition, modifications were made to reproducibly limit suture tension by use of a removable suture spacer during tying. Other advantages included the option of performing the procedure under local anesthesia and the potential for less pain at the anchor site compared to conventional suprafascial fixation.

Although bone anchor techniques may be used with any of the described vaginal suspensions, a popular technique, based on the Gittes suspension, was described by Benderev (34) in 1994. The procedure involves placement of suprapubic bone anchors and a Z stitch through the full thickness of the anterior vaginal wall and pubocervical fascia using a specially designed suture carrier. Results of this technique were reported in 53 women of whom 92% were cured at a mean follow-up of 15 months. Leach and Appell (35) reported 12-month results on 125 women with genuine stress incontinence with a 95% cure rate for stress incontinence. Longer-term follow-up on this same group of patients, however, was less impressiveh—at 3 years the cure rate declined to 82%. Using questionnaire analysis, others have shown only 43% and 24% dry and improved rates, respectively, at 6 to 18 months (36). With a modification using vaginally placed nickel titanium alloy bone anchors, Nativ's group (37) reported an 82% dry rate and 14% rate of a 50% decrease in pad use.

Anterior Vaginal Wall Suspension

Evolution

The number of bladder neck suspension procedures described over the last 60 years reflects a continuous effort to improve on prior techniques. The anterior vaginal wall suspension (AVWS) is the end result of careful study of the inadequacies and the strengths of its many predecessors. The central concept on which the AVWS is based was originally put forth by Raz,

who recognized that failure of many anti-incontinence procedures derived from a failure to address the vaginal wall as a whole; procedures corrected either anterior vaginal wall prolapse (e.g., Kelly-type plication) or urethral hypermobility (e.g., Marshall-Marchetti-Krantz bladder neck suspension), but not both. Because urethral hypermobility-related incontinence and cystocele frequently occur concomitantly or "potentially" (after repair of one or the other), Raz believed that bladder-base descent and urethral hypermobility must be corrected at the time of cystocele repair regardless of the presence or absence of incontinence. At the time, there were no transvaginal procedures that addressed both components of the anterior vaginal wall. The Burch colposuspension was the only bladder neck suspension procedure that approximated this "ideal" technique. Thus, Raz proceeded to describe several transvaginal bladder neck suspension techniques based, initially, on a modification of the Pereyra suspension reported in 1981.

In this original modification of the Pereyra BNS, referred to as the "Raz needle suspension," support was provided to the anterior vaginal wall from the level of the mid-urethra to the bladder neck, thereby correcting urethral hypermobility without supporting the proximal anterior vaginal wall. Nonabsorbable suture was placed in the urethropelvic ligament in a helical fashion, and then secured to the anterior rectus fascia after retropubic dissection to free any scar and facilitate avoidance of bladder or vascular injury during passage of a single- or double-pronged ligature carrier. Lateral dissection away from the urethra through an inverted-U vaginal incision not only simplified entry into the retropubic space, but also avoided the sequelae of placing suspension sutures too medially (i.e., urethral obstruction), as in the Marshall-Marchetti-Krantz (MMK) bladder neck suspension. In this way, Raz had developed the first transvaginal procedure that approximated what the Burch procedure did through an abdominal approach. Several variations with the same goal of curing stress incontinence by providing support to the proximal urethra and bladder neck were subsequently described including the "vaginal wall; slings" in which suspension sutures were placed bilaterally at two sites: (1) the bladder neck, incorporating the vesicopelvic fascia, urethropelvic ligament, and anterior vaginal wall; and (2) the midurethral segment, incorporating the site of insertion of the levator ani, medial edge of the urethropelvic ligament, and anterior vaginal wall.

Further modifications extended the anterior vaginal wall support from the original sites at the proximal urethra and bladder neck, maintaining correction of urethral position and support, to include the proximal anterior vaginal wall or cystocele base, thereby additionally correcting any clinically evident or potential cystocele. This technique, referred to as the "four-corner bladder and bladder neck suspension procedure," was described in 1989 in a series of 120 patients with moderate cystocele, of whom 93 were also diagnosed with genuine stress incontinence. With mean follow-up of 2 years, excellent cure rates of 94% and 98% were obtained for subjective correction of incontinence and cystocele, respectively. In addition, obstruction was relieved in 83% (10 of 12 patients), preoperative bladder instability improved in 54% (13 of 24 patients), and de novo instability occurred in 5%. Despite these promising results, however, longer follow-up ultimately revealed a significant cystocele recurrence rate.

Upholding the original premise of the Raz four-corner suspension, Leach and Zimmern made further modifications that sought to broaden the anchor of the anterior vaginal wall, with the ultimate goal of improving the durability of the repair. It was hypothesized that failure occurred due to inadequate anchoring of the suspension sutures; specifically, there was inadequacy of one or more of the following: the method of suture placement, the strength of the tissue into which sutures were placed, the physical characteristics of the suspension material, development of fibrosis around the suture, or a combination of these factors. Experimental findings in a rabbit model reported by Bruskewitz et al (38) suggested that loops of suture material resulted in a lower incidence of tissue pull-through and tension loss over time, theoretically related to a lower initial tension and a greater cross-sectional area of the anchor material. With these findings, Zimmern et al (39) described a version of the four-corner bladder neck suspension in which sutures were placed in a helical fashion and incorporated broadly into the full thickness of the vaginal wall (without the epithelium) at both the bladder neck and cystocele base. The proximal set of sutures included the cardinal ligaments in the presence of a uterus, or scar at the vaginal cuff if hysterectomy had been

performed; these served to correct anterior vaginal wall prolapse while also providing a more even distribution of suture tension and protection of the bladder neck repair. The bladder neck sutures did not include the urethropelvic ligament, as in the Raz procedure, as this structure was thought to be "usually extremely tenuous" and suture placement at this site was associated with risk of iatrogenic ureteral obstruction. Results for this procedure were reported in 1997 for a mean follow-up of 37 months with an 83% subjective cure or improvement rate for incontinence but 57% recurrence for grade 1 to 2 cystocele based on both physical exam and objective measurement on standing cystogram (40). A central defect was responsible for cystocele recurrence in most cases and was postulated to have occurred as a result of suture pull-through from the cardinal ligament complex or apical cuff.

In the development of the current procedure, the AVWS, efforts have been made to optimize the techniques of previously described transvaginal suspension procedures while remaining true to the original concept proposed by Raz. A description of the indications, technique, and outcomes for the AVWS follow.

Indications

The AVWS is indicated in patients with stress urinary incontinence secondary to urethral hypermobility alone, or associated with a mild to moderate cystocele owing to a lateral defect. The two pairs of suspension sutures, proximal and distal, act to correct the cystocele and urethral hypermobility, respectively. The procedure is not indicated in cases of intrinsic sphincteric deficiency with a well-supported urethra, as sufficient urethral coaptation is not achieved. Recurrent incontinence after prior anti-incontinence surgery, however, is not a contraindication, provided urethral hypermobility has been demonstrated. A Valsalva leak point pressure threshold of 50 cmH_2O has been suggested as a guide to determining whether a sling or suspension is appropriate (41). The standing voiding cystourethrogram with lateral views allows an objective assessment of urethral mobility by facilitating measurement of resting and straining urethral angles, as well as size and configuration of an associated cystocele (42).

Although a grade III to IV cystocele was believed to be a contraindication for the AVWS during our initial experience with the technique, more recently indications have been successfully extended to use in patients with a large cystocele. Other options to treat a large cystocele and urethral hypermobility include anterior colporrhaphy plus bladder neck suspension (e.g., distal set of AVWS sutures only) or "goal post" technique (43). More recent experience has also been successful in combining the AVWS with a "classic" pubovaginal sling in patients with cystocele and stress incontinence owing to intrinsic sphincteric deficiency rather than urethral hypermobility.

Given that there is no indication for hysterectomy, that uterine descent is only mild to moderate, and that the patient desires preservation of the uterus, the proximal pair of suspension sutures can be placed securely in the cardinal ligaments to reposition the cervix. With more advanced uterine descent (i.e., to the level of the distal third of the vagina or beyond), vaginal hysterectomy is generally recommended.

Operative Technique (Figures 8.1 to 8.3)

The patient is placed in a high lithotomy position using candy-cane stirrups, and the lower abdomen, perineum, and vagina are prepped and draped. A Scott ring retractor (Lone Star Medical Products) is placed to aid exposure. A 16-French urethral Foley catheter with the balloon inflated to 10 cc allows for identification of the bladder neck by palpation, and this site is marked transversely with an ink pen to identify the distal limits of the anterior vaginal wall plate. The cervix or vaginal apex/cuff (if prior hysterectomy) will comprise the proximal limit of the plate, and marking sutures are placed at this site in the midline and 1.5 to 2 cm on either side. A longitudinal incision is initiated 1.5 cm lateral to the bladder neck on the vaginal wall and extended proximally to the apical/cervix marking suture on the same side. The same incision is made on the contralateral side. These incisions deviate slightly lateral more proximally, resulting in a trapezoidal configuration of the anterior vaginal wall plate. The dimensions of the anterior vaginal wall between the incisions are approximately 3 cm in width and 4 to 8 cm in length, accounting for normal anatomic variability. In the presence of a moderate

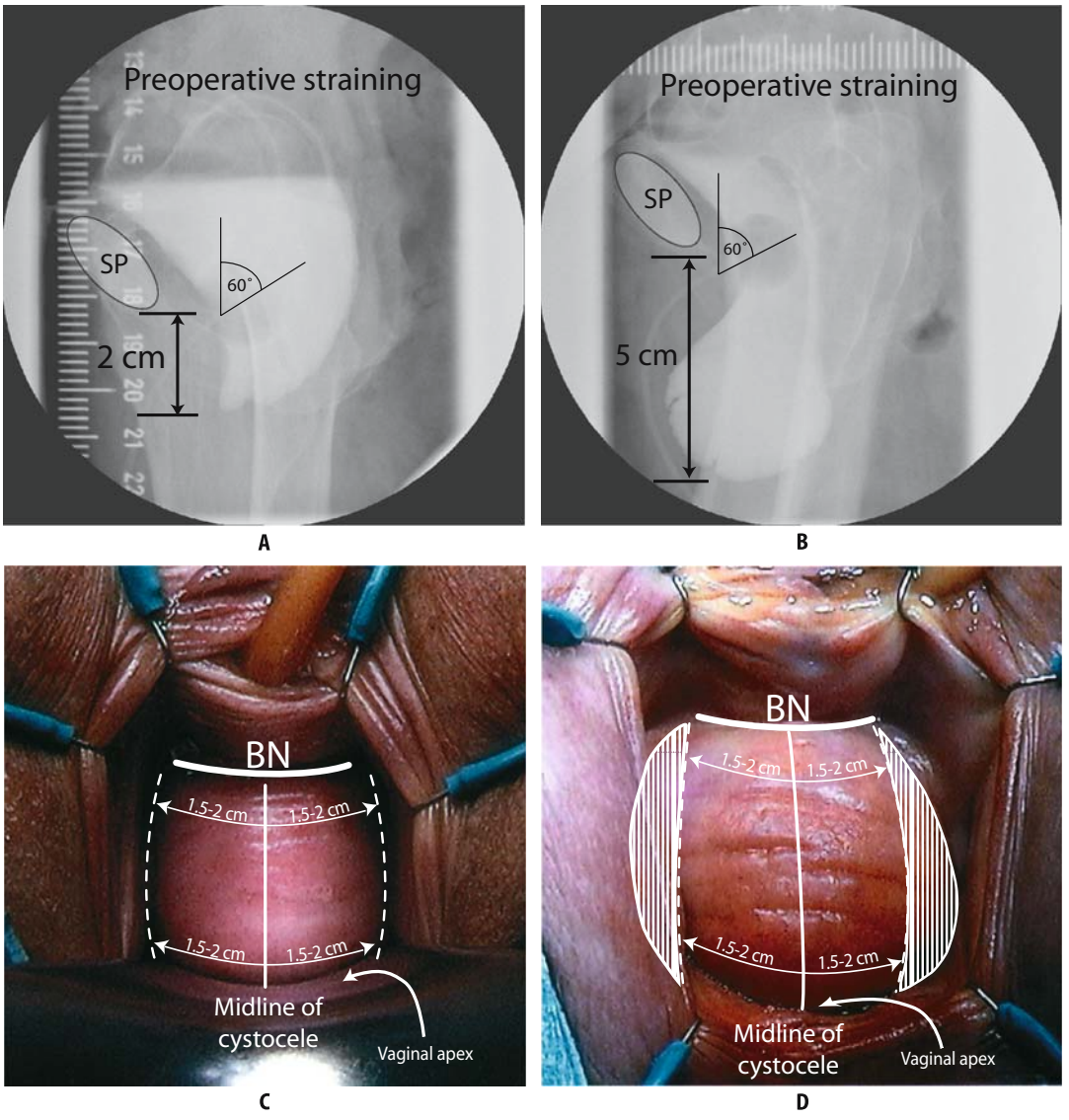
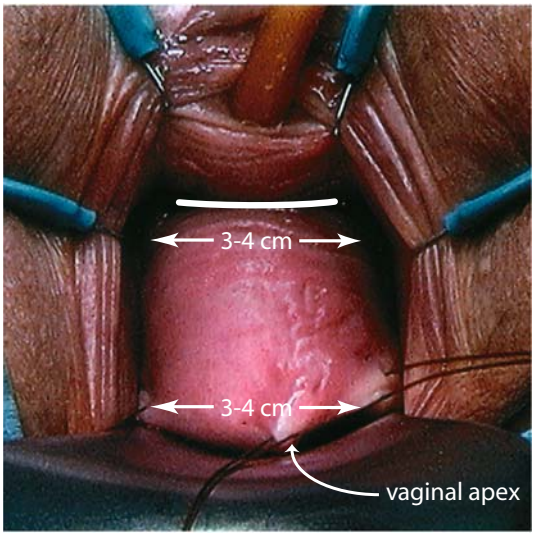


Figure 8.1. Surgical technique of the anterior vaginal wall suspension. Intraoperative photos and pre- and postoperative standing voiding cystourethrogram (VCUG) images illustrating the technique and anatomic outcomes after anterior vaginal wall suspension (AVWS) performed for incontinence with urethral hypermobility in the presence of a small/moderate-size (left) or large (right) cystocele.
A,B: lateral standing VCUG images objectively demonstrate urethral hypermobility on resting and straining lateral views (straining view only shown). The urethral angle at straining is indicated. A moderate-size cystocele is shown in A and a large cystocele in B. Cystocele grade on VCUG is measured on the straining views (grade I <2 cm, grade II 2–5 cm, grade III >5 cm below the symphysis pubis [SP]).
C,D: Superimposed markings on preoperative photos indicate key anatomic landmarks: the bladder neck (BN), vaginal apex, and lateral vaginal sulci. The midline of the anterior vaginal wall between the lateral sulci is marked from the BN to vaginal apex to allow precise measurement of the in situ anterior vaginal wall plate, which is created between two longitudinal incisions, each 1.5 to 2 cm lateral to the midline. For a small/moderate size cystocele, only the lateral incisions are made, while for a large cystocele, redundant AVW skin (between the lateral sulci and longitudinal incisions of the in situ AVW plate) is marked for excision so as to prevent redundancy after closure.



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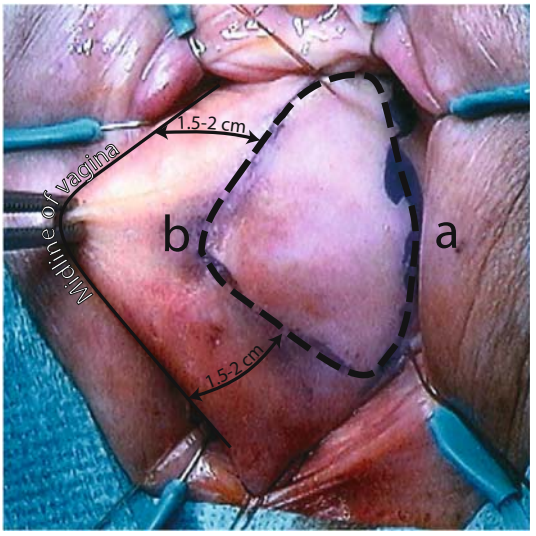

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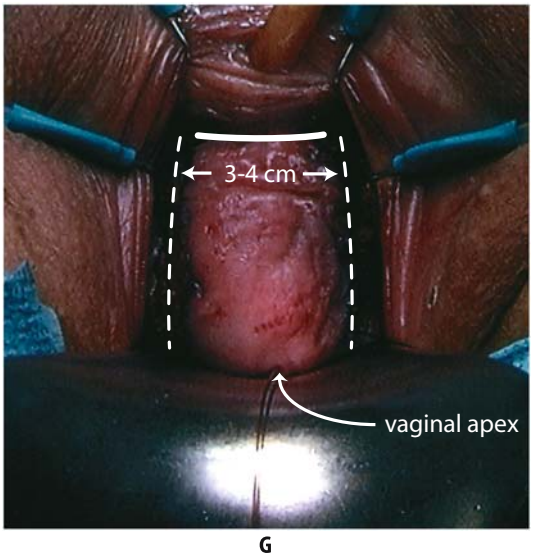

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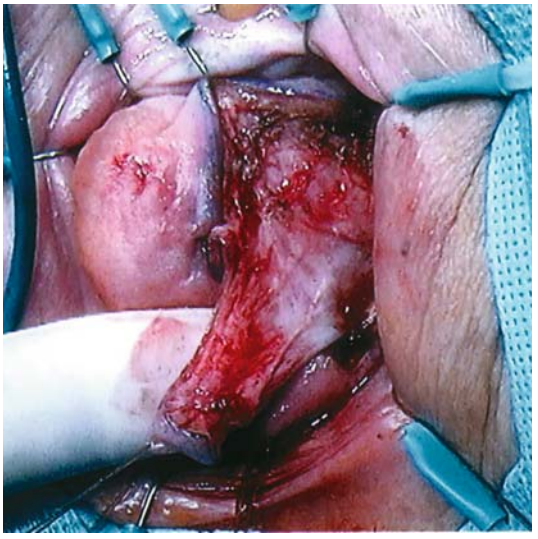

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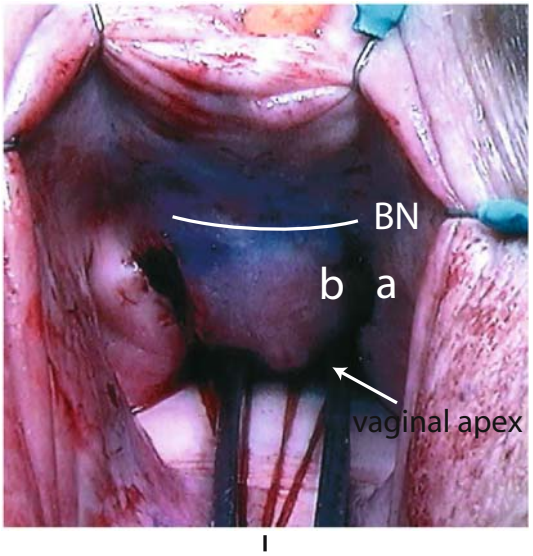

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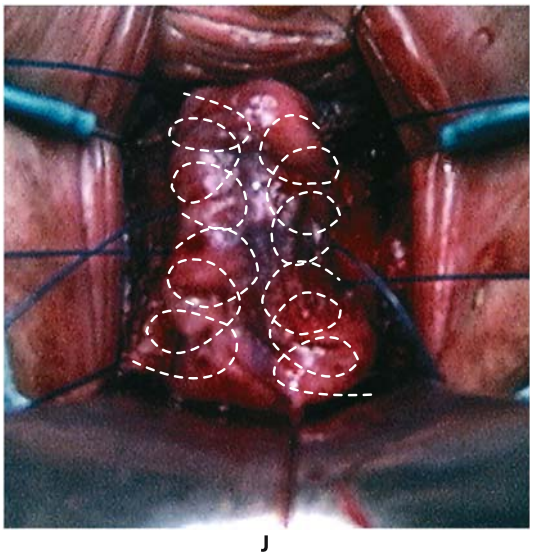
Figure 8.1. E–H: The BN and vaginal apex are marked with a marking pen and three chromic sutures (midline and 1.5–2 cm on either side), respectively, for both small/moderate and large cystoceles (E). Redundant lateral AVW skin between point *a* and *b* is excised bilaterally for large cystoceles only (F,H). The lateral aspect of the incision is undermined only enough to facilitate closure of the incision later, while no undermining is performed medially on the in situ AVW plate.
I: The final midline AVW plate measures 3 to 4 cm in total width and extends from the BN to vaginal apex. The AVW plate is the same for the small/moderate-size cystocele and large cystocele, regardless of whether of not lateral AVW excision is performed.



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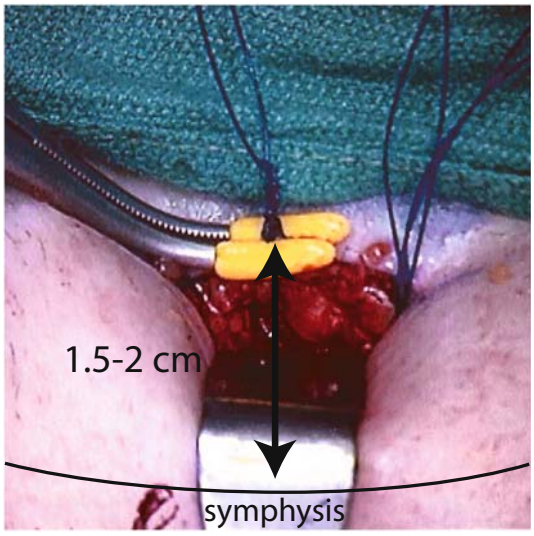

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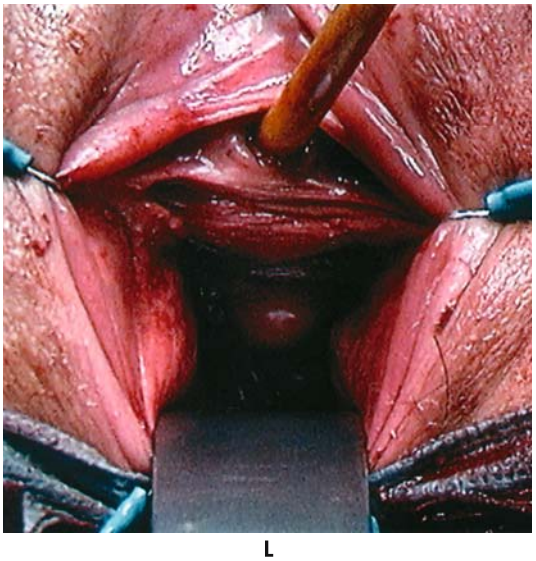

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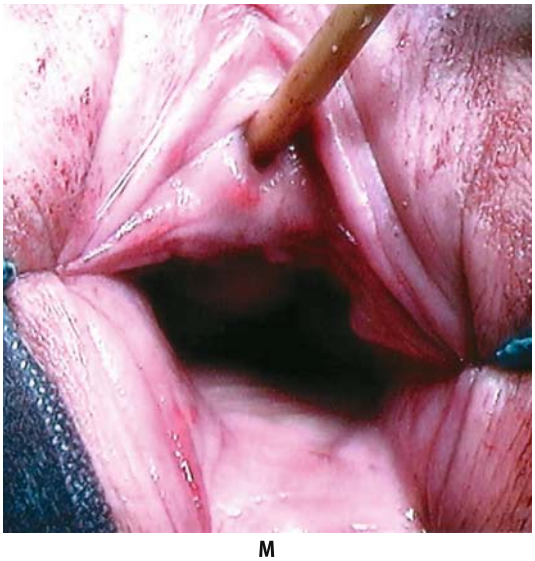

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Figure 8.1. J,K: Four No. 1 polypropylene sutures (taper CT-2 needle, Ethicon D-4412) are placed, one in each equal quadrant of the in situ AVW plate (J). Each suture is passed 3 to 5 mm below the AVW epithelium in a broad, overlapping manner, such that the entire AVW plate is included in the four sutures. Using a double-pronged ligature carrier, each suture is transferred through a 2- to 3-cm suprapubic incision after development of the retropubic space using finger dissection (K). Sutures are tied without tension. A right-angled clamp ensures that each knot is tied at a level of 1.5–2 cm above the insertion of the tendinous rectus sheath on the symphysis pubis.

L–O: Final anatomic results shown on intraoperative photos and standing lateral VCUG views (at 6 months postoperative) demonstrate a well-supported AVW through its entire length for both small/moderate-size (left) and large cystoceles (right). Note the anatomic vaginal axis, absence of secondary cystocele and correction of urethral hypermobility on VCUG.

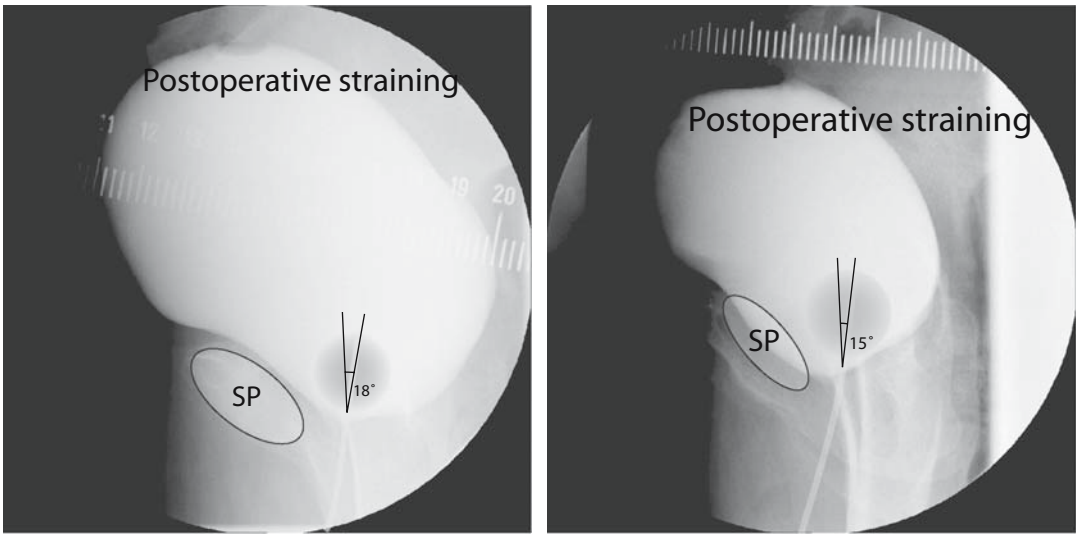

Figure 8.1. *Continued.*

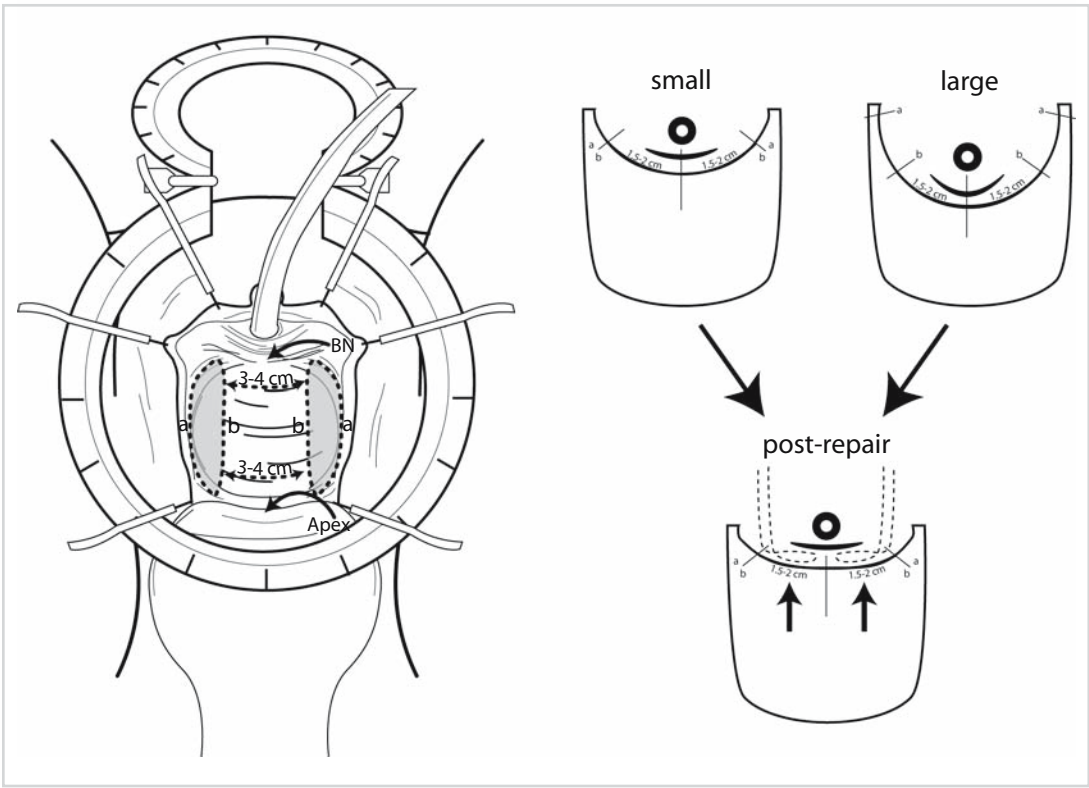

Figure 8.2. Surgical technique of the anterior vaginal wall suspension—schematic. The surgical setup for the anterior vaginal wall suspension (AVWS) with retractor in place is illustrated on the left for the case of a large cystocele in which lateral AVW skin is marked for excision between points *a* and *b*. The final AVW plate is 3 to 4 cm in total width and extends from the bladder neck (BN) to vaginal apex. On the right, cross-sectional diagrams illustrate the AVWS with and without resection of lateral AVW skin (between *a* and *b*) for small and large cystoceles. The final AVW plate and final anatomic result with suspension sutures in place are the same in both cases.

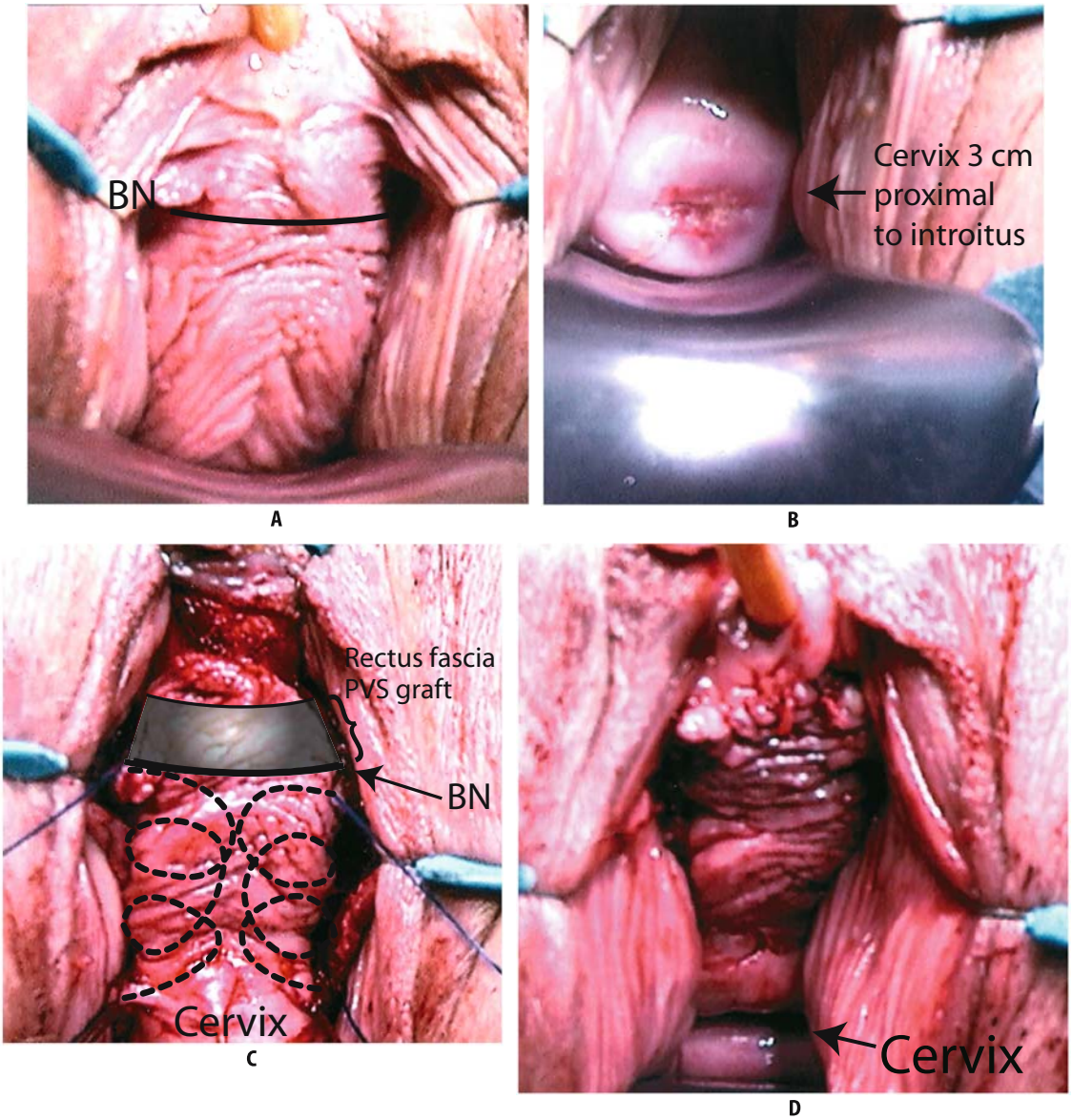

Figure 8.3. Versatility of the anterior vaginal wall suspension, with uterine preservation and "classic" pubovaginal sling for intrinsic sphincteric deficiency. Operative photos demonstrate the use of the anterior vaginal wall suspension (AVWS) in a patient with stress urinary incontinence due to intrinsic sphincteric deficiency as well as a moderate-size cystocele. In addition, this patient desired uterine preservation. Preoperative photos show a grade II/III cystocele (A; BN, bladder neck) and cervical position after placing distal traction (B). The cervix does not descend beyond the distal third of the vagina—the criterion for uterine preservation. The upper anterior vaginal wall (cystocele) is supported by a single pair of helically placed sutures, which incorporate the cardinal ligaments at the proximal aspect. Distally, an autologous fasical pubovaginal sling is placed beneath an inverted-U vaginal flap, which extends off the proximal AVWS longitudinal incisions bilaterally. Both pairs of sutures are passed suprapubically. Final anatomic result demonstrating a well-supported AVW through its entire length, from the bladder neck to the cervix (D). PVS, Pubovaginal Sling.

to large cystocele (Baden-Walker grade >II or POP-Q stage >II) with lateral detachments and central defect, excision of a segment of vaginal wall lateral to each of the two longitudinal incisions (corresponding to the lateral detachment) is performed to eliminate redundancy and reconstitute the lateral vaginal sulci. It is important to preserve 0.5 to 1 cm of anterior vaginal wall lateral to each incision to ensure a tension-free closure.

In preparation for placement of the suspension sutures into the in situ anterior vaginal wall plate, the plate, is divided into equal quadrants using an ink pen. One suture (No. 1 polypropylene on a taper CT-2 needle, Ethicon D-4412, New Brunswick, New Jersey (USA)) is placed in each quadrant. For a right-handed surgeon, the first suture is placed at the proximal extent of the vaginal wall incision on the left side into the scar at the vaginal cuff or cardinal ligament, and run in a helical fashion toward the mid-vagina (half the length of the vaginal wall plate). The helical bites are taken to the midline of the vaginal plate and securely incorporated approximately 3 to 5 mm deep to the epithelium. Each subsequent bite overlaps the preceding one, for a total of three to four passes per suture on average. The second suture on the same side is placed at the mid-vagina, overlapping the end of the first suture, and run in the same manner to the distal extent of the lateral vaginal wall incision. On the right side, two additional sutures are placed similarly, but starting at the distal extent of the incision (bladder neck) and running proximally.

A 2 to 3 cm wide suprapubic incision is made approximately one fingerbreadth above the pubic symphysis in the midline. The incision is deepened to the level of the tendinous insertion of the rectus fascia on the symphysis pubis. The subcutaneous space is developed enough to allow for accurate retropubic passage of the ligature carrier (guiding the instrument with a retropubic finger tip), and for soft tissue coverage of the suture knots. It is important to avoid more lateral dissection to prevent injury to the genital branch of the genitofemoral and ilioinguinal nerves.

To minimize bleeding, development of the retropubic space is performed after both placement of the vaginal wall plate sutures and creation of the suprapubic incision have been completed. With the bladder on full drainage, the dissection is started laterally at the level of the bladder neck. Blunt or sharp dissection may be used, although in our experience the former is adequate unless there has been extensive scarring from prior anti-incontinence surgery. After the endopelvic fascia is perforated, the retropubic space is developed further using a sweeping motion of the index finger in a lateral-to-medial direction. Because one follows the plane of the tear that resulted in the lateral defect, development of this space proceeds without significant resistance and usually with minimal bleeding. After prior surgery, such as a Burch or MMK bladder neck suspension, the risk of bladder injury is greater during both the retropubic dissection and passage of the ligature carrier. When the space is adequately developed, the dissecting finger can be palpated through the suprapubic incision with only rectus fascia and muscle intervening, thus allowing safe passage of the Raz double-pronged ligature carrier under fingertip-guidance. The ends of the suspension sutures are threaded through the eyes of the ligature carrier, which is then withdrawn suprapubically. The procedure is performed twice on each side, allowing transfer of all four suspension sutures from the vagina to the suprapubic incision. Although a Raz double-pronged ligature carrier is preferred, when the patient is significantly obese or there is dense scarring either in the abdominal wall or retropubically, a sharper, single-pronged instrument (Raz or Stamey) may be necessary.

After administration of intravenous indigo carmine, cystoscopy with 30- and 70-degree lenses is performed to confirm the absence of bladder perforation or ureteral injury. If sutures are present in the bladder, they are pulled out via the vaginal incision and repositioned. In case of a small bladder perforation, conservative management with simple urethral Foley drainage for several days is recommended. A larger perforation may necessitate a multiple layer closure in addition to placement of a suprapubic catheter. Duration of drainage should take into consideration the location of the perforation. There is a higher risk of vesicovaginal fistula formation in more dependent cystotomies close to the bladder neck than for more lateral and bladder dome injuries. The former situation is one in which interposition of a fat pad graft may be considered after primary closure and verification of water-tightness. When there is intravesical bleeding, endoscopic fulguration is usually sufficient along with upsizing the Foley catheter or changing to a three-way irrigation catheter in preparation for potential bladder irrigation to prevent clot formation.

The vaginal wall incisions are closed with running 2–0 or 3–0 absorbable sutures. The suspension sutures are tied suprapubically 1.5 to 2 cm above the rectus fascia without tension. This is achieved by securing the suture at the appropriate level with a rubber-shod right-angle clamp. The goal is to support the vaginal wall plate in a horizontal position, preserving the

130-degree, "banana-shaped" normal vaginal axis. In this way, restoration of anatomy without overcorrection of either the bladder neck or apex is achieved and risk of secondary enterocele or rectocele is minimized. An antibiotic-soaked vaginal pack is inserted and the suprapubic incision is closed, ensuring that the polypropylene knots are well buried. On postoperative day one, the vaginal pack is removed and a voiding trial is performed before discharging the patient the same day.

Outcomes and Advantages

The efficacy of the AVWS has been assessed with both subjective and objective outcome measures. In 2000, Lemack and Zimmern (44) reported the results of questionnaire analysis with a mean follow-up duration of 25 months in 61 of 102 patients who responded. Subjective cure or improvement of stress incontinence was obtained in 77%, and response to a quality of life question (analog scale response to the question "If you were to spend the rest of your life with your urinary condition just the way it is now, how would you feel about that?") was significantly improved compared to preoperatively, decreasing from a median score of 6.7 to 2 (0 = pleased, 10 = terrible). De novo incontinence occurred in 8% and diuretic use was the only poor prognostic indicator. Objective outcomes for the AVWS were assessed using the standing voiding cystourethrogram (VCUG) in a study by Showalter et al (42), in which VCUG findings were compared in 76 continent controls and 52 women who had undergone an AVWS for urethral hypermobility and concomitant grade I or II cystocele. At 3 to 6 months postoperatively, there was no difference in urethral angle between the two groups, and a significant reduction in the lateral cystocele height was observed, comparable to that in a group of 36 women who had undergone conventional anterior colporrhaphy for grade III cystocele. Lemack and Zimmern (45) reported on sexual function following AVWS with or without posterior repair of rectocele. Using a mailed questionnaire developed by the authors with a 60% response rate, questionnaire information was obtained for 29 patients who underwent AVWS alone and 27 who underwent both AVWS and posterior repair. There was no difference in the proportion of sexually active women preoperatively compared to postoperatively and a 20% postoperative rate of dyspareunia was noted compared to 29% preoperatively. Overall, the AVWS did not adversely affect sexual function and symptomatic vaginal narrowing was rare.

Beyond the advantages of vaginal procedures over abdominal procedures described elsewhere in this chapter, there are many advantages specific to the AVWS that derive from the technique's rationale. First, the procedure restores anterior vaginal wall anatomy and eliminates UHM without producing secondary anatomic defects. Although prevention of secondary prolapse initially depends on accurate preoperative staging (i.e., identification of existing or potential defects), attention intraoperatively to avoid alteration of the vaginal axis by providing support with minimal tension to the *entire* length of the anterior vaginal wall is critical to restoration of anatomy. The VCUG outcomes following AVWS have objectively demonstrated no difference in urethral angle and bladder base descent between cystograms of postoperative patients and age-matched controls (42). In terms of restoring function, the midterm continence results of the AVWS are comparable to the gold standard of bladder neck suspensions, the Burch colposuspension. Like the Burch procedure, the vaginal wall support of the AVWS is broadly based, secured to a strong anchor (the rectus muscle tendon as it inserts on the posterior pubic symphysis), and involves retropubic dissection to further enhance vaginal support by promoting scar formation. Of equal importance is that voiding function is not sacrificed at the expense of establishing continence. This is achieved by (1) more lateral placement of the vaginal suspension sutures (similar to the Burch procedure) so as to avoid outlet obstruction (as in the MMK), and (2) providing support to the upper vagina to avoid a secondary angulation at the urethrovesical junction. Although results of the AVWS thus far indicate a low reoperation rate for incontinence and cystocele, it is important to recognize that secondary vaginal procedures (e.g., conventional pubovaginal sling) or abdominal (e.g., mesh sacrocolpopexy) are not made more difficult after AWVS as the planes of dissection, particularly the vesicovaginal space, are not significantly altered.

Preservation of sexual function is facilitated by preserving normal vaginal configuration—not only axis, but also length and width. Vaginal support without overtensioning, both

proximally and distally, allows for a normal vaginal axis, whereas vaginal narrowing and shortening are avoided by minimizing vaginal skin excision or advancement and midline plication, which contrasts to other procedures, particularly the anterior colporrhaphy. The option of uterine support in the appropriate patient allows flexibility in the decision for or against vaginal hysterectomy. Finally, the AVWS provides a relatively cost-effective procedure based on operative materials, procedure time (approximately 1 hour), and patient recovery. In this day and age when the use of new technology is often at odds with cost-efficiency demands, a technique such as the AVWS, which uses no expensive materials such as synthetic grafts, heterologous materials, or bone anchors should be a welcome addition to the surgical options available to treat incontinence and cystocele.

Although the procedures utilizing in situ anterior vaginal wall to treat incontinence and anterior prolapse as originally described by Raz in the 1980s are less commonly used today, these basic concepts have been applied to procedures other than the AVWS described in more contemporary series (41,46–53). These "vaginal wall slings" and "four-corner suspensions," despite the common name, can vary considerably in both technical detail and specific clinical indications depending on the author. For example, Su et al (46) applied a modified Raz vaginal wall sling with a broader suture anchor and no retropubic dissection to patients with recurrent genuine stress urinary incontinence without urethral hypermobility, whereas Mikhail and coworkers (53) used a different modification of the Raz vaginal wall sling, eliminating the vaginal U advancement flap, in patients with primary genuine stress urinary incontinence and urethral hypermobility. Others, such as Kaplan et al (50,51) and Appell's group (41) have reported on results after the Raz vaginal wall sling and "in situ sling," respectively, in series that included both patients with anatomic stress incontinence and intrinsic sphincteric deficiency. Variations in outcome measures, in addition to those in technique and indications, make direct comparison of efficacy difficult. Generally, however, these series suggest that continence outcomes are best in women with mild to moderate stress incontinence owing to either urethral hypermobility or ISD, whereas anterior prolapse results are best in those with low- to moderate-grade cystocele. Urodynamic prognostic factors have been identified by several authors. For example, Goldman et al (41) found that a Valsalva leak point pressure of greater than 50 cmH_2O was associated with a continence success rate of 93% after the in situ sling, which was later supported by Kilicarslan et al (52), who found that a Valsalva leak point pressure ≥50 cmH_2O and maximum urethral closure pressure ≥30 cmH_2O were associated with a 91% success rate after the in situ sling.

Conclusion

The AVWS is a reliable surgical option for treating stress urinary incontinence due to urethral hypermobility alone or associated with a cystocele. The transvaginal approach has clear advantages with respect to performing concomitant vaginal procedures as well as short duration of recovery and minimal overall morbidity. In addition, the procedure is short, simple, easy to teach, and cost-effective. The midterm continence and cystocele outcomes are comparable to more well-established bladder neck suspension techniques, and longer-term outcome results are forthcoming.

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9

Stress Urinary Incontinence Secondary to Intrinsic Sphincteric Deficiency

Robert W. Frederick and Gary E. Leach

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Intrinsic Sphincteric Deficiency

Surgical management of stress urinary incontinence (SUI) has evolved over the last 20 years. Numerous procedures have been introduced and modifications to established procedures have been reported in the literature. Our understanding of the female continence mechanism has evolved as well. Currently, female SUI is attributed to urethral hypermobility, intrinsic sphincteric deficiency (ISD), or a combination of both conditions. This chapter focuses on the surgical management of SUI due to ISD.

Definition

In 1980, McGuire et al (1) described the concept of intrinsic urethral insufficiency through fluoroscopic observations during urodynamics testing. They observed that some patients with SUI had a deficient sphincteric mechanism characterized by an open bladder neck and proximal urethra at rest, with minimal or no urethral descent during stress. Ghoniem et al (2) later described three grades of ISD based on videourodynamics and abdominal leak-point

pressures (ALPP). The most obvious type of ISD (ISD-C), in their description, was that of an open, fixed, nonfunctioning (pipe-stem) urethra with a high position of the bladder neck, and an ALPP of <70 cmH_2O. The second type (ISD-B), which was most common in their series, was characterized by a beak-shaped, open bladder neck at rest, and an ALPP <90 cmH_2O. The subtlest type (ISD-A) was the most difficult to diagnose, because the bladder neck was not open at rest, and it could only be diagnosed by videourodynamics. The ALPP was lowest in this group, <12 cmH_2O, and fluoroscopic visualization of the bladder neck revealed that upon straining, the bladder neck would open and contrast would appear in the urethra, indicating an incompetent intrinsic sphincter under stress. In their series, all three subtypes of ISD had proximal urethral closure pressures <10 cmH_2O.

Diagnosis

Currently, there is no single test that can confirm the presence of ISD. A satisfactory patient history will detect those at greatest risk for ISD as a contributing factor to their SUI. Common causes of ISD are found in Table 9.1 (3). Pelvic examination should be performed, looking for evidence of estrogen deficiency and/or urethral hypermobility as indicated by an upward movement of the urethral axis greater than 30 degrees from the resting angle with stress (4), although it is very important to note that ISD may be concurrently present in patients with urethral hypermobility (5).

Urodynamic testing may be suggestive of ISD by a Valsalva leak point pressure less than 60 cmH_2O (6) or a maximum urethral closure pressure less than 20 cmH_2O (7,8). But overall, there is poor correlation between these two urodynamic measurements (6,9) and they lack reliable reproducibility, making their usefulness as stand-alone indicators of ISD marginal at best. Fluoroscopic visualization of the bladder neck during urodynamic testing typically reveals an open bladder neck at rest (1), and can augment the physical examination in the assessment of urethral hypermobility. Urodynamic testing is particularly important in patients with neurologic causes for their voiding dysfunction or a history of pelvic radiation so that bladder-filling abnormalities, such as detrusor overactivity or decreased bladder compliance, can be excluded as the cause of the patients incontinence. Cystourethroscopy should be performed in all patients who have had a previous anti-incontinence procedure to exclude the presence of previously placed sutures or mesh within the bladder or urethra.

The "PUB" classification system for evaluating SUI (Figure 9.1) (3) requires assessment of the urethral position (P) by examination or fluoroscopy, and urethral (U) and bladder (B) function by urodynamic testing. This method for the evaluation allows the surgeon to recognize the different components responsible for SUI in a given patient, and make appropriate recommendations for treatment.

Table 9.1. Common contributing causes of intrinsic sphincteric deficiency (ISD)

Urethral trauma
Previous anti-incontinence procedures
Previous urethral surgeries—diverticulum or fistula repair
Chronic urethral catheterization
Neurologic
Sacral arc denervation
Pelvic nerve injury from trauma or radical pelvic surgery
Pelvic radiation
Estrogen deficiency

Significance

DeLancey (10) described the "hammock hypothesis" to explain how urethral closure pressure increases during a cough. He noted that the stability of the suburethral layer depends on the intact lateral connection of the vaginal wall and endopelvic fascia to the arcus tendineus fascia pelvis and levator ani muscles. Without intact suburethral support, the urethra is not compressed during stress maneuvers, which may result in SUI. Although the mechanism for SUI due to hypermobility is explained by the hammock hypothesis, historically procedures directed at restoring the bladder neck and proximal urethra to their normal anatomic position (retropubic suspension and needle suspension procedures) have had decreased success when ISD is present (8,11).

The goal of treatment for ISD is to restore sufficient outlet resistance to the intrinsically compromised urethra. This goal should be achieved without causing outlet obstruction and with the

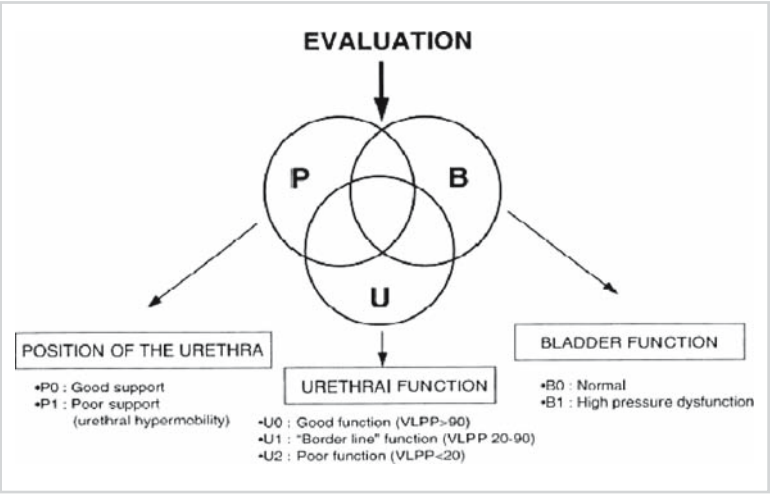

Figure 9.1. "PUB" classification system for stress urinary incontinence. VLPP, _____. (From Haab F, Zimmern PE, Leach GE. Female stress urinary incontinence due to intrinsic sphincteric deficiency: recognition and management. J Urol 1996;156(1):3–17, with permission.).

maintenance of normal micturation. Currently, there are three accepted options of treatment for ISD: suburethral slings, injectable bulking agents, and the artificial urinary sphincter.

Suburethral Slings

In 1907 Giordano performed the first sling operation by wrapping a gracilis muscle flap around the urethra in a patient with epispadias (12). In 1910 Goebell (13) described the use of pyramidalis to create a urethral sling in children with myelomeningocele. In the following years, many different materials and modifications to these original slings were described. Aldridge (14) is acknowledged for establishing the basis of modern-day slings in 1942, when he described the use of rectus fascia. He mobilized rectus fascial strips, leaving them attached medially, tunneled them through the rectus muscle 4 cm above the pubis, and passed them to a small incision in the anterior vaginal wall, where they were sutured together beneath the proximal urethra and bladder neck. Aldridge further described an "almost bloodless plane" lateral to the urethra that permits entry into the retropubic space from the vaginal incision, permitting safe sling passage. He additionally noted the favorable relationship between the rectus muscles/fascia and the urethra in the presence of a sling, which may provide compression of the urethra with increases in abdominal pressure.

The suburethral sling is believed to prevent SUI by two mechanisms. First, the sling provides a "hammock" upon which the urethrovesical junction is supported in its normal anatomic position at rest. Second, during increases in abdominal pressure the sling provides a "backboard" against which the urethra is compressed. Sling procedures that utilize the rectus fascia for attachment, may have additional upward movement of the sling with rectus muscle shortening during stress, which may provide increased outlet resistance.

Indications

Traditionally, sling procedures were employed as treatment for SUI caused by ISD. However, with the good long-term results of slings over the last 20 years, and the ability of slings to treat both urethral hypermobility and ISD, many physicians employ the suburethral sling as primary treatment of SUI regardless of its cause (15,16). Patients with recurrent SUI when other anti-incontinence procedures fail are good candidates for the sling, as well as patients with comorbidities that put them at increased risk of failure, such as chronic obstructive pulmonary disease (COPD), obesity, and connective tissue disorders, and young athletically active patients.

Not all patients with ISD are good candidates for suburethral sling. Patients with severe or total urethral function loss, such as those resulting from long-term Foley catheterization (17), neurologic pathology, previous radiation, or urethral loss from reconstructive procedures,

may not obtain adequate outlet resistance with a sling. In these patients, bladder neck closure with urinary diversion or augmentation cystoplasty with an outlet procedure may be necessary as a last resort to achieve continence.

It is important to assess the patient's detrusor function prior to recommending a sling procedure for their SUI. Severe detrusor overactivity at low bladder volumes or poor detrusor compliance are relative contraindications to procedures that will increase outlet resistance without concurrent treatment of these conditions. Additionally, patients with impaired detrusor contractility or inadequate bladder emptying on preoperative urodynamics may be at increased risk for long-term urinary retention after a sling procedure, and should be counseled accordingly.

To minimize transient postoperative voiding dysfunction, prior to the sling surgery, we teach all patients self-catheterization. When a patient is unable or unwilling to do self-catheterization, a suprapubic tube is placed at the time of the sling procedure. By ensuring that the patient is able to effectively manage her bladder emptying, postoperative bladder overdistention and unnecessary prolonged hospitalization can be avoided.

There are many different techniques and materials available for suburethral sling surgery. This section describes the traditional technique for sling placement, upon which many modifications have been based (133). The different materials used in sling surgery, results for the treatment of ISD, and complications are discussed.

Autologous Slings

Autologous rectus fascia and fascia lata pubovaginal slings have been used for over 30 years. Of the various sling procedures, these have the longest follow-up outcomes reported in the literature (132), and have become the standard to which other sling procedure outcomes are compared (18). To be considered a candidate for autologous pubovaginal sling, the patient must be medically able to tolerate a surgical procedure with general anesthetic.

Technique of Fascial Harvest

The choice of which autologous fascia to use for the sling, rectus or fascia lata, is largely determined by surgeon preference. Advocates of rectus fascia prefer to obtain the sling through the same incision that is used to secure the sling suprapubically, and note that a satisfactory strip can be obtained in patients regardless of scarring from previous retropubic surgeries (19). Advocates of fascia lata prefer to perform a more limited suprapubic dissection and are able to obtain a longer strip from a location that has not been irradiated or operated on previously. Neither fascial graft has been shown to be superior to the other with respect to outcomes or morbidity. In each case, the graft is harvested prior to the vaginal dissection.

To obtain a rectus fascial graft, an 8- to 10-cm transverse incision is made approximately 4 cm above the pubic symphysis. The subcutaneous tissue is dissected using electrocautery and blunt dissection to expose the rectus fascia. A 1.5–2 cm × 8–10 cm strip of rectus fascia is then excised (Figure 9.2A). The fascial defect is closed using a delayed absorbable suture. Each end of the sling is oversewn with a heavy monofilament suture with maintenance of suture length, as this will ultimately be used to secure the sling. The fascial strip is placed in normal saline irrigation while the vaginal dissection is performed.

To obtain a fascia lata graft, the lower extremity above the knee is prepped and draped. A 2- to 3-cm transverse incision is made 2 to 3 cm above the level of lateral femoral condyle on the lateral aspect of the leg and dissection is carried down to the fascia lata (Figure 9.2B). A 2-cm-wide strip of fascia is elevated. A Crawford fascial stripper may be used to obtain a strip 18 to 22 cm in length through one incision (20), or a second transverse incision 15 to 20 cm proximal to the first can be made and a strip of fascia between these incisions can be excised by pushing partially opened, long, heavy, straight scissors along the longitudinal plane of the fascial fibers. A compression dressing is applied to the lateral aspect of the thigh after wound closure. It is not necessary to close the fascial defect.

Technique of Sling Placement

With the patient in the lithotomy position, normal saline is injected under the vaginal epithelium to assist with dissection. An inverted U-shaped incision is made in the anterior vaginal wall from the mid-urethra to a point proximal to the bladder neck as identified by

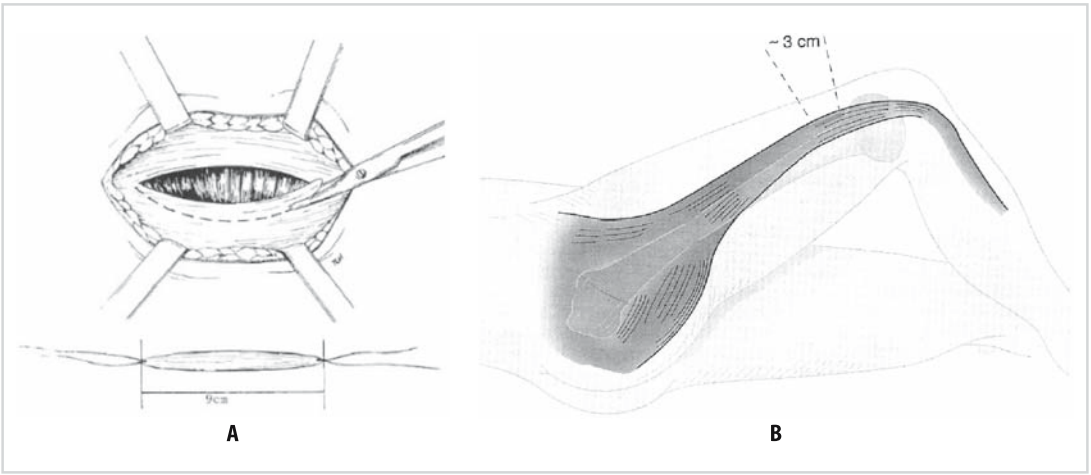

Figure 9.2. Autologous fascial harvesting techniques. A: Rectus fascia harvest. (From Walsh PC. Campbell's Urology, 8th ed. © 2002, with permission from Elsevier.) B: Fascia lata harvest. (From Latini JM, Lux MM, Kreder KJ. Efficacy and morbidity of autologous fascia lata sling cystourethropexy. J Urol 2004;171(3):1180–1184, with permission.).

the Foley balloon. Allis clamps are placed on the vaginal wall to aid in its careful dissection off of the proximal urethra and bladder neck, exposing the periurethral fascia. Sharp dissection is then carried out laterally, with the scissors parallel to the perineum on the surface of the periurethral fascia until the retropubic space is entered laterally adjacent to the inferior pubic ramus (Figure 9.3A). Once access to the retropubic space is obtained, blunt finger-dissection along the inner surface of the pubis is used to extend access up to the rectus muscle laterally on each side. It is important to remember that patients who have had prior retropubic operations often will have significant retropubic fibrosis. Sharp dissection or blunt dissection on the undersurface of the pubis into the retropubic space minimizes the risk of bladder injury.

Once the retropubic pathway for the sling has been established, a transverse incision is made just above the pubic symphysis. A long, curved-clamp is passed under direct finger guidance to the vaginal incision (Figure 9.3B). The suture attached to the end of the sling is grasped by the clamp and brought out through the suprapubic incision. This is repeated on the contralateral side (Figure 9.3C). Prior to determining the correct tension and securing the sling in place, cystoscopy is performed to ensure no bladder injury has occurred.

There is no standard method for determining the sling tension necessary to achieve continence, while avoiding postoperative outlet obstruction. Proper sling tension remains subjective and relies on surgeon experience. Some advocate placing an instrument between the sling and the urethra, with the urethra in the neutral position, and tying the suprapubic sutures either to the rectus fascia separately on each side, or together over the rectus fascia (21). Others tension the sling so that bladder neck motion is stopped when traction is applied to the Foley catheter (22). The authors routinely perform urethroscopy using a 0-degree lens and a blunt-tipped urethroscope sheath, visualizing the proximal urethra and bladder neck while tension is applied to the sling. The point at which an indentation is seen in the floor of the bladder neck and proximal urethra is the tension at which we secure the sling.

The vaginal and suprapubic incisions are closed. A vaginal pack and the urethral Foley catheter are left in place. On the first postoperative day the vaginal pack and the urethral Foley are removed, and a voiding trial is performed. The patient is discharged from the hospital once it is determined that she is able to adequately manage her bladder emptying (with self-catheterization if needed), usually on the second postoperative day.

Variations of this traditional procedure have been described in an effort to simplify the procedure, shorten the operative time, and decrease morbidity. These variations are numerous and include the use of nonautologous grafts or

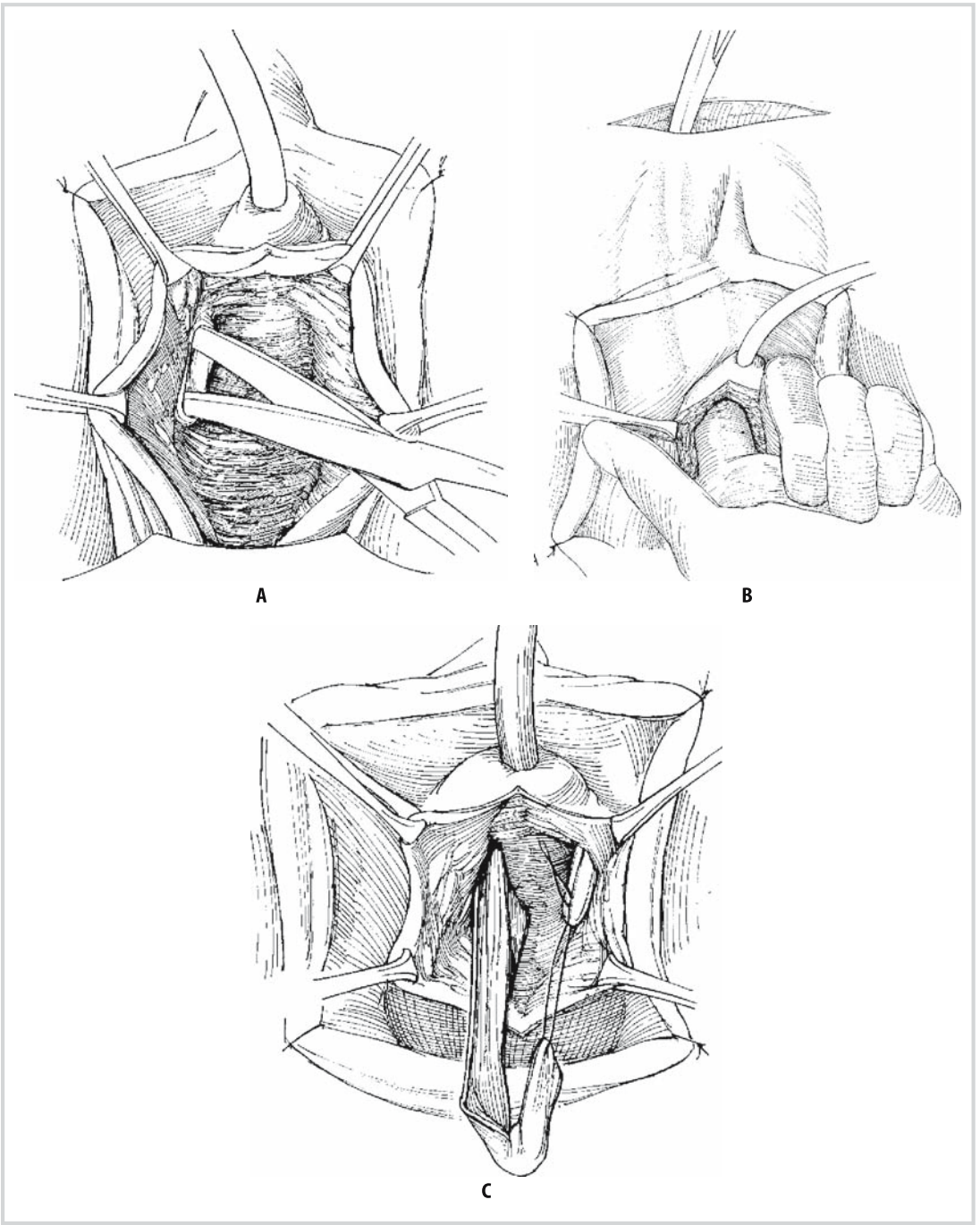

Figure 9.3. Traditional technique for sling placement. A: Retropubic space is entered laterally through the vaginal incision. B: Curved clamp passed through the retropubic space with direct finger guidance. C: Sling pulled up to the suprapubic incision by clamp (From Hinman F. Atlas of Urologic Surgery, 2nd ed., pp. 566–567. Copyright 1998, with permission from Elsevier.)

synthetic mesh to avoid the morbidity of fascial harvest, varying lengths of slings, from full-length to patch grafts, and different sites of fixation for the sling, such as Cooper's ligament, suprapubic or transvaginal pubic bone anchor fixation, and passive fixation by tissue adherence to the mesh within the retropubic space or obturator foramen. Currently there are no randomized trials comparing the different variations of slings with respect to treatment of ISD. The choices of which sling material and which method of sling placement are at the discretion of the surgeon (130).

For all types of SUI, urethral hypermobility, and ISD, autologous fascial pubovaginal slings are reported to have cure rates of 70% to 90% and cure/improved rates of 85% to 95% (15,16,18,23,24). Continence rates for patients with pure ISD appear to be slightly lower than that of patients with urethral hypermobility. With a mean follow-up of 22 months, Cross and colleagues (25) reported continence rates confirmed by videourodynamics of 96% (43/45) in patients with preoperative urethral hypermobility vs. 89% (65/73) in patients with preoperative ISD. With a mean follow-up of 51 months, Morgan and associates (16) reported continence rates of 91% for SUI due to urethral hypermobility vs. 84% for SUI owing to ISD. Results of various sling procedures as treatment for SUI owing to ISD are noted in Table 9.2.

Allograft/Xenograft Slings

To decrease operative time and avoid the morbidity of autologous fascial harvest, the use of cadaveric allografts and xenografts has increased in recent years. The different nonautologous grafts are listed in Table 9.3 (26). These nonautologous grafts exhibit different elasticity and tensile strength. Kubricht et al (27) found that freeze-dried, gamma-irradiated cadaveric fascia lata had a tensile strength twice that of freeze-dried porcine small intestine submucosa. When comparing freeze-dried cadaveric fascia lata to solvent-dehydrated fascia lata, Lemer et al (28) found the solvent-dehydrated fascia to be significantly stronger by tensiometry. Although it is apparent that these grafts have different properties, it remains unclear which provides the best long-term results for sling surgery.

Results using nonautologous grafts for sling surgery have been comparable to autologous slings with short- to intermediate-term follow-up. Brown and Govier (29) found a SUI cure rate of 74% and cured/improved rate of 93% with a mean follow-up of 12 months after freeze-dried cadaveric fascia lata sling, which was not significantly different from the 73% cured and 100% cured/improved after autologous slings at the same institution with mean follow-up of 44 months. In another comparison of allograft vs.

Table 9.2. Results for suburethral sling series as treatment for ISD

Type of sling	Author, year (ref.)	Sling material	*n*	Mean follow-up, months (range)	% success
Autologous	Mason, 1996 (95)	Rectus	63	12 (3–27)	94
	Zaragoza, 1996 (23)	Rectus	60	25 (11–34)	100
	Barbalias, 1997 (96)	Rectus	32	32 (30–38)	66
	Hassouna, 1999 (98)	Rectus	82	41 (6–96)	89
	Kreder, 1996 (24)	Rectus/FL	27	22 (9–32)	96
	Haab, 1997 (81)	Rectus/FL	37	48 (24–60)	73
	Wright, 1998 (99)	Rectus/FL	33	16 (15–28)	94
	Richter, 2001 (100)	Rectus/FL	57	42 (0.5–134)	84
	Govier, 1997 (101)	FL	30	14 (3–33)	70
Synthetic	Barbalias, 1997 (97)	PTFE	24	30	83
	Staskin, 1997 (102)	PTFE	122	24	88
	Yamada, 2001 (103)	PTFE	72	67 (50–75)	78
	Morgan, 1985 (104)	Marlex	208	>60	77
	Rezapour, 2001 (40)	TVT	49	48	86
Allograft	Wright, 1998 (99)	Cad FL	59	10	98
	Ruiz, 2000 (105)	Cad FL	105	18	93

FL, Fascia lata; PTFE, polytetrafluoroethylene; TVT, transvaginal tape.

Table 9.3. Allograft and xenograft materials used in sling surgery

	Sling material	Trade name (manufacturer)	Processing technique
Cadaveric allografts	Fascia lata	FasLata (CR Bard, Inc., Murray Hill, New Jersey)	Freeze-dried, gamma irradiated
		Suspend (Mentor, Santa Barbara, CA)	Solvent-dehydrated, gamma-irradiated
	Decellularized dermis	Duraderm (CR Bard, Inc., Murray Hill, New Jersey)	Freeze-dried
		Alloderm (LifeCell Corp., Branchburg, NJ)	Freeze-dried
	Acellular dermal matrix	Repliform (Boston Scientific, Natick, Massachusetts)	Freeze-dried
		Urogen (American Medical Systems, Inc., Minnetoka, MN)	Gamma-irradiated
Xenografts	Acellular porcine dermis	Dermatrix (Advanced UroScience, Saint-Paul, MN)	
		Pelvicol (CR Bard, Inc., Murray Hill, New Jersey)	
	Acellular matrix from porcine small intestine submucosa	Stratasis (Cook Urological, Bloomington, IN)	
		Fortaflex (Organogenisis, Canton, MA)	

autologous sling with 2 years' minimum follow-up, Flynn and Yap (30) found a cure rate of 71% and cured/improved rate of 84% with mean follow-up of 29 months in the allograft group vs. 77% cured rate and 90% cured/improved rate in the autologous sling group with mean follow-up of 44 months. The use of allograft in their series resulted in less postoperative pain and disability.

A question that has been raised concerning the use of allografts in sling surgery is graft durability. Although most allograft sling series report success rates comparable to autologous slings, the length of follow-up in the allograft series has been relatively short. Carbone and colleagues (31) reported disappointing results in 154 patients treated with freeze-dried cadaveric fascia lata and transvaginal bone anchor fixation. They found a high SUI recurrence rate of 38% within 1 year and attributed these early failures to cadaveric allograft degeneration based on findings at reoperation. Fitzgerald and associates (32) noted that upon reoperating on freeze-dried cadaveric fascial sling failures, the slings had undergone some form of degeneration or autolysis, and in some cases the sling could not be identified. Elliot and Boone (33) found no evidence of rapid graft degeneration following solvent-dehydrated cadaveric fascia lata sling, with a 96% cured/improved rate using 12 months as the minimum follow-up. After performing over 400 sling procedures using solvent-dehydrated cadaveric fascia lata, the authors have noted no evidence of rapid graft degeneration as well. When comparing the various materials used in sling surgery after 12 weeks of subcutaneous implantation in the rabbit model, Dora et al (34) found that human cadaveric fascia and porcine xenografts showed a marked decrease (60–89%) in tensile strength and stiffness, whereas polypropylene mesh and autologous fascia did not differ in tensile strength from baseline. With intermediate-term outcomes using nonautologous grafts for sling surgery reported in most series as comparable to that of autologous slings, the significance of these findings is not known.

Another concern with the use of allografts has been the risk of disease transmission. Measures used to prevent disease transmission in tissue allografts include donor screening and a multistep tissue sterilization process. Despite these measures, the presence of intact DNA material has been reported (35). Another potential concern is for the transmission of prion disease, such as Creutzfeldt-Jakob disease. Prions are protein molecules that can resist conventional means of sterilization. Although there is a theoretical risk, to date there have been no reported cases of disease transmission with the use of cadaveric allografts in continence surgery.

Synthetic Slings

In recent years the use of synthetic mesh slings has gained popularity. Many of the early mesh slings, such as Marlex, Mersilene, silicone, and Protogen (Boston Scientific, Natwick, MA), were shown to have increased complication rates, such as urethral and vaginal erosions requiring mesh removal (18,36,37). In 1996 Ulmsten and associates (38) introduced the tension-free vaginal tape (TVT) procedure as a sling procedure performed with local anesthetic using a loosely woven polypropylene mesh. This sling

aims to re-create the pubourethral ligament and support of the suburethral vagina, by its placement at the mid-urethra without tension, and does not require suture fixation. It. With follow-up out to 5 years in some series, the success rates are similar to that of autologous slings (39,40), and the previous problems of mesh erosion have been minimal. Modifications to the TVT procedure include the Suprapubic arc (AMS; Minnetouka, MN) procedure, where needle passage for sling placement is performed from the suprapubic incisions down to the vagina, and the newer transobturator slings, in which there is no retropubic needle passage and the ends of the mesh sling are brought through the obturator foramen on either side.

Early results using a transobturator technique are promising. Delorme and associates (41) reported 91% cured and 100% cured/improved rates for all types of SUI using the transobturator technique (TOT) in 32 patients with a minimum follow-up of 12 months (mean 17 months). In a prospective randomized trial comparing 1-year outcomes of TVT (31 patients) to transobturator suburethral sling (30 patients), deTayrac et al (42) found comparable cure rates, 84% for TVT vs. 90% for TOT, with significantly lower operating times, 15 minutes vs. 27 minutes, and lower incidence of intraoperative bladder injuries, 0 vs. 10%, in the TOT group. Further discussion on mid-urethral slings is provided in Chapter 10.

Bone-Anchored Slings

Another method for securing the suburethral sling by transvaginal pubic bone anchor fixation has been described (43). Advantages of using transvaginal bone anchors include the ability to perform a sling procedure completely transvaginally without retropubic needle passage, minimal postoperative pain, and a consistent, stable point of fixation. Nonautologous allograft or synthetic sling materials are employed, obviating the need for fascial harvest. The theoretical disadvantage of bone anchor fixation is the potential for osseous complications, such as osteitis pubis or osteomyelitis.

Results for the treatment of SUI using bone anchor slings have been variable. As stated previously, Carbone and associates (31) experienced a high early failure rate using freeze-dried cadaveric fascia lata. In a later report on their experience with transvaginal bone anchor gelatin-coated Dacron sling, they reported a 95% cured/improved rate for SUI, but patients with significant ISD were excluded from this study (44). Giberti and Rovida (45) reported on 63 patients receiving gelatin-coated Dacron bone anchored slings. With 17 months mean follow-up, the cured rate was 82% and the cured/improved rate was 91%, but they noted that all of the patients with preoperative ISD failed.

In the authors'experience using solvent-dehydrated, nonfrozen cadaveric fascia lata with bone anchor fixation in 330 patients with a mean follow-up of 25 months (maximum follow-up of 63 months), the cured rate for all types of SUI was 59% and the cured/improved rate was 80%. When comparing those patients in our series who had ISD preoperatively to those who did not, with Intrinsic sphincteric deficiency (ISD) defined as VLPP < 50, the failure rate was 24% vs. 18%, respectively. This difference was not statistically significant.

Complications of Suburethral Slings

The most common complication of suburethral sling procedures is voiding dysfunction/inadequate bladder emptying requiring intermittent catheterization or suprapubic catheterization drainage to avoid urinary retention. These symptoms are usually transient and resolve within the first week postoperatively. Prolonged urinary retention >3 months postoperatively has been reported to occur 2% to 10% in most sling series, with a procedure to loosen an obstructing sling or formal urethrolysis being required in 1% to 5%.

Another common cause of postoperative morbidity following sling surgery is urinary urgency/urge incontinence. De novo urinary urgency has been reported to occur in 5% to 30% of patients, and de novo urge incontinence has been reported in up to 10% of patients. The etiology of these symptoms is not clear, but may include an unmasking of undiagnosed preoperative detrusor overactivity, a direct effect of increased bladder outlet resistance on detrusor function, or denervation from surgical dissection. These symptoms are usually transient in the absence of overt bladder outlet obstruction, and respond well to anticholinergic therapy and behavioral modification/biofeedback. Interestingly, many patients who suffer from mixed urinary incontinence preoperatively have resolution of their urge incontinence following sling surgery. Schrepferman and associates (46) reported that after pubovaginal sling,

preoperative urge symptoms resolved in 91% of patients with low pressure (<15 cmH_2O) detrusor instability preoperatively, in 32% of patients with sensory instability (no unstable detrusor contractions) preoperatively, and in 28% of patients with high pressure (>15 cmH_2O) detrusor instability preoperatively. In the authors' experience, after transvaginal suburethral sling, 35% of patients with preoperative urge incontinence have persistent urge incontinence postoperatively.

Injury to the urethra or bladder may occur during suburethral sling surgery. Patients who have had previous retropubic or anti-incontinence operations are at increased risk. With careful dissection, these complications can usually be avoided. It is important that any injury to the bladder or urethra during sling surgery is identified with intraoperative cystoscopy to prevent the subsequent morbidities of erosion, fistula formation, or infection. If a small, uncomplicated urethral injury occurs in a patient with healthy urethral tissues, it can be repaired primarily in layers and the sling operation can be completed followed by urethral catheter drainage. If the urethral injury is more extensive or the patient has poor tissues, such as those with previous radiation, it is prudent to repair the urethra, augment the repair with a Martius graft, and postpone sling placement until healing has occurred. If a bladder injury occurs during sling passage, on the side of the injury, the sling is pulled back down into the vaginal incision and sling passage is repeated. The surgeon may choose to provide continuous bladder drainage by suprapubic tube or urethral catheter for 2 to 7 days postoperatively depending on the degree of injury.

Some infrequent, but potentially serious complications have been reported with the mid-urethral polypropylene procedures that pass the sling blindly through the retropubic space. Because the vaginal and suprapubic dissections are limited and passage of the sling through the retropubic space is performed without direct guidance, major vascular injuries (47), bowel perforations (48–50), and seven deaths have been reported by the manufacturer, six of which were due to unrecognized bowel injury (51). Kobashi and Govier (49) noted a mean decrease in hematocrit level of 7.1% on the first postoperative day following the SPARC procedure, and 4 of 140 patients (2.9%) required blood transfusions postoperatively.

When using bone anchors for sling fixation, concern has been raised about the potential for osseous complications. In our 5-year experience of over 400 transvaginal bone anchor slings using solvent-dehydrated cadaveric fascia lata (52), we reported two cases of postoperative osteitis pubis that resolved within 3 months with conservative treatment, no cases of osteomyelitis, and no bone anchors have required removal. Infectious osseous complications experienced previously with suprapubic bone anchor fixation for suspension procedures (53) have not been experienced with transvaginal techniques.

Injectable Bulking Agents

As an alternative to open surgery, injectable bulking agents have become a common therapy for SUI owing to ISD. The purpose of this form of therapy is to increase the volume or bulk within the proximal urethral wall, between the external sphincter and bladder neck, thereby compressing the urethral mucosa into the lumen and providing better coaptation, thus increasing outflow resistance (Figure 9.4). Historically, bulking agents have not been used to treat urethral hypermobility, as it provides no external support to return the bladder neck or proximal urethra to their normal anatomic position.

The first reported periurethral injection therapy was reported in 1938, when Murless (54) injected sodium morrhuate (a sclerosing agent) through the anterior vaginal wall in an attempt to obtain scarring of the periurethral tissues to achieve continence. Subsequently, Quackles (55) injected paraffin wax transperineally and Sachse (56) injected Dondren (a sclerosing agent). In these early experiences, results were not optimistic and significant complications, such as pulmonary embolism and urethral sloughing, were reported. In the last 30 years, with the development of more suitable materials for injection, like polytetrafluoroethylene (PTFE) (57), glutaraldehyde cross-linked collagen (58), and carbon-coated zirconium beads (59), this minimally invasive therapy has seen increasingly widespread use.

Indications

The ideal candidate for injectable therapy has been described as one with diminished urethral function (ISD), a well-supported urethra, and normal bladder function (60). Despite the

Figure 9.4. Anatomy and cystoscopic views of the bladder neck and urethra. (Courtesy of Carbon Medical Technologies, Inc., St. Paul, MN, with permission.) A: Open bladder neck prior to injection of bulking material. B: Coaptation of the bladder neck and proximal urethra after injection.

general perception that injectable bulking therapy should be used to treat isolated ISD, several series have included patients with and without urethral hypermobility and have reported no significant difference in outcomes (61–64). Patients with comorbidities that are prohibitive of, or who refuse, more invasive surgery are good candidates for injectable therapy, as well as those patients with recurrent SUI and a well-supported urethra after a previous anti-incontinence operation.

In a randomized controlled trial comparing collagen vs. open surgery (modified Burch, suburethral sling, or bladder neck suspension) as first-line treatment for SUI, Collet and associates (65) found that at 12 months follow-up, collagen was 53% successful vs. 72% success in the surgical group, with success being defined as 24-hour pad test <2.5 g. They additionally noted no statistical difference between the groups with respect to improvement in quality of life or patient satisfaction, whereas complications were significantly less frequent and severe in the collagen group. Prior to conducting the trial, a large survey of urologists and gynecologists revealed that a 20% difference in results would be acceptable for considering bulking therapy as first-line treatment for SUI.

Techniques of Injection

Prior to performing a proximal urethral bulking procedure, the patient should have sterile urine and be taught how to perform self-catheterization in the event that urinary retention occurs in the early postoperative period. The procedure may be performed in the office setting with local anesthetic (topical and injectable lidocaine), or in an ambulatory surgical center or operating room if intravenous sedation is preferred by the patient or the surgeon. Two techniques for injection have been described: transurethral and periurethral. The authors routinely perform bulking procedures under monitored sedation, providing optimal patient comfort while avoiding patient movement during needle placement and injection, using the periurethral technique, which avoids mucosal disruption and bulking agent extrusion through the injection site. Faeber and colleagues (66) compared transurethral to periurethral injection techniques and found no significant difference in continence outcomes, complications, or number of injections per patient, but did note that a significantly higher volume of collagen was injected when the procedure was performed periurethrally.

For transurethral injection the patient is placed in the lithotomy position and a 12-degree, blunt-tipped cystoscope with an injection needle port is introduced into the patient's urethra. A syringe of the desired bulking agent is attached to the needle and the needle is primed. The scope is positioned at the mid-urethra, and rotated for needle placement at the 4 o'clock position. The needle is advanced with the bevel toward the urethral lumen, and the urethral mucosa is

punctured at a 45-degree angle until the bevel of the needle is covered (Figure 9.5A). Keeping the needle in place the scope is re-angled back parallel with the urethra, and the needle is advanced 1 to 2 cm so that the tip is located in the submucosa of the proximal urethra. The bulking material is injected with consistent, moderate thumb pressure on the plunger (Figure 9.5B). With correct needle placement, the flow should be even and smooth. Viewed cystoscopically, the urethral mucosa should rise as the material is introduced. Injection is continued until the resulting submucosal bleb has crossed the midline. If circumferential closure is not obtained from the initial injection site, the procedure is repeated at the 8 o'clock position. The objective is to obtain complete coaptation of the urethral mucosa when viewed cystoscopically with the irrigation on. Care should be taken not to advance the cystoscope proximal to the mid-urethra once injection is initiated, so that mucosal disruption is avoided. The bladder may be drained by passing a well-lubricated, 10-French red rubber catheter.

For the periurethral technique, the patient is placed in lithotomy position and the cystoscope is introduced into the bladder. With the scope held in the neutral position, parallel to the floor, the periurethral groove is identified approximately 0.5 to 1 cm lateral to the meatus. An 18-gauge, 1.5-inch, angled needle is attached to a syringe filled with normal saline or lidocaine that will be used for hydrodissection. The needle is then inserted at the 3 o'clock position in the urethral groove and advanced 2 to 3 cm, keeping the needle hub parallel to the scope (Figure 9.6A). The 15-degree angle of the needle guides the tip into the correct submucosal plane. To verify placement, the cystoscope is withdrawn to the mid-urethra and the needle tip is wiggled, causing tenting of the overlying urethral mucosa. Hydrodissection is performed by injecting 1 to 2 cc of fluid. A mucosal bleb should be visualized during hydrodissection if the needle is in the correct position. If no bleb is seen, the needle should be withdrawn and repositioned. With correct needle placement confirmed, the needle is held in place while switching the syringe to one filled with bulking material. The material is injected under direct cystoscopic visualization as previously described with transurethral injection (Figure 9.6B). Once an adequate amount of material has been delivered, a figure-of-eight absorbable suture is placed around the needle puncture site in the urethral groove. The suture is tied down as the needle is removed to prevent extrusion of bulking material and bleeding from the puncture site.

Bulking Agents

Currently, the ideal bulking agent has not been found. The ideal agent should be hypoallergenic, biocompatible, nonimmunogenic, noncarcinogenic, and durable without biodegradation or migration (67). Other important considerations for bulking agents include ease

A B

Figure 9.5. Transurethral injection technique. (Courtesy of Carbon Medical Technologies, Inc., St Paul, MN, with permission.) A: Needle puncture at the mid-urethra, at a 45-degree angle. B: Needle advanced submucosally, parallel to the urethra, to the proximal urethra for injection.

of injection (agents that require higher pressures to inject, have higher extravasation rates), requirement for specialized injection equipment, need for preparation or special handling of the material before injection, and cost. A list of approved and investigational injectable agents is found in Table 9.4. Presently, autologous fat, cross-linked collagen, and carbon-coated beads are the only Food and Drug Administration (FDA)-approved bulking agents for the treatment of SUI owing to ISD in the United States.

Autologous Fat

In 1989, the periurethral injection of autologous fat was first reported by Gonzalez et al (68). Using a liposuction technique, subcutaneous fat was harvested from the anterior abdominal wall, washed to remove debris, and injected using a transurethral technique. Autologous fat has the advantages of being biocompatible, readily available, and inexpensive. The primary disadvantage of using autologous fat as a bulking agent appears to be poor durability related to a high rate of resorption. Within 6 months, 50% to 60% volume loss of free fat grafts has been demonstrated by magnetic resonance imaging (69). This rapid resorption rate is thought to be a result of inadequate neovascularity to the central portion of the graft and destruction of the normal adipocyte architecture during the retrieval and washing process (70,71). Other available bulking agents have been shown to be more effective for the

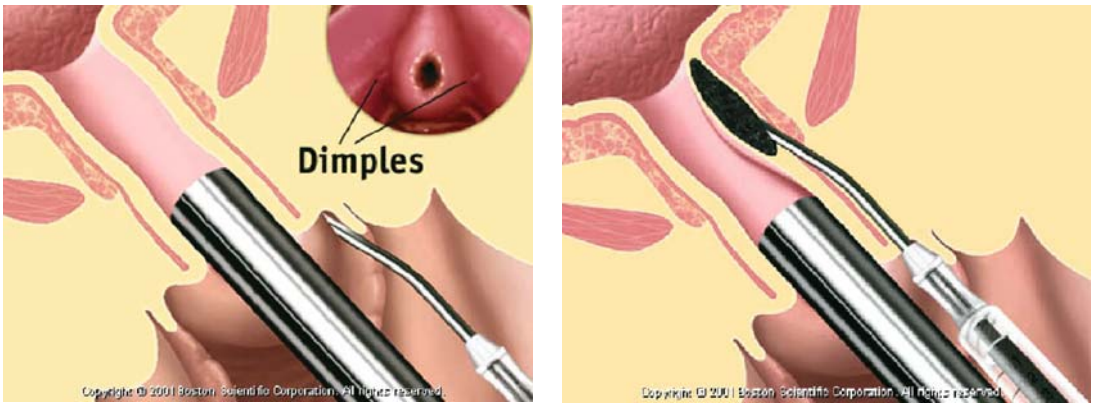

Figure 9.6. Periurethral injection technique. (Courtesy of Carbon Medical Technologies, Inc., St Paul, MN, with permission.) A: Needle puncture in the groove lateral to the urethral meatus. B: With needle placement confirmed, bulking material is injected.

Table 9.4. Currently available and investigational injectable bulking agents

Agent	Trade name	Company	Approval status
Autologous fat			
Bovine cross-linked collage	Contigen	Bard, Covington, GA	FDA approved 1993
Carbon-coated zirconium beads	Durasphere	Boston Scientific, Boston, MA	FDA approved 1999, no longer available
Graphite-coated zirconium beads	Durasphere EXP	Boston Scientific, Boston, MA	FDA approved 2003
PTFE (Teflon)	Urethrin	Mentor, Santa Barbara, CA	Approved in Canada/Europe
Silicone	Macroplastique	Uroplasty, Minneapolis, MN	FDA trials ongoing
Dimethylsulfoxide and ethylene vinyl alcohol copolymer	Uryx	Genyx Medical Inc., San Diego, CA	FDA submission
Hyaluronic acid and dextranomer microspheres	Zuidex	Q-med, Uppsala, Sweden	FDA trials ongoing
Calcium hydroxyapatite	Coaptite	Bioform, Franksville, WS	FDA trials ongoing

FDA, Food and Drug Administration; PTFE, polytetrafluoroethylene.

treatment of female SUI, making the use of autologous fat less desirable.

Cross-Linked Collagen

Glutaraldehyde cross-linked (GAX)-collagen is derived from bovine dermis, purified into an acellular derivative, enzymatically treated to eliminate antigenicity, and finally cross-linked with glutaraldehyde for resistance to host collagenases (72). More than any other bulking agent, there have been numerous studies looking at the efficacy and safety of collagen as treatment for female SUI. Because collagen is well tolerated with proven safety, it is currently the most widely used injectable bulking agent. Preoperative skin testing must be performed as a 4% allergy rate has been reported. Once injected, there is minimal host inflammatory response and no migration (134).

Graphite-Coated Zirconium Beads

Durasphere EXP is a synthetic bulking agent composed of graphite-coated zirconium beads that are suspended in a water-based carrier. This material is nonreactive, nonantigenic (no skin test is required), and nonbiodegradable, making it the authors' agent of choice for bladder neck injection. Durasphere EXP is similar to its predecessor, Durasphere (carbon-coated zirconium beads), with two exceptions: it is not visualized on plain radiographs, and the particle size is slightly smaller (90–212 μm). There was one prior report of possible carbon-coated zirconium bead migration to local and regional lymph nodes, as evidenced on x-rays obtained 3 months after injection (73). These patients suffered no resultant sequelae, and tissue examination was not performed to confirm that what was seen on the postoperative radiographs was indeed particles that had migrated.

Polytetrafluoroethylene (PTFE, Teflon)

Polytetrafluoroethylene is a colloidal suspension of microparticles varying in size, the majority of which are <50 μm. It is commonly used as a urethral bulking agent in Europe and Canada, but has never gained approval in the United States due to safety concerns. Because of the small particle size, a propensity for migration has been noted to local and distant sites with resultant foreign-body granulomatous reaction (74,75). Polytetrafluoroethylene is locally reactive as well with cases of urethral granuloma formation, urethral fibrosis, and periurethral abscess reported (76). Claes and associates (77) reported a case of febrile alveolitis believed to be attributed to pulmonary particle migration after PTFE for SUI. Other than this case, significant clinical sequelae of PTFE particle migration have not been reported.

An additional drawback to PTFE as an injectable therapy for SUI is the high viscosity of the substance, making it more difficult to inject. A high-pressure injection syringe or gun is necessary for agent delivery. The pressures required to inject PTFE increase the risk of injection site extrusion and/or urethral mucosal disruption during placement.

Silicone

Macroplastique is composed of silicone microparticles, ranging in size from 50 to 300 μm, suspended in a water-soluble carrier. Its use was first reported in 1992 (78). Like PTFE, with a portion of the particles being <70 μm in size, migration of silicone particles has been demonstrated (79). Unlike PTFE, there is no granulomatous reactive response to silicone particles. Owing to the uncertain etiologic role of silicone in the development of collagen vascular disorders, and the implant's propensity to migrate after injection, approval for this agent in the United States is not imminent.

Dimethylsulfoxide (DMSO) and Ethylene Vinyl Alcohol Copolymer

Uryx is an injectable solution that was originally developed as an embolic agent for the treatment of vascular anomalies. When this solution contacts body tissues or fluid, the DMSO diffuses away from the copolymer, resulting in precipitation of a soft, solid mass. Studies have demonstrated that Uryx is biocompatible and nonmigratory, without significant adverse reactions in human studies for embolic purposes (80). This substance is currently undergoing trials for FDA approval as a urethral bulking agent.

Hyaluronic Acid and Dextranomer Microspheres

This substance was approved in the United States for subureteric injection for the treatment of vesicoureteral reflux in 2001. Both constituents, cross-linked dextran and hyaluronic acid, are biocompatible and biodegradable. Tolerability and safety have been demonstrated in the pediatric population. Presently, trials evaluating the efficacy and durability of dextranomer as a bulking agent for the treatment of SUI are ongoing (129).

Calcium Hydroxyapatite

This is a synthetic injectable consisting of hydroxyapatite spheres, 75 to 125 µm in size, suspended in a gel of sodium carboxylmethylcellulose. Calcium hydroxyapatite is naturally found in bone and teeth, and has been used safely for orthopedic and dental procedures for many years. The microspheres do not migrate, and are biocompatible, nonimmunogenic, and nonantigenic. This substance can be visualized radiographically. The efficacy and durability of calcium hydroxyapatite as a urethral bulking agent is currently in clinical trials.

Results

Published continence results of various injectable agents are found in Table 9.5. Injectable agents have attained sufficient continence improvement to be declared a success (by varying definitions) by the evaluating physicians 60% to 80% of the time at varying lengths of follow-up. Strict continence, defined as no urinary leakage (not uniformly reported in published series), is achieved in the minority of patients after injectable therapy, with rates in the 20% to 50% range typically reported. With the exception of autologous fat, which has been shown to have poor efficacy durability (81), the results of the various agents have been comparable. All of the available agents may require more than one injection to achieve initial success, and subsequent injections later to maintain the continence improvement.

The only large randomized, controlled trial comparing bulking agents, carbon-coated zirconium beads to collagen, was published by Lightner and associates (59). At 12 months' follow-up, they showed a modestly superior cure/improved continence rate in the Durasphere group, but this difference was not statistically significant. In a recent follow-up study of this cohort (82),

Table 9.5. Continence results for the different injectable bulking agents

Author, year (ref.)	Injectable material	No. of pts.	Mean follow-up	Mean no. of injections	% Cured (C)	% Improved (I)	% Failed
Trockman, 1995 (106)	AF	32	6	1.6	12	44	44
Haab, 1997 (81)	AF	45	7	1.7	13	30	57
	Collagen	22	7	1.9	24	62	14
Winters, 1995 (107)	Collagen	160	24	NR (1–3)	50	28	22
Monga, 1995 (61)	Collagen	60	24	1.6	48	20	32
Richardson, 1995 (108)	Collagen	42	46	2	40	43	17
Herschorn, 1996 (62)	Collagen	187	22	2.5	23	52	25
Homma, 1996 (109)	Collagen	78	24	1.9	7	65	28
Smith, 1997 (110)	Collagen	94	14	2.1	38	29	33
Swami, 1997 (111)	Collagen	111	39	NR	25	40	35
Corcos, 1999 (112)	Collagen	48	48	2.2	30	40	30
Politano, 1982 (113)	PTFE	51	6	1.8	51	20	29
Lopez, 1993 (114)	PTFE	128	31	1.3	54	19	27
Herschorn, 2000 (115)	PTFE	46	12	2	30	41	29
Lightner, 2001 (59)	Carbon	61	12	1.7	80% (C/I)		20
	Collagen	68	12	1.6	69% (C/I)		31
Harriss, 1996 (116)	Silicone	40	36	1	40	18	42
Barranger, 2000 (117)	Silicone	21	24	1	19	29	52
Radley, 2001 (118)	Silicone	56	19	NR (1–3)	20	41	39
Tamanini, 2003 (119)	Silicone	21	12	1.4	38	29	33
Mayer, 2001 (120)	Coaptite	10	12	1.7	70% (C/I)		30
Stenberg, 2003 (121)	Dextranomer	16	>60	NR	56% (C/I)		44

Durasphere remained effective in 33% of patients at 24 months and in 21% of patients at 36 months compared to 19% and 9% with the same follow-up in the collagen group. Neither bulking agent was shown to provide durable improvement in continence.

Complications

Complications following injectable therapies for SUI are uncommon and, when they occur, typically short-lived. Immediate postoperative urinary retention rates of 5% to 25% have been reported. Indwelling urethral catheters should be avoided, so that molding of the newly injected material around the catheter does not occur. Urinary retention is always transient, with resolution typically occurring within the first 2 days.

Irritative voiding symptoms may develop in up to 20% of patients. Stothers and associates (83) found de novo urinary urgency and urge incontinence to be the most common complication after transurethral injection of collagen in 337 patients, occurring in 12.6%. These symptoms usually resolve within the first week postoperatively, but a minority will persist.

Sweat and Lightner (84) reported three cases of sterile abscess formation following transurethral injection of collagen and one case of pulmonary embolism following autologous fat injection. Other rare complications include delayed bladder outlet obstruction (85,86), urethral prolapse (87), delayed skin hypersensitivity and systemic arthralgia (83), and pseudocyst formation (88).

Artificial Urinary Sphincter

Another treatment option for SUI owing to ISD is placement of an artificial urinary sphincter. Because of the proven efficacy, durability, and comparatively low morbidity of suburethral slings, the artificial urinary sphincter has never gained popularity as a first-line treatment for ISD in females in the United States. The artificial sphincter is a novel therapy, in that it provides circumferential compression at the level of the proximal urethra/bladder, and minimizes the risk of postoperative urinary retention by its ability to lower outlet resistance during voiding.

Scott (89) first reported the use of implanted prosthetic sphincters for the treatment of urinary incontinence. Since that time, several series have been reported using the artificial sphincter for the treatment of urinary incontinence of various etiologies, including post-prostatectomy incontinence in men, congenital incontinence owing to epispadias or exstrophy, neuropathic dysfunction, traumatic urethral injuries, and SUI owing to severe urethral incompetence in women.

Device modifications over the last 30 years have simplified placement of the sphincter, decreased the morbidity and revision rates, and improved the duration of proper device function. Important sphincter modifications include development of a narrow-backed cuff, an easily palpable deactivation button that allows delayed activation without another procedure, kink-resistant tubing that is color coded for easy intraoperative identification, and "quick-connect" tubing connectors that eliminate the reliance on sutures for device continuity (131).

Indications

In female patients, an artificial urinary sphincter is indicated for the treatment of SUI owing to ISD. Women with severe urethral incompetence are the most suitable candidates, such as those with a fibrotic, pipe-stem urethra from previous failed anti-incontinence surgery or a history of bladder neck/urethral reconstruction. Prior to consideration for artificial sphincter placement, candidates should be evaluated for evidence of detrusor overactivity or poor detrusor compliance, as these conditions could result in upper tract deterioration after device implantation. If present, high-pressure detrusor dysfunction should be controlled medically, or in refractory cases surgically, prior to placement of an artificial sphincter.

Patients who have impaired detrusor contractility or elevated postvoid residuals may have a sphincter implanted, but should be advised of the potential need for intermittent catheterization postoperatively. Urinary tract infection must be eradicated prior to sphincter implantation to prevent device contamination at the time of placement. Candidates must be medically able to tolerate a surgical procedure with general anesthetic. Uncontrolled high-pressure detrusor dysfunction is an absolute contraindication to

artificial sphincter implantation. Female patients with a history of pelvic irradiation are thought to be unsuitable candidates for artificial sphincter, because the risk of cuff erosion is too high (90).

It is particularly important to establish that the patient has the physical ability to use the device and is motivated to do so properly. Candidates must have adequate mental capacity and manual dexterity. They should understand that pump manipulation will be necessary every time they need to urinate.

American Medical Systems (AMS) 800 Artificial Urinary Sphincter

The AMS 800 artificial urinary sphincter consists of a control pump, a cuff, and a pressure-regulating reservoir balloon (Figure 9.7) (American Medical Systems, Minnetoka, MN). The device is composed primarily of solid silicone elastomer. The components are filled with either normal saline or isotonic contrast media, and the device is assembled by the surgeon intraoperatively.

The cuff is placed around the proximal urethra/bladder neck in the female patient (Figure 9.8). Cuff sizes range from 4.0 to 11.0 cm, with 7 to 9 cm being the typical cuff sizes used in women. It is imperative to implant the appropriately sized cuff, as cuffs that are too large will not provide adequate urethral compression to prevent incontinence, and cuffs that are too small will cause urethral atrophy and are more likely to erode.

The reservoir is placed in the retropubic space. The balloon wall tension provides the pressure that pushes fluid back into the cuff after voiding, and maintains outlet resistance during bladder filling. Two reservoir pressure ranges are available, 51 to 60 cmH_2O and 61 to 70 cmH_2O.

The control pump is placed subcutaneously in the labia majora in female patients. The upper part of the pump contains a resistor and valves to transfer fluid to and from the cuff. There is a small button on the upper part of the pump that should be palpable through the labial skin. This button, when pressed with the cuff open, prevents fluid from traveling back into the cuff, thus deactivating the device. The lower part of the pump forms a bulb that, when squeezed, opens the cuff to allow voiding.

Figure 9.7. AMS-800 artificial sphincter: consisting of a urethral cuff, pump with deactivation button, and balloon reservoir. (AMS 800™ Urinary Control System, courtesy of American Medical Systems, Inc., Minnetonka, MN, www.AmericanMedicalSystems.com.)

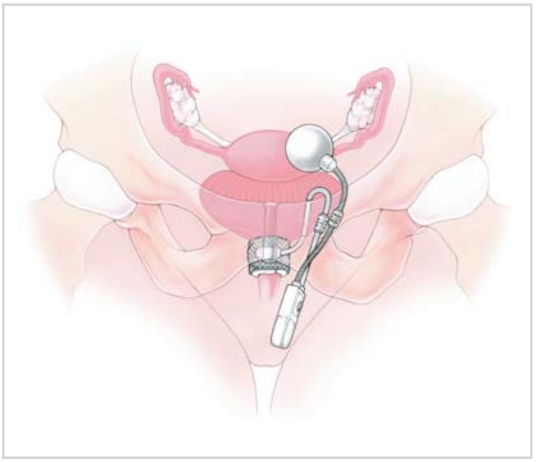

Figure 9.8. The AMS-800 artificial sphincter after placement in the female. (AMS 800™ Urinary Control System, courtesy of American Medical Systems, Inc., Minnetonka, MN, www.AmericanMedicalSystems.com.)

Technique for Artificial Urinary Sphincter Placement in Females

When placing an artificial urinary sphincter, strict precautions should be used to avoid contamination or damage to the device. The patient should receive 24 hours of intravenous antibiotics with the first dose administered just prior to

starting the procedure. Oral antibiotics should be continued for 1 week postoperatively. The sphincter components should be soaked in antibiotic irrigation on the field prior to placement and device handling should be limited. Rubber-shodded mosquito clamps should be used to clamp the tubing. Care must be taken not to puncture the device components or tubing with surgical instruments or suturing needles during wound closures. Blood must not enter the device tubing, as it can obstruct the free flow of fluid within the device required for proper function.

Historically, artificial urinary sphincters were placed entirely through a suprapubic approach for fear of device contamination from a clean-contaminated vaginal wound. To facilitate the dissection between the urethra/bladder neck and the vaginal wall, Appell (91) described a transvaginal approach for cuff placement. In his series of patients, there was no increase in the incidence of cuff erosions or implant infections, and these results were later corroborated by Hadley and associates (92).

When a suprapubic approach is elected, a transverse, muscle-cutting incision is made 3 cm above the pubic symphysis. Dissection is carried down anterior to the bladder in the retropubic space. In patients who have a history of multiple previous retropubic operations, dense fibrosis may be encountered, making dissection difficult. In this situation, one may consider a formal cystotomy to facilitate the dissection. Once the bladder is freed down to the level of the bladder neck/proximal urethra as identified by the Foley balloon, longitudinal incisions are made in the endopelvic fascia on each side of the bladder neck.

In a plane distal to the ureteral orifices, careful dissection is performed to develop a plane between the bladder neck and the vaginal wall. A long Babcock placed around the Foley catheter, right-angle scissors, and palpation of the vaginal wall aid in this part of the dissection. Once a suburethral tunnel is made, it is widened using a right-angle clamp to enable passage of the cuff. The cuff-sizer is passed around the bladder neck and cinched down so that it lays flush around the bladder neck without compressing it. The appropriate size cuff is passed around the urethra with a right-angle clamp and it is secured in place by pulling the perforated tab over the tubing insert on the cuff. The tubing from the cuff is then passed through the lower abdominal fascia just over the pubic symphysis into the subcutaneous space.

The reservoir is then placed in the retropubic space lateral to the bladder on the same side the labial pump is to be implanted. The reservoir is filled with normal saline or isotonic contrast and the tubing is brought through the abdominal fascia in the same manner as the cuff tubing. A Hegar dilator (Medical Resources Lewis Center, OH) is then used to bluntly dissect a path in the subcutaneous space into the labia for pump placement. The pouch created in the labia must be superficial so that the pump and the deactivation button lay just beneath the skin for easy palpation.

Once all of the components are in place, the tubing is connected in the subcutaneous space using the "quick-connect" tubing connectors according to the manufacturers instructions. Device function is confirmed by squeezing the labial pump and then the device is deactivated for the next 6 weeks. A urethral Foley is left in place overnight. If inadvertent bladder injury or formal cystotomy occurred, a suprapubic tube is placed on the side opposite the reservoir and left to drain for 10 to 14 days before removal. If an injury to the bladder neck or urethra occurs during dissection, this should be repaired primarily, and sphincter placement should be delayed a minimum of 12 weeks.

When the transvaginal approach is elected, an inverted U-shaped incision is made in the anterior vaginal wall. The vaginal wall is dissected off of the urethra and bladder neck, and the retropubic space is entered laterally on the undersurface of the pubic bone as previously described for pubovaginal sling placement. Circumferential dissection around the bladder neck is performed using a Babcock clamp around the Foley catheter and Metzenbaum scissors, keeping the plane of dissection on the surface of the pubic bone. Once an adequate space is created around the bladder neck, the cuff-sizer is passed and the appropriate size cuff is placed in the same manner as previously described.

A transverse incision is made just above the pubic symphysis and carried down to the abdominal fascia. With the bladder and urethra retracted contralaterally through the vaginal incision, the cuff tubing is passed through the retropubic space and brought through the fascia into the suprapubic incision. The vaginal incision is closed and a betadine soaked vaginal pack is placed. A 2-cm transverse incision is made in the fascia on the same side that the

labial pump is to be implanted. The rectus muscle is split using a curved clamp and a retropubic pocket is made for the reservoir with blunt finger dissection. The reservoir is placed and filled. Pump placement and tubing connections are made subcutaneously as previously described. If there is any concern about he integrity of the vaginal wall tissue or the vaginal wound closure, a Martius labial fat pad graft should be interposed from the labium contralateral to the pump.

Results and Complications

Results for the artificial urinary sphincter in females with ISD have been good, particularly when one considers that the patients have usually failed multiple other anti-incontinence operations. Continence results, revision rates, and removal rates from published series of artificial sphincters are noted in Table 9.6. Continence rates of 70% to 90% can be expected in those patients who do not develop early (within the first 6 months) cuff erosion or infection. Revision rates for the artificial urinary sphincter in females have decreased with advances in device technology. Revision or replacement of the device should be expected in 10% to 20% of patients over 10 years.

Erosion rates, vaginal and urethral, are higher in females than males after artificial urinary sphincter placement (93). In series that have included previously irradiated women, the majority of the devices erode (93,94) into the urethra. Consequently, most would agree that in women with a history of pelvic irradiation, an artificial urinary sphincter should not be considered a viable treatment option. Early device erosion/infections are likely the result of urethral or vaginal injury during dissection. These injuries are more common in women with multiple previous anti-incontinence procedures, particularly suburethral slings (94). It is difficult to generalize the risk of erosion/infection of artificial urinary sphincter in females with the available published series, as there are differences in length of follow-up, etiology of incontinence, technique of sphincter placement, and patient comorbidities (previous surgery or radiation). If previously irradiated women are excluded from sphincter placement, the risk of sphincter removal owing to infection/erosion is approximately 30% to 40% over 10 years.

Because there is only one location to place the cuff in women, when an artificial urinary sphincter erodes or becomes infected management can be complicated. The device must be removed and urethral reconstruction with Martius or omental grafts is required. In cases where significant urethral tissue loss occurs, urinary diversion may be required. Because of the relatively high risk of artificial urinary sphincter infection/erosion in females and the potentially morbid management of these complications when they occur, we stress that patients considering this option of treatment for their SUI should be appropriately counseled.

Conclusion

Our understanding of the etiology of SUI and the options for SUI treatment have evolved over the last 30 years. The preoperative evaluation should document the contributing factors to SUI:

Table 9.6. Female artificial urinary sphincter series

Author, year (ref.)	No. of pts.	Mean follow-up (months)	% Success (≤1 pad per day)	% Revision	% Removal (infection/erosion)
Scott, 1985 (122)	139	36	84	NR	8
Donovan, 1985 (123)	31	24	68	29	33
Diokno, 1987 (124)	32	30	91	21	3
Appell, 1988 (91)	34	36	100	9	0
Parulkar, 1990 (125)	24	40	71	50	17
Webster, 1992 (126)	24	31	100	17	0
Duncan, 1992 (94)	29		65	7	28
Costa, 2001 (127)	206	47	87	NR	6
Thomas, 2002 (90)	68	144 (median)	82*	18	46

* Success rate calculated for patients with sphincter remaining in situ.

urethral hypermobility, ISD, and detrusor dysfunction. When ISD is present, three treatment options are indicated: suburethral sling, injectable bulking agents, and artificial urinary sphincter. In patients who are surgical candidates, suburethral slings offer the best efficacy and durability, with low morbidity. Injectable bulking agents are useful in patients who are not surgical candidates, or have recurrent SUI with a well-supported urethra. Currently available bulking agents have demonstrated good efficacy and minimal morbidity in the short-term, but have not been shown to be durable. Additional treatment sessions may be necessary for the maintenance of continence. The artificial urinary sphincter may offer the minority of women with severe ISD, having failed other treatment options, a viable option to achieve continence. In the experienced surgeons' hands, continence results have been good with the artificial urinary sphincter, but relatively high complication rates have prohibited its generalized use.

Surgical treatment for SUI owing to ISD should be individualized for each patient based on the several factors, including concurrent medical comorbidities, the patient's goals and quality of life, history of previous failed continence surgery, and the need for additional concurrent vaginal or pelvic surgery. Pelvic reconstructive surgeons should be able to recognize the contribution of ISD to a patient's SUI, and be familiar with the surgical techniques, cure rates, and the diagnosis and management of complications of the treatment options for ISD outlined in this chapter.

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10

The Mid-Urethral Tapes

Bruno Deval and François Haab

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The tension-free vaginal tape (TVT) Gynecare was first described in 1996 by Ulmsten (1) as a minimally invasive procedure to treat female stress urinary incontinence (SUI). This technique quickly gained a major place in incontinence surgery in Europe and is now being used more and more in North America. Prior to TVT, the gold standard technique to treat SUI was the Burch procedure. Several randomized controlled trials have compared the efficacy and safety of TVT and the Burch procedure. These studies demonstrated that TVT had a lower morbidity and an equal or superior efficacy (on midterm follow-up), justifying the widespread use of this technique (2). The long-term results (5-year outcome) of the procedure are also known (82% to 85% of patients are cured), and they justify the use of this technique (3,4). However, there are concerns regarding its operative safety. A Finnish series (5) of 1455 women treated for SUI demonstrated few vascular injuries (venous lacerations were the most frequent injury reported), whereas Zilbert and Farrell (6) reported a case of right external iliac artery injury. In addition, two deaths due to serious vascular injuries have been reported to the manufacturers (7). Three bowel perforations have also been reported (8). Postoperative voiding difficulties such as transient urine retention are present in 8% to 17%, and urgency in 5% to 15%. Most of these complications seem to be related to the penetration of the retropubic space. Keeping the principle of a minimally invasive procedure to reinforce the structures supporting the urethra, E. Delorme introduced a procedure that would avoid these complications. In 2001, the transobturator procedure was described, in which the tape is inserted through the obturator foramen from outside to inside (in extenso from the thigh folds to underneath the urethra) (9). Even though the transobturator out-in TVT technique is claimed to be a safe procedure, it may cause urethra and bladder injuries (Figure 10.1). In 2003, De Leval (10) described a novel surgical technique that allows the passage of a tape through the obturator foramens, from inside to outside, with the use of newly designed surgical instruments. This technique avoids damage to the urethra and bladder and, for this reason, makes cystoscopy unnecessary. However, the long-term safety of this type of tape is not known, particularly in relation to changes in the synthetic material and changes in bladder and urethral functioning caused by the tape, such as voiding disorders and bladder overactivity.

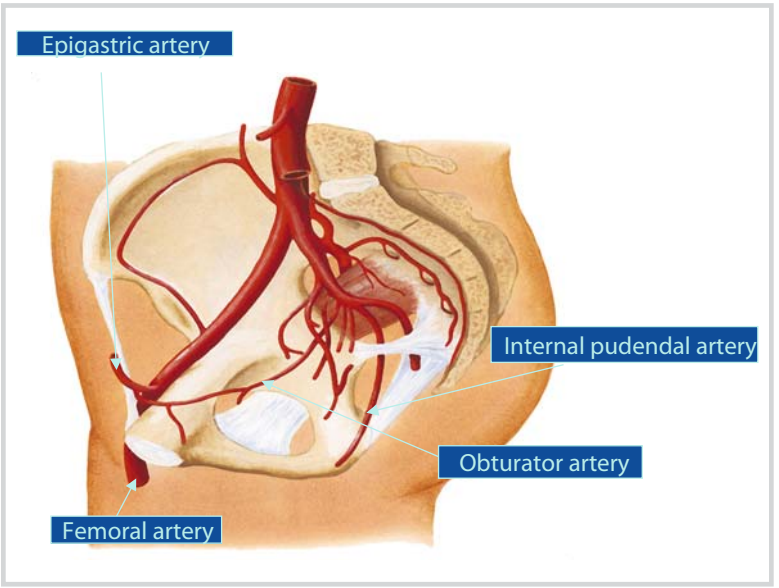


Figure 10.1. The obturator hole is free of major vessels in its anteroinferior part, allowing safe needle passage.

Surgical Techniques

The TVT Technique

The overall concept was to place a synthetic sling at the level of the mid-urethra in order to restaure the physiologic support provided by the pubourethral ligaments. After initial research, the tape proposed was a monofilament polypropylene woven mesh. This material appeared from the begining to be safer than other materials like Dacron or polyester. Originally the technique was described as an ambulatory surgery performed under local anesthesia. The tape is inserted from the vagina using a very limited dissection, and positioned into the retropubic space immediately behind the pubic bone. The tension of the tape had to be adjusted using an intraoperative cough test in order to avoid an excessive tightening of the tape. Overall the procedure appeared very easy to perform with a high reproducibility after an initial proper training.

Since the original description of the technique, some changes have been introduced and some controversies still remain. Several randomized trials have assessed the role of the type of anesthesia chosen for the procedure, considering the fact that the intraoperative cough test could be done only when the procedure is performed under local anesthesia or eventually under general anesthesia. Most of these comparative trials concluded that the success rate of the TVT procedure is not correlated with the mode of anesthesia chosen or with the performance of an intraoperative cough test.

Concerning the intraoperative complications, most of them (e.g., bladder injury, bowel or vessels injuries) could be prevented when the technique has been done according to the original procedure. First, the patient should be placed in the lithotomy position on the operating table, but any excessive flexion of the legs over the abdomen should be avoided in order to maintain easy access to the retropubic space. The tip of the needles should absolutely follow the pubic bone and stay medial, with ideally a skin perforation located 1 to 2 cm apart from the midline. Owing to the risk of bladder injury, intraoperative cystoscopy is mandatory. The bladder examination should be carried out using either a rigid cystoscope with a 70-degree lens of a flexible cystoscope. In case of bladder perforation, the needle is simply removed and repositioned immediately.

The mean duration of the operation is between 20 and 30 minutes, and most patients can be discharged the same day. Postoperatively, heavy lifting should be avoided for 3 to 4 weeks to allow tape incorporation into the surrounding tissues.

The Outside-In Procedure

The procedure was originally described with the use of a special tape, Obtape (Mentor-Porges, Plessis-Robinson, France), made of nonwoven, non-knitted, thermally bonded polypropylene (TBP). There is a black line down the middle of the tape, on the vaginal side, to allow the tape to be positioned the right way around and along the midline. The other specific item of equipment is a tunneler, a specially curved needle with a blunt tip and an eye for the tape to be passed through. More recently, other companies have introduced procedures allowing a transobturator placement of suburethral meshes. The most popular one is the Monarc-AMS (American Medical Systems, Minnetonka, MN) technique using a monofilament polypropylene nonwoven mesh and an helical needle.

The procedure is done under general, spinal, or local anesthesia. The patient is placed on the operating table in the lithotomy position with hyperflexion of the legs. After hydrodissection of the vagina is performed, a vertical midline vaginal incision is made in the middle third of the urethra, passing through the entire thickness of the vaginal wall. Starting at the incision, the vagina is released laterally on either side of the urethra with Mayo scissors over a width of approximately 15 mm. The dissection stops against the ischiopubic ramus. The dissection must be in the deep tissue layer between the vesicovaginal fascia and the urethra, and not too superficially between the vesicovaginal fascia and the vaginal skin. The lateral margin of the ischiopubic ramus is identified between an index finger placed in the laterovaginal fornix and thumb placed in front of the obturator foramen. A puncture incision is made 15 mm lateral to the ischiopubic ramus on a horizontal line level with the preputium clitoridis (Figure 10.2). The tunneler is held in the same hand as the side on which the operator is working. Two types of tunneler can be used: a simple curved Emeth needle or a helical needle. The choice between these two options is made according to the surgeon's preference.

The tunneler is held vertically with the handle downward; it is then introduced through the skin incision, and it crosses the obturator membrane. As the membrane is crossed, a specific resistance is felt, which is easily recognized. The tunneler is then turned to a horizontal position, with the handle pointing medially. The tip of the tunneler is led medially toward the urethra, aiming above the urethral meatus and

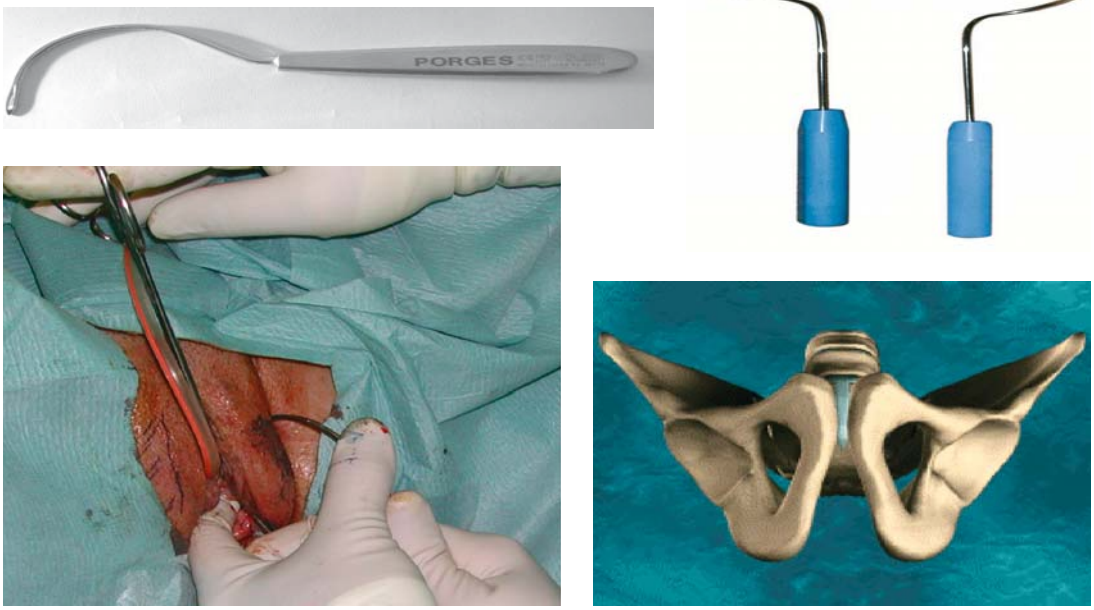


Figure 10.2. After an incision is made at the level of the mid-urethra, the needle is introduced in the obturator hole. A helicoidal or simple curved needle can be used.

underneath the symphysis pubis. The safest method is to lead the tunneler around the ischiopubic ramus while remaining in contact with it. The aim of this procedure is to trace a perineal route with the instrument below the superior fascia of the levator ani. A finger is placed in the incision to check that the tunneler is not piercing the vagina and is passing well above the laterovaginal fornix some distance away from it. The index finger is introduced into the vaginal incision to fold the urethra up and protect it from the needle. The finger will then make contact with the tip of the tunneler laterally underneath the symphysis pubis. The tunneler is then guided by the finger into the vaginal incision (Figure 10.3). Once this procedure has been completed, it is prudent to check that the vagina and urethra have not been pierced by the tunneler. The end of the tape is introduced into the eye of the needle and then pulled through to place it in position. The texture of the tape allows the tape to be pulled hard without risk of breaking. The tape is inserted tension-free behind the urethra (Figure 10.4). The low elasticity of thermally bonded polypropylene makes it possible to adjust the position of the tape precisely.

There are two important points to remember during this adjustment to reduce the risk of compressing the urethra, which causes voiding disorders:

- Leave a visible space between the tape and the urethra.
- Avoid adjusting the tape with the patient in the Trendelenburg position, as the cervical and urethral region is at its highest in this position. It is therefore better to place the patient in the horizontal position or even tilted to ensure that the urethra is at its lowest.

No study has assessed the potential benefits of an intraoperative cough test during this procedure.

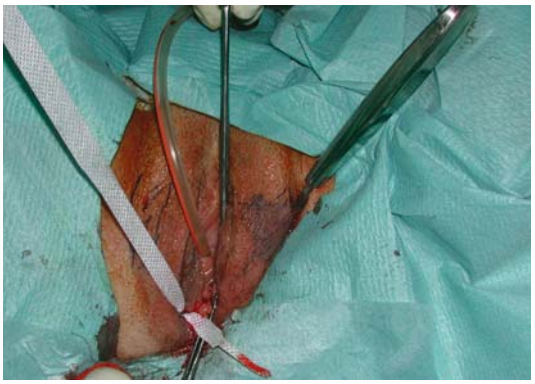
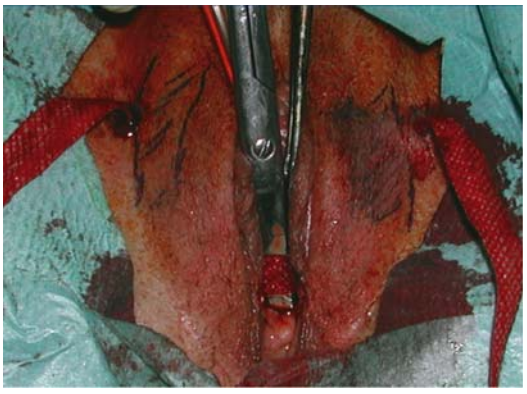


Figure 10.3. The tape is grasped and pulled through the vaginal incision in the obturator hole.

The Inside-Out Surgical Procedure

Three specific surgical instruments were created for the procedure: helical passers, plastic tubes, and an introducer. The helical passers are pairs of instruments, specific for the left and right sides. They are stainless steel instruments with a spirally shaped section and a handle. The spiral section comprises an open circular segment having a 3-cm radius terminated by



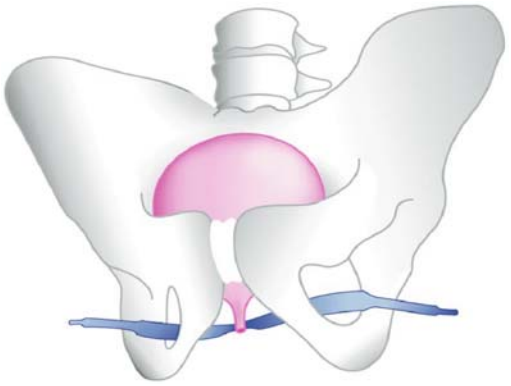


Figure 10.4. The tape is positioned at the level of the mid-urethra without any excessive tension.

two linear segments. On a horizontal plane perpendicular to the handle's axis, the gap between the extremities of the spiral section is 2 cm. The element supported by the helical passer is a polyethylene tube with a sharp pointed distal end. It bears a lateral opening, which allows the insertion of the spiral segment of the helical passer into its lumen. The proximal end of the tube is opened and it can be attached intraoperatively to a nonabsorbable synthetic tape.

The introducer is a stainless steel device that has two segments: a proximal tubular hollow segment and a distal, semicircular, 7-cm-long gutter. The introducer acts as a shoehorn to ease, without danger, the slipping in of the passer, introduced alongside the gutter, from the perineal space through the obturator foramen.

The surgical procedure is generally carried out under spinal anesthesia but may also be performed under general or local anesthesia. Two grams of third-generation cephalosporin are administered intravenously at the time of anesthesia induction. The patient is first placed in the gynecologic position, legs on stirrups and thighs in hyperflexion. The patient's buttocks reach the edge of the table. The operative field is cleaned with a standard antiseptic agent and draped with multiple drapes rather than a single trousers-shaped drape, with care being taken to keep the groin folds in the operative field. Labia minor are suspended by fixation to the skin with nylon suture a few centimeters above the vulvar ostium, inside the thigh folds, in order to expose the vulvar vestibulum. A 16-French Foley catheter is inserted into the bladder.

The points where the needles will exit at the skin level are identified by tracing a horizontal line at the level of the urethral meatus. The exit points are located 2 cm above this line and 2 cm outside the thigh folds. A 5-mm skin incision is made at each exit point.

The anterior vaginal wall is suspended with two Allis clamps on either side of the midline, 1 cm proximally to the urethral meatus. A median sagittal incision of the vaginal wall is started at this level and is continued proximally (toward the vaginal pouches) over a 1-cm distance. Both vaginal mucosal and submucosal tissues are incised. Minimal paraurethral subvaginal dissection is then carried out laterally with the blade, over a few millimeters distance, on either side. One Allis clamp grasps the right minor and major labia, while another Allis clamp holds the left margin of the suburethral vaginal incision, to clearly expose the most posterior aspect of the right vulvar vestibulum. Fine dissection scissors are introduced through the blade-initiated dissection path, and then further, on a horizontal plane with a 45-degree angle relative to the urethral sagittal plane, toward the upper part of ischiopubic ramus. It is important to correctly expose the vulvar vestibulum and to respect the specific direction of the dissection in order to avoid any perforation of the vaginal wall.

Once the upper part of the ischiopubic ramus is reached—a bone contact is perceived—the right obturator membrane is perforated with the tips of the scissors, which are then slightly opened. During the dissection, bleeding can occur but is never important and only occasionally requires a blood-aspirating device. The introducer is then pushed in the preformed dissection pathway until it reaches and perforates the obturator membrane (Figure 10.5). The open side of the introducer's gutter must be facing the operator. The distal end of the tube is mounted onto the spiral segment of the needle and the assembled device is gently slipped along the gutter of the introducer so as to pass through the obturator foramen. The introducer and Allis clamps are removed. At this step, the handle of the passer must be aligned in a parallel manner with the sagittal axis of the vulvar slit. Then, owing to a rotational movement of the passer, the pointed tip of the tube appears at the previously incised skin exit points at the level of the thigh folds. The tube is pulled from the supporting passer, which is removed by a backward-rotational movement, until the first centimeters of the tape become externalized. The same technique is applied to the left side. It is important to take care not to twist the tape.

When both tubes have been extracted through the skin incisions, the ends of the tape are cut. The tape is then aligned under the junction between the mid- and distal urethra and the tension of the tape is adjusted by exerting traction on its two ends and by interposing a pair of scissors between the tape and the urethra so as to leave a space, avoiding any tension of the tape. The plastic sheaths are then removed simultaneously. An alternative procedure for correctly aligning the tape under the urethra is to grasp the tape at its middle with Babcock forceps so as to create a small, 5-mm-long tape loop. As described above, traction is exerted on the distal ends of the tape, avoiding compression of the urethra.

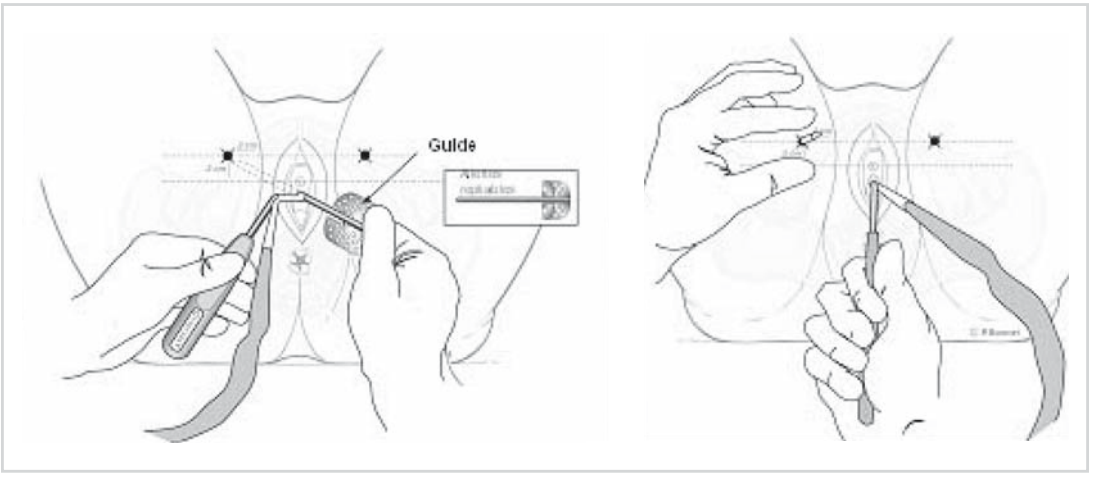


Figure 10.5. The TVT-O technique. The tape is introduced in the obturator hole from the vaginal incision. After an incision is made beneath the urethra with limited dissection laterally, the special curved needle is pushed on a guide through the obturator hole.

Results

The TVT Procedure

The original TVT procedure has been widely assessed, with more than 300 publications in international journals. Most published results report stress incontinence owing to a hypermobile urethra. The cure rate in these patients is above 85%. The failure rate usually ranges from 5% to 10%, mainly owing to persistent or de novo urgency symptoms. However, one remarkable thing is that the overall results are remarkably consistent throughout the literature. This suggests that the procedure is highly reproducible and well standardized, and no doubt accounts for its rapid and widespread proliferation. Moreover, unlike laparoscopic Burch colposuspension or suburethral slings, which are not easy to position, the TVT procedure does not appear to be operator dependent.

Few studies have evaluated long-term follow-up. Nilsson et al (1) recently published 7-year results of the procedure. A total of 80 women have been evaluated at a mean follow-up of 91 months (range 78–100 months). Assessment variables included a 24-hour pad weighing test, a stress test, a visual analog scale for assessing the degree of bother, and a questionnaire assessing the subjective perception of the women about their continence status. At 7-year follow-up, both objective and subjective cure rates were 81.3%. Asymptomatic pelvic organ prolapse was found in 7.8%, de novo urge symptoms in 6.3%, and recurrent urinary infections in 7.5%. No other long-term adverse events have been described in that series.

Only one study has compared the results of the Burch colposuspension and those of the TVT procedure (2). The trial was conducted in 14 centers in the United Kingdom and Ireland. A total of 344 patients were included in the study and randomized; 170 patients underwent a TVT procedure and 146 a Burch colposuspension. At 6 months' follow-up, the continence rates based on objective and subjective criteria were not statistically different in the two groups. Regarding the complications, the authors found an advantage for the Burch over the TVT for the bladder perforation rate (2% versus 9%). However, the estimated blood loss was the same in both groups. The TVT procedure appeared significantly better than the Burch on the following items: postoperative opiate analgesia (21% versus 91%), mean duration of hospital stay (2.2 days versus 6.5 days), and number of patients rehospitalized (9 versus 18 patients). Moreover, a medico-economic analysis has been derived from that study showing that TVT is a more cost-efficient procedure compared to the Burch colposuspension.

Currently, there are no identified prognostic factor for success. Whether sphincter deficiency as given by the measurement of urethral pressure or of the Valsalva leak point pressure is a cause of

failure remains a moot point. Even if this remains a controversial issue, the results of the TVT procedure appeared inferior in a context of intrinsic sphincteric deficiency defined either by a low closure pressure of the urethra or by a low Valsalva leak point pressure. Furthermore, it appeared that patients who have had multiple surgeries for SUI with a subsequent rigid urethra have poorer results. Among other pronostic factors, age and obesity have been identified has having a negative impact on postoperative results.

Based on these results, the TVT procedure has become a first-line therapy when surgery is considered to cure stress urinary incontinence.

The Outside-In Procedure

Delorme et al (11) published in 2004 the results on 32 consecutive patients; 90.6% were cured and three (9.4%) were improved. The mean operating time was 15 minutes. No intraoperative complications were recorded. One patient had complete postoperative bladder retention, which resolved after 4 weeks of self-catheterization. There were no problems with urethral erosion, residual pain, or functional impairment related to the tape. Five patients had voiding disorders, suggesting bladder outflow obstruction. Two patients developed de novo urge incontinence.

Costa et al (12) published in 2004 the results of a multicenter trial on 183 women with SUI associated with urethral hypermobility. The mean follow-up was 7 months (range 1–21 months). At 1-year follow-up, 80.5% of the patients were completely cured and 7.5% were improved. The overall perioperative complication rate was 2.2% with no vascular, nerve, or bowel injury. Six patients (3.3%) had postoperative urinary retention. Cindolo et al (13) published in 2004 the results on 80 females affected by SUI associated with urethral hypermobility and without severe urogenital prolapse. The mean operative time was 16 minutes (range 11–36 minutes). No major intraoperative complications were observed. One bladder neck laceration occurred and was treated intraoperatively. No cystoscopy was performed. The mean hospital postoperative stay time was 1.1 (1–6) days. All patients were examined periodically at 7, 30, and 90 days from intervention (mean follow-up 4 months, range 1–8). There was no urethral erosion. One vaginal erosion with inguinal abscess was diagnosed and treated without removing the sling. Two patients with de novo urge incontinence were observed. The objective and subjective cure rates were 92% and 97%; 96% expressed good quality of life (satisfied/very satisfied).

Few results have been published using the Monarc system. The largest report on this technique has been presented at the International Continence Society-International Urogynecological Association (ICS-IUGA) meeting in 2004 (14). The authors reviewed the results of two prospective trials conducted in nine countries and including 204 patients. The follow-up was rather short and most of the data were related to the morbidity issues. In this series no major intraoperative complications have been found. Groin pain occurred in 1.6% of the patients, and vaginal erosion occurred in 1.0%. Six patients (2.9%) had surgical revision to release sling tension or remove the sling.

The Inside-Out Surgical Procedure

De Leval (10) published in 2003 the results on 107 consecutive patients (mean age: 62 years) using the same operative protocol in all case subjects, independently of the patient's size and weight. The mean operative time was 14 minutes (range 7–20) in cases of isolated SUI treatment. No bladder or urethral injuries and no vascular (hematoma or bleeding) or neurologic complications were encountered. To date, no other reports have been published on this new promising approach.

Comments

De Lancey's (15) theories on pelvic support for the bladder and urethra help to explain the mechanism of action of urethral suspension in the treatment of stress urinary incontinence. The new minimally invasive suspension techniques using a polypropylene tape satisfy the requirements for functional surgery. In the medium term, the results in the treatment of female stress urinary incontinence are satisfactory. Unlike the retropubic tapes, the purely perineal local location of the transobturator minimizes the risk of trauma to internal organs (bladder perforation, damage to the intestine or to blood vessels and nerves). The position of the transobturator tape is similar to that of the natural hammock supporting the urethra

described by De Lancey. Bladder perforation is the most common complication occurring during TVT. Previous series reported an incidence between 0.8% and 21%. With the transobturator procedures, the risk of bladder perforation appears to be dramatically reduced.

Dargent et al (16), who performed cystoscopy during the transobturator obtape procedure at the beginning of their experience, reported no bladder injury in the first 71 patients. However, one case of bladder injury was recently reported in a patient who had an associated cystocele (17). Overall, we do not recommend a cystoscopy during any transobturator procedure when it is performed in normal conditions, which means for patients with no associated cystocele.

Despite a high cure rate, the TVT procedure can be complicated by bladder outlet obstruction. This complication can appear in various clinical forms, such as urinary retention, voiding difficulties, and de novo urgencies or frequencies. Transient urinary retention incidence ranges from 2.3% to 27% after TVT. This is a consequence of an increasing urethral resistance created by the suburethral insertion of the tape. These retentions are usually partial and transient. Training in self-catheterization allows the patients to get through this difficult phase. If complete obstruction occurs, this should lead to transection of the tape. Long-term retention is a rare complication of the TVT procedure; its incidence ranges from 0.6% to 3.8%. This risk is increased for patients previously operated on for SUI, probably because of the temptation to provide excessive tension exerted on the urethra during the second procedure. However, voiding difficulties are frequent after TVT; their incidence ranges from 5% to 38.9%. Since the introduction of the TVT procedure, some details of the initial concept have changed. Most of the users stopped doing the cough stress test, as it led to postoperative urinary retention or voiding difficulties. It is now recommended to just place the tape beneath the urethra. It is recommended that patients should be informed about the risk and carefully monitored for obstruction symptoms after surgery.

Conclusion

The transobturator approach is an effective and safe technique for the treatment of female stress urinary incontinence, alone or in combination with prolapse repair. It allows minimally invasive surgery to be used in stress urinary incontinence to restore the physiologic and anatomic conditions of continence, as far as possible. The first operative and postoperative results after more than a year of follow-up show that this tape satisfies the aims we set ourselves. However, randomized trials will be necessary to demonstrate the potential superiority of these techniques compared to the original TVT in terms of intraoperative complications or postoperative voiding dysfunction.

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Part IV

Surgery for Prolapse

11

Anterior Compartment

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The goal of repair is to restore pelvic anatomic support of the anterior vaginal wall. This is rarely an independent surgery. Often, surgery entails addressing incontinence as well as prolapse of the uterus and posterior compartment. The end result must restore anatomy and function by restoring normal vaginal axis and depth while preserving urinary, bowel, and sexual function. Treatment of cystocele must address all defects of the pelvic floor. In the anterior compartment, we must correct urethral hypermobility, weakness of lateral bladder support (paravaginal), perivesical fascia (central), and cardinal-sacrouterine ligament complex. Options for surgical treatment include abdominal, laparoscopic, or vaginal approaches. This chapter focuses on the various vaginal techniques popularized to repair cystoceles and introduces our new technique that addresses all the defects of the anterior compartment.

Anterior Colporrhaphy

In 1914, Kelly and Drum initially described the anterior colporrhaphy as a treatment for stress incontinence. The urinary results were disappointing, with failure rates up to 50% (1–3), but repair of the anterior vaginal prolapse was successful, and this became a widely popularized treatment for cystoceles from central defects.

Technique

Injection of generous quantities of sterile saline (with or without vasopressors) just beneath the vaginal mucosa can facilitate dissection in the proper plane and control bleeding. A midline incision is made through the vaginal mucosa extending from the apex of the vagina to within 1 cm of the external urethral meatus. It is important that the dissection be made just beneath the vaginal mucosa so that all fascial tissue is left attached to the bladder. The flaps are dissected laterally as far as possible, by sharp dissection, exposing the white pubocervical (perivesical) fascia. Final separation of the

fascial attachments of the urethra and bladder can be made by the operator's index finger dissecting in the paravesical space beneath the pubic ramus. Plication sutures of interrupted 2-0 or 3-0 absorbable material are then placed. The original Kelly procedure for incontinence starts distally at the proximal urethra and bladder neck. Because another procedure will most likely be done for urethral hypermobility or incompetence, these sutures are no longer necessary. Approximating vertical mattress sutures in the pubocervical fascia are taken from the bladder neck to the cardinal ligament (Figure 11.1). Firm bites are taken, but to avoid placement inside the bladder and kinking of the ureters, they cannot be too deep. The posterior floor of the bladder should be inverted with an instrument as the sutures are tied. In the posterior aspect, approximating stitches can be placed in the cardinal-uterosacral ligament complex for additional support. Excess vaginal skin is trimmed and the mucosa reapproximated with continuous or interrupted 2-0 or 3-0 absorbable sutures.

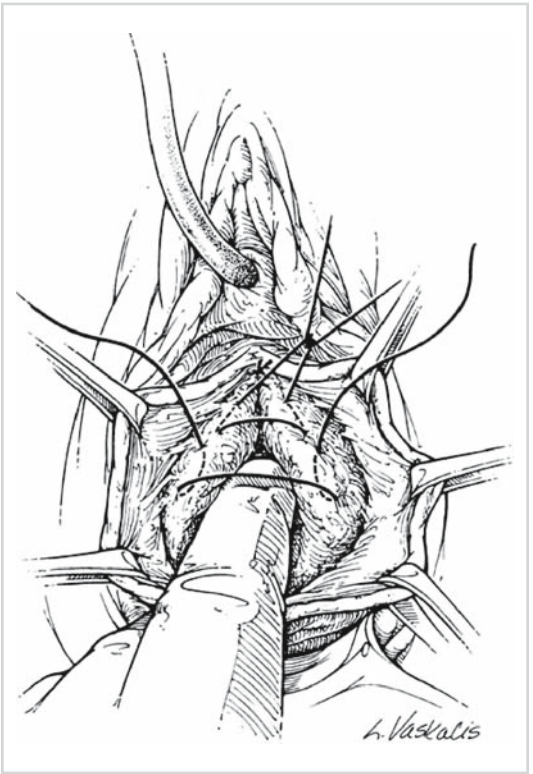

Figure 11.1. Anterior colporrhaphy. The anterior submucosal layer is imbricated with 2-0 or 3-0 delayed absorbable continuous or interrupted suture. [From Nichols (37), pp. 334–362. © 1993, with permission from Elsevier.]

Results

The reported recurrence of anterior vaginal prolapse after anterior colporrhaphy alone is up to 20% (4). Limitations of this repair include addressing only the central defect and the use of already attenuated native tissue. A randomized study of three different anterior colporrhaphy techniques by Weber et al. (5) compared the effects of standard anterior colporrhaphy versus ultralateral anterior colporrhaphy (dissection laterally to the limits of the pubic rami with plication of the muscularis in the midline under tension), versus standard anterior colporrhaphy plus mesh (polyglactin 910 mesh placed over the plication and anchored at the lateral limits of the dissection). Over 50% of the women enrolled had stage III or greater anterior vaginal wall prolapse. At 1 year, the percentages of satisfactory or optimal anatomic outcome were relatively low: 10 or 33 (30%) for the standard colporrhaphy group, versus 11 of 24 (46%) for the ultralateral colporrhaphy, versus 11 of 26 (42%) for the standard plus mesh group. This adds to the data reflecting the lack of success of anterior colporrhaphy alone for anterior compartment defect.

Weaknesses in the lateral vaginal attachments to the arcus tendineus fascia pelvis result in anterior prolapse from a lateral or paravaginal defect and is seen in 80% to 85% of patients (6), much greater than that for central defects alone. The vaginal paravaginal repair was first described by White (7) in 1912 based on autopsy dissections, and Richardson et al (8) revived the paravaginal repair for lateral defects. From the level of the urethrovesical junction to near the vaginal apex, the vaginal muscularis and adventitia are reapproximated to the arcus tendineus fascia pelvis. This repair can be performed via a retropubic abdominal (21) or a vaginal approach (9). A vaginal approach requires more technical skill. Patient selection is important, as a narrow pubic arch limits exposure to the retropubic space. One must also be cautious not to neglect a concurrent central defect, as this may be worsened by paravaginal lateral tensioning of the anterior vaginal wall. The advantages are decreased morbidity, and the central defects can be addressed at the same time.

Vaginal Paravaginal Repair

Technique

The patient is placed in the lithotomy position, and the bladder is drained via a catheter. The procedure is performed through a midline, an inverted U or V, or bilateral parallel incisions in the anterior vaginal wall. The pubocervical (perivesical) connective tissue should be dissected off of the vaginal epithelium sharply to the medial border of the descending pubic ramus. The retropubic space is entered sharply using Metzenbaum scissors through the endopelvic fascia. The pubocervical fascia is separated from the sidewall of the pelvis, exposing the obturator fascia and the arcus tendineus fascia pelvis. The arcus tendineus can be followed from the back of the pubic ramus to the ischial spine by retracting the bladder and urethra medially using a Briesky-Navratil retractor. Four to six interrupted permanent sutures are placed between the arcus tendineus with underlying obturator membrane laterally and the pubocervical fascia medially. The sutures extend from the back of the pubis distally at the level of the urethrovesical junction to the ischial spine proximally. The sutures should be left untied. The process is repeated on the other side. The stitches are then tied sequentially in a distal to proximal direction, alternating from one side to the other. If a central defect exists, traditional anterior colporrhaphy sutures can then be placed to plicate the redundant connective tissue. The vaginal epithelial flaps are trimmed and reapproximated once all sutures have been placed and tied.

Results

A review of seven retrospective cohorts showed a failure rate of 3% to 39% (Table 11.1). Although the rate of recurrence of anterior prolapse was high (39%) in the series from Shull et al (9), most of the recurrences were mild (32%) and the prolapse was less than preoperatively.

Table 11.1. Results of vaginal paravaginal repair for treatment of anterior vaginal prolapse

Author	Recurrence	Follow-up, years, range (mean)
Shull et al, 1994 (9)	4/56 (7%) severe 18/56 (32%) mild	0.1–5.5 (1.6)
Benson et al, 1996 (20)	12/46 (26%)	1–5.5 (2.5)
Farrell and Ling, 1997 (38)	6/27 (22%)	0.75
Scotti et al, 1998 (39)	3/35 (8.6%)	0.5–4.3 (3.25)
Elkins et al, 2000 (25)	6/25 (24%)	0.5–3
Mallipeddi et al, 2001 (40)	1/35 (3%)	0.7–3 (1.8)
Young, 2001 (24)	22/100 (22%)	0.1–3 (1)

Four-Corner and Six-Corner Suspension

The four-corner suspension was devised by Raz et al (10) for patients with stress incontinence, urethral hypermobility, and mild to moderate cystocele with lateral defects. It did not include anterior colporrhaphy. It was subsequently modified to a six-corner suspension (11). The difference is an additional set of proximal sutures (at the level of the cardinal ligament) to support the bladder.

Technique

Two oblique incisions or an inverted-U incision is made from the mid-urethra to the proximal vagina. The pubocervical fascia is exposed. The endopelvic fascia on each side is perforated using curved Mayo scissors (hug underneath the pubic ramus while pointing toward the ipsilateral shoulder) to enter into the retropubic space. The pubocervical fascia connecting the bladder to the arcus tendineus is separated from the pelvic sidewall anteriorly. The lateral attachments of the bladder base are exposed proximally to the cardinal ligaments. Three sets (six-corner suspension) of 1-0 polypropylene sutures are placed on each side. Each suture incorporates multiple passes through the tissue and is laterally placed to avoid periurethral scarring and outflow obstruction. The proximal suture is placed through the cardinal ligament and vaginal wall to support the bladder base. The middle suture is at the level of the bladder neck, and the distal suture is at the mid-urethra. The sutures are passed up individually to a small suprapubic incision with the double-pronged ligature carrier. Indigo carmine is administered intravenously, and cystoscopy confirms ureteral patency and the absence of suture in the bladder or urethra. The sutures are lifted to ensure adequate anatomic reduction of

the cystocele and then tied sequentially to themselves and to the corresponding one from the opposite side. It is important to avoid tension on the polypropylene sutures to prevent postoperative urinary retention.

Results

Early results of the four-corner suspension were encouraging (2% recurrence rate), but unfortunately, there were a significant number of late failures (44). Four- or six-corner suspension without colporrhaphy for mild to moderate cystocele has not been widely reported. In some reports, patients had large cystoceles plus anterior colporrhaphy with recurrence rates of 40% to 59% (12,13). The technique has also been modified with the addition of mixed fiber mesh (14). As a result, the durability of the procedure is uncertain.

Anterior Colporrhaphy and Suspensions

Evidence exists that concomitant procedures at the time of anterior compartment prolapse repair can adversely affect long-term outcomes. Kelly et al (15) reported a high cystocele recurrence in 24% of patients at a mean of 62 months. Raz et al (16) reported a recurrence rate of 11%. In a randomized trial of anterior colporrhaphy with or without four-corner suspension, Kohli et al (17) reported a recurrence rate of 33% versus 7% in patients who had not undergone needle suspension. This effect was also seen in a randomized, prospective comparison of needle colposuspension versus endopelvic fascia plication in women undergoing vaginal reconstruction for stage III or IV pelvic organ prolapse (18). Especially when combined with a sacrospinous vaginal vault suspension, those patients randomized to receive concomitant needle suspension developed a high incidence of early, advanced, recurrent, anterior vaginal prolapse. Sacrospinous vaginal vault suspension has also been associated with recurrent anterior segment prolapse (19). Theoretically it is thought to be caused by altering the vaginal axis (retroversion) with exposure of the anterior wall to greater abdominal pressure or a neuropathy caused by the vaginal dissection (20).

Anterior Colporrhaphy and Sling

Conversely, concomitant suburethral slings at the time of reconstructive vaginal surgery have been shown to significantly reduce the recurrence of anterior vaginal wall prolapse. Cross et al (21) reported recurrence rates of 8% (grades 3 and 4) and 15% (grade 1) in 36 of 42 patients. To improve the long-term failure rate of cystocele repair, Kobashi and Leach (22, 43) described a transvaginal technique using cadaveric fascia lata as a sling and support for the cystocele. A T-shaped segment is incised. The ends of the T are placed retropubically and fastened to the pubis using bone anchors; this is the sling portion of the procedure. The remainder of the patch is secured to the medial edges of the levator muscles bilaterally with No.0 polydioxanone suture and back to the vaginal cuff or cervix proximally with absorbable sutures. The short-term data were excellent (1 to 6 months' follow-up) with no cystocele recurrence. The follow-up data on this technique included 132 patients with a mean follow-up of 12.4 months (range 6–28 months). The recurrence rate of cystoceles was 12.9%, all grade 1 or 2. There was a 9.8% rate of apical vaginal prolapse after this procedure (22). The presence of any type of suburethral sling was associated with a 54.8% reduction in prolapse recurrence (23). This finding should be taken into consideration when planning surgical repair for the woman with prolapse and stress incontinence or suspected masked stress incontinence.

Complications

Significant bleeding with cystocele repair is unusual. Bleeding may occur if dissection is carried out in the wrong plane during transvaginal procedures; therefore, the vaginal wall should be taken off of the perivesical fascia directly on its white shiny surface. Perforation of the endopelvic fascia to gain access to the retropubic space is another potential source of bleeding. Packing with a small laparotomy sponge can be all that is necessary, but oversewing the area with figure-of-eight stitches is often required. The blood transfusion rate for transvaginal paravaginal repair ranged from 9% to 12% (24,25), in contrast to a transfusion rate of 0% to 4% in series of abdominal paravaginal defect repair. The limited exposure and techni-

cal challenge of the vaginal approach likely explain this difference.

Bladder or ureteral injuries are rare, but must not be missed. Intraoperative cystoscopy after administration of intravenous indigo carmine will facilitate visualization of the efflux of blue-stained urine. Failure to see the efflux may signify kinking or ligation of a ureter. The offending suture must be removed and replaced.

Bladder injuries can be reduced by ensuring that the bladder is empty prior to dissection or perforating into the retropubic space. Should inadvertent injury occur, two-layer closure needs to be performed. If the tissue quality is poor, especially in those with a history of pelvic irradiation, an omental, peritoneal, or labial flap interposition is recommended to prevent fistula formation. If a bladder injury is not detected until after surgery, a trial of conservative therapy with a catheter may be attempted.

Early postoperative complications for cystocele repair include wound infection, immediate urinary retention, and irritative voiding symptoms. Retention is more likely in cases in which an anti-incontinence procedure was also performed, but it is usually transient. There was only one case of prolonged retention requiring urethrolysis in the cohort of patients who underwent repair of cystocele using a sling and patch made of cadaveric fascia (22).

Long-term complications include voiding dysfunction such as stress urinary incontinence (SUI), detrusor instability, and incomplete voiding; SUI can be minimized with proper preoperative evaluation and performance of simultaneous anti-incontinence procedure. De novo urge incontinence is a known complication of all bladder surgery and occurs in 5% to 7% of patients (10,16). However, preexisting urge incontinence has been reported to resolve in 63% of cases (26). Other complications include chronic pain, vaginal shortening or stenosis, and dyspareunia. Care should be taken not to aggressively excise excessive vaginal wall, causing vaginal shortening. Finally, a missed or de novo prolapse of other organs (apical prolapse or enterocele) can result postoperatively.

Adjunctive Materials

Because of reported long-term recurrences of anterior vaginal prolapse, classic techniques modified by the use of surrogate materials have been tried in an attempt to improve outcome. These include synthetic mesh (Mersilene, Marlex (42), Prolene), cadaveric allograft fascia (Repliform), and xenograft fascia (Pelvicol, Stratasis).

Julian (27) reported a 66% cure rate for a standard anterior colporrhaphy for recurrent anterior prolapse compared with a 100% cure rate when Marlex mesh was used. However, there was a 25% incidence of mesh-related complications. This approach was not advocated as a primary procedure; rather, it was recommended only for those patients with prior failures. Other observational studies have subsequently been published describing the usually successful experience of using a synthetic mesh, most often Marlex, in reducing recurrence of anterior vaginal wall prolapse (28,29). These studies are most often limited by their small numbers and lack of long-term follow-up.

In a study by Dora et al (30), rabbits had implantation of human cadaveric fascia, porcine dermis, porcine small intestine submucosa, polypropylene mesh, and autologous fascia in the anterior abdominal wall. They were sacrificed at various time points, and tensiometry and image analysis were performed. Each type of human cadaveric fascia and porcine allografts had a marked decrease in tensile strength; in contrast, polypropylene mesh and autologous fascia did not experience any change from baseline.

Xenografts have also been used as reinforcement in prolapse repair. Theoretically these materials may be better tolerated by the vagina than synthetics, but they too have been associated with minor erosions. In addition, there are concerns regarding transfer of animal disease to the host human. These materials are also expensive, and there is no published literature proving their benefits or efficacy.

One prospective randomized controlled trial was performed using polyglactin 910 mesh to prevent recurrent anterior vaginal wall prolapse by Sand et al (31). This mesh is absorbable and was used as a bulking material folded into the anterior colporrhaphy stitches. The approach is thought to enhance scarring just anterior to the suture line, providing greater protection to an area potentially more vulnerable to direct intraabdominal downward forces. Patients with anterior vaginal wall prolapse to or beyond the hymenal ring were eligible. At 1 year postoperatively, 30 of 70 women (43%) who did not receive

mesh had recurrence versus 18 of 73 women (25%) who did receive the mesh ($p = .02$). Prolapse to the hymenal ring occurred in 8 of 70 controls (11.4%) and in two of 73 women (2.7%) with mesh repair ($p = .04$). No patient had recurrent prolapse past the hymen.

Currently, many materials are available for use, but the ideal biocompatible material should be chemically and physically inert, noncarcinogenic, durable, sterile, readily available, noninflammatory, and inexpensive. None exists that mimics autologous tissue, but there are several benefits associated with synthetics that we favor as the surrogate material of choice. They are available in any size and can be easily tailored to the surgeon's preference. They are durable, permanent, and maintain their strength over time. In this era of newly discovered infectious agents, from HIV to prions, one can be at ease that synthetics are free of every pathogenic disease. The cost is also significantly less compared with biomaterials and cadaveric fascia. The main concern in the past has been foreign-body reaction, erosion, and infection that is related to the weave of the mesh and the size of the pores. Multifilaments (Gore-Tex, Mersilene) tend to produce a more chronic inflammation that can be detrimental compared with monofilaments, which produce an acute inflammatory reaction followed by formation of fibrous tissue (32). Pore size influences the flexibility of the mesh used, as well as fibroblast and leukocyte infiltration and passage (33). We currently solely use polypropylene (Prolene) because it is nonabsorbable, macroporous, monofilamentous, flexible, and sterile. The large pore size (>75 μm) allows for the ingrowth of macrophages, fibroblasts, collagen, and blood vessels. This aids in rebuilding autologous tissue within the mesh and allows for the chemotaxis of macrophages in battling infection.

Authors' Technique

There have been numerous modifications to the anterior colporrhaphy, including the use of synthetic or allograft materials, variations in suture placement, and anchoring techniques in order to improve cystocele repair. The long-term results of anterior colporrhaphy alone have been disappointing. The paravaginal repair addresses the lateral defect in anterior compartment prolapse, but even when paired with anterior colporrhaphy, recurrence rates were significant. The main flaw remains—the approximation of already attenuated tissue. The four- and six-corner suspension technique and its variations were not significantly better in the rate of recurrence; rather, some studies had a higher rate of recurrence of mild cystoceles (12). The quest for a technique that can provide the strength and characteristics that will contribute to a lasting repair continued.

Our technique differs from others in that it is a modification of a transvaginal paravaginal repair using soft Prolene mesh that addresses four defects: urethral hypermobility, lateral bladder support (paravaginal), perivesical fascia support (central), and separation of sacrouterine ligaments. The four key technical points are as follows: (1) A distal urethral sling is almost always performed prior to repair of a high-grade cystocele. The only exceptions would be prior sling placement and nonmobile urethra. (2) A single round mesh (5 × 5 cm) repairs the central as well as the lateral defect. (3) The mesh attaches laterally to strong anchoring tissue, the periosteum of the descending ramus of the symphysis and the infralevator obturator fascia, inferior to the line of arcus tendineus. The retropubic space is not entered; the sutures are not attached to the arcus tendineus fascia pelvis or above it as in the classic paravaginal repairs. (4) The pathologically separated cardinal ligaments are reapproximated and forms the most proximal support of the bladder and round mesh.

Procedure

With the patient in the dorsal lithotomy position, a 16-French Foley catheter is placed in the bladder. A suprapubic tube (SPT) is placed after the bladder has been adequately filled. Exposure is maximized with a weighted vaginal speculum and a Scott ring retractor.

If there is concomitant uterine prolapse and a hysterectomy is required, a transvaginal hysterectomy is performed at this time prior to the cystocele repair. We close the cuff but will not yet tie the vault suspension sutures. If a hysterectomy is not necessary, we start with the distal urethral sling and prepare the bladder by dissecting the bladder away from the vaginal wall flaps. Any enterocele defect will be opened, the cul-de-sac repaired with purse-string sutures, and the vault secured to the inferior edge of the sacrouterine ligaments bilaterally. The purse-

string sutures are left uncut, to be the base of the cystocele repair.

We perform a distal urethral prolene sling (DUPS) in all patients with stage IV cystoceles (34). The incidence of occult stress urinary incontinence can be as high as 22% to 80% among patients with high-stage vaginal vault prolapse (35). Owing to the known masked urinary incontinence, and the high incidence of postoperative de novo stress incontinence, many authors routinely perform a concomitant anti-incontinence surgery in all anterior vaginal reconstruction, independent of the continence status. Beck and associates (36) reported a 10% incidence of urinary incontinence after 519 anterior colporrhaphy procedures for prolapse in continent patients.

An Allis clamp is used to retract the urethra superiorly. Two parallel incisions are made in each paravaginal sulcus, carefully avoiding the inner labia. Metzenbaum scissors are used to dissect the vaginal wall from the periurethral fascia. A small window is made in the retropubic space with a pair of curved Mayo scissors directed parallel to the urethra. The medial edges of the urethropelvic ligaments and retropubic fat can then be seen. A tunnel between the vaginal wall and periurethral fascia is made at the level of the distal urethra with a fine right angle, approximately 1.5 cm cephalad from the urethral meatus. A soft Prolene mesh sling, measuring 1×10 cm, is passed through this superficial tunnel. On each end of the sling, a 0-polyglactin suture has been doubly secured prior to the beginning of the procedure. The sling is positioned using the Raz double-pronged ligature carrier (Cook® Urological, Spencer, IN) through a 1-cm midline transverse suprapubic incision (inferior to the SPT). An Allis clamp is placed on each arm of the sling, on either side of the urethra, and held in a horizontal plane while tying down the sutures. This is very important in preventing tying the sling with too much tension. Additionally, the ties are only secured at the level of the superficial subcutaneous fat (3 mm below the skin), not at the level of the fascia. The vaginal incisions are closed with running locking 3-0 polyglactin sutures.

An Allis clamp is used to grasp the anterior vaginal wall at the point of greatest cystocele descent (about midway between the urethra and vaginal cuff). A vertical midline incision is made in the anterior vaginal wall extending from the bladder neck to the posterior edge of the cystocele. The dissection is directed laterally in the avascular plane between the vaginal wall and perivesical connective tissue. The bladder is exposed laterally to the descending rami of the symphysis pubis, distally to the bladder neck, and proximally to the vaginal cuff. This exposes the perivesical connective tissue that is sometimes referred to as the pubocervical fascia. An important reminder: this is not true fascia, rather a meshwork of connective tissue (Figure 11.2).

The main points of anchor include the infralevator obturator fascia as it condenses on the pubic bone anchors laterally on each side. This is the basis of our vaginal paravaginal defect repair, acting as an immobile structure to secure the mesh. Posteriorly, the dissection reaches the peritoneal fold, exposing the attenuated and pathologically separated cardinal ligaments as they fuse with the perivesical fascia. Sutures are placed through the cardinal ligaments and approximated midline, to form the most proximal support of the bladder. This approximation is an important component of our surgery as the separation of the cardinal-sacrouterine complex is a key factor in the formation of cystoceles. The needle used for the approximation is left in place to be used later to secure the mesh in place.

The reconstruction starts with the central defect repair. Horizontal mattress sutures are placed in the lateral aspects of the perivesical

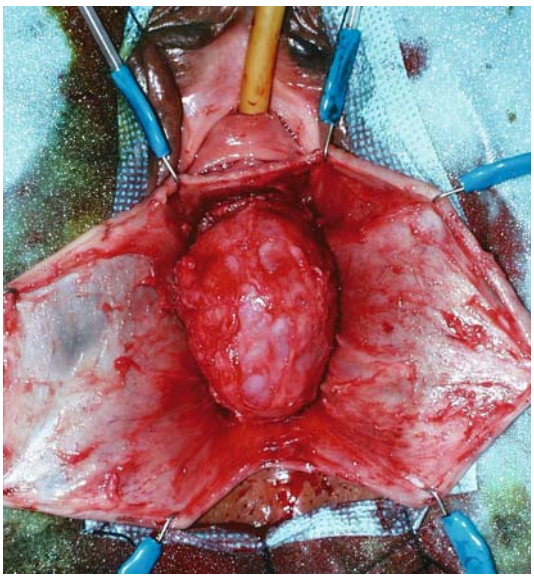

Figure 11.2. The vaginal wall has been opened and dissected off of the bladder, exposing the pubocervical (perivesical) fascia.

fascia (3-0 polyglactin) from the bladder neck to the vaginal cuff (Figure 11.3). Once all sutures have been placed, cystoscopy is performed to ensure that there is no bladder or ureteral injury; 5 mL of indigo carmine is given 15 minutes prior to cystoscopy so that ureteral efflux can be easily visualized. The centrally imbricating sutures are then tied in an anterior-to-posterior direction. Given the presence of the mesh, it is doubtful these sutures are even necessary. We still reduce the central hernia in this manner to allow ease of mesh attachment and placement. To correct the lateral defect, we aim for the periosteum of the descending ramus of the symphysis pubis. A 0-polyglactin suture is placed through the previously dissected infralevator obturator connective tissue just over the periosteum (Figure 11.4). We have found this to be a reliable, strong, nonmobile anchor. A circular soft Prolene mesh is cut in the shape of a disk (5 × 5 cm). This is secured to the previously plicated cardinal ligaments posteriorly, and the obturator fasciae laterally. Two additional sutures are placed anteriorly, one on each side of the proximal urethra/bladder neck through the perivesical fascia, to complete the fixation of the mesh. The mesh is trimmed as needed to ensure taut positioning (Figure 11.5). The excess vaginal wall is then trimmed.

If a vault repair was also performed, the colposuspension sutures (to the sacrouterine ligaments) are tied prior to trimming the excess vaginal wall. The midline vaginal incision is

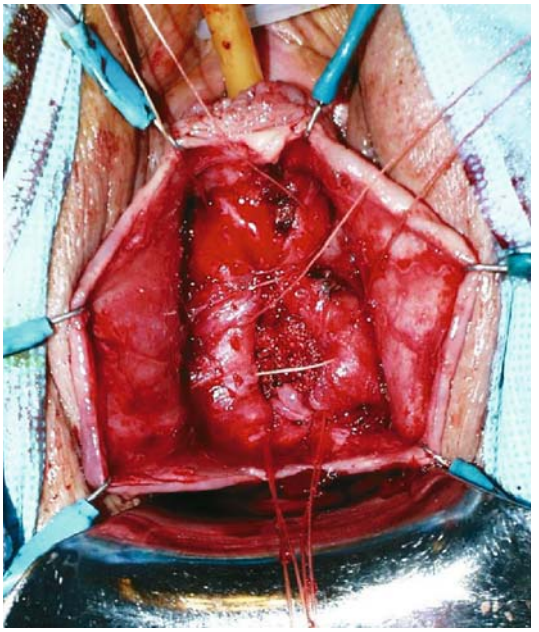

Figure 11.3. Anterior colporrhaphy sutures in place.

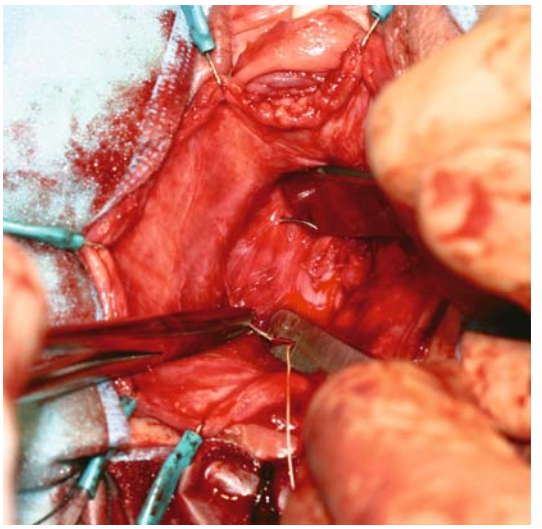

Figure 11.4. An 0-polyglactin suture is placed through the obturator fascia over the periosteum just above the descending ramus of the symphysis pubis. This is below the arcus tendineus.

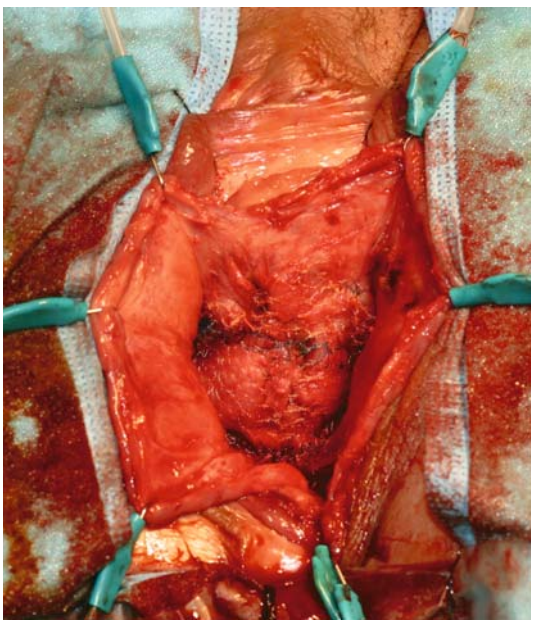

Figure 11.5. The disk-shaped mesh has been trimmed to fit tautly in position. It is secured anteriorly on each side of the proximal urethra, laterally to the obturator fascia, and posteriorly to the cardinal ligaments.

closed with a running 3-0 polyglactin suture. If a rectocele is present, we restore the rectovaginal fascia, levator hiatus, and perineal defects.

An antibiotic-soaked vaginal pack is placed until discharge. Most patients go home after 24 hours of observation. The suprapubic tube is capped, and attempts at voiding are instituted prior to discharge. Patients are instructed in the use of the suprapubic catheter in checking postvoid residuals at home. The majority of patients void within 72 hours, so the placement of a suprapubic tube or urethral catheter (and possible preoperative teaching of intermittent catheterization) is the surgeon's preference. Because many of our patients are not local residents, we currently place SPTs in a majority of our patients. We keep the catheter for at least 1 week to minimize possible urinary extravasation with its removal.

Our early series of 94 consecutive patients with stage IV cystocele repairs showed cure or improvement of the anatomic prolapse in 82% of patients. The range of follow-up was 8 to 22 months. Our complication rate was 8%. There was transient retention in two patients and de novo urinary incontinence in 4% of the patients. Although no patient developed recurrent high-grade cystocele, two patients developed mild grade 2 cystoceles. No complications related directly to the mesh were seen—specifically, no erosions or graft infections (Urology 66:57–65, 2005 by Rodriguez, LV et al.). We have previously reported our promising results with the Prolene sling in treating stress urinary incontinence (34). We now have similar success in the treatment of anterior compartment prolapse without any cases of permanent retention.

Conclusion

The diagnosis and treatment of stage IV cystoceles is challenging, even to the most experienced pelvic surgeons. Forces that alter the normal support of the anterior compartment often result in disorders of the other compartments, resulting in posterior vaginal wall prolapse, which includes uterine or vaginal vault prolapse, and perineal laxity. Therefore, to effectively evaluate and treat women with anterior compartment relaxation with or without urinary incontinence, it is imperative that the clinician not only understand the normal structure and function of the lower urinary tract, but also has a working knowledge of the anatomy and pathophysiology of pelvic support. The surgeon will then be able to effectively address their female patients who present with complaints related to deficiencies in pelvic support, and appropriately apply the current methods of evaluation and treatment discussed in other chapters of this book.

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12

Uterine and Vaginal Vault Prolapse

Peggy A. Norton

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We are what we repeatedly do. Excellence, then, is not an act, but a habit.

Aristotle

The surgical management of pelvic organ prolapse is more challenging than that for stress urinary incontinence, and detection and correction of apical repairs can be the most difficult of all pelvic floor defects. One-third of procedures performed for pelvic organ prolapse are secondary procedures (1). The number of procedures performed in the United States to treat posthysterectomy vaginal vault prolapse increased dramatically from 1437 procedures in 1979 to 22,025 procedures in 1997 (2), while the overall number of procedures performed for pelvic organ prolapse declined from 226,000 in 1979 to 205,000 in 1997. Despite this apparent epidemic of apical prolapse, residency training for urologists and gynecologists alike favors repair of cystoceles and rectoceles. Moreover, defects of the anterior and posterior vaginal walls are more common and easier to detect than apical defects such as uterine prolapse and vaginal vault prolapse (3). For these reasons, correction of apical defects remains a surgical challenge for many surgeons.

Suspension of the vaginal apex is the keystone of surgical repair for pelvic organ prolapse. Good suspension of the uterus or posthysterectomy vaginal cuff protects the ventral and dorsal walls from transabdominal forces that push these tissues toward the introitus. Recognition that an apical defect exists remains a major diagnostic problem in the evaluation of pelvic organ prolapse. While anterior and posterior wall defects can be demonstrated on vaginal exam with a Sims speculum or half blade of a bivalve speculum, the apex may be undeveloped in the supine position used for examination or surgery. A careful examination with the patient sitting at a 45-degree angle

or standing often produces the abdominal pressure needed to expose the apical defect. Apical defects are best demonstrated in the standing position (4). Clark et al (5) reported that the highest rates of reoperation for pelvic floor disorders in a managed care system occurred in women undergoing surgery for apical defects (33% reoperation) or combined anterior/apical (15%) or posterior/apical (12%). Thus, failure to appreciate an apical defect prior to surgery may lead to poor surgical results, and is an important reason for surgical failure in pelvic organ prolapse.

There is no specific degree of descent that mandates surgical correction. In general, stage II pelvic organ prolapse is the level of descent at which prolapse often becomes symptomatic (6). However, resuspension of the apex may be considered at levels above this (less descent), especially with posthysterectomy vaginal vault prolapse. For example, an anterior wall defect to 2 cm above the hymeneal ring is quite common (7), while vaginal vault prolapse to the same level is uncommon and may be much more symptomatic, often because there is a large enterocele inside the vault prolapse. Apical defects rarely present as an isolated prolapse, and consideration of whether to repair the apical defect needs to include sexual function and whether the other defects will suffer from lack of good apical support. As another example, a woman with a large rectocele to the introitus and a vaginal cuff at 5 cm often needs apical resuspension; there is often an enterocele pushing the cuff down, and resuspension of the posterior fibromuscular wall of the vagina into such a low apex leads to a vagina that is too short for comfortable coitus.

Once the degree of descensus has been assessed (see Chapter 4), a decision is made about whether repair of the apical defect is indicated, either in isolation or as part of a general repair for prolapse. Just as with other conditions that affect quality of life without threatening life, surgical correction of uterine or vault prolapse must be a balance between risk and benefit. While the risk of surgery is well known to surgeons, patients may assume that risks apply to others and not to themselves. The benefit of prolapse surgery is not guaranteed: As a general rule in pelvic organ prolapse, patients should be sufficiently bothered by their condition to undertake surgery, knowing that in one third of cases, the result will not be satisfactory (1,5).

Surgical goals may differ depending on whether the patient wishes to be sexually active, her lifestyle, outcomes of prior corrective procedures, comorbidities, and risks for recurrent prolapse. Patients wishing to continue heavy lifting or exercise, or with risk factors for recurrence such as higher defects (stage III and IV) or younger age (8) may consider the most durable procedure, often an abdominal approach such as sacrocolpopexy (9). Nevertheless, vaginal repair is to be preferred owing to shorter hospitalization and recovery (10). For patients wishing to be sexually active, the postoperative goal should be a vaginal length of approximately 9 to 10 cm with good caliber maintained throughout the vagina. Overcorrection of the anterior wall leads to significant vaginal shortening, while overcorrection of the posterior wall leads to a "shelf" owing to plication of the levators across the midline, and subsequent dyspareunia. The apex can be overcorrected, but this usually occurs with abdominal surgeries in which the vagina is placed on excessive tension, often with a result of excessive vaginal length.

Specific procedures to address apical defects can be categorized by the absence or presence of the uterus, either posthysterectomy vaginal vault prolapse or uterine prolapse. The latter includes vaginal hysterectomy used to treat the prolapse, and prophylactic procedures to prevent future pelvic organ prolapse or to preserve the uterus in the presence of support defects. The technique is described for the procedures that are widely applicable.

Procedures for Uterine Prolapse

The cervix is located in the anterior (ventral) vaginal wall, often several centimeters nearer the hymeneal ring than the posterior cul-de-sac. Optimally, the cul-de-sac is 10 cm above the hymeneal ring, with the cervix at 8 to 9 cm above (11). Descensus with Valsalva to the midvagina, termed stage I in the Baden-Walker system, corresponds to a cervix located 4 to 5 cm above the hymen, equivalent to C = −4, stage I in the pelvic organ prolapse quantification (POPQ) system. Once the uterus descends to 2 to 3 cm above the hymen, it is still termed stage I prolapse in the POPQ system, but may be entirely normal in many women, with adequate vaginal length for coitus due to the higher cul-de-sac (12). Descent to a centimeter above or below the hymeneal ring (POPQ point C = +1 to −1) is a stage II apical prolapse (Baden-Walker

stage II) and is the level at which most uterine prolapses become symptomatic (13). If a patient complains of symptoms due to prolapse above this level, consideration should be given to other sources for the complaints (13). Uterine prolapse at this level can still be managed with a pessary, but consideration should be given to surgical management if the patient is symptomatic. Beyond this level, the prolapsed uterine is increasingly symptomatic and managed surgically in many instances.

In a few isolated cases, cervical elongation occurs and represents good apical support, with the cervix appearing at the introitus due to elongation of the cervix itself. The measure C is the cervical descent to symptomatic levels (i.e., within 1 cm of the hymeneal ring), while the D (measuring descent of the cul-de-sac) is at the level of 8 to 10 cm above the hymeneal ring. Although such patients have good apical support for reattachment at hysterectomy, the hysterectomy can be more difficult. Occasionally such patients are managed with a Manchester amputation of the cervix (14).

Once the decision is made to treat uterine prolapse with surgery, the usual course is to plan removal of the uterus as part of the treatment. Any unexplained vaginal bleeding, or any abnormal Pap smear needs to be evaluated before removal of the uterus. In general, unless the postmenopausal bleeding can be explained by such factors as regular withdrawal from progesterone as part of hormone replacement therapy, an endometrial biopsy should be performed prior to hysterectomy. For pre- or perimenopausal women, any abnormal uterine bleeding needs to be evaluated similarly: bleeding more often that every 21 days, bleeding 7 days or longer, or excessive menstrual bleeding, especially in women at high risk for uterine cancer such as obese or nulliparous women. A bimanual exam should be performed as part of the preoperative assessment to exclude adnexal enlargement, and the bimanual exam repeated at the beginning for surgery in case of a pelvic mass.

Vaginal Hysterectomy

Vaginal Hysterectomy has been described in many other texts, but in the case of pelvic organ prolapse, particular attention should be paid to preservation of the uterosacral ligaments for resuspension of the vaginal apex. In the absence of cervical elongation, uterine prolapse to the level of the hymeneal ring means that the uterosacral ligament is attaching to the cervix just above the hymen, and simple resuspension of the vaginal cuff to the ligaments at this level may not result in a well-supported vaginal apex posthysterectomy. Factors that favor the vaginal approach for hysterectomy include a wide pubic arch, some descensus of the uterus and cervix, parity, concomitant repairs requiring a vaginal approach, and any factors that might discourage the abdominal approach such as obesity. Factors that discourage the vaginal approach include uterine enlargement (beyond the size of a 12 week pregnancy [15]), narrow pubic arch (16), a history of cesarean or pelvic adhesions, and desired prophylactic oophorectomy. While these factors do not preclude a vaginal approach, careful thought must be given to these cases and the patient informed of the possibility of changing to an abdominal approach during the operation. The presence of a large adnexal mass or known dense pelvic adhesions or uterine enlargement beyond the size of a 16-week pregnancy (palpable fundus midway between the pubic symphysis and the umbilicus) are best managed abdominally.

Technique

The cervix is grasped, scored circumferentially with scalpel (Figure 12.1), and the vaginal skin and underlying fibromuscular walls will eventually be sewn together to form the new apex of the vaginal cuff. Next, the anterior and posterior

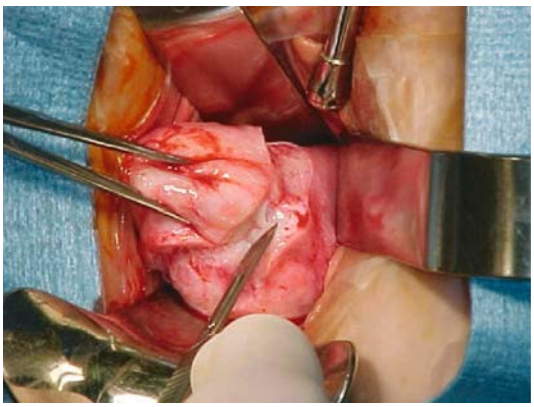

Figure 12.1. The cervix is placed on traction and scored with scalpel or cautery.

reflections of the peritoneum behind the vaginal wall are identified. An anterior colpotomy is performed usually before the posterior colpotomy. The surgical plane between the cervix and the bladder may be obscured by prior cesarean section, and given this risk of dependent bladder perforation we usually leave some urine in the bladder to assist with early diagnosis of cystotomy. With posterior colpotomy, the uterosacral ligaments should be palpated so that the site of entry into the posterior cul-de-sac does not unintentionally interrupt either uterosacral ligament (Figure 12.2). The apex will be resuspended to the uterosacral ligaments, so this pedicle should be ligated at the safest point in a cephalad direction (Figure 12.3). Each pedicle is clamped with a curved Heaney clamp, cut, and ligated with delayed absorbable suture. Progressive pedicles are taken of the uterosacral ligaments, the cardinal ligaments, the uterine arteries, the broad ligament, and the utero-ovarian ligament. Once the utero-ovarian ligaments are transected, the specimen is passed off and pedicles inspected. If the ovaries are to be removed, the tube and ovary are grasped with a Babcock clamp, and the pedicle clamped with care to remain medial to the ureter.

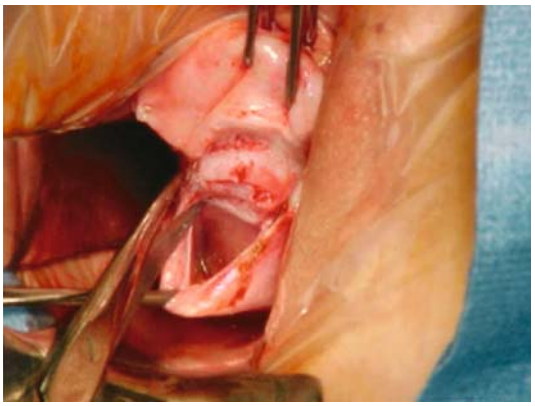

Figure 12.2. After the posterior colpotomy, the uterosacral ligaments can be palpated with the cervix on traction.

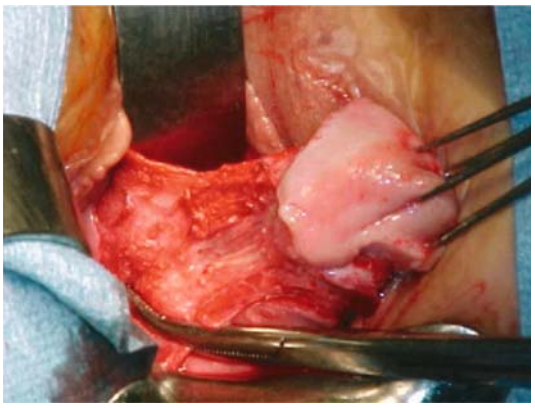

Figure 12.3. The uterosacral ligament is skeletonized, the ureter palpated against the pubic ramus, and the ligament clamped, cut, ligated, and held. This results in a uterosacral pedicle that is 4 to 5 cm more cephalad than if the pedicle is taken at the insertion into the cervix.

At any point along the way, the ureter is close to the plane of dissection. Hurd and colleagues (17) studied the relationship between the cervix and the ureter on computed tomography (CT), and found that at the most dorsal reflection of the ureter, the average distance from ureter to cervical margin was 2.3 ± 0.8 cm (range, 0.1–5.3 cm) They concluded that finding that this distance is <0.5 cm in 12% of the women studied may explain the relatively common occurrence of ureteral injury during hysterectomy. In uterine prolapse, the ureters have a less predictable course and may be pulled caudal and medial by the prolapsing uterus. Delancey (18) studied the effect of prolapse on the course of the ureter, and found that for every 3 cm of cervical descent the ureters descend 1 cm, thereby widening the ureterocervical gap and permitting ligament shortening during vaginal hysterectomy.

Prophylactic Suspension of the Vaginal Cuff

The support of the vaginal vault after hysterectomy requires some consideration, and may be achieved by a "prophylactic" procedure in cases of normal uterine support: attachment of uterosacral ligaments to the vaginal cuff, McCall culdoplasty, and Mayo culdoplasty (Figure 12.4).

The simplest technique of prophylactic vault suspension mimics the procedure performed abdominally: the sutures placed in the uterosacral ligament pedicles are held and reattached to the vaginal cuff by drawing each end through the vaginal cuff using a free Mayo needle.

McCall Culdoplasty

With the open cuff, a delayed absorbable suture is placed at approximately the 5 o'clock position into the cuff traveling cephalad (Figure 12.5). The suture is then brought lateral to medial

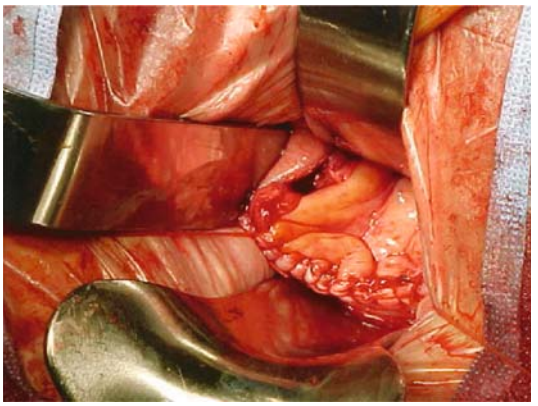

Figure 12.4. The right uterosacral ligament can be traced from the held sutures of the pedicle cephalad. The posterior cuff has been sutured to control bleeding.

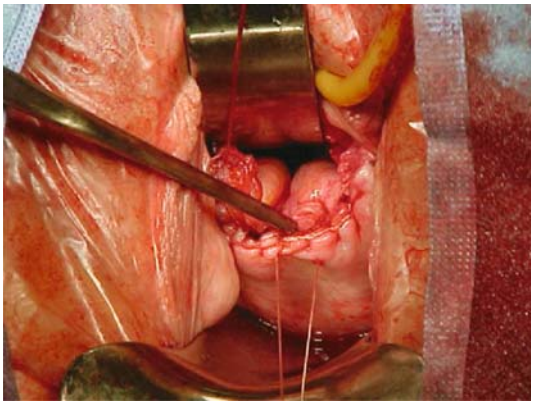

Figure 12.5. The external McCall suture is completed by bringing the suture out at the 7 o'clock position on the posterior cuff. The two ends are then tied together after completing the internal McCall sutures.

through the uterosacral ligament on the patient's left, and then in an interrupted fashion across the peritoneum and into the contralateral uterosacral ligament. The suture is then brought back out through the cuff at approximately the 7 o'clock position and both ends tied down. Several internal McCall sutures may be placed through the peritoneum from the uterosacral ligament to the uterosacral ligament to close the cul-de-sac prior to tying the external McCall sutures.

Mayo Culdoplasty

Webb and colleagues (19) reported on a large cohort of women followed for a median 16 years after Mayo culdoplasty for posthysterectomy vaginal vault prolapse with 73% follow-up; 15% of women had symptoms or signs of prolapse, and the authors commented on the increasing numbers of patients presenting with this problem over the study period.

Cruikshank and Kovac (20) reported better support of the apex with the McCall culdoplasty in a randomized trial comparing this procedure with simple peritoneal closure or vaginal Moschowitz procedures. In women undergoing hysterectomy for benign indications, 25% developed an apical defect by 3 years, and for those undergoing simple peritoneal closure, almost 40% developed an apical defect. The best outcomes were achieved with the McCall culdoplasty, where only two of 32 subjects developed apical defects. These discouraging numbers by skilled vaginal surgeons point to the technique as a possible explanation for the increasing rates of posthysterectomy for vault prolapse seen in the U.S.

Resuspension of the Vaginal Apex After Vaginal Hysterectomy for Uterine Prolapse

In cases of uterine prolapse at the time of vaginal hysterectomy, multiple procedures have been recommended. In addition to the culdoplasty techniques recommended in textbooks, there are several reports of uterine preservation with apical support procedures. These are mostly retrospective case series using the sacrospinous ligament fixation involving fewer than 50 subjects with short follow-up and poorly defined outcome criteria (21,22).

There are two options for suspending the vaginal cuff to the uterosacral ligaments at the time of vaginal hysterectomy for uterine prolapse: shortening the ligaments at the time of transecting the ligament as the first pedicle of the hysterectomy, or placing sutures higher in the ligament at the time of attachment to the apex, essentially as a high uterosacral ligament suspension. If the shortening of the ligaments is to be done at the time of transection, considerable shortening must be accomplished to establish a site appropriately cephalad for resuspension, optimally at 8 to 10 cm. With a cervix at the hymeneal ring, the uterosacral insertion is approximately –2 cm, thus considerable shortening needs to occur. The location of the ureter should be established by palpation through the anterior colpotomy, pinning the

ureter against the pubic ramus. The ligament should be skeletonized some distance up the ligament before clamping, as much as 4 to 6 cm. If resuspension is to be performed after removal of the uterus, this is usually done after the anterior and possibly posterior wall defects are corrected. With traction on the uterosacral pedicle in the direction of the ceiling (instead of the surgeon's nose, which pulls the ureter toward the ligament), a suture should be placed into the ligament lateral to medial (to direct the needle away from the ureter) at a depth 8 to 10 cm cephalad to the introitus. These sutures should then be attached into the anterior and posterior vaginal cuff. If permanent suture is used, the posterior cuff alone is sufficient because the anterior cuff is near the course of the ureter. Permanent suture is often considered because it offers additional strength and durability, but has the additional risk of granulation at the cuff. If insufficient length can be accomplished, then one of the following apical suspensions should be considered: high uterosacral ligament suspension or sacrospinous ligament suspension. These procedures are described below for vaginal vault suspension, but can be performed at time of vaginal hysterectomy. There are no reports comparing each of these procedures. Cruikshank (20) reported better support of the apex with the McCall culdoplasty in a randomized trial comparing this procedure with simple peritoneal closure or vaginal Moschowitz procedures.

Vaginal Procedures to Preserve the Uterus

Although most published descriptions of uterine prolapse involve removal of the uterus, there are a few descriptions of uterine preservation. This may be considered if the woman desires preservation or future childbearing, or it may be a philosophical decision to preserve the uterus. The paradigm to remove the uterus because of pelvic organ prolapse needs to be challenged: surgeons in France do not routinely remove the uterus for support defects, and it may be that surgical education in techniques for uterine preservation might increase the options for many women. Two large randomized trials compared traditional abdominal hysterectomy to supracervical hysterectomy, in which the uterus is removed but the cervix is conserved along with its ligamentous support structures (23).

Uterine preservation with apical support procedures are mostly retrospective case series (level 3 evidence) using the sacrospinous ligament fixation involving fewer than 50 subjects with short follow-up and poorly defined outcome criteria (21,24).

Laparoscopic Shortening of the Uterosacral Ligaments

This procedure is done with permanent sutures through the insertion of the ligament into the cervix, and at a point cephalad where a contiguous ligament can be identified (instead of an empty sleeve of peritoneum). How high should the resuspension be? One can push the uterus in a cephalad direction to accomplish a point of C = −8 cm or higher, and then suspended to a point on the ligament to maintain this elevation.

Two additional procedures might be considered for apical resuspension with uterine preservation, especially in the case of desired fertility. A high uterosacral ligament suspension to the cervix can be performed through a posterior colpotomy. The posterior cul-de-sac is opened as with the beginning of vaginal hysterectomy. A permanent suture may be placed in the uterosacral ligaments and attached to the cervix in the midline. This procedure seems to produce modest suspension but some prevention of further prolapse. Likewise, a sacrospinous ligament suspension to the cervix has been described, with subsequent pregnancies (25). In our hands this procedure is best performed in a woman with a fairly large cervix (multiparous) with the sutures placed more medially (and therefore more dorsally) on the coccygeus muscle with its underlying sacrospinous ligament; otherwise, the cervix is difficult to draw laterally in some individuals.

Posthysterectomy Vaginal Vault Prolapse

Vaginal vault prolapse occurs after surgical hysterectomy, and level for level is more symptomatic than uterine prolapse to the same anatomic degree. Correct assessment of the apex includes direct visualization of the cuff (seen with two small puckers at the lateral margins in patients with some suspension) with an open Graves speculum. The patient is asked to bear

down while in a semisitting supine lithotomy, and the speculum is withdrawn until further descent of the apex ceases. The distance from the apex to the hymeneal ring can then be measured in centimeters. Similar to uterine prolapse, it may be helpful to repeat the examination with the patient in the standing position and estimating the distance from the apex to the introitus. Small bowel pushing the apex down is common, and this enterocele can often be palpated as loops of bowel in the prolapsing vault. A vault sitting from a 1 cm above the hymeneal ring (POPQ C = –1, stage II) or beyond is usually symptomatic and treatment should be considered.

More clinical judgment is needed to decide whether apical defects above this level require treatment. In isolated apical defects from 2 to 7 cm above the hymeneal ring, deep dyspareunia is the main concern. Because these defects are more commonly seen in combination, asymptomatic apical defects may need to be addressed surgically to suspend and optimize repair of symptomatic anterior and posterior wall defects. Thus, asymptomatic apical defects to approximately midvagina (C = –4 or –5) may need to be included in the repair of cystoceles and rectoceles, if these defects are symptomatic. Each case needs to be individualized; apical defects require more skill and more complex surgery for repair, and the risk/benefit ratio for surgery needs to reflect this. But the more common error seen with treatment of the apex is failure to detect the apical problem.

In the case of posthysterectomy apical defects, vaginal procedures can be either supportive or obliterative. Available data on published series and trials with more than 50 subjects are listed for sacrospinous ligament suspension (Table 12.1), high uterosacral ligament suspension (Table 12.2) and colpocleisis/colpectomy (Table 12.3).

Table 12.1. High uterosacral ligament suspension procedures

Reference	*n*	Follow-up, months (range)	Success rate	Complications
Pohl and Frattarelli, 1997 (40)	40	6–40	89%	
Jenkins, 1997 (41)	50	6–48	88%	
Barber, 2000 (42)	46	15.5 (3.5–40)	90%	11% ureteral
Karram et al, 2001 (43)	168	6–36	89%	2.4% ureteral
Shull, 2000 (44)	289	Not stated	87%	1% ureteral
Amundsen, 2003 (45)	33	28 (6–43)	82%	

Table 12.2. Sacrospinous ligament suspension procedures[a]

Citation	*n*	Follow-up	Success rate	Outcome measures
Morley and DeLancey, 1988 (46)	78	1 mo–11 yr	78%	Subjective, objective
Imparato 1992 (47)	155	?	90%	Objective
Shull 1992 (48)	81	2–5 yr	65%	Objective
Pasley, 1995 (49)	156	6–83 mo	94%	Subjective, objective
Benson et al, 1996 (50)	42	12–66 mo	29%	Objective (third party), RCT
Hardiman, 1996 (51)	125	26.4 mo	(98%)[b]	Objective
Penalver, 1998 (53)	160	18–78 mo	85%	Objective
Colombo, 1998 (54)	62	4–9 yr	73%	Subjective, objective
Meschia, 1999 (55)	91	1–6.8 yr	(94%)[b]	Objective
Sze, 1997 (52)	54	7–72 mo	67%[c]	Objective
Lantzsch, 2001 (56)	123	6 mo–9 yr	(97%)[d]	Objective

RCT, randomized controlled trial.
[a] Using publications reporting more than 50 subjects, interpretable data. One RCT is included in which 42 subjects were randomized to SSLS.
[b] Apex only; recurrent cystocele 16%, recurrent rectocele 10%, recurrent enterocele 6%.
[c] 13/18 anterior wall recurrence.
[d] Apex only; 10 recurrent cystoceles, one recurrent rectocele, one recurrent enterocele.

Table 12.3. Obliterative vaginal procedures for apical defects

Citation	*n*	Patient age, years (mean)	Follow-up (months)	Cure (%)	Comments
Partial colpocleisis					
Fitzgerald, 2003 (57)	64	78		97	*
Moore, 2003 (62)		30	19	90	three reoperations for prolapse
Total colpectomy					
DeLancey and Morley, 1997 (59)	33	78	35	100	
Cespedes 2001 (58)	38	77	24	100	
Harmanli et al, 2003 (60)	41		28.7	100	12 TVH, 10 paravaginal
von Pechmann, 2003 (61)		62	12	97	37 TVH

* 14% takedown rate in patients undergoing concomitant pubovaginal sling.

Suspensory Procedures

High Uterosacral Ligament Suspension

First reported in 1997, this procedure suspends the vaginal apex to the remnants of the uterosacral ligaments at the level of the ischial spines and cephalad, with attention to incorporation of the rectovaginal fascia and pubocervical fascia into the permanent sutures at the apex. The procedure maintains the vaginal axis in the midline, allows adjustment of the vaginal length, and can include the use of allograft or xenografts in the suspension.

Technique

Since considerable distortion of the vaginal walls can occur in pelvic organ prolapse, the new vaginal apex should be identified and marked with two silk sutures at that point where the anterior and posterior walls will have equal length and tension and the final length of the vagina will approximately 10 cm. If there is excessive length, the "toe" of the apex may be removed; if there is insufficient length in a sexually active woman, an abdominal procedure using mesh may be preferable, since the vaginal approach is unlikely to result in more vaginal length.

The vaginal wall is opened in the midline from perineal body to bladder neck, taking care over the vaginal apex to avoid opening the enterocele prematurely. A modest amount of lateral dissection in the anterior and posterior walls can identify whether the fibromuscular wall of the vagina can be repaired, or whether a tissue graft is needed. Now the enterocele should be entered and the bowel packed out of the way with tagged lap sponges. The right side of the pelvis between the sigmoid and the side wall should be well visualized up to the level of S4, and the course of the ureter appreciated. A lighted retracter (Miyazaki retractor, Marina Medical, Hollywood FLA) can improve visualization dramatically. Beginning at approximately the 8 o'clock position on the open peritoneum, a long Allis clamp is used to place traction on the peritoneum and is tracked upward toward the sacrum. While the more caudal portion of the uterosacral ligament may be an empty peritoneal sleeve, the remaining cephalad portion of the ligament may be identified with the Allis clamp, optimally at a location 9 to 10 cm above the hymeneal ring. Two double-armed sutures of No. 0 Prolene are placed at 10 and 9 cm on the ligament, and traction on these sutures should not deviate the ureter medially. We avoid braided permanent suture because any suture migration into the vagina causes granulation tissue, while unbraided suture is less likely to cause it. A third delayed absorbable suture is usually placed at the level of the ischial spine; this suture will be incorporated into the vaginal skin to re-create the cuff. The procedure is repeated on the patient's left side, beginning at the 4 o'clock position on the open peritoneum. The six sets of suture, three on each side, are tagged and held for incorporation in the anterior and posterior fibromuscular walls of the vagina.

Now a standard anterior colporrhaphy is completed along with any anti-incontinence procedure. The plicated anterior vaginal wall should be viewed as a rectangle (more properly, rhombus) with the wider cephalad end incorporated into the apical suspension to the uterosacral ligaments. The two permanent uterosacral

sutures are brought through the cephalad edge of the fibromuscular wall at the lateral margin and 1 cm medial; the midportion of the wall is avoided to prevent narrowing of the rectosigmoid. The third delayed absorbable suture is brought through the vaginal skin at the marked new apex, taking into consideration that some midline trimming of vaginal skin will occur. The fibromuscular wall is now attached to the permanent sutures on the other side, along with the delayed absorbable skin suture. At this point, the anterior vaginal wall should be trimmed and closed with a running delayed absorbable suture to the new apex.

The action is repeated on the posterior wall, first performing a midline colporrhaphy or site specific defect repair, then attaching the posterior arms of the uterosacral sutures to the cephalad edge of the fibromuscular wall of the posterior vagina. If the repaired vaginal wall lacks length or sufficient strength to be incorporated into the apex, a tissue graft (allograft or xenografts) may be attached to the intact wall and used for the apical suspension. The other end of the delayed absorbable suture is brought out through the marked vaginal apex using a free needle.

Now the uterosacral sutures are tied down in sequence, taking care to push the fibromuscular walls cephalad and excluding any small bowel. This brings the anterior vaginal wall in direct contact with the posterior vaginal wall at the uterosacral suspension site. The apical absorbable sutures are tied down to suspend the vaginal skin. We avoid trimming the suture until cystoscopy confirms that the ureters have not been deviated or kinked by the suspension. Now the posterior vaginal skin may be trimmed and the skin closure continued on from the anterior wall.

Intraoperative ureteric injury with the high uterosacral ligament suspension has been reported to be 1% to 11% (26) and intraoperative cystoscopy after these sutures are tied is an important part of the procedure. Long-term outcomes have yet to be reported, but Karram and colleagues (26) reported on 168 of 220 women with at least 6 months' follow-up. Eighty-nine percent of the women expressed satisfaction with the results of the procedure, and 10 women (5.5%) underwent a repeat operation (by the authors) for recurrence of prolapse in one or more segments of the pelvic floor. Bowel dysfunction has been described owing to narrowing of the rectosigmoid as it passes through the levator plate. Despite these seeming disadvantages, the procedure has largely replaced the sacrospinous ligament suspension in many urogynecologic and female urologic practices in the U.S. because it optimizes the vaginal length, restores vaginal axis to its original axis to the uterosacral ligaments, and provides good support with permanent sutures (27).

Iliococcygeus Fascia Fixation

This procedure can be used when the intraperitoneal approach is not feasible during vaginal repair of the apex. It sometimes is performed with a suture-passing device, and is performed bilaterally. Shull et al (28) reported on 42 women with 6 weeks to 5 years of follow-up after iliococcygeus fixation; apical support was optimal in 39 patients (93%), but eight patients had apical or other defects (19%). Meeks et al (29) reported a 96% objective cure in 110 subjects followed 3 to 13 years. In a retrospective case-control study, Maher and colleagues (10) reported similar subjective (94%, 91%) and objective (67%, 53%) success with the sacrospinous ligament suspension ($n = 78$) compared to the iliococcygeus fascial fixation ($n = 50$).

Mayo Culdoplasty

This modification of the McCall's culdoplasty was used in a large retrospective series from the Mayo clinic (19), with 82% of patients "satisfied" on subjective follow-up with few intraoperative complications. It may achieve its suspension in a similar mechanism to the uterosacral ligament suspension, although no direct comparisons exist.

Sacrospinous Ligament Suspension (SSLS) or Fixation

The popularity of this vaginal apical procedure has been somewhat superseded by the high uterosacral ligament suspension, although the SSLS may still be considered in cases where the uterosacral ligament approach is not feasible (such as severe pelvic adhesions preventing access to the cul-de-sac). The advantage of the procedure is simultaneous repair of the anterior and posterior wall defects, ability to excise

excess vaginal skin, and less postoperative bowel dysfunction. See above for two randomized controlled trials (9,10), with similar results favoring the abdominal approach. The technique is elsewhere in multiple gyn surgery texts. The unilateral suspension does not seem to compromise coital function; however, sacrospinous ligament suspension cannot lengthen an already shortened vagina. Infrequent complications include buttock pain or sacral/pudendal nerve injury. The recurrence of cystocele high in the vagina has been reported at 20% to 22% in several studies (30), and as high as 92% in one series (31). There is some evidence that the Michigan modification, which draws all four vaginal walls in direct contact with the coccygeus muscle using absorbable suture, may avoid this complication (32). Bilateral suspension has also been described (33).

Levator Myorrhaphy with Apical Fixation

This procedure has been reported by a single urology group (34,35) that described an apical fixation with closure of the levator ani in the posterior wall, but 3 of 14 sexually active patients reported dyspareunia; 42 of 47 patients were described as "cured," but subjective follow-up was available on 35 subjects at a mean of 27.9 months. Five (14%) had undergone subsequent repairs for symptomatic prolapse, and a further seven were found to have a significant cystocele on examination. One patient had a reoperation for ureteral obstruction, while 5 of 47 had an intraoperative ureteric compromise requiring release of suture. The procedure was described as safe and effective, but compared to other procedures the rates of dyspareunia and ureteric injury are high, and the levator myorrhaphy cannot be recommended for posthysterectomy vaginal vault prolapse at the present time for women who wish to preserve vaginal coital function until other centers can reproduce this group's results.

Obliterative Procedures

LeFort Colpocleisis/Total Colpectomy with High Levator Myorrhaphy

These procedures are offered to women with stage III to IV pelvic organ prolapse (POP) who no longer wish to preserve coital function. With partial colpocleisis, rectangles of vaginal epithelium are excised from the dorsal and ventral surfaces of the prolapse, and the vagina is inverted with the scarring of the raw surfaces (reinforced with sutured skin edges) acting to obliterate the vagina. The enterocele is not addressed, and the uterus is left in situ unless there is separate pathology. In colpectomy, all vaginal skin is removed, and a variety of modifications have been reported, including concomitant hysterectomy and/or high levator myorrhaphy.

Technique

The aim of the colpocleisis is to adhere the anterior wall of the vagina to the posterior wall. Two rectangles of skin are measured from each wall, leaving enough skin on the side walls to permit passage of a finger up either side (Figure 12.6). Dissection of the skin is assisted with saline injection. The apex or "toe of the sock" is left alone, especially when the cervix is present at this point. Beginning at the apex midsection of the two rectangles, a delayed absorbable suture is begun in a running line in either direction, inverting the apex (Figure 12.7). As the sutures are brought along the sides of the rectangles, the raw surfaces of the two walls can be further sutured with fine delayed absorbable sutures in interrupted mattress sutures. Once the vagina is inverted back into the pelvis, the most caudal portion of the rectangles are sutured with the

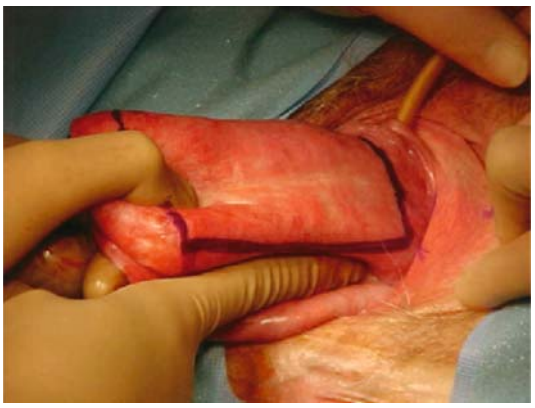

Figure 12.6. Marking the rectangles for excision on a colpocleisis. Note that some skin is left on the lateral walls; these become the vaginal tubes laterally. The bladder neck is spared, and there is no need to excise the apex.

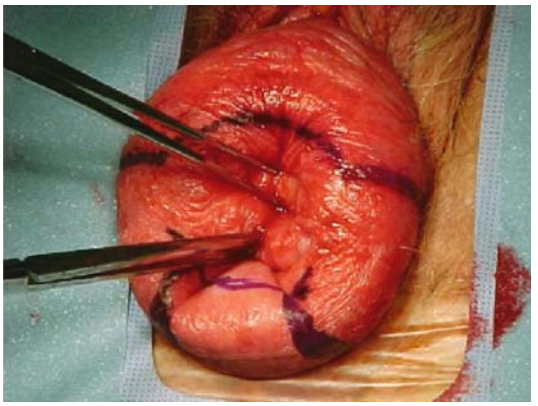

Figure 12.7. The cephalad portions of the ventral and dorsal rectangles can be seen. The inversion begins with two suture lines that connect the two lines and run to the left and right simultaneously. Note that in this figure the vaginal skin rectangles have yet to be excised.

remaining running suture lines. A tight perineorrhaphy further reinforces the obliteration of the vagina.

In the United States, the number of LeFort procedures has declined from a high of 17,200 in 1992 to a low of 900 procedures in 1997 (2), while the number of vaginectomy procedures ranged from a high of 3229 procedures in 1989 to a low of 32 procedures in 1995. Nevertheless, obliterative procedures have an important role to play in the management of pelvic organ prolapse: in many women in their 80s and 90s, the loss of coital function is balanced by the positive impact on their daily activities (36). These procedures are performed on an outpatient basis with an immediate return to normal activities, and success rates have been described as high as 100%, but the ventral (anterior) wall of the vagina is drawn to the dorsal (posterior) wall; thus, if the bladder neck is incorporated into the obliteration, the risk of urinary incontinence after the procedure can be as high as 42% (37), unless the distal anterior wall is spared or unless an anti-incontinence procedure is performed concurrently.

The enterocele as a separate entity has been reported by few group. Tulikangas et al (38) reported that of 49 women undergoing vaginal repair of enterocele using permanent suture at the time of a variety of concomitant procedures, one third had a recurrence of stage II prolapse within the mean follow-up period of 16 months, with a loss of vaginal length (median 2.5 cm) and introital caliber (median 2.5 cm) that did not appear to affect sexual function in most subjects.

Abdominal Approach to Vaginal Vault Prolapse

The principal abdominal procedure for posthysterectomy vaginal vault prolapse is the *abdominal sacrocolpopexy*, using permanent mesh or donor fascia from the apex or both vaginal walls to the anterior longitudinal ligament at the level of S2 or S3. The procedure can also be performed laparoscopically. When considering whether to use the vaginal approaches described above, the abdominal approach is often recommended in younger women because of the perceived durability of the mesh suspension. The procedure is considered the gold standard for apical resuspension despite the need for abdominal surgery and risk of mesh erosion. There is an extensive review of abdominal sacrocolpopexy published recently (39).

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13

Enterocele and Rectocele/Perineorrhaphy

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Enterocele

Introduction/Definition

An enterocele is a hernia of the peritoneum-lined pouch of Douglas, and it may contain intraabdominal contents including small bowel and omentum. Most commonly the hernia is at the vaginal apex or the proximal posterior vaginal wall on the rectum. Rarely, it is seen at the apical anterior vaginal wall under the bladder. Before discussing the pathophysiology and treatment of enterocele, we will review the relevant normal pelvic anatomy.

Anatomy

See Chapter 1 for a detailed anatomic presentation. To review briefly, the levator plate is horizontal and provides significant support for the pelvic organs, vagina, and rectum. Knowledge of the normal vaginal axis is critical to understanding the pathophysiology of anatomic failure and ultimately surgical correction. The distal vagina forms an angle of approximately 45 degrees from the vertical (Figure 13.1). The proximal vagina forms an angle of 110 degrees from the distal vagina and lies nearly horizontal over the rectum on the levator plate. The vaginal vault is strongly supported by the uterosacral and cardinal ligament complex and lies posteriorly on the rectum. This allows normal increases in abdominal pressure to compress the vagina against the rectum.

Pathophysiology

Four subcategories of enterocele have been described and are conceptually important in understanding the underlying pathophysiology (1). *Congenital* enteroceles occur with failure of complete fusion of the rectovaginal septum, resulting in an open cul-de-sac. These are rare, and may occur with no associated anterior or posterior compartment prolapse. *Pulsion* enteroceles are caused by conditions leading to chronic increases in intraabdominal pressure. *Traction* enteroceles are common and are "pulled down" with a vaginal vault or uterine

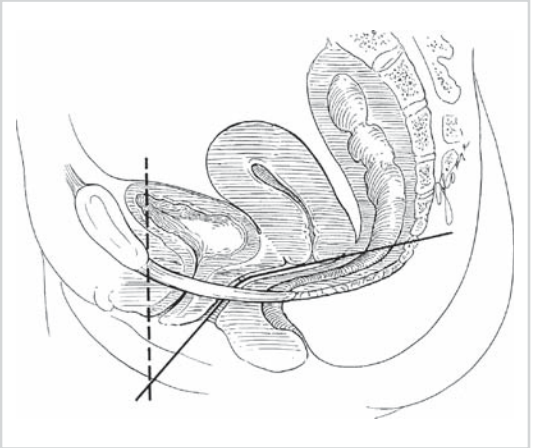


Figure 13.1. Female pelvis—lateral view. The distal vagina is seen forming an angle of 45 degrees from the vertical, with the proximal vagina forming an angle of 110 degrees from the distal vagina. Note the near horizontal lie of the rectum over the levator plate. (From Raz S. Female Urology, 2nd ed. Philadelphia: WB Saunders, 1996:226. Copyright 1996, with permission from Elsevier.)

prolapse. Lastly, iatrogenic or *acquired* enteroceles occur with surgical alteration of the vaginal axis or may be seen after hysterectomy with inadequate closure of the cul-de-sac. An example is the retropubic bladder neck suspension that may alter the vaginal axis anteriorly and vertically, exposing the cul-de-sac to increases in abdominal pressure and ultimately enterocele formation (3% to 17% of the time) (2,3). Therefore, prophylactic closure of the cul-de-sac at the time of retropubic bladder neck suspension may minimize the risk of iatrogenic enterocele.

Evaluation

Patients with small enteroceles are typically asymptomatic. Symptomatic patients may report the sensation of vaginal or perineal fullness or mass, or lower back pain that progresses during the day and improves in the supine position.

Physical examination is critical and may be performed with the patient in the lithotomy position, sitting position, or, less commonly, standing. Two posterior blades of a Graves speculum facilitate sequential evaluation of the anterior vaginal wall, vaginal apex, and posterior wall. Elevation of the anterior vaginal wall with a half blade of the speculum provides exposure of the vaginal apex and the posterior vaginal wall. The patient is asked to cough and perform the Valsalva maneuver during the exam. The second half of the speculum can retract posteriorly, further exposing the cervix or vaginal apex. An enterocele may be located posterior to the cervix, or after hysterectomy at the vaginal apex or high posterior wall. The vaginal apex must be carefully assessed because some degree of vault descensus is commonly observed with enterocele. Clinically it can be difficult to differentiate an enterocele from an apical rectocele and simultaneous rectal and vaginal examination may aid in the diagnosis. The experienced surgeon recognizes that there may be some clinical uncertainty and must be prepared to correct whatever anatomic defect is confirmed at the time of surgery.

Additionally, radiologic studies reported in the diagnosis of enterocele include defecography, fluoroscopy, dynamic cystocolpoproctography, and magnetic resonance imaging (MRI). The popularity of MRI in the evaluation of pelvic organ prolapse has increased and provides high-quality imaging of all three compartments and may help surgical planning (4,5). Although MRI has been shown to be sensitive and specific in identifying enterocele and is more accurate than physical examination alone in identifying enterocele, its routine clinical use may be limited in the presence of a confident physical exam (6). Dynamic MRI has been used after surgical repair of pelvic organ prolapse to detect defects in patients with persistent complaints after surgery (7).

Nonsurgical Treatment

Poor surgical candidates and patients with minimal symptoms and early prolapse may be candidates for vaginal estrogen and pessary use. Patients should be educated about dietary modifications to avoid constipation, and to avoid activities such as heavy lifting and straining.

Surgical Indications

Symptomatic patients with significant enterocele have a strong indication for surgery. Though isolated enteroceles may occur, most commonly an enterocele is associated with additional pathology including cystocele, rectocele, vaginal vault/uterine prolapse, and perineal body abnor-

malities. Patients with urethral or ureteral obstruction from prolapse, intractable vaginal mucosal ulceration, or evisceration mandate intervention. The presence of stress urinary incontinence or fecal symptoms, and the patient's sexual activity must be considered when choosing the appropriate surgical treatments.

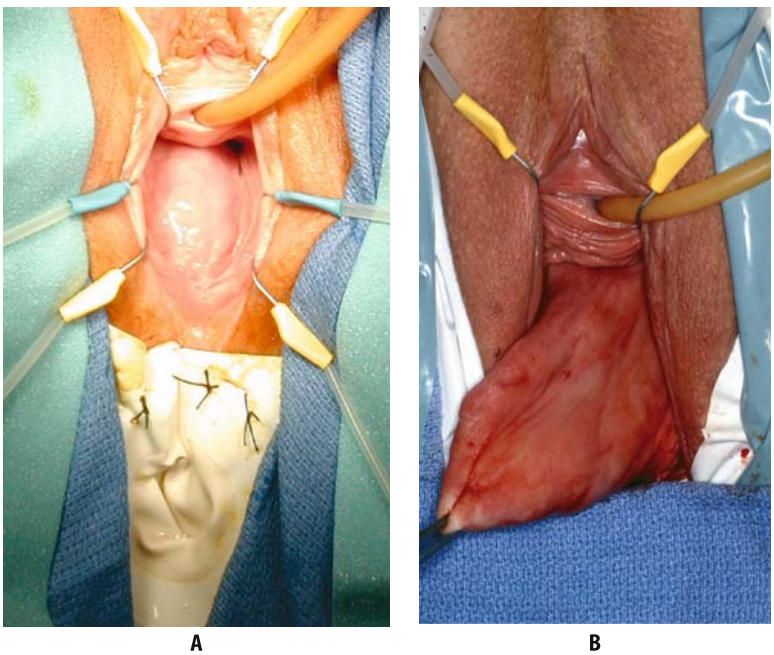
Surgical Repairs

Nichols and Randall (8) described four rules of enterocele repair: (1) identify the enterocele and its likely etiology; (2) mobilize and excise or obliterate the enterocele sac; (3) perform high ligation of the neck of the sac, providing occlusion; and (4) close the hernia defect by providing support below the sac, and restore the normal axis of the vagina. Surgical repair of the enterocele can be performed vaginally, abdominally, or laparoscopically.

Coexisting abdominal pathology is the primary indication for abdominal repair, most commonly concurrent hysterectomy. The Moschowitz (9) procedure places multiple purse-string sutures from the bottom of the cul-de-sac continuing cephalad to obliterate the cul-de-sac. Careful attention must be placed on avoiding lateral suture placement that may medially deviate and obstruct the ureters. Halban (10) described obliteration of the cul-de-sac placing sutures in the sagittal plane between the anterior rectal wall and the posterior vaginal wall/bladder. This method should avoid the lateral suture placement that may medially deviate and obstruct the ureters. Finally, if the uterosacral ligaments can be identified, cul-de-sac closure may be strengthened with midline plication of the uterosacral ligaments. Laparoscopic procedures for enterocele repair are performed with the same objectives as the abdominal procedures (11).

Transvaginal enterocele repair is preferred when possible due to the decreased morbidity, reduced recovery time, and decreased hospital costs. In our experience patients rarely have an isolated enterocele, and the vaginal approach allows us to repair vaginal vault prolapse, cystocele, rectocele, and stress incontinence with a single vaginal surgery. In those cases with associated vaginal pathology, we usually approach the vaginal vault and enterocele first.

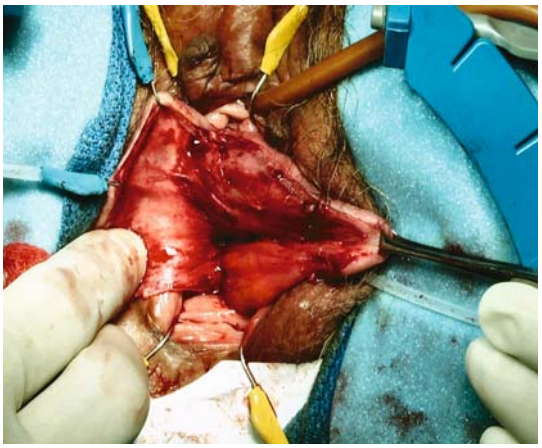
Patients are placed in lithotomy position after spinal or general anesthesia, and the lower abdomen and vagina are prepared and draped in the standard fashion. An O'Connor transurethral resection of the prostate (TURP) drape is placed to allow repeated rectal examination if needed (Figure 13.2). A rectal pack may also be used to help identify the rectum intraoperatively. A posterior weighted speculum and a figure-of-



A B

Figure 13.2. A: Mid-level rectocele with perineal body laxity, good anterior, and apical support. The O'Connor drape (TURP drape), useful for repeated rectal examination, is secured with sutures at the 3, 9, and 12 o'clock positions. B: Large enterocele with vault prolapse after hysterectomy and retropubic bladder suspension. Imaging would help identify the components of this postsurgical prolapse.

eight lone-star retractor (Lone Star Medical Products, Stafford, Texas) are positioned. We find that wearing a headlight aids visualization. A Foley catheter is inserted and the bladder is drained. At this time any associated anatomic defects are reevaluated and confirmed. Though we hydrodissect the anterior and posterior walls with saline for cystocele and rectocele repair, we do not hydrodissect the vaginal apex because the saline bleb may simulate an enterocele sac and may complicate the dissection. A vertical or transverse incision is made along the enterocele, and the vaginal wall is sharply dissected with scissors from the underlying pubocervical fascia and enterocele sac (Figure 13.3). Rectal examination via the TURP drape may help avoid inadvertent rectal injury. The peritoneal sac is opened and a moist laparotomy pad is placed to pack the abdominal contents cephalad, and Deaver or right-angle retractors are placed anteriorly and posteriorly for exposure. We again carefully reassess vault support, and, if necessary, permanent vault suspension sutures are placed at this time using the levator myorrhaphy vault repair (12) (Figure 13.4). We then perform a high ligation of this peritoneal hernia, placing a No. 0 delayed absorbable purse-string suture into the prerectal fascia posteriorly, continuing in a plicating manner to the uterosacral and cardinal ligaments laterally, the base of the bladder ante-



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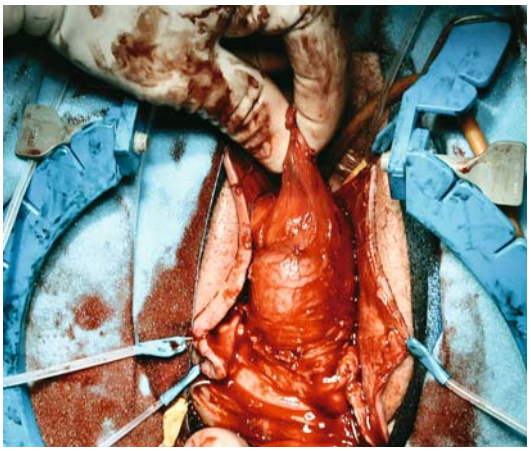

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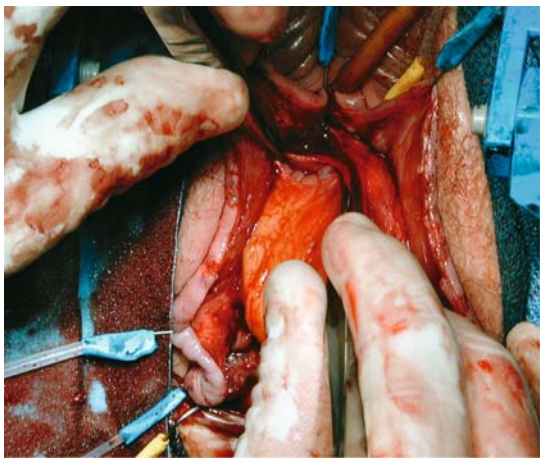
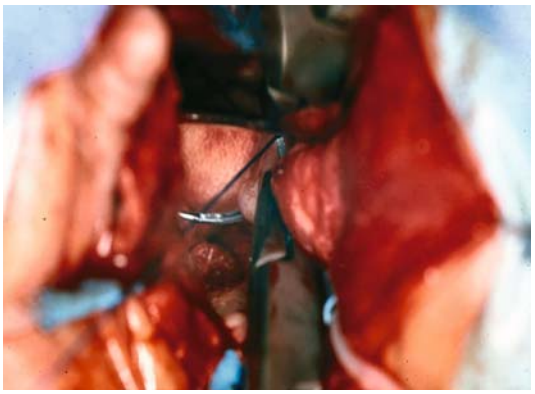


C

Figure 13.3. A: Inspection of the everted vaginal apex identifies the thick, muscular bladder anteriorly and the wispy, fat-filled enterocele sac posteriorly. Care is required here, as prerectal fat may look similar. B: Rectal examination demonstrates the tented rectal wall while the wispy apical tissue is inspected and confirmed to be enterocele sac. C: The enterocele sac is opened to prepare for levator myorrhaphy that helps obliterate the enterocele and provide vault support.



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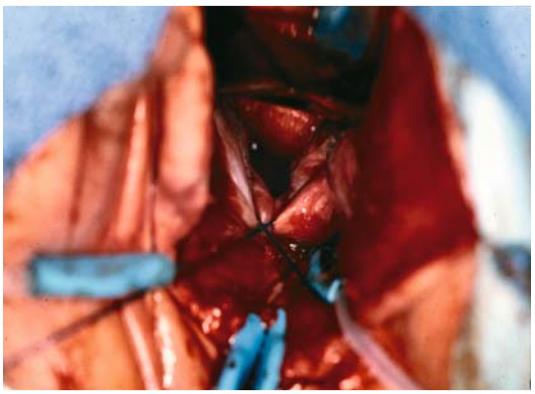


B

Figure 13.4. A: The enterocele has been opened, a Deaver retractor displaces the bladder anteriorly and a peritoneal sponge is placed to pack the bowel contents cephalad. The levator myorrhaphy suture is placed posterior and medial to avoid the ureter. B: The new apical support is demonstrated after suture placement on the opposite side. This provides strong apical support and proper vaginal axis, and helps obliterate the cul de sac. A purse-string suture is placed to highly ligate the enterocele sac. Cystoscopy after intravenous indigo carmine is performed with the vault suspension and high ligation sutures on tension to rule out inadvertent ureteral injury.

riorly, the contralateral uterosacral-cardinal ligament complex, and ending again at the prerectal fascia posteriorly. A second suture is placed in a similar manner to the first. To preserve vaginal depth, these sutures are placed as cephalad as comfortably possible. The sutures are then tied and the excess enterocele sac is excised. We perform cystoscopy after administering intravenous indigo carmine to rule out inadvertent ureteral obstruction from lateral suture placement. If necessary, ureteral catheters may be passed to assess patency. We now approach the anterior compartment and sling if necessary and finish with the posterior compartment. The excess vaginal mucosa is conservatively excised and closed using a running 2-0 delayed absorbable suture. The vaginal pack and Foley catheter are removed on postoperative day 1 and the patient discharged.

In patients undergoing vaginal hysterectomy, it is recommended to perform a McCall-type cul-de-plasty to obliterate the cul-de-sac and prevent enterocele formation (13). A series of permanent purse-string sutures are placed in the uterosacral ligament, anterior sigmoid colonic serosa, and the opposite uterosacral ligament traveling caudally until the posterior vaginal cuff is reached. The vaginal apex is then resuspended to the uterosacral ligament complex, the cul-de-plasty sutures are tied, and the potential enterocele sac is obliterated. We would perform cystoscopy after intravenous indigo carmine is admininistered to ensure ureteral patency.

Richardson (14) described the specific fascial defect in the endopelvic fascia at the vaginal apex from failure to close the anterior and posterior walls suitably after hysterectomy. This enterocele results from the peritoneum coming into contact with the vaginal epithelium and is repaired by direct closure of the detached edges.

Colpocleisis remains an alternative in patients who are poor surgical candidates and not sexually active, usually the elderly. This less invasive and faster procedure can provide good results with decreased morbidity. A large rectangle of vaginal mucosa is denuded from the anterior and posterior vaginal walls. Closure of the vagina is achieved by approximating the anterior and posterior vaginal walls with a series of No. 0 delayed absorbable purse-string sutures.

Surgical Results and Complications

Enterocele repair has been performed for nearly a century yet there are few long-term outcomes reported. Raz et al (15) reported 86% cure in 81 patients with a 15-month follow-up. Lemack et al (16) reported on 35 of 47 patients evaluated a mean 28 months after levator myorrhaphy with physical examination and postoperative sexual function and incontinence questionnaire. Five patients required reoperation (anterior enterocele in three, vault prolapse in one, and symptomatic enterocele in one). Of the sexually active, 11 of 14 (79%) reported no dyspareunia. Comiter (17) reported 96% cure rate in

100 women at 17.3-month follow-up. Miklos et al (18) reported on 17 patients who underwent site-specific enterocele repair and all were cured at a mean short-term follow-up of 6.3 months. Most other reported series have success rates around or above 90%.

Intraoperative complications include bladder and ureteral injury, bowel and rectal injury, as well as significant bleeding. Delayed complications include recurrent prolapse, de novo stress or urge incontinence, urinary retention, vaginal shortening, bowel incarceration, and vaginal evisceration. Careful surgical technique can minimize each of the above risks.

Rectocele/Perineal Body Defect

Introduction/Definition

A rectocele is a hernia of the anterior wall of the rectum and posterior vaginal wall into the lumen of the vagina. Rectoceles may result from an isolated tear in the rectovaginal septum, detachment of the septum from the perineal body, or attenuation and thinning of the septum. Perineal body defects are due to weakness or relaxation of the perineal musculature and are often associated with rectocele. Perineorrhaphy refers to the surgical repair of the perineal body defect. Although rectocele and perineal body defects are distinct entities, they are often repaired simultaneously and will be discussed together. The relevant anatomy is briefly reviewed to elucidate the etiology, diagnosis, and treatment of posterior compartment defects.

Anatomy

See Chapter 1 for a detailed anatomic presentation. To briefly review, the vagina and rectum are divided by the *rectovaginal septum*, also known as the prerectal fascia (Figure 13.5). This septum contains Denonvilliers' fascia and is adherent to the undersurface of the posterior vaginal wall. The rectovaginal septum extends from the posterior cervix and uterosacral ligament complex to the levator fascia of the pelvic sidewall laterally and caudally to insert into the central tendon of the perineal body. Isolated tears in the rectovaginal septum may result in rectocele in a high, middle, or low position on

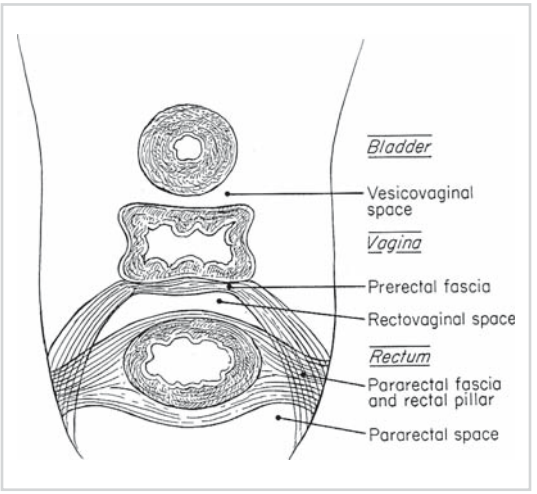


Figure 13.5. Important anatomy in rectocele repair. The prerectal fascia runs from the pelvic side wall laterally and extends from the uterosacral-cardinal ligament complex to the central tendon. The rectovaginal space provides a potential plane of dissection. The pararectal fascia envelops the rectum and provides additional support. (From Raz S. Female Urology, 2nd ed. Philadelphia: WB Saunders, 1996:226. Copyright 1996, with permission from Elsevier.)

the posterior vaginal wall. Posterior to the rectovaginal septum is the *rectovaginal space*, a convenient plane of dissection for surgical access. A second layer of fascia, the *pararectal fascia*, originates from the pelvic sidewall laterally, and divides into anterior and posterior sheets that envelop the rectum, and may provide additional strength for surgical repair. The perineal body consists of interlacing muscle fibers of the bulbocavernosus muscle, the superficial and deep transverse perineal muscles, and the external anal sphincter at its junction with the rectovaginal septum. Disruption of this caudal attachment of the rectovaginal septum to the perineal body may contribute to a perineal body defect.

Pathophysiology

Many patients with rectocele are asymptomatic, which makes it difficult to identify the true incidence. Though birth trauma is a known risk factor, rectocele may be observed in young asymptomatic nulliparous women. Chronic constipation and other defecation disorders with chronic straining may weaken the rectovaginal septum and lead to a rectocele. A pseudorectocele results from congeni-

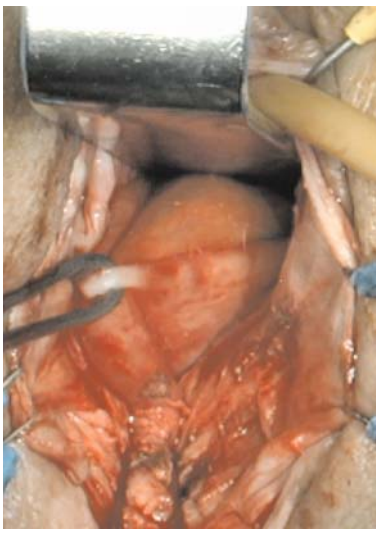
tal absence of, or acquired injury to, the perineal body and can be corrected with perinealreconstruction.

Rectoceles have been characterized based on their location in the vagina. High rectoceles must be distinguished from enteroceles and are often concurrent, occurring secondary to weakness of the upper rectovaginal septum from the enterocele. Midvaginal rectoceles are the result of stretching and laceration of the rectovaginal septum and pararectal fascia, usually from obstetric trauma. The midvaginal rectocele occurs above the levator hiatus in contrast to the low rectocele caused by traumatic detachment of the rectovaginal septum from the central tendon of the perineal body. Richardson (19) further categorized rectoceles based on the location of the isolated tear in the rectovaginal septum. He demonstrated five locations most commonly torn and this categorization is important in considering site-specific rectocele repair. The common low rectocele results from a transverse fascial defect above the perineal body. The other common defects include the midline vertical defect, lateral separations, and a high transverse tears (Figure 13.6). This concept of site-specific rectocele repair may be important if the repair of an isolated defect leaves less scarring and risk of dyspareunia compared to traditional midline plication.

Evaluation

Although many patients are asymptomatic, the most common complaint referable to rectocele is constipation. Vaginal symptoms may include a bulging mass in the vagina, perineal or low abdominal pressure, vaginal laxity with intercourse or dyspareunia, and low back pain that worsens during the day and resolves when supine. Rectal symptoms may include constipation, incomplete evacuation, the need to digitally splint the vagina or perineum, pain, and fecal incontinence. Perineal body defects may contribute to fecal incontinence as well as decreased sexual sensation.

Physical examination is performed with the patient in the lithotomy position, using the posterior half of a Graves speculum to displace the anterior vaginal wall. A rectocele appears as a bulge of the posterior vaginal wall, exaggerated with the Valsalva maneuver. Rectal examination may identify the site of laxity, and simultaneous rectal and vaginal examination (often standing) may help identify the small bowel hernia and differentiate enterocele from an apical rectocele. Noting a wide introitus with a short distance from the posterior vagina to the anus helps identify perineal body defects (Gh and Pb measurements on the pelvic organ prolapse quantification [POPQ]). Multiple staging schemes have been



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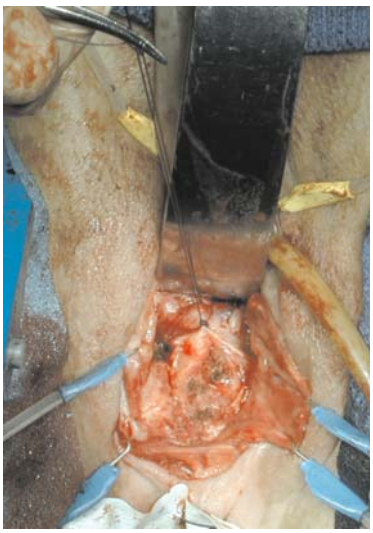

B

Figure 13.6. A: This posterior dissection demonstrates a transverse tear of the rectovaginal fascia. Determining whether the fatty bulge above is prerectal fat or enterocele is aided by rectal examination or palpation of a rectal pack. B: The midline plication of the prerectal and pararectal fascia approaches the perineum and will transition into a perineal body repair if needed.

utilized to grade the size of prolapse including the Baden-Walker grading system, and the international standard POP-Q system.

The gold standard for diagnosing rectocele remains physical examination, but ancillary studies may help evaluate posterior vaginal wall defects. Defecography uses fluoroscopy to observe rectocele or other defecation problems and can identify the size of the rectocele and its clinical relevance in defecation. Colpocystodefecography uses oral, rectal, and vaginal contrast, and is primarily used to identify posterior compartment abnormalities. The superior imaging of MRI, specifically dynamic MRI defecography, may limit the clinical utility of these other techniques in evaluating rectocele; MRI appears to be equally sensitive to colpocystoproctography in identifying rectocele, but less sensitive in identifying cystocele and enterocele (6,20). Dynamic ultrasonography allows for excellent visualization of the entire pelvic floor during provocative maneuvers. Both dynamic ultrasound and MRI provide superior anatomic visualization, but they remain investigational at the current time.

Nonsurgical Treatment

Nonsurgical treatments remain an invaluable option for symptomatic patients who are poor surgical candidates. These include bowel training and dietary modification with increased fiber intake, hormone replacement therapy in postmenopausal women, and vaginal pessary. Asymptomatic women with mild to moderate posterior defects should be treated conservatively.

Surgical Indications

Symptomatic patients with posterior compartment prolapse are candidates for surgical repair. Patients who require digital splinting to evacuate may respond well to surgery. Chronic constipation, diarrhea, fecal incontinence, and back pain should prompt further evaluation to identify the etiology of these symptoms prior to any surgical procedure.

Patients with an asymptomatic rectocele who are undergoing other vaginal surgery present a challenging clinical scenario. Authors favoring repair in asymptomatic patients argue that restoring the normal vaginal axis may reduce the risk of subsequent prolapse. No publications have shown objective data to support this. Because historical studies report high rates of dyspareunia (up to 30%) after the traditional midline plication, many have advocated observation of asymptomatic posterior defects (21). An alternative surgical repair, the site-specific rectocele repair, is based on the observations of distinct defects in the rectovaginal septum. The more limited repair may provide a lower incidence (0% to 10%) of postoperative dyspareunia (22–24). However, others continue to report dyspareunia rates from 19% to 27% after site-specific rectocele repair, supporting the opinion that asymptomatic patient should be treated conservatively (2). If the site-specific rectocele repair proves to be durable and has lower rates of dyspareunia, it may be reasonable in the asymptomatic patient. Long-term objective outcomes are needed.

Surgical Repairs

Transvaginal approaches are the most common repair, though colorectal surgeons have described transanal, transperineal, and combined transvaginal/transrectal approaches. Abdominal and laparoscopic approaches have been described. Though rectovaginal septum and perineal body defects are anatomically separate, they are often associated and repaired concurrently.

The site-specific rectocele repair requires the surgeon to identify and repair specific defects in the rectovaginal septum (Figure 13.6). The patient is placed in the dorsal lithotomy position and an O'Connor TURP drape is placed to allow repeated rectal examination to identify the site-specific fascial defects or tears. A Foley catheter is placed and a Lone-Star ring retractor positioned. Wearing a headlight aids visualization. We would repair any associated vaginal pathology before approaching the rectocele and perineal repair to avoid limiting exposure. This repair is started with two Allis clamps carefully placed at the introitus on each side lateral to the midline. These are brought together in the midline to ensure the introitus easily accommodates two to three fingers. The vaginal epithelium is opened at the posterior fourchette transversely, and the posterior vaginal wall is the incised in the midline to above the rectocele. The

vaginal wall is dissected off of the underlying rectovaginal septum. It is important to dissect directly on the vaginal wall to avoid inadvertent rectal injury, particularly at the introitus where there may be scarring from prior obstetric trauma. This dissection extends to the vaginal apex, laterally to the tendinous arch of the levator ani, and inferiorly to the perineal body. The most common defect is the low transverse detachment from the perineal body. Rectal examination helps define the edges, and Allis clamps may be used to test fascial strength. The fascial defect is then plicated with 0 or 2-0 delayed absorbable suture over the anterior rectal wall. Repeat rectal examination confirms repair integrity and may identify additional defects that are repaired as described. Excess vaginal mucosa is conservatively trimmed and the posterior vaginal wall closed using 2-0 delayed absorbable suture in a running fashion. The perineal body and central tendon is then repaired by reapproximating the bulbocavernosus, deep and superficial transverse perineal muscles in the midline using two to three vertical mattress 0 or 2-0 delayed absorbable sutures (Figure 13.7). The perineal skin is closed in a running subcuticular fashion using 4–0 absorbable suture. A vaginal pack is placed until the following morning, when the Foley catheter and vaginal pack are removed. There is early interest in reinforcement of site-specific rectocele repair with synthetic and biologic materials, but this remains investigational (25).

The traditional midline rectocele repair begins as above with placement of the Allis clamps that are brought together in the midline to ensure the introitus easily accommodates two to three fingers. The apex of the rectocele is identified and the posterior vaginal wall is hydrodissected with normal saline. A triangular section of the mucocutaneous junction is excised between the Allis clamps exposing the perineal body. A triangle of posterior vaginal wall is excised with the apex pointed at the rectocele apex. Dissection of the posterior vaginal wall flap is performed sharply with Metzenbaum scissors until the prerectal fascia is identified. A midline incision is then made in the posterior vaginal wall proximally to the vaginal apex. When it is difficult to identify the attenuated rectovaginal septum centrally, the dissection is carried laterally until good fascia is encountered. The midline rectocele repair is then performed, incorporating the pararectal and prerectal fascia in an interrupted fashion starting above the apex of the rectocele (Figure 13.6). The most proximal sutures incorporate the uterosacral ligament complex to add further support and prevent enterocele formation. This is carried down the distal vagina using interrupted or figure-of-eight 2-0 delayed absorbable suture. If necessary, the perineal body and central tendon are repaired by reapproximating the bulbocavernosus, deep, and superficial transverse perineal muscles in the midline using two to three vertical mattress 0 or 2-0 delayed absorbable sutures. It is critical to check your surgical progress with frequent examinations to avoid excessive narrowing of the vaginal introitus or creation of a posterior shelf, possible sources of dyspareunia. The posterior vaginal wall is closed using 2-0 delayed absorbable suture in a running fashion. A vaginal pack is placed until the following morning.

Colorectal surgeons report using a transanal approach with the patient placed in the jackknife position. This technique involves endorectal plication sutures to reduce the size of the rectal lumen. Studies by Arnold et al (26) and Kahn et al (27) found no significant difference in dyspareunia between the two approaches. Lamah et al (28) described anterior levatoroplasty for rectocele performed via a transperineal approach. Combined transvaginal/transperineal approaches have also been reported (29).

New Approaches

Reasons for surgical failure include abnormal vaginal axis as well as the inherent tissue weakness encountered in patients with prolapse. The poor tissue quality has prompted many to use either biologic material or synthetics to replace or reinforce the repair (Figure 13.7). Reconstruction attempts to re-create an envelope of support that extends from the anterior compartment to the vaginal apex and continues to the posterior compartment and attaches to the perineal body (trying to achieve support similar to the abdominal sacrocolpopexy).

Laparoscopic approaches for pelvic prolapse including enterocele and rectocele have been reported. These vary from laparoscopic site-specific rectocele repair (11) to laparoscopic replacement of the rectovaginal septum from the uterosacral ligaments to the lateral pelvic sidewall to the perineal body using either biologic or synthetic materials (30). Laparoscopic procedures are performed with the same objectives as the abdominal procedures (11).

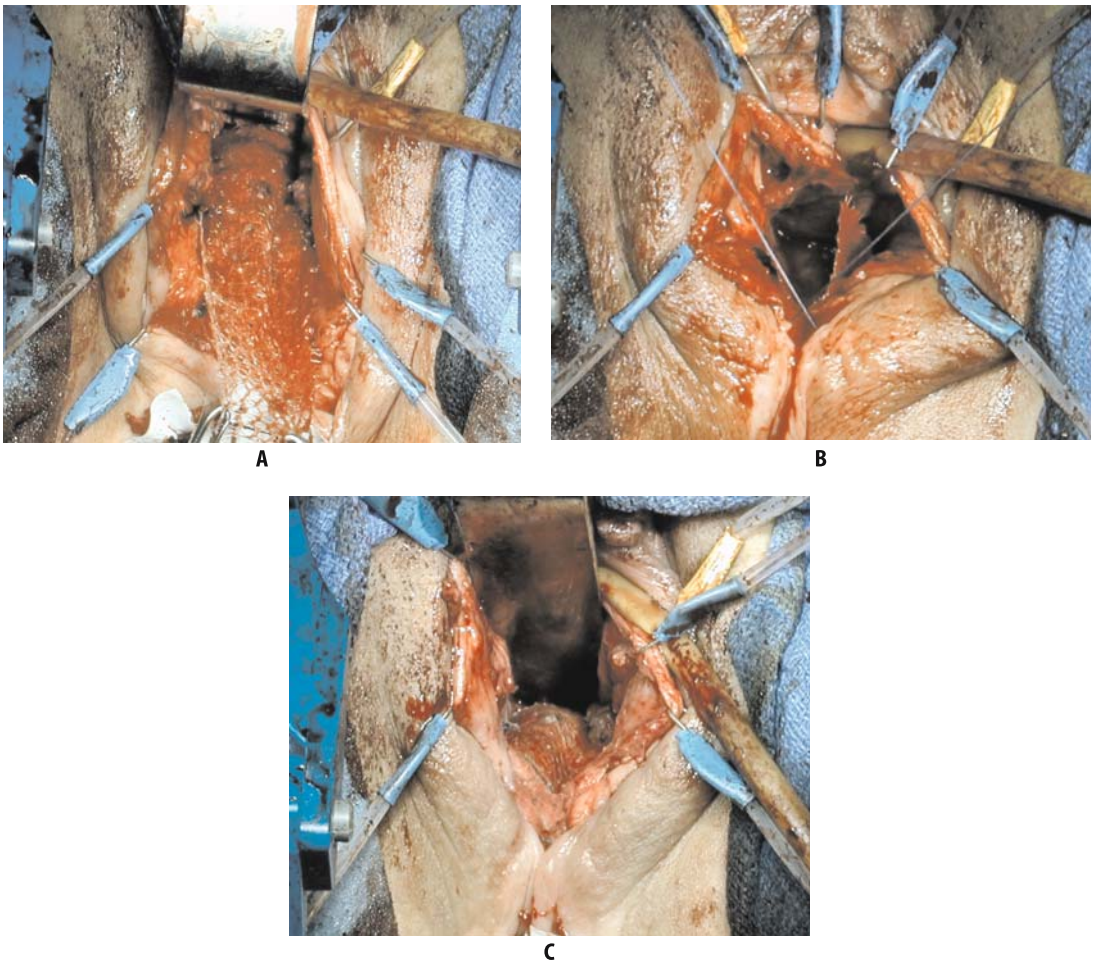

Figure 13.7. A: Posterior incision showing the placement of wide weave soft Prolene mesh anchored apically to the vault repair. The mesh will be secured to the perineal body after perineorrhaphy is completed. B: The perineorrhaphy sutures placed into the transverse perineal muscles are evaluated to minimize postoperative dyspareunia. C: The Prolene mesh is secured to the perineal body repair. Care is taken to avoid redundant mesh at this site and minimize the risk of erosion.

The infracoccygeal sacropexy, also known as posterior intravaginal slingplasty, provides access to the sacrospinous ligament by "tunneling" through the ischiorectal fossa (31). This approach creates an apical fixation point or "neoligament" of Prolene mesh secured to both sacrospinous ligaments (Figure 13.8). A needle is tunneled through the ischiorectal fossa and delivered through the area of the sacrospinous ligament, careful to avoid the pudendal artery and nerve. The anchoring Prolene mesh is delivered from the vaginal incision through the sacrospinous area and tunneled back out through the ischiorectal fossa and the skin of the buttocks. The surgeon can attach either biologic or synthetic material to this apical fixation point for the anterior or posterior repair, completing the envelope of support. The procedure appears safe and demonstrates good short-term results; however, long-term efficacy remains to be proven (32,33).

Surgical Results and Complications

There are few long-term studies documenting the success rates of rectocele and perineorrhaphy. Ginsberg et al (34) reported a 2% recurrence rate of rectocele at a mean follow-up of 15 months in 144 patients. Singh et al (35) reported a 92% anatomic cure rate in 42 women undergoing site-specific rectocele repair with 18-month follow-

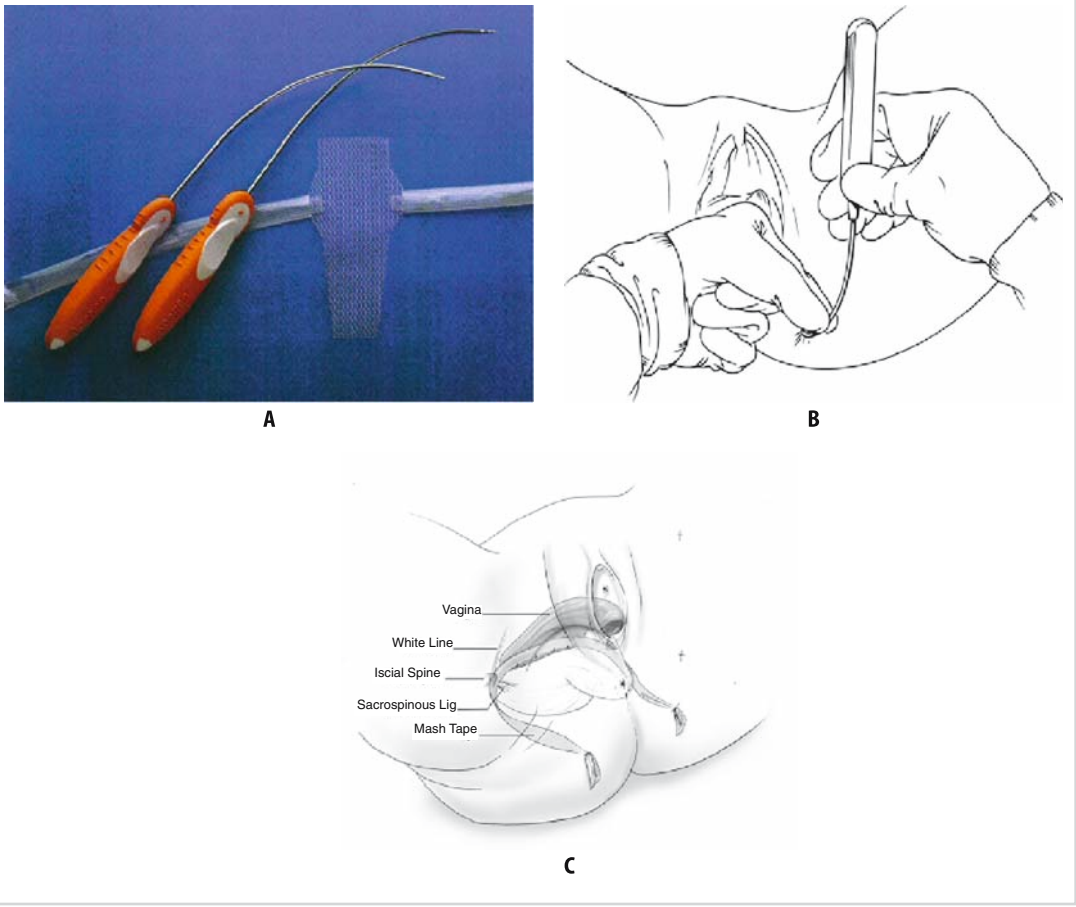

Figure 13.8. A: Access to the sacrospinous ligament through the ischiorectal fossa requires a curved needle passer to deliver the strip of Prolene mesh. Additional Prolene mesh is attached and can be extended down to and secured to the perineal body to complete the posterior repair. B: The surgeon passes the needle through the ischiorectal fossa under finger guidance (retracting and protecting the rectum medially) to deliver the needle tip through the area of the sacrospinous ligament. This is done on both sides to establish bilateral sacrospinous fixation. C: The vaginal apex is secured to the Prolene tape. When the tape ends are pulled taut, the vaginal apex is elevated to the level of the sacrospinous ligaments.

up. Cundiff et al (36) and Porter et al (2) both reported recurrence rates of 18% at 12- and 6-month follow-up, respectively. Lemack and Zimmern (37) published a unique study in which the same sexual function questions were used pre- and 1 year postoperatively in patients undergoing either an anterior vaginal suspension procedure alone or in combination with a posterior repair. The incidence of dyspareunia was no different between women who underwent posterior repair in addition to anterior vaginal wall suspension and those who did not. One must consider other possible sources of sexual dysfunction including altered sensation, diminished lubrication, and orgasmic dysfunction.

Complications reported with rectocele and perineal body repairs may be divided into intraoperative and postoperative. Intraoperative complications include bleeding requiring transfusion and inadvertent rectal laceration. Proctotomy should be repaired in two layers and the postoperative antibiotic regimen and diet may need to be modified. Postoperative complications include transient urinary retention, dyspareunia, persistent constipation, and recurrent prolapse. Unrecognized rectal injuries can lead to rectal-vaginal fistula (38). Careful surgical technique to ensure adequate vaginal capacity can minimize the risk of postoperative dyspareunia.

Conclusion

Urologists and gynecologists frequently encounter enteroceles, rectoceles, and perineal body defects. Understanding pelvic anatomy, the pathophysiology of the vaginal apex and posterior compartment, and their role in clinical symptoms is critical in the diagnosis and management of these conditions. Multiple approaches exist in the surgical treatment of posterior vaginal wall prolapse, with surgeon experience and preference determining the repair of choice.

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Part V

Surgery for Fecal Incontinence

14

Surgery for Fecal Incontinence

Rebecca G. Rogers

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Fecal incontinence is underreported by patients and underrecognized by providers. The true prevalence of fecal incontinence is unknown, but in the few published population-based studies, rates range from 0.5% to 13% and are six to eight times more common in women than men (1). Anal continence is maintained by a variety of mechanisms including normal stool delivery and consistency, intact sensation and motor enervation, an intact anal sphincter complex, and a functioning puborectalis muscle (2,3). Loss of anal continence may result from damage to a single part of the continence mechanism or may result from multiple insults over time. While the term *anal incontinence* includes the loss of gas, liquid stool, and solid stool and may be preferred by some clinicians and organizations, the term *fecal incontinence* is used in this chapter because of the surgical focus: incontinence to gas is unlikely to result in surgical management. The treatment of fecal incontinence includes behavioral and physical therapy, medications, as well as surgical therapy. Because of varied etiologies of anal incontinence, as well as poor long-term results of anal continence surgery, any approach to treatment of anal incontinence should include a trial of nonsurgical intervention.

Evaluation of fecal incontinence is discussed in Chapter 5 and includes the type of loss (loose or formed stool, mucus, or flatus) the frequency of incontinence, as well as the impact of loss of the patient's quality of life. Several severity scales and quality-of-life measures for fecal incontinence have been validated that can evaluate symptom severity and well as changes in quality of life (4,5). Although surgeons often rate loss of formed stool as more severe than loss of flatus, when evaluated objectively patients often rate the impact of loss of either flatus or formed stool similarly (4). Surgical treatment should be dictated by symptom severity as well as realistic expectations of the limitations of surgical intervention.

This chapter discusses the vaginal approach to surgery for fecal incontinence; describes the most common surgery performed for the treatment of fecal incontinence, which is repair of obstetrical anal sphincter lacerations; and reviews other vaginal surgeries for fecal incontinence treated remote from delivery, including sphincteroplasty, rectal prolapse repair, neosphincters, neuromodulation, and repair of rectovaginal fistulas. Postanal repair and posterior levatorplasty have not been proven effective in the treatment of anal incontinence and are not discussed (6).

Obstetrical Anal Sphincter Lacerations and Repair

The most common cause of fecal incontinence in women is anal sphincter injury at childbirth.

Anal incontinence can occur in up to one third of women with obstetrical sphincter injuries with immediate or delayed onset of symptoms (2). Because of occult injury, the incidence of anal sphincter damage at the time of vaginal delivery is higher than the number of observed injuries would suggest. Overt anal sphincter injury is relatively rare in women without episiotomy or operative vaginal delivery, with an incidence that ranges from 0% to 6.4% (2,7–9). Occult anal sphincter laceration, as identified by ultrasonography, ranges from 6.8% to 44% of parous women (10,11). Twenty percent to 50% of all women with sphincter injuries report anal incontinence symptoms (10,12,13).

Episiotomy and operative vaginal delivery increase the incidence of severe pelvic floor trauma, yet were performed in 29% and 9% of vaginal births, respectively, in 2001 (14,15). A meta-analysis of six randomized trials compared restrictive to liberal use of episiotomy in 4850 women and concluded that liberal use of episiotomies conferred no benefit and was associated with other complications (16). Operative vaginal delivery was similarly reviewed in 2582 women and concluded that vacuum delivery was associated with a much lower risk of anal sphincter laceration than delivery with forceps [relative risk 0.41, 95% confidence interval (CI) 0.33–0.50] (17). Prevention of anal sphincter laceration and subsequent development of anal incontinence partly lies in decreasing the use of these interventions at the time of delivery.

The anal sphincter complex includes the internal and external anal sphincters (IAS and EAS) and the rectal mucosa, and lies in close proximity to the puborectalis (Figure 14.1). The complex extends for a distance of 3 cm up the anal canal, with the two sphincters overlapping for a distance of approximately 1.7 cm. The EAS, made up of striated muscle, is responsible for the squeeze tone of the anal canal but only 10% to 20% of the resting tone. In contrast, the IAS, which is made up of smooth muscle, provides

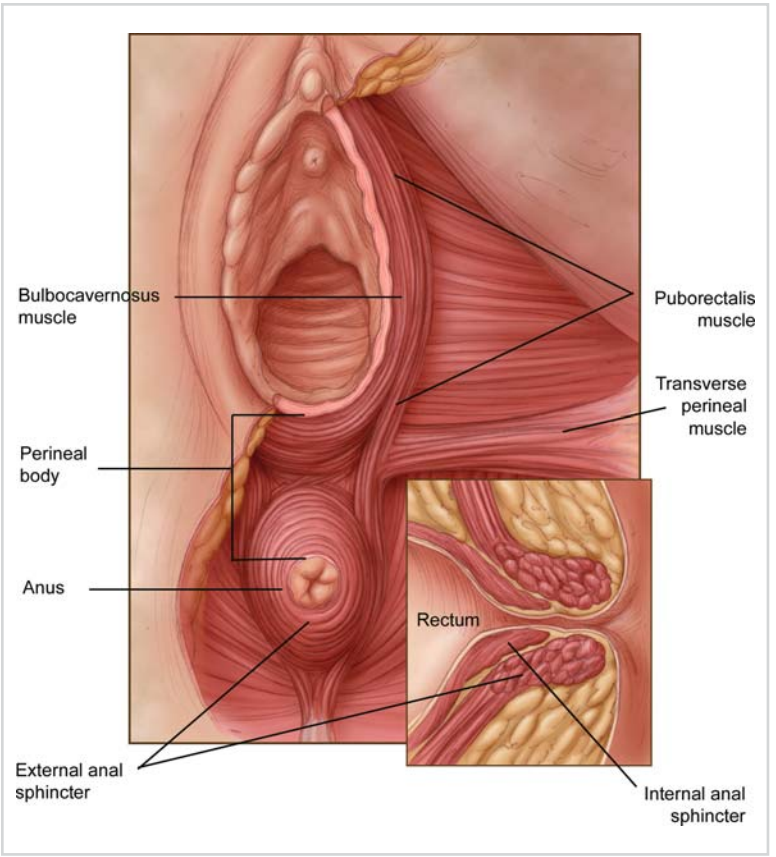

Figure 14.1. Anal sphincter complex. (Reproduced with permission. © Brian Evans.)

80% to 90% of the resting tone of the anus. The IAS can be identified as a glistening layer below the EAS, and may be retracted laterally. It lies adjacent to the rectal mucosa and is continuous with the longitudinal smooth muscle of the colon (18). The anal sphincter complex is attached to the perineal body, which in turn is attached to the rectovaginal septum and the uterosacral ligaments. Repair should address both the IAS and EAS as well as reestablishing the continuity from the perineal body to the posterior rectovaginal septum.

Poor lighting, an unprepared operative field contaminated by fecal material, and lack of adequate analgesia and surgical assistance often confounds repair of obstetrical lacerations. The goals of obstetrical laceration repair should mimic those of repairs remote from delivery. Achievement of these goals may require moving the patient from the delivery room to the operating suite or delaying repair until adequate help is available. Although the type of suture material utilized for primary repair of anal sphincter laceration repair has not been studied in randomized trials, polyglycolic acid (PGA) and catgut have been compared for repair of less severe lacerations and episiotomy in large randomized trials (19–21). Polyglycolic acid suture was associated with significantly decreased pain and need for analgesia in the immediate postpartum period, as well as decreased rates of dehiscence. Long-term pain and dyspareunia have not been as well studied, and no advantage of one suture over the other has been documented for obstetrical anal sphincter laceration repair (21). The use of a Gelpe retractor may help with visualization in order to repair the laceration.

Anal sphincter lacerations that extend through the anal canal begin with repair of the rectal mucosa using fine, delayed absorbable sutures, such as 3-0 or 4-0 PGA (Figure 14.2). These sutures can be placed in either a running or interrupted fashion. Sutures should not penetrate the bowel lumen if possible, although no study has shown that this prevents fistula formation. Some authors support placing a second imbricating layer. The IAS is repaired using a similar suture in either a continuous or interrupted fashion (Figure 14.3). Repair of the IAS is controversial, although one author has noted increased continence rates in women with an intact IAS after repair of third- or fourth-degree lacerations (22). Because the IAS is responsible for the majority of the resting anal tone, as the IAS is approximated, the anal canal begins to resume its normal anatomic shape.

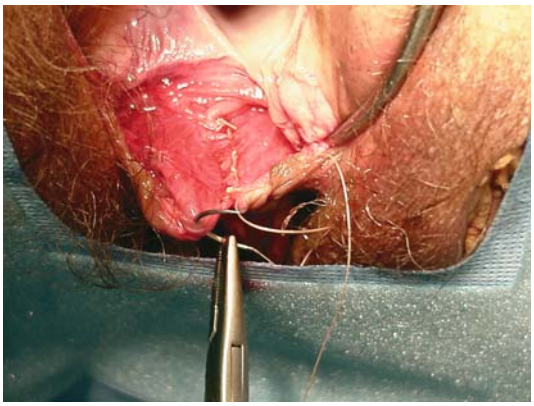

Figure 14.2. Repair of rectal mucosa in a cadaver. (From Kammerer-Doak DN, Rogers RG. Obstetric anal sphincter lacerations, part 2. The Female Patient 2002;32:17, with permission.)

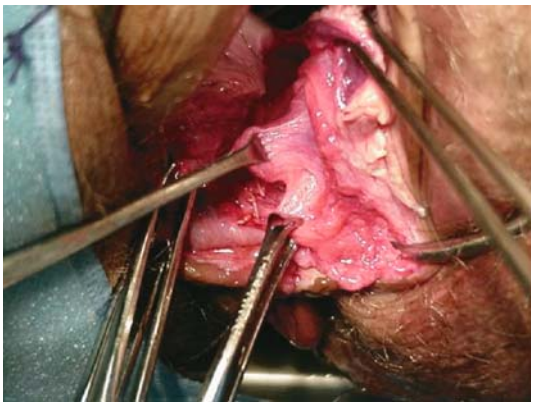

Figure 14.3. Demonstration of the internal anal sphincter in a cadaver. Note the glistening white tissue grasped in Allis clamps. (From Kammerer-Doak DN, Rogers RG. Obstetric anal sphincter lacerations, part 2. The Female Patient 2002;32:17, with permission.)

Two methods of EAS repair are commonly used: the traditional end-to-end technique and the overlapping technique. If an end-to-end repair is to be performed, no further dissection may be required. The end-to-end technique approximates the torn ends of the sphincter as you would approximate the faces of a clock at the 12, 3, 6, and 9 o'clock positions (Figure 14.4). If an overlapping repair is planned, one end of the sphincter may need to be dissected from the underlying tissues so that the two ends can overlap one other without tension. The overlapping technique employs vertical mattress sutures to achieve an overlap of 2 to 3 cm, with the intent

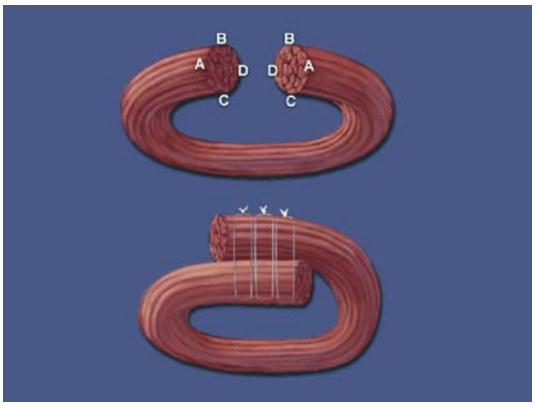

Figure 14.4. End to end versus overlapping repair of the external anal sphincter. (Courtesy of Ciné-Med, Inc., Woodbury, CT.)

that a greater area of contact will allow the torn ends to scar together. Both techniques use prolonged, delayed monofilament absorbable suture, such as 2-0 or 3-0 polydioxanone sulfate (Ethicon) or Maxon (Davis and Geck, Wayne, NJ) (23,24).

Two studies have compared the end-to-end and overlapping techniques. A cohort study with historic controls found anal incontinence symptoms decreased from 41% to 8% with overlapping compared to end-to-end repair, and that anatomic success as measured by an intact sphincter complex on ultrasound increased from 15% to 85% (23). A randomized controlled trial of 112 women with anal sphincter lacerations compared an end-to-end and overlapping technique and found that anatomic and functional success rates were equally poor with both methods. Despite primary repair, over 60% of patients had evidence of sphincter separation on ultrasound and over half of the patients complained of anal incontinence symptoms (24). Given these limited data, there is no obvious superior technique for repair of obstetrical anal sphincter lacerations. After repair of the anal sphincter complex, the second-degree laceration is repaired including perineorrhaphy with reattachment of the distal rectovaginal septum to the perineal body.

Despite the importance of primary repair, little attention has been paid in traditional training programs to the evaluation and repair of obstetrical anal sphincter lacerations, and many providers report that they feel that they were inadequately trained to perform repairs (25). Functional and anatomic outcomes following primary repair were thought to be excellent. Nonetheless, 20 prospective studies have reported fecal incontinence rates of 15% to 59% following primary repair, with five studies that documented sphincter disruption ranging from 40% to 91% despite primary repair (26). Fecal incontinence symptoms following primary repair of obstetrical anal sphincter laceration may increase over time. Three-month failure rates of 17% increased to 42% at 2 to 4 years in a study of 96 women after anal sphincter laceration and repair. Of the 38% of women with symptoms who felt treatment was needed, only a few sought evaluation secondary to embarrassment, socioeconomic reasons, or not knowing where to go for help (27). This underlines the need to incorporate routine questions regarding bowel and bladder function into prenatal care. Other complications related to third- and fourth-degree lacerations include infection (0.5–4%), breakdown or dehiscence (2–10%), and development of rectovaginal fistula (0.3–3%) (21–23,28–30). Evaluation of quality-of-life changes after repair of obstetrical anal sphincter laceration is less well studied, although women who sustain a fourth-degree laceration have a 2.7-fold increase (95% CI 1.7–7.7) in dyspareunia following their repair at 6 months postpartum compared to women without laceration at the time of childbirth (31).

Perioperative care has not been well studied. Many experts recommend at least one dose of broad-spectrum intravenous antibiotic administered during repair, and some continue oral antibiotics for 1 week following repair (23,24,32). Stool softeners, perineal care such as sitz baths, and pelvic rest are also commonly advised. Dietary recommendations following primary repair have not been studied.

Sphincteroplasty

In women with an anal sphincter defect and fecal incontinence remote from delivery, the mainstay of surgical interventions is anterior overlapping sphincteroplasty. Parks and McPartlin (33) introduced the overlapping repair in 1971 because of what was thought to be unsatisfactory success rates with end-to-end repairs. Initially, results with overlapping sphincteroplasty were thought to be good, with patients reporting symptom improvement as good or

excellent with short-term follow-up in 60% to 82% of patients (34) (Table 14.1). Four studies have reported less promising longer-term results with mean follow-up of 3 to 10 years with cure ranging from 0% to 28% after overlapping repair (35–38) (Table 14.2). Anorectal physiologic testing or clinical features do not predict long-term outcomes other than patient age in one study (35) and the presence of a persistent internal anal sphincter defects in another study (38). Incontinence to flatus was common. A single randomized trial compared overlapping to end-to-end repair in 23 patients and found that patient rated success of 75% was the same in both groups at a mean of 18 months' follow-up (39).

Women with anal sphincter defects and abnormal neurologic testing such as delayed pudendal nerve motor latencies should be counseled that their chance of continence following surgery even in the short term may be decreased when compared to women with normal testing. Reported success rates of 10% to 67% with follow-up periods ranging up to 5 years have

Table 14.1. Outcomes after sphincteroplasty

Author	No. of patients	Follow-up period, months, mean (range)	Success (%)	Improved (%)
Fang et al, 1984 (54)	76	35 (2–62)	82	89
Browning and Motson, 1988 (55)	83	39.2 (4–116)	78	91
Ctercteko et al, 1988 (56)	44	50	75	—
Laurberg et al, 1988 (57)	19	18 (median: 9–36)	47	79
Yoshioka and Keighley, 1989 (58)	27	48 (median: 16–108)	—	74.1
Wexner et al, 1991 (59)	16	10 (3–16)	76	87.5
Fleshman et al, 1991 (60)	55	0 (12–24)	72	87
Simmang et al, 1994 (61)	14	0 (6–12)	71	93
Engel et al, 1994 (62)	55	15 (6–36)	60.4	—
Engel et al, 1994 (63)	28	46 (median, 15–116)	75	—
Londono-Schimmer et al, 1994 (64)	94	58.5 (median; 12–98)	50	75
Sitzler and Thompson, 1996 (65)	31	(1–36)	74	—
Felt-Bersma et al, 1996 (66)	18	Vrije University	—	72
Olivera et al, 1996 (67)	55	Cleveland Clinic Florida	70.1	80
Nikiteas et al, 1996 (68)	42	Birmingham	60	—
Gilliland et al, 1998 (34)	100	Cleveland Clinic Florida	24 (median; 2–96)	69

From Gilliland et al (34).

Table 14.2. Long-term results following overlapping sphincteroplasty

Author	Patients with follow-up/total (%)	Follow-up, mean (range)	Outcomes
Malouf et al, 2000 (36)	46/55 (84)	77 months (60–96)	0% continent 10% incontinent flatus only 79% soiling 21% incontinent solid stool 8/46 other surgery
Karoui et al, 2000 (38)	74/86 (86)	40 months	28% continent 23% incontinent flatus only 49% incontinent stool
Halverson and Null, 2002 (37)	49/71 (69)	69 months (48–141)	14% continent 54% incontinent stool 7/49 other surgery
Gutierrez et al, 2004 (35)	135/191 (71)	10 years (7–16)	6% continent 16% incontinent flatus only 19% soiling 57% incontinent stool 5/135 other surgery

been reported (34). Despite poor objective outcomes with sphincteroplasty, many patients are satisfied with the improvement in function despite continued incontinence, and would choose to undergo the surgery again (34,36). Detailed counseling and goal setting by both patient and providers is essential when considering performance of these repairs.

Traditionally, extensive bowel preparation including both mechanical and antibiotic treatments with a restricted diet for 1 to 3 days has been recommended prior to surgery to repair the anal sphincter, but no randomized data support these practices. Six randomized trials evaluating bowel surgery compared patients undergoing mechanical bowel preparation to those with no preparation and found no differences in wound infection rates [44/595 vs. 35/609, odds ratio (OR) 1.34, 95% CI 0.85–2.13) or other parameters measured (40).

To perform an overlapping sphincteroplasty, the patient can be positioned in either the prone jackknife or the lithotomy position. The ends of the EAS are identified prior to starting by palpating the area of dimpling at either side of the vaginal opening (Figure 14.5). The surgery begins with a curvilinear incision through the perineum (Figure 14.6). Comparison of an arc incision anterior to the anal verge versus a curvilinear transverse incision in the posterior fourchette in the line of the vaginal mucococutaneous junction found that incisions made in the posterior fourchette had fewer wound complications, although functional outcomes were similar (41). The ends of the EAS are dissected from the surrounding tissues until the two arms of the EAS can be brought together and overlapped for a distance of approximately 2 to 3 cm (Figures 14.7 and 14.8). A pediatric nerve stimulator can help to identify the ends of the sphincter. Any scar tissue at the ends of the sphincter is left in place to help hold sutures. The internal anal sphincter is identified and imbricated used a fine, delayed absorbable suture, such as 3-0 or 4-0 PGA. The EAS sphincter can then be repaired in either an overlapping or end-to-end technique as described above for primary repair. A perineorrhaphy is then performed. Some surgeons advocate leaving the skin unclosed for drainage, whereas others report closing the skin. Wound infections have been reported in up to a third of cases (42). Postoperative recommendations vary based on anecdotal evidence, with many surgeons recommending dietary restriction and stool softeners. A single study has randomized 54 patients undergoing anorectal reconstructive surgery to "regular" diet versus a "bowel confinement" regimen following other colorectal surgery and found no benefit to dietary restriction (43).

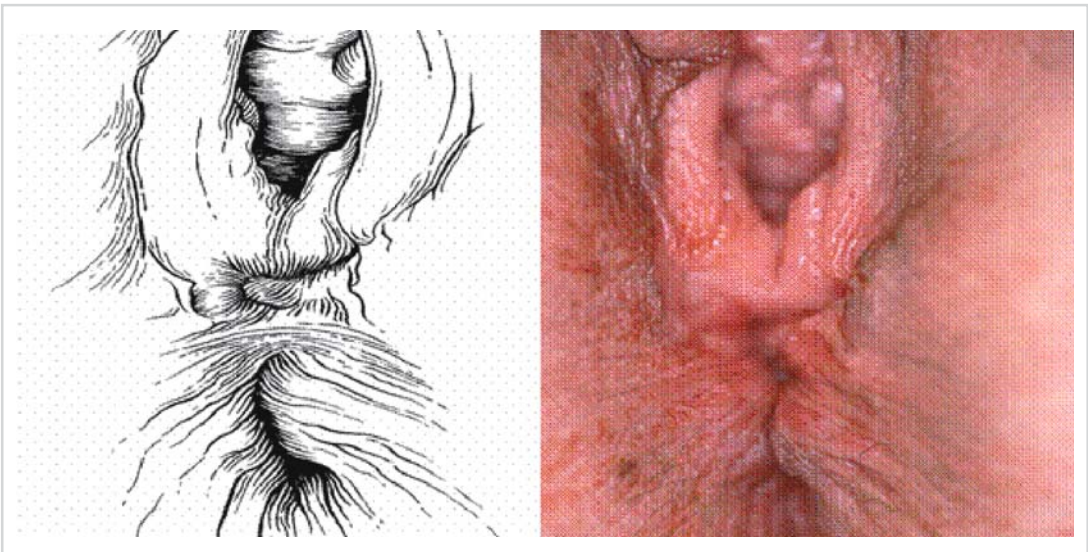

Figure 14.5. Patient with disrupted anal sphincter. Note the radial folds posteriorly that are absent anteriorly and the dimples at the 3 and 9 o'clock positions. (From Stenchever and Fenner [6]. © 2001, with permission from Elsevier.)

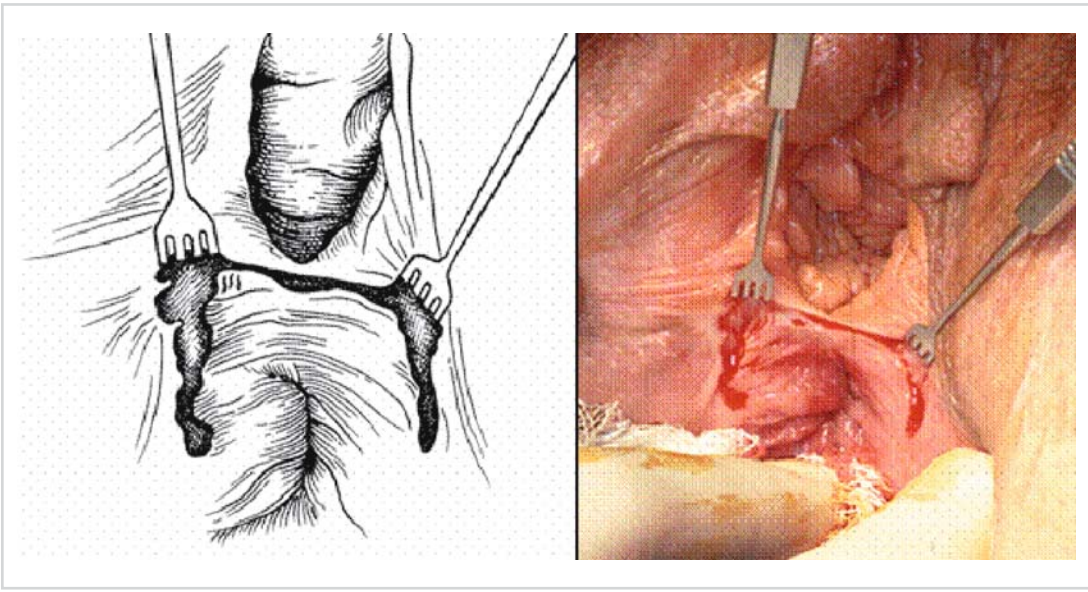

Figure 14.6. Curvilinear transverse incision near anal verge. (From Stenchever and Fenner [6]. © 2001, with permission from Elsevier.)

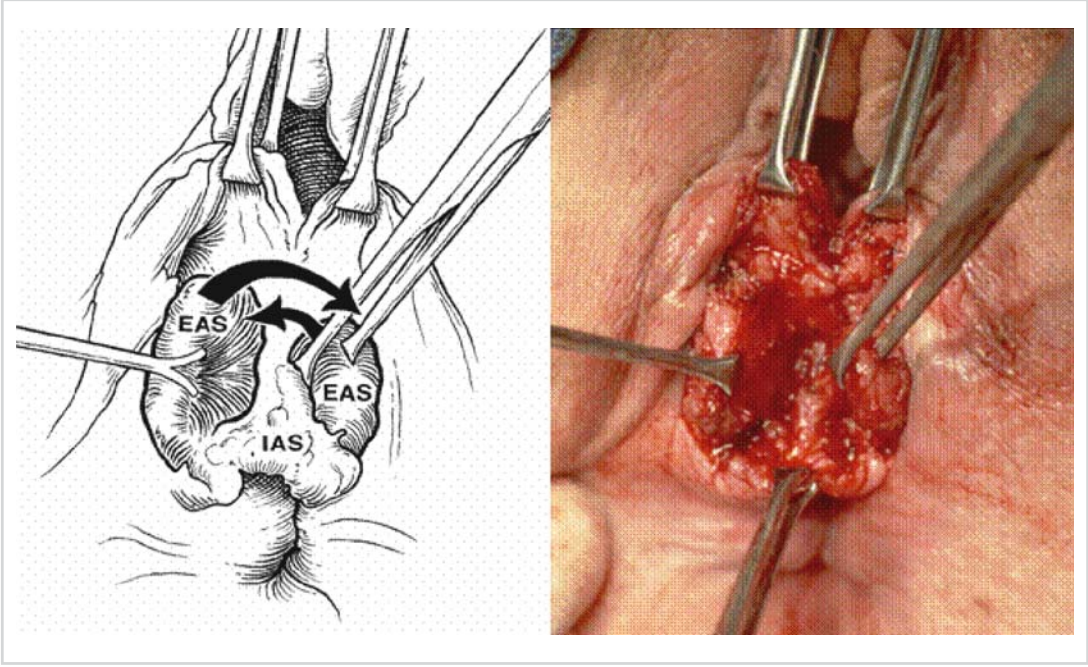

Figure 14.7. Dissection of the internal and external anal sphincter (IAS, EAS). (From Stenchever and Fenner [6]. © 2001, with permission from Elsevier.)

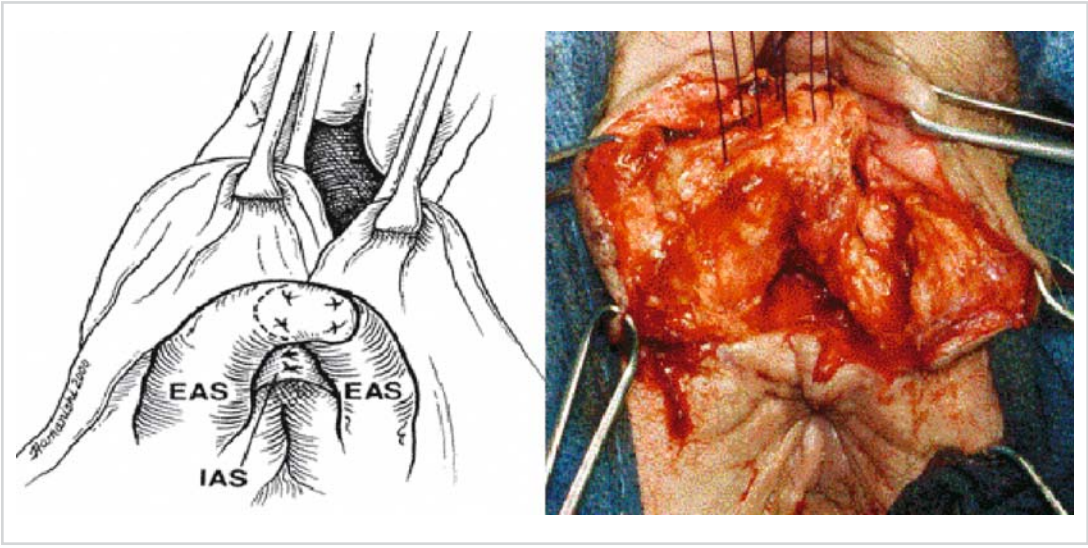

Figure 14.8. Overlapping repair of the external anal sphincter. (From Stenchever and Fenner [6]. © 2001, with permission from Elsevier.)

Rectal Prolapse Repair

Rectal prolapse, the protrusion of all layers of the rectal wall through the anus, can result in anal incontinence. Rectal prolapse can be repaired either transperineally or transabdominally. Transperineal procedures include anal encirclement operations, in which a subcutaneous suture is placed around the anus; perineal rectosigmoidectomy, in which redundant bowel is resected; and Delorme procedures, in which the bowel is not resected but the mucosa stripped and the muscle layer plicated to act as a buttress to retain the bowel. Success rates for surgery to reduce rectal prolapse range from 0 to 60%, with over 113 different procedures described (44). A single trial of 20 patients compared abdominal versus vaginal approach for the repair of rectal prolapse and found that resolution of anal incontinence was greater in the 10 patients undergoing the abdominal approach (OR 8.07, 95% CI 1.35–48.38) (45).

Neosphincters

Neosphincters have been used to treat women who have failed sphincteroplasty and wish to pursue further corrective surgery. Muscle flaps, including graciloplasty or gluteus transposition, and the artificial anal sphincter have all been used with variable success. All of these procedures require a highly motivated patient.

In 1952, graciloplasty was first described for the treatment of anal incontinence in children with congenital defects. It has since been used to treat anal incontinence in adults. In this procedure, the gracilis muscle is mobilized along its entire length and then wrapped around the anus and anchored to the opposite ischial tuberosity. Because the gracilis muscle is made up of fatigue-prone type 2 fibers, chronic stimulation is employed to convert the muscle to fatigue-resistant type 1 fibers. Complications are frequent and include infection and reoperation rates of up to 40%. A prospective study of 123 adults treated at 20 institutions with dynamic graciloplasty found 90% of patients reported a 50% or greater improvement in incontinent events 1 year after surgery (46).

Artificial anal sphincters have been available since 1996 and are indicated in patients with anal incontinence caused by neuromuscular disease or trauma (Figure 14.9). The device consists of a silicone rubber cuff that that is used to encircle the anal canal. The cuff is connected to a pump that is placed in the labia majora. Most reports have small numbers of patients with limited follow-up (47). A single series of 17 patients followed 5 years after implantation of the device found that only eight of 17 had implanted devices that were still working. Of those who retained the device, a 50% improvement was noted, for a

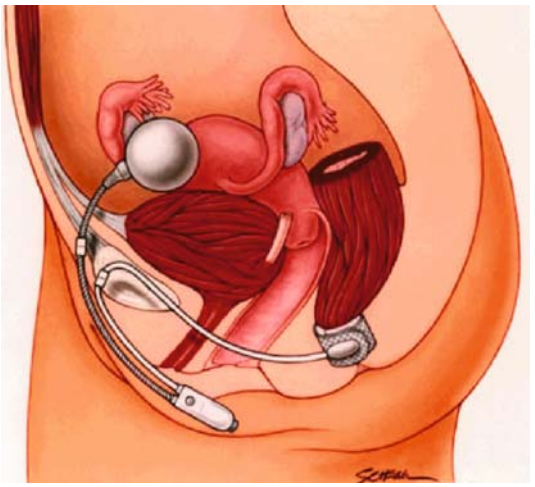

Figure 14.9. Acticon® Neosphincter. (Courtesy of American Medical Systems, Inc., Minnetonka, MN, www.AmericanMedicalSystems.com.)

success rate of 24%. Complications were common, and 63% of patients required revisions of their implant (48). Other complications included infection and mechanical breakdown. In the short term, 75% satisfaction rates and 33% complication rates, similar to the muscle transpositions, have been reported (6).

Neuromodulation

Neuromodulation was first introduced for the treatment of urinary retention, frequency, and urgency. It is still considered experimental in the treatment of anal incontinence, although several case series have reported improvement in anal continence in patients both with and without sphincter disruptions (49–51). The advantage of the procedure is that there is a trial period when the stimulator is placed prior to permanent implantation to see if the patient improves. Neuromodulation may offer a minimally invasive procedure for the treatment of anal incontinence. The exact pathophysiology of the effect of neuromodulation on anal incontinence is unknown.

Rectovaginal Fistula Repair

Rectovaginal fistula should always be considered as part of the differential diagnosis when treating a patient with anal incontinence. The most common cause of rectovaginal fistulas worldwide is obstructed labor. Although vesicovaginal fistula is a much more common occurrence in this population, approximately 17% of fistulas seen at a large fistula center in Addis Addaba, Ethiopia, were rectovaginal fistulas (52). Fistula secondary to obstructed labor is rare in the developed world, and the risk of rectovaginal fistula following fourth-degree obstetrical laceration is less than 1% (21–23,28–30). Other causes of fistula include neoplasm, inflammatory disorders, iatrogenic, and foreign-body erosions.

Symptoms associated with rectovaginal fistula may range from vaginal flatus to frank stool in the vaginal vault. Obstetrical rectovaginal fistulas may also involve the anal sphincter complex. Evaluation of the sphincter complex is important and should be addressed at the time of repair to improve continence results (53).

Many different procedures have been described for the repair of rectovaginal fistula. Regardless of method, the basic tenets of repair are consistent. Repair should be attempted only in a patient who is free from local inflammation. To achieve this may require waiting 1 to 3 months for infection to resolve or diverting colostomy. Most authors advocate wide dissection to ensure closure without tension, excision of the fistulous tract if enough vaginal and rectal tissue remains to complete the repair, and meticulous attention to hemostasis and dissection. Success rates for simple (less than 2.5 cm in size located in the distal rectovaginal septum) rectovaginal fistulas range from 40% to 86% (53).

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Part VI

Vaginal Approach to Abdominal or Vaginal Surgery Failures: Now What?

15

Vaginal Approach After Failed Previous Surgery for Incontinence

Christopher C.R. Chapple

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After any failed surgery for incontinence, or after any vaginal surgery complicated by incontinence for that matter, it is essential to carry out a complete evaluation of the patient—both subjectively and objectively. Certainly recurrent incontinence after previous surgery can usually be treated successfully, but it requires precise patient evaluation because it is imperative that the exact functional derangement is defined and the precise etiological factors are identified. This is particularly important when there is more than one abnormality present, since incorrect treatment may aggravate symptoms rather than cure them. A careful balance should be struck between the treatment modality to be chosen and the patient's expectations. In addition to a clear history, a full examination—physical, urodynamic, and, where appropriate, imaging—should be performed. Although in some patients with a history of recurrent incontinence it may not be possible to demonstrate any significant abnormality, it is essential to exclude a significant abnormality.

History

The most helpful classification of potential causes of incontinence is based on etiology:

1. Sphincter failure (stress incontinence)
2. Bladder overactivity (urgency incontinence)
3. Anatomic anomalies (uretero, vesico, or urethrovaginal fistulae)
4. Overflow incontinence
5. Temporary causes (infection, immobility, fecal impaction)
6. Functional disorders

Urgency and frequency may be described by patients with sphincter failure or bladder overactivity. It is not unusual for patients to present with a combination of urge and stress (1–3). When both symptoms are present, the incontinence is called *mixed* (4). Mixed is especially common in older women. Often, however, one symptom (urge or stress) is more bothersome to the patient than the other. Identifying the most

bothersome symptom is important in targeting diagnostic and therapeutic interventions.

It is important to remember that more than one condition often coexist. The bladder is an unreliable "witness." Furthermore, reported symptoms are not specific to any underlying abnormality.

Salient features within the history include the following:

- Type of leakage
  - Severity compared to preoperative
  - Quality of life impact
- Storage symptoms
  - New and old
- Voiding symptoms
- De novo symptoms
- Nature of previous surgery
- Other significant symptoms

Whatever the cause of the incontinence it is vital to assess the impact it has on the patient's lifestyle. The severity of the problem can be established by asking about the frequency of incontinent episodes and the type and amount of protection used (e.g., number of pads worn per day).

Stress leakage may occur with any activity that results in a rise in intraabdominal pressure, most commonly coughing, sneezing, laughing, getting up from a chair, or walking. Symptoms are usually better at rest, so nocturia is not characteristic.

With urgency incontinence patients complain of a loss of voluntary control of bladder activity and micturition, resulting in urgency, urgency incontinence, frequency, nocturia, and nocturnal enuresis. They often describe triggers such as cold weather, hand washing, and the "key in the door" situation when they are able to inhibit micturition for some time only to leak as they enter the house. Sometimes the trigger for overactive bladder contractions may be associated with a rise in intraabdominal pressure (e.g., coughing or sneezing), in which case the patient may appear to be describing stress incontinence.

Dribbling incontinence may cause patients to complain of "being wet all the time." It is important to establish to what extent this is a figure of speech. Continual leakage of urine is uncommon and is usually associated with overflow incontinence. Rarely there is an anatomic abnormality such as a fistula. Occasionally there may be gross genuine stress incontinence with a wide-open bladder neck resulting in continuous leakage of urine. Overflow incontinence occurs when the bladder is chronically overdistended. In both men and women decreased bladder sensation resulting in incomplete voiding may be a consequence of a neurologic deficit, for example, in multiple sclerosis or diabetic neuropathy.

Many women with severe prolapse recall that as the prolapse worsened, no doubt by producing urethral kinking, their stress incontinence symptoms improved. Certainly reduction of a vaginal prolapse during the examination by the clinician can unmask so-called occult incontinence in up to 80% of clinically continent patients with severe prolapse (5,6).

Self-administered questionnaires may be used to elicit both symptoms and the impact on quality of life, and several are available that have been validated with psychometric testing. An example of a simple symptom questionnaire is the Urogenital Distress Inventory Short Form (UDI-6) (7), which has been validated in older men and women (8). Out of the myriad of available quality-of-life questionnaires, the Incontinence Impact Questionnaire (IIQ) (9,10) is an example of one that has been validated and modified, and a seven-item shortened form has been constructed (7) and found to be reliable. Likewise the Kings Health Questionnaire has been widely validated and is commonly used. It is an incontinence-specific questionnaire that is available in 27 languages (11). The International Consultation on Incontinence (ICI) has recently developed the ICIQ which is a disease-specific quality-of-life questionnaire with a large number of disease area–associated modules that are currently under development and evaluation (12). These questionnaires will inevitably be primarily used in the context of research rather than in routine clinical practice.

Further Diagnostic Evaluation of Patients

A general assessment of the patient reveals important factors such as obesity and poor mobility. Specific systemic examination should include abdominal examination to reveal bladder distention and evidence of previous surgery. In women, vaginal examination should be carried out with the patient lying in the left

lateral position using a Simms speculum and asking the patient to bear down or cough to objectively demonstrate stress leakage of urine and assess the degree of bladder neck mobility and uterovaginal prolapse. If a neurologic cause is suspected, tone, power, sensation, and reflexes of the lower limbs should be assessed. Rectal examination allows assessment of anal tone and the anal reflex.

In addition to routine tests such as a urine examination, further investigation should utilize urodynamic assessment, which strictly speaking includes any test of lower urinary tract function. Tests used for urodynamic assessment are described below in order of complexity.

Frequency/Volume Charts

The patient records the time and volume of any voids over a set period (usually 72 hours), together with fluid intake and noting any episodes of incontinence. This simple test can be very helpful in revealing habits that contribute to urinary symptoms (e.g., large intake of caffeine in the evenings or infrequent voids during working hours).

Pad Tests

Weighing a perineal pad before and after use (techniques vary between 1-hour testing and 24-hour testing) facilitates estimating the amount of urine lost over a set period of time.

Flow Rate

The patient is asked to pass urine into a flow meter, which gives a graphical representation of the urine flow rate over time. Characteristic flow rates patterns are seen in obstruction, but many flow rates are equivocal and should be interpreted with caution. Both poor detrusor function and obstruction cause a reduction in flow rate. Furthermore, detrusor pressure may initially increase to overcome obstruction so that any reduction in flow rate is masked.

Ultrasound

Ultrasound is frequently used to estimate postvoiding residual volumes of urine.

Conventional Cystometry

During controlled filling and subsequent voiding, the relationships among pressure, volume, leakage, and symptoms are assessed. Pressures are measured with transducers attached to fluid-filled lines inserted into the rectum or vagina (abdominal pressure) and bladder (vesical pressure). Urodynamics is important in the differential diagnosis of detrusor overactivity and urodynamic stress incontinence. It is only by detecting changes in detrusor pressure that impaired compliance and detrusor overactivity can be diagnosed, but it is essential that these findings be correlated with reported symptoms and leakage.

Videocystourethrography

This is a further refinement of cystometry using contrast medium to fill the bladder. This allows x-ray imaging during coughing and straining and provides information on the anatomy of the bladder, the presence of any vesicoureteric reflux, the degree of bladder neck and urethral mobility, and the level of any outflow obstruction. This is certainly a useful diagnostic option in the preoperative evaluation of complicated/recurrent female urinary incontinence.

Ambulatory Urodynamics

This form of cystometry overcomes some of the problems associated with conventional urodynamics. The equipment is portable, allowing patients to move freely and void in private. In addition, patients fill their bladder spontaneously after drinking a fluid load. As the technique is not adequately standardized with internationally accepted diagnostic criteria, it is best regarded as a research tool at present, particularly since some studies have reported involuntary detrusor contractions in up to 70% of apparently normal subjects.

Urethral Pressure Profilometry

Although urethral pressure profilometry (UPP) has the potential to be highly informative, the test has multiple problems, the most significant being the large overlap in values obtained from

normal and symptomatic patients. It does not discriminate stress urinary incontinence (SUI) from other urinary disorders, provide a measurement of the severity of the condition, or predict a return to normal following successful intervention.

Abdominal Leak Point Pressures

Abdominal leak point pressure (ALPP) is defined as the vesical pressure at leakage during abdominal stress in the absence of detrusor contraction. The abdominal stress may be induced by a cough (CLPP) or a Valsalva maneuver (VLPP), with the two stressors differing physiologically in particular with regard to the rate and nature of pressure rise that is seen. Although higher abdominal pressures can be achieved with CLPP, the VLPP is better controlled and less variable (13). Generally, CLPP is used for patients who do not leak during VLPP measurement. The pressure at which the urine is expelled can be measured visually, fluoroscopically, by flowmetry, or by electrical conductance.

Although the concept of ALPP as a method of investigating incontinence is empirically sound, its value is limited by a lack of standardized methodology. Variations occur in the type of catheter (transurethral, rectal, vagina), catheter caliber, bladder volume, and patient position. The exact baseline used during the test also varies (e.g., zero level or the level at which the pressure just starts to rise), which can make a dramatic difference to the ALPP value. For ALPP to be a valid test, it is assumed that the transurethral catheter used does not obstruct the urethra or alter coaptation, straining or coughing does not distort the urethra, and no pelvic relaxation or contraction occurs. However, it is difficult to know whether these are actually occurring during the test, which is a major drawback.

Few data are available on the magnitude of the change in ALPP post-SUI treatment, and how this correlates with cure, improvement, or failure. One general finding is that VLPP does not change significantly if the treatment fails. For example, following suburethral sling operations in 30 women, VLPP increased significantly after a successful operation (mean change: 61.1 cmH_2O; $p < .001$) but not after failure (mean change: 9.7 cmH_2O, $p = .226$) (14).

Neurophysiologic Evaluation

The electrical activity of action potentials of depolarizing striated muscle fibers in the urethra can be studied with electromyography using surface or needle electrodes. Results must be interpreted in the light of symptoms and other investigations. This remains a research tool but has provided valuable insight into the pathophysiology and the effect of treatment on various conditions.

General Management of the Failed Surgical Procedure

Essentially the principle behind using these techniques in the patient with failed previous surgery is that by taking a careful targeted history and doing a focused examination and appropriate diagnostic evaluation with the correct admixture of urodynamic investigations, the precise nature of the incontinence, the associated symptoms, and the underlying pathophysiology will be clearly identified.

Let's consider a patient who presents following a previous failed procedure. After taking an appropriate history and determining that the problem is continuing incontinence, the examination of the patient, after providing a general assessment, should focus on the urethral support/mobility, pelvic floor muscle contractility, other vaginal support, and the presence of scarring, fistula, foreign body, or atrophy. Diagnostic evaluation should include imaging using transvaginal ultrasound or videocystography complemented by appropriate urodynamic assessment, as outlined above, and possibly cystoscopy. At the end of this process the clinician should understand why the previous previous procedure has failed.

Management after the failure of prior surgery, and following appropriate assessment that demonstrates continuing incontinence, can be either nonsurgical or surgical.

Nonsurgical Management

Nonsurgical management, when appropriate, should be tried prior to surgery and can take many forms. These are beyond the scope of this textbook and are briefly summarized as:

- Pelvic floor physiotherapy (including lifestyle advice)
- Drug therapy (duloxetine)
- Intravaginal devices (pessaries)
- Topical estrogens (not of efficacy for the treatment of stress incontinence but useful in counteracting symptomatic atrophic vaginitis and improving the state of the vaginal tissues)

Surgical Management

Surgical management depends on the findings after the patient evaluation, including history, examination, and objective urodynamic assessment. Most slings fail because they provide insufficient urethral support, and retropubic procedures have produced an inadequate or excessive vaginal repositioning. Certainly redo surgery has a lower success rate than primary surgery, and with this in mind there is a strong case to be made that women with recurrent SUI, particularly following failed retropubic surgery, should be managed in tertiary referral units (15). As with any surgery it is essential to critically evaluate the situation with regard to effectiveness, durability, morbidity, cost, and the therapeutic alternatives that exist.

Reoperative surgery for recurrent stress incontinence is complicated by factors such as scarring in the periurethral and retropubic area, sphincteric weakness, limited paravaginal tissue mobility, and patient apprehension exacerbated by the failed previous surgery. McGuire and colleagues (16) were among the first to introduce the concept of type III stress incontinence, or intrinsic sphincter dysfunction (ISD), namely an intrinsic malfunction of the urethral sphincter, regardless of its anatomic position. They observed that some patients in whom multiple retropubic operations failed had a deficient sphincteric mechanism, characterized by an open bladder neck and proximal urethra at rest, with minimal or no urethral descent during stress. Indeed in any patient sphincteric incontinence that is unaccompanied by urethral descent or rotation is likely to be a manifestation of some degree of ISD since the normal urethra is intended to remain closed no matter what the degree of stress or rotational descent. Inevitably a variable degree of urethral hypermobility and ISD is present in most patients. Certainly one of the commonest associations with ISD is that of previous urethral or periurethral surgery (e.g., anti-incontinence surgery, urethral diverticulectomy), resulting in periurethral fibrosis, scarring, or denervation (17). Indeed the prevalence of ISD after two or more failed anti-incontinence operations has been reported to be as high as 75% (18).

Primary continence surgery may fail as a result of inappropriate surgical technique, poor tissue quality, sphincteric deficiency or a continuing decline in the functional integrity of the continence mechanisms. Obesity, intraoperative hemorrhage, and previous surgery are all factors that have been shown to hamper surgical access and limit surgical success (15). Some authors describe clinical and intraoperative findings suggestive of primary technical failure. Lee and Symmonds (19) noted that 66% of their patients undergoing a repeat Marshall-Marchetti-Krantz procedure had preoperative evidence of hypermobility and little or no evidence of retropubic adhesions in the urethrovesical areas, suggesting that these women may not have had adequate retropubic suspension of the urethra and bladder neck.

An interesting study used laparoscopy to determine the etiology of failed colposuspensions in five cases. In one the bilateral sutures had given way, two had an intact colposuspension with sphincteric deficiency found on subsequent urodynamic study, and two had sutures that had given way on one side, resulting in lateral torsion of the bladder neck (20). Indeed, Maher et al (21) suggest that patients who responded to a repeat colposuspension after surgical lysis of the adhesions around the bladder neck may have had a prior suspension that distorted rather than supported the bladder neck.

A wide variety of procedures have been described for the management of recurrent stress urinary incontinence. Conventional sling techniques have proven effective but are generally associated with a higher morbidity (22,23). In a series of fascia lata slings following previous retropubic continence surgery, 10 out of 60 women (17%) required sling removal, eight due to voiding difficulties and two due to retropubic abscesses from infected hematomas (22). Others more recently have reported a retrospective case review series of 14 patients in whom an initial suburethral sling procedure failed (24), and who then underwent a repeat pubovaginal sling procedure for recurrent stress urinary incontinence. Mean follow up after reoperation was only 17

months (range 5 to 41). Long-term urinary retention developed in one of the 14 patients (7%). There were no deaths. Two patients (14%) had postoperative complications, including a pelvic abscess and an osteomyelitis pubis. Based on the Blaivas-Groutz anti-incontinence scale, seven of the 14 patients (50%) were cured, one (7%) had a good response, four (29%) had a fair response, two (14%) had a poor response, and none had treatment failure. Subjectively 12 of the 14 women (86%) considered themselves cured or improved and two (14%) considered the operation to have failed. Very clearly, retrospective data of this nature based on small numbers of patients with inadequate assessment of outcome and inadequate long-term follow-up data are unsatisfactory, and only serve to demonstrate the deficiencies in our knowledge in this area, particularly since retrospective chart reviews have been shown to overestimate cure rates and may be influenced by the patient–physician relationship and by inaccuracies in the medical records (25–27).

Although traditional synthetic slings have a higher risk of urethral erosion, reported sling removal rates vary from 4% to 22% with development of stress urinary incontinence of up to 50% after sling removal (28). Nevertheless, several authors have reported excellent medium-term results with minimal morbidity in patients with intrinsic sphincteric deficiency (23,29,30), and it is clear that pubovaginal slings are a durable and effective option (31). Haab et al (32) described 16 patients with previous retropubic or vaginal suspension undergoing a successful tension-free vaginal tape (TVT) procedure. In their series of 62 women followed over a median of 16.2 months, 87% were cured and 9.6% improved. No erosion or infection occurred. In another study, 51 women with recurrent SUI were treated with TVT and followed prospectively for a minimum of 2 years according to a protocol. Twenty percent of the women had already undergone two previous continence procedures, whereas 80% had undergone only one. The mean follow-up period was 25.3 months. The objective cure rate was 89.6%, and the subjective cure rate 80.4%. No serious complications occurred. No significant difference was observed between pre- and postoperative residual urine, maximal urethral closure pressure, and total and maximum voided urine volume values. However, the changes in urinary frequency, minimum voided volume, pad test results, and visual analogue scale scores were highly significant (33). A retrospective, multicenter study of 245 consecutive women who were treated with TVT for genuine stress urinary incontinence (157 for primary and 88 for recurrent genuine stress urinary incontinence) over a 27-month period was performed. Concurrent surgical repairs were performed as required. Women with recurrent genuine stress urinary incontinence were older (mean age 64.6 versus 59.4 years, $p = .004$) than those with primary incontinence; they were less likely to have an intact uterus (22.7% versus 66.9%, $p < .001$), and were more likely to have intrinsic sphincter deficiency (70.5% versus 47.1%, $p < .001$). The mean duration of follow-up was 38 (±16) weeks. Cure rates among patients with recurrent versus primary genuine stress urinary incontinence were similar (85% and 87%, respectively, $p = .23$). Complication rates were similarly low in both groups (4.5% and 7.6% for recurrent and primary genuine stress urinary incontinence, respectively, $p = .35$). Postoperative voiding dysfunction occurred at low rates in both groups (34).

The most appropriate management strategy for patients with a combined hypermobility and sphincteric weakness, which occurs in many patients who have failed previous surgery, remains controversial. Some maintain that despite the presence of a weak outlet, stress incontinent women with anatomic hypermobility in the majority of cases will benefit from a simple resuspension (35). Although transvaginal needle suspensions are less invasive and may produce good short-term success, they are less successful in the long term (28). Certainly in other series patients with significant recurrent mobility, mobilizing and resuspending the vesicourethral segment via a retropubic approach has been described with good medium-term success (15,19,36). An open retropubic approach offers an excellent opportunity to fully mobilize the vesicourethral segment and achieve satisfactory resuspension, but carries with it significant morbidity. Scarring and fibrosis from previous surgery could prevent adequate suspension in some cases, and suture cut-through is more likely. Following failed surgery, patients may often have coexisting sphincteric weakness that places them at greater risk of recurrence following colposuspension (37,38).

Nevertheless, Maher et al (21) and Cardozo et al (15) have both shown good objective (72%

and 79%) and subjective (89% and 80%) success with repeat colposuspension at a mean follow-up of 9 months. Nitihara et al (36) reported a 69% subjective success at a mean follow-up of 6.9 years. Urge incontinence and sphincteric weakness are the main causes of failure and dissatisfaction; urge incontinence accounted for 63% (12/19). The remaining seven with persistent stress incontinence in Nitihara's series demonstrated sphincteric deficiency with mean Valsalva leak point pressures of 65 cmH_2O. The low pressure urethra has often been quoted as an adverse risk factor for colposuspension (37–39), but this topic also remains controversial. Several authors have studied the urethral pressure profilometry changes following colposuspension and have noted a statistically significant increase in the postoperative pressure transmission ratio but minimal changes in the postoperative maximal urethral closing pressure, functional urethral length, and continence area (40–42).

Certainly others favor a pubovaginal sling for all patients with outlet weakness (43,44). Kreder and Austin (45) performed pubovaginal slings in 16 women with type II/type III stress incontinence and reported 81% success at a mean follow-up of 22 months; 19% had postoperative urge incontinence and 7% required long-term self-catheterization. Slings, however, do not correct gross prolapse. A combined Raz urethral suspension and pubovaginal sling has also been described in eight patients with 88% cured in the short term (46,47). Pubovaginal fascial sling procedures can be combined with anterior colporrhaphy to repair multiple defects of the anterior vaginal wall. Cross et al (48) reported a grade 3 and 4 cystocele recurrence rate of 8% and a 15% grade 1 recurrence rate in 36 of 42 patients who returned for follow-up. The continence rate was 89%. New-onset urge was seen in 16%, and one patient required urethrolysis at 6 months for retention. Because of inherent difficulties associated with sacrospinous fixation, an innovative vaginal procedure—the levator myorraphy—has been reported by Zimmern's group (49) and has been carried out in over 200 women. It restores the vaginal axis and prevents a posterior enterocele recurrence by re-creating the levator shelf high within the peritoneal cavity and fixing the vault in that position.

Postoperative urge symptoms may occur or persist and are a major cause of patient dissatisfaction. Usually the etiology is completely unknown. Women having repeat continence surgery have been found by some but not others to be at a greater risk of developing postoperative detrusor overactivity than those undergoing primary surgery (50). Cardozo et al (51) have speculated that bladder neck denervation during surgery may result in bladder neck incompetence, which by stimulating urethral afferents allows urethral triggering of detrusor contractions. In support of this supposition, a period of electromyographic silence immediately preceding a detrusor contraction has been demonstrated in some stress-incontinent women with associated detrusor overactivity, suggesting a preceding urethral reflex that possibly triggers the problem. Persistence of an open bladder neck after surgery has also been associated with postoperative urge symptoms, and sling placement at the bladder neck may reduce its incidence (29). It has to be concluded that although the development of de novo urgency still remains one of the most troublesome of postoperative sequelae following continence surgery, as yet no satisfactory hypothesis has been advanced to either allow its occurrence to be predicted or to guide its treatment.

Many authors have attempted to identify urodynamic indices that may predict the likelihood of developing postoperative detrusor overactivity without success. Brown and Hilton (52) showed that although ambulatory urodynamics was more sensitive in picking up involuntary detrusor activity both pre- and postoperatively, it could not reliably predict postoperative detrusor overactivity. It has also been suggested that patients demonstrating higher pressures during unstable contractions may be at greater risk of persistent symptoms (50). At present it must be concluded that no correlation has ever been shown between postoperative obstruction and detrusor overactivity in stress incontinent women. The relationship among outlet obstruction, preexisting overactivity, and postoperative detrusor overactivity are clinically observed trends that will require larger studies of sufficient power to prove their true relevance (29,53).

Conclusion

This chapter evaluated the management of the patient with continuing or recurrent incontinence after a failed previous procedure. Other problems such as obstruction and other complications such as a fistula as a cause of continuing

incontinence are covered in other texts. Clearly, it is essential to carry out a comprehensive evaluation of all patients, and then consider the merits of further intervention after taking account of patient-perceived outcomes.

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16

Vaginal Approach to Postsurgical Bladder Outlet Obstruction

Victor W. Nitti and Nicole Fleischmann

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Bladder outlet obstruction resulting in voiding dysfunction following anti-incontinence procedures can be a disappointing outcome for both patient and surgeon. When stress incontinence is replaced by lower urinary tract symptoms (LUTS) such as frequency, urgency or urge incontinence, difficulty voiding, or urinary retention, the patient may have more severe complaints than at initial presentation. It is a challenging task for the clinician to decide what if any action to take and when to take it and by what approach. Several considerations are the type of anti-incontinence procedure, postoperative physical findings, the patient's degree of bother, and any addition testing that may be performed. Recent work has focused on clarifying the etiology and incidence of this condition, as well as providing new definitions on bladder-outlet obstruction in women. In addition, effective, less invasive ways of treating this condition have been described. The prevailing doctrine is not to make a bad situation worse and to find the simplest solution that produces the least anxiety for the patient. The vaginal approach to sling incision and urethrolysis is appealing for this reason. This chapter discusses the incidence and etiology of postsurgical obstruction, the diagnostic evaluation, and the current management and treatment for this condition, with specific emphasis on the vaginal approach.

Incidence

The true incidence of obstruction after incontinence surgery is not known. Older studies estimated it to occur in between 2.5% and 24% of patients (1–6). Obstruction may go undiagnosed if it is not severe enough to cause significant urinary retention. For example, an obstructed patient may experience detrusor overactivity with relatively normal emptying. Also, some patients seek second opinions regarding less-than-optimal surgical outcomes, and therefore most series on obstruction after incontinence surgery do not contain the critical denominator of the total number of patients undergoing surgery from which the obstructed patients were derived. In 1997 a meta-analysis of surgical procedures for the treatment of stress incontinence, undertaken by the American Urological Association Stress Urinary Incontinence Clinical Guideline Panel, showed that the reported incidence of urinary retention for more than 4

weeks postoperatively was 5% for retropubic and transvaginal suspensions and 8% for sling procedures (no statistical difference) (6). There were no accurate data available for a determination of the risk of permanent urinary retention, but the panel's opinion was that it "generally does not exceed 5%." Although recent changes in our understanding of how stress incontinence operations work (i.e., by support rather than tension) and the introduction of new techniques, like the tension-free vaginal tape (TVT) and similar TVT-like procedures, have undoubtedly reduced the incidence of postoperative obstruction, it still remains a problem nevertheless. Two large contemporary pubovaginal sling series found the need for surgical intervention for obstruction in 1% to 3% of patients (7,8). More recently the TVT procedure has been shown to have similar rates of postoperative intervention for obstruction, 1.7% to 4.5% (9–12).

Dunn et al (13) recently performed an extensive literature review to determine the incidence of "voiding dysfunction" after incontinence procedures. They searched the Medline database from 1966 to 2001 for various procedures. All available studies were retrospective collections, case reports, or case cohort series. Rates of voiding dysfunction varied from 4% to 22% following Burch colposuspension, 5% to 20% following Marshall-Marchetti-Krantz urethropexy, 4% to 10% following pubovaginal sling, 5% to 7% after needle suspension, and 2% to 4% following TVT. Although it cannot be said that all patients with voiding dysfunction in these series were obstructed, it can be inferred that a number were.

Etiology

Surgical procedures for the correction of stress urinary incontinence are designed to restore support to the urethrovesical junction or improve coaptation of the urethra in cases of intrinsic sphincter dysfunction. This can be accomplished in a variety of ways that include cystourethropexy and colposuspension and sling procedures. Although most believe that support rather than "obstruction" is the basis of incontinence procedures, some have proposed that surgery works, at least in part, by creating an obstruction, or relative obstruction, which is necessary for a successful outcome (14). Others have disputed this concept, reporting no change in postoperative urodynamic parameters in successful slings at 3 to 6 months after surgery (15). Clinical obstruction after incontinence surgery is typically a result of technical factors usually related to excessive tension on sutures or the sling. Less commonly, improper placement of the same can cause obstruction. Clearly, the most important aspect in preventing urethral obstruction is to avoid placing tension on the suspension, whether it is done with sutures (i.e., colposuspension) or a sling. Excess tension can cause an obvious overcorrection or "hypersuspension" of the bladder neck or urethra. However, in most cases of obstruction, hypersuspension is not evident on physical exam. Periurethral scarring secondary to the surgical procedure itself can also result in obstruction, which may have somewhat delayed presentation.

The concept of placing the sling at the bladder neck has been challenged by the overwhelming popularity and success of the TVT placed at the midurethra. Although no tension is placed, TVT can still cause obstruction in 2% of patients. A more recent variation on the midurethral sling using a transobturator approach has shown similar obstructive symptoms as TVT at 1 year. Five of 32 patients followed for at least 1 year had voiding disorders suggestive of obstruction, and subsequently required surgical intervention for obstruction (16).

Additional factors that may affect a patient's ability to empty after anti-incontinence surgery include preoperative voiding dysfunction and a cystocele or other prolapse that was either uncorrected at the time of surgery or occurred postoperatively. Prolapse of sufficient size may kink the urethra. Impaired detrusor contractility, a condition that is present preoperatively, may contribute to a relative obstruction when urethral resistance is increased by an anti-incontinence procedure. Finally, preexisting or learned voiding dysfunction can affect emptying after surgery. The patient who habitually voids by abdominal straining may have difficulty emptying after incontinence surgery because of increased urethral resistance. Dysfunctional voiding or incomplete relaxation of the external urinary sphincter can also occur postoperatively, although it is rare.

Diagnostic Evaluation

Transient voiding dysfunction and urinary retention are frequent and expected after many

types of anti-incontinence surgery. This is the rationale behind concomitant placement of suprapubic tubes or teaching clean intermittent catheterization preoperatively. Tension-free vaginal tape and transobturator slings are an exception to this, as retention and obstruction should not persist beyond a few days. After traditional pubovaginal sling (and variants) or colposuspension, most women begin voiding sufficiently on their own within a few days to weeks, while others may take longer to resume normal voiding. Storage symptoms such as urgency, frequency, and urge incontinence are often more refractory than retention because they can be related to bladder changes. Sometimes such symptoms can take months to resolve. It has been common practice to delay evaluation of the patient with urinary retention or severe storage symptoms after pubovaginal sling, colposuspension, and needle suspension for approximately 3 months postoperatively. Although this time frame is arbitrary, most data found in the literature is based on a waiting period of at least 3 months to ensure adequate time for obstruction/retention to resolve and to minimize the risk of recurrent stress incontinence. After 3 months, there is a very low probability that any persistent retention will resolve without intervention. Recently, some surgeons, including ourselves, have advocated earlier intervention in cases of complete retention; however, less data on outcomes and recurrence of stress incontinence are available. Few studies have focused on outcomes with respect to waiting a longer period of time before intervention. Although it seems intuitive that longer standing symptoms (especially detrusor overactivity) will be less likely to respond to relief of obstruction the longer the patient is obstructed, this has not been proven conclusively. Leng et al (17) recently conducted a retrospective review of 15 women who underwent urethrolysis and found that patients with persistent postoperative symptoms ($n = 8$) had a significantly longer time from surgery to intervention than those who had no symptoms ($n = 7$). The mean time to urethrolysis was 31.25 ± 21.94 months versus 9 ± 10.1 months, respectively. The large overlap, small sample size, and the fact that more patients in the successful group had urinary retention (5/7 vs. 3/8) make it difficult to draw definitive conclusions. We have not excluded obstructed patients from intervention based on duration of obstruction.

The waiting period advocated for obstruction and retention for more traditional anti-incontinence procedures has been largely abandoned for TVT and TVT-like procedures. In these cases, quicker intervention is suggested when obstruction is suspected (9–12). Owing to the immobility of the polypropylene mesh and the tremendous ingrowth of fibroblastic tissue at 1 to 2 weeks, patients with severe symptoms or urinary retention are less likely to improve after this time period.

History and Physical Exam

The diagnostic evaluation of the patient with voiding dysfunction after incontinence surgery begins with a focused history and physical examination. Key points in the history are the patient's preoperative voiding status and symptoms and the temporal relationship of the lower urinary tract symptoms to the surgery. The type of procedure performed and the number and type of other procedures done are also important. Urodynamic data such as uroflow and pressure flow studies from before incontinence surgery are useful if available. If patients are straining to void (perhaps by habit), they should be instructed to stop this behavior, as incontinence procedures are designed to prevent the flow of urine with abdominal straining. Finally, it is important to determine if the symptom of stress incontinence persists.

The most obvious presenting symptom of obstruction after incontinence surgery is the inability to void or intermittent retention. Patients may also experience voiding (obstructive) symptoms including slow or interrupted stream and straining to void. Storage (irritative) symptoms of urinary frequency, urgency, and urge incontinence, which persist after surgery, may also be a sign of obstruction even if emptying is complete. Carr and Webster (18) reviewed the presenting symptoms of 51 women undergoing urethrolysis for voiding dysfunction and obstruction following incontinence surgery and found storage symptoms in 75%, obstructive symptoms in 61%, de novo urge incontinence in 55%, need for periodic intermittent catheterization in 40%, persistent retention in 24%, recurrent urinary tract infections in 8%, and painful voiding in 8%. Obviously storage and voiding symptoms and retention can coexist in any combination.

Physical exam may show overcorrection or hypersuspension where the urethra and urethral meatus appear to be pulled up toward the pubic bone and "fixed." The angle of the urethra becomes more vertical than is normal. When severe, this is usually quite obvious, but can be confirmed by a Q-tip test. However, not all obstructed patients appear to be overcorrected. It is important to assess for cystocele and other forms of prolapse that may cause obstruction (owing to a kinking of the urethra). The patient should also be examined for persistent urethral hypermobility and stress incontinence.

Urodynamics

Recent interest in female bladder outlet obstruction (BOO) has resulted in the publication of several unique proposals of urodynamic criteria for the diagnosis of female BOO. Chassagne et al (19) used the cutoff values of detrusor pressure at maximum flow rate (P_{det} Q_{max}) of more than 20 cmH_20 and maximum flow rate (Q_{max}) of less than 15 mL/s to define obstruction. In 2000, Lemack and Zimmern (20) revised these values to a cutoff of Q_{max} of 11 mL/s or less and P_{det} Q_{max} of 21 cmH_20 or more. Nitti et al (21) used video-urodynamic criteria, with less emphasis on pressure-flow dynamics, to diagnose BOO. In this study, obstruction was defined as radiographic evidence of an obstruction between the bladder neck and distal urethra in the presence of a sustained detrusor contraction of any magnitude during voiding. Blaivas and Groutz (22), realizing the possibility of test-induced catheter obstruction, designed a nomogram based on the maximum noninvasive flow rate (free Q_{max}) and the maximum detrusor pressure during voiding (P_{detmax}). Although each urodynamic definition for obstruction has merit, further investigation should provide a better understanding of when to use which criteria.

The diagnosis of obstruction in women after incontinence surgery can be particularly difficult to make urodynamically. In cases of urinary retention and incomplete emptying, urodynamic studies may not be necessary before intervention, particularly if preoperative contractility and emptying are known to be normal. However, in cases of de novo or worsened storage symptoms, including urge incontinence without a significantly elevated postvoiding residual (PVR), a formal urodynamic evaluation is preferred. Classic high-pressure, low-flow voiding dynamics (or obstruction by any of the above criteria) confirm the diagnosis of obstruction, but their absence do not always rule out obstruction. Many women with suspected obstruction after incontinence surgery do not generate a significant contraction on urodynamic studies but are obstructed nevertheless. Outcomes of surgical intervention in such cases are identical to those in women with classic high-pressure low flow dynamics.

There appear to be no consistent preoperative parameters, urodynamic or otherwise, that predict success or failure of urethrolysis. For example, Foster and McGuire (23) found that patients with detrusor instability had a higher rate of failure, but a later study as well as others found this not to be the case. Nitti and Raz (24) found that as the PVR increased, so did the rate of failure, but others have not confirmed this correlation. Carr and Webster (18) found that the only parameter predictive of success was no prior urethrolysis. It is well established that urodynamics may fail to diagnose obstruction in a significant number of women obstructed from anti-incontinence procedures. Additionally, patients with nondiagnostic urodynamic studies or who failed to produce a detrusor contraction have the same outcomes as those with urodynamic findings classic for obstruction, namely high-pressure, low-flow voiding. In the study by Nitti and Raz, four women who failed to generate a contraction during urodynamic testing had a successful urethrolysis. They also reported that the urodynamic findings in patients considered failures after transvaginal urethrolysis failed to elucidate the reason for their continued voiding dysfunction. Owing to the limitations of urodynamics in these patients, the temporal relationship of the surgery to the onset of voiding and storage symptoms is relied upon as an indicator of obstruction. Likewise, if the patient fails to resume preoperative voiding or improve significantly, then continued obstruction is suspected.

Classic high-pressure, low-flow voiding dynamics do confirm the diagnosis of obstruction, but are far from a consistent finding. Urodynamics can also yield important information regarding instability, impaired compliance, bladder capacity, and voiding

characteristics. Based on our experience, video-urodynamics offers an advantage over simple urodynamics in this patient population, because of the ability to simultaneously image the bladder outlet.

The utility of urodynamics may be considered as follows:

1. For the patient in retention, urodynamics can provide valuable information (e.g., detrusor overactivity or significantly impaired compliance, the latter being an absolute indication for intervention) and can confirm a diagnosis of obstruction but should not exclude the patient from urethrolysis, even if there is no contraction or impaired contractility. Urodynamics may also identify learned voiding dysfunction.
2. For the patient with storage symptoms with normal emptying, urodynamics can diagnose obstruction and, equally as important, rule out obstruction. It can help to provide a specific diagnosis that is useful in directing therapy, especially if obstruction can be ruled out.

Endoscopy and Imaging

Endoscopic evaluation of the urethra may show scarring, narrowing, occlusion, kinking, or deviation of the urethra. These finding are especially helpful in cases where urodynamics are equivocal. The urethra and bladder should be carefully inspected for eroded sutures or sling material and the presence of a fistula. This is facilitated by the use of a rigid scope with a 0- to 30-degree lens and little or no beak to allow for complete distention of the urethra. In cases where intervention is anticipated, endoscopy should be done routinely, either before surgery or at the time of surgery prior to incision. Radiographic imaging may be done independent of video-urodynamics. A standing cystogram in the anterior-posterior, oblique, and lateral positions, with and without straining, assesses the degree of bladder and urethral prolapse and displacement or distortion of the bladder. A voiding cystourethrogram can assess the bladder, bladder neck, and urethra during voiding to determine the presence of narrowing, kinking, or deviation. While not mandatory, imaging can be extremely useful in equivocal cases.

Management of Iatrogenic Obstruction

Conservative Treatment

Treatment of obstruction and its timing are usually dictated by the degree of bother of symptoms. In some cases an obstructed patient opts for conservative management including clean intermittent catheterization (CIC) if necessary. In the woman who is not very bothered by catheterization and prefers this option to repeat surgery and a risk of recurrent stress urinary incontinence, CIC is a reasonable treatment plan. Most women ultimately choose definitive treatment; however, chronic CIC is an option in select cases. Patients who are emptying well but have significant storage symptoms secondary to iatrogenic obstruction may be treated initially with pharmacotherapy (anticholinergics) or pelvic floor physiotherapy. In our experience these measures are not all that successful when obstruction exists, but can be considered before surgery. The role for urethral dilation in cases of iatrogenic obstruction secondary to pubovaginal sling and colposuspension is not clear. Although many practitioners report anecdotal success, no peer reviewed literature exists. It is our opinion that urethral dilatation is of limited utility in these cases. Karram et al (11) did report an 82% cure or improved rate with urethral dilatation for with varying amounts of voiding dysfunction in 28 women after TVT. The cutting of suspension or sling sutures above the rectus has been described anecdotally with variable success.

When conservative measures in a symptomatic patient fail, definitive surgical therapy by either formal urethrolysis or sling incision may be required. The two most common transvaginal procedures for obstruction are transvaginal urethrolysis, which can be done for any incontinence procedure, and sling incision, which can be done for any type of sling procedure. In addition, there is limited experience with manipulation of TVT and TVT-like slings.

Transvaginal Urethrolysis

Urethrolysis may be accomplished through a retropubic or a transvaginal approach. Both methods have shown equivalent success rates

and rates of recurrent stress urinary incontinence, although most of these series include patients who are obstructed from a number of different anti-incontinence surgeries. The type of urethrolysis chosen depends on several factors including patient presentation, type of incontinence procedure performed, failed prior urethrolysis, and surgeon preference. It has been our practice to perform transvaginal urethrolysis as a primary operation, and a retropubic urethrolysis as a secondary operation, for example after failed transvaginal urethrolysis. We prefer the transvaginal technique because of its ease and the reduced morbidity and recovery time afforded by avoiding an abdominal procedure. However, there are times when a retropubic approach may be the best primary procedure, for example, when vaginal anatomy precludes a transvaginal approach; in cases where original incontinence surgery was associated with bladder perforation, fistula, or other operative complication; when there is a synthetic sling that must be removed; or in cases where the patient wishes to avoid a vaginal incision.

All urethrolysis procedures begin with a thorough endoscopic examination of the urethra, bladder neck, and bladder. Urethroscopy may show scarring, narrowing, occlusion, kinking, or deviation of the urethra. Eroded sutures or sling material or evidence of a fistula should be excluded. A rigid scope with a 0- to 30-degree lens and little or no beak to allow for complete distention of the urethra is ideal for female urethroscopy. Also it is common to find that the urethra or urethrovesical function is fixed and there is lack of mobility when moving the cystoscope up and down. After urethrolysis, mobility should be restored.

The most commonly used transvaginal technique was originally described by Leach and Raz (25). A midline or inverted-U incision approximately 3 cm long is made in the anterior vaginal wall. A midline incision should extend from the midurethra to 1 to 2 cm proximal to the bladder neck. In the case of an inverted U, the apex should be located halfway between the bladder neck and urethral meatus, and the lateral wing should extend proximal to the bladder neck. With either incision, lateral dissection is performed along the glistening surface of the periurethral fascia to the pubic bone. The retropubic space is entered sharply by perforating the attachment of the endopelvic fascia to the obturator fascia (Figure 16.1A). The urethra is dissected bluntly and sharply off of the undersurface of the pubic bone and completely freed proximally to the bladder

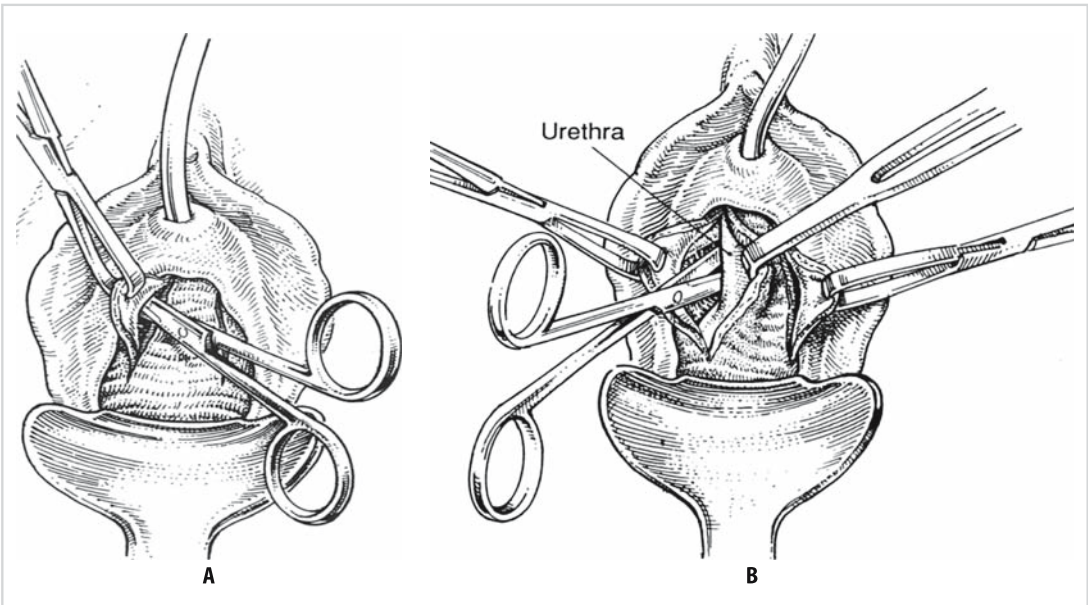

Figure 16.1. A: Transvaginal urethrolysis. An inverted-U incision in the anterior vaginal wall and entrance into the retropubic space. B: Transvaginal urethrolysis. The urethra is sharply dissected off of the undersurface of the pubic bone. The endopelvic fascia, periurethral fascia, and vaginal wall are retracted medially to expose the urethra in the retropubic space. (From Nitti and Raz [24]. © 2002, with permission from Elsevier.)

neck. Sharp dissection is usually required here (Figure 16.1B). The urethra should be completely freed proximally to the bladder neck so that the index finger can be placed between the urethra and the symphysis pubis (Figure 16.2). If previously placed sutures are identified, they should be cut; however, if none is identified, it is important to make sure that full urethral mobility is achieved.

Some authors routinely use a Martius labial fat pad graft with all transvaginal urethrolysis (26), whereas most reserve it for select cases (e.g., repeat urethrolysis, extensive fibrosis). Arguments in favor of the routine use of a Martius flap include (1) decreased risk of recurrent fibrosis, (2) decrease risk of urethral injury should future pubovaginal sling be required, and (3) the fact that it may provide some degree of urethral support (26). Arguments against routine use are increased morbidity and operative time, and the fact that series that use a Martius flap routinely do not show significantly better outcomes or lower stress urinary incontinence (SUI) rates than those that don't. We reserve the Martius flap for special circumstances.

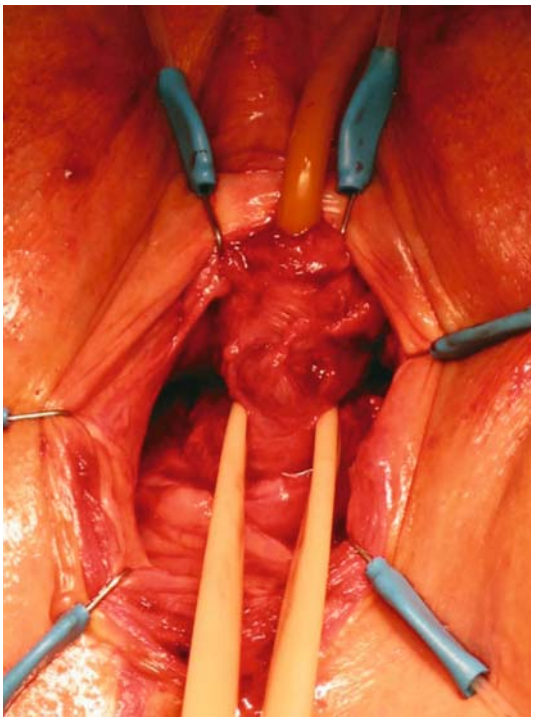

Figure 16.2. Intraoperative photo after completed urethrolysis. A Penrose drain has been placed around the urethra, isolating it from the pubic bone.

In select cases (e.g., extensive mobilization or stress incontinence coexisting with obstruction) it may be desirable to resupport the urethra at the time of urethrolysis. Resuspension or pubovaginal sling may be done. Currently our practice is to consider a resuspension or sling only if the patient has stress incontinence prior to urethrolysis or if support structures are severely compromised during urethrolysis. Resuspension does increase the risk of persistent obstruction, and since most patients are distraught about obstruction, we feel it is best to take care of that problem and deal with recurrent SUI at a later time should it occur. Rates of recurrent SUI after resuspension vary between 0% and 19% when resuspension is not performed (18,23,26–28). Many of these patients may be salvaged with transurethral collagen injections should stress incontinence recur. Goldman et al (27) reported a 66% response rate to collagen in women with recurrent stress incontinence after transvaginal urethrolysis. In addition, the option for repeat surgery for SUI at a later date exists. It is important to discuss with patients preoperatively the pros and cons of resuspension and the treatment of recurrent stress incontinence, as this could effect the decision to resuspend or not.

Success rates for transvaginal urethrolysis vary from 65% to 93% (Table 16.1). Most of these series include patients who are obstructed from a number of different anti-incontinence surgeries.

Suprameatal Urethrolysis

An alternative transvaginal approach to urethrolysis, via a suprameatal approach, has been described by Petrou et al (29). An inverted-U incision is made around the top of urethral meatus (approximately 1 cm away) between the 3 and 9 o'clock positions. Using sharp dissection, a plane is developed above the urethra. Then, with a combination of sharp and blunt dissection, the urethra, vesical neck, and bladder are freed from the pubic and pelvic attachments anteriorly and laterally. The index finger may then be passed into the retropubic space, and with a sweeping motion from medial to lateral, further freeing may be performed. If obstruction is caused by a pubovaginal sling, the lateral wings of the sling may be cut. Likewise, if the obstruction is caused by suspension sutures, these may be cut. As with transvaginal

Table 16.1. Summary of series on urethrolysis and sling incision/loosening for the treatment of obstruction after incontinence surgery

Reference	No.	Type of urethrolysis	Success[a]	Recurrent SUI[b]
Zimmern et al (36)	13	Transvaginal	92%	N/A
Foster and McGuire (23)	48	Transvaginal	65%	0
Nitti and Raz (24)	42	Transvaginal	71%	0
Cross et al (28)	39	Transvaginal	72%	3%
Goldman et al (27)	32	Transvaginal	84%	19%
Carey et al (26)	23	Transvaginal with Martius flap	87%	16%
Petrou et al (29)	32	Suprameatal	67%	3%
Webster and Kreder (37)	15	Retropubic	93%	13%
Petrou and Young (38)	12	Retropubic	83%	25%
Carr and Webster (11)	54	Mixed	78%	14%
Amundsen et al (32)	32	Transvaginal and sling incision	94%-retention 67%-urge sx	9%
Nitti et al (33)	19	Sling incision	84%	17%
Goldman (34)	14	Sling incision	93%	21%
Klutke et al (9)	17	TVT incision or loosening	100%	6%
Rardin et al (10)	23	TVT incision	100%—retention 30%—urge sx cured 70%—urge sx improved	39% (2/3 less SUI than pre-TVT)

SUI, stress urinary incontinence; sx, symptoms; TVT, tension-free vaginal tape.
[a] Success is usually defined as cure or significant improvement in presenting symptoms (resumption of normal bladder emptying for patients in retention, and resolution of symptoms for patients with obstructive symptoms or frequency, urgency, or urge incontinence). In some series success for specific symptoms is noted.
[b] Recurrent SUI is defined as percentage of patients without SUI before urethrolysis who experienced SUI after urethrolysis.

urethrolysis, a Martius flap may be placed. Petrou et al reported a 65% success rate for retention and a 67% success for urgency symptoms, with a 3% recurrent stress incontinence rate. This approach may be beneficial if dissection between the urethra and pubic bone is excessively difficult. It may be particularly applicable for cases of repeat transvaginal urethrolysis (after a failed prior urethrolysis) or when scarring is particularly dense.

Transvaginal Sling Incision

When obstruction results from a sling procedure (whether autologous, allograft, xenograft, or synthetic) transvaginal sling incision may be performed. This procedure is simpler and less morbid than formal transvaginal urethrolysis and has similar results. The technique of midline sling incision was originally described by Ghoneim and Elgmasy (30) using a free vaginal interposition graft and later modified as a simple midline incision without interposition (31–33).

Our technique starts with an inverted-U or midline incision to expose the area of the bladder neck and proximal urethra (33). As the vaginal flap is dissected off, the sling should be identified above the periurethral fascia. The sling may be encased in scar tissue and thus require careful dissection of the scar to identify the sling. If the sling has significant tension on it, it may be especially difficult to identify. Insertion of a cystoscope or sound into the urethra, with upward retraction, may help to exposing the bladder neck to better isolate the sling. Once the sling is isolated, it should be separated from the underlying periurethral fascia with sharp or blunt dissection. The dissection may be facilitated by grasping the sling with an Allis clamp on either side of the midline and exerting downward pressure. Care should be taken to avoid injury to the bladder and urethra by beginning the dissection distally, identifying normal urethra, and then proceeding more proximally until the plane between the sling and urethra is identified. A right-angle clamp can be placed between the urethra and periurethral fascia and the sling, lifting the sling. The sling is then cut in the midline (Figure 16.3A). Alternatively, if scarring is dense and the plane between the sling and periurethral fascia cannot easily developed, the sling can be isolated lateral to the midline, off of the urethra. The edges of the sling are mobi-

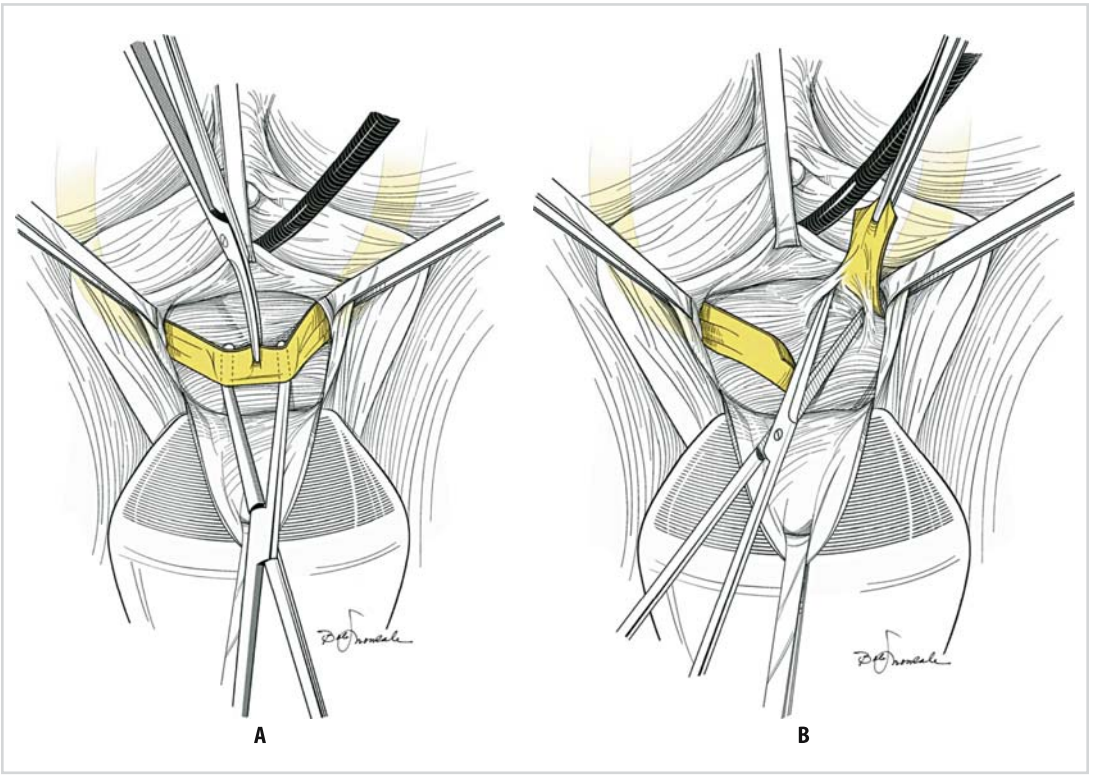

Figure 16.3. A: After an inverted-U or midline incision, the sling is isolated in the midline and incised. A right-angle clamp may be placed between the sling and the periurethral fascia to avoid injury to the urethra. B: The sling is freed from the undersurface of the urethra toward the endopelvic fascia. Ends may be excised or left in situ. (From Nitti et al. [33]. © 2002, with permission from Elsevier.)

lized off of the periurethral fascia to, but not through, the endopelvic fascia (Figure 16.3B). In cases of extreme tension the ends of the sling may retract back into the retropubic space after incision, but more often the sling stays secure to allow this mobilization. Lateral support is preserved because the retropubic space is not entered, and the urethra is not freed from the undersurface of the pubic bone. The ends of the sling can be left in situ or excised. We typically excise synthetic material and leave autografts and allografts in place. If the sling cannot be clearly identified, then formal transvaginal urethrolysis should be done.

Our experience with sling incision has shown results equivalent to those of formal urethrolysis. With a mean surgical follow-up of 12 months (range 1–55), sling incision was successful in 16 patients (84%) (33), similar to other reported series (32,34). Two of the failures had a successful retropubic urethrolysis. Three of 18 women (17%) without stress incontinence before sling lysis developed it postoperatively at 1 and 22 months.

Midurethral Synthetic Sling Takedown

Tension-free vaginal tape and other midurethral synthetic slings can be incised in a similar manner as described above. In the early postoperative period, the sling can be simply incised without further dissection (9). Others have reported segmental resection of the suburethral portion of the sling (10). Sometimes the sling can twist on itself and become very narrow (Figure 16.4). Unlike autologous and biologic slings, it is imperative to identify the sling and cut it. Urethrolysis, without incision of an obstructing TVT, may not relieve obstruction.

In cases of early intervention (1–2 weeks) it may be possible to loosen the TVT. Using local anesthesia the suture used to close the vagina can be cut, thus opening the incision. The sling is

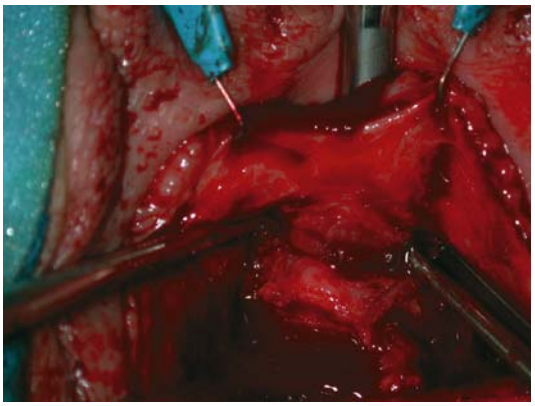

Figure 16.4. Obstructing tension-free vaginal tape (TVT), which has twisted into a 2-mm band. A right-angle clamp can be placed between the TVT and the periurethral fascia, and the TVT can be isolated and cut.

identified and hooked with a right-angle clamp. Spreading of the right-angle clamp (9) or downward traction on the tape will usually loosen it (1–2 cm). If the tape is fixed, it can simply be cut. The vaginal wall is then reapproximated.

Loosening or cutting of TVT has excellent results (9–12), In the two largest series of 17 and 23 patients, restoration of normal voiding and emptying occurred in all patients (9,29), whereas storage symptoms were partially relieved in 70% and completely relieved in 30% (29). Significant stress incontinence recurred in 6% to 13% of patients (9,10). In one study an additional 26% of patients had a recurrence of SUI, but it was significantly improved over baseline before TVT (10).

Failed Urethrolysis

Failure of urethrolysis may be due to persistent or recurrent obstruction, detrusor instability, impaired detrusor contractility, or learned voiding dysfunction. Recurrent obstruction may result from periurethral fibrosis and scarring or intrinsic damage to the urethra, which has occurred as a result of the urethrolysis surgery. When obstruction persists it is reasonable to attempt a repeat urethrolysis. We have found this to be effective in relieving urinary retention, but not as effective in treating persistent storage symptoms. We reported on the efficacy of repeat urethrolysis in 24 women who failed initial urethrolysis and remained in urinary retention (35). Both transvaginal and retropubic approaches were chosen depending on the clinical situation. Obstruction was cured in 96%, but storage symptoms completely resolved in only 12.5% and were improved in 75%; SUI recurred in 18%. These data clearly support aggressive repeat urethrolysis in the face of initial failure, At least for retention and incomplete emptying. In general, if an aggressive transvaginal urethrolysis fails, then a retropubic approach may be considered. In cases where it is unknown how aggressive the initial transvaginal procedure was or if only a sling incision was done, then a repeat transvaginal approach may be appropriate.

Conclusion

Although urethral obstruction after incontinence surgery occurs at a relatively low incidence, it is still frequently seen because of the large number of incontinence procedures performed. The diagnosis is primarily a clinical one, though recent urodynamic definitions of bladder outlet obstruction in women may be helpful. Ultimately, the decision to intervene is made based on the clinician's suspicion of obstruction and the degree to which the symptoms are bothersome. With the popularity of TVT and other midurethral slings, intervention is being advocated at an earlier time than with more traditional pubovaginal slings and retropubic suspensions. Definitive treatment of postoperative obstruction is predominantly surgical. Classically, complete urethrolysis is performed, but in cases of obstruction after sling procedures, simply cutting the sling via a vaginal approach appears to be just as effective, with similar rates of recurrent stress urinary incontinence.

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17

Vaginal Approach to Pelvic Prolapse

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Those who do not learn from history are destined to repeat it.

—George Santayana, 1924

After pelvic organ prolapse repair, nearly 30% of women undergo additional surgical intervention for prolapse recurrence (1). Despite this fact, there are few published reports specifically examining prolapse recurrence and its optimal surgical management. Furthermore, the definition of a surgical failure is not always clear, as there are cases in which organ dysfunction may persist, despite a technically sound outcome, whereas some asymptomatic patients may have a recurrent low-grade or -stage prolapse.

Using common scenarios encountered in clinical practice, this chapter focuses on mechanisms of failure and options for vaginal repair. Abdominal repair and nonoperative treatment (pessary placement) are beyond the scope of this chapter and are not discussed. Furthermore, surgical techniques described elsewhere in this book are not repeated here.

Evaluation

In planning for surgical repair of recurrent prolapse, a thorough reassessment is important, as studies obtained preoperatively no longer reflect the current situation. When retrievable, information from the original preoperative assessment, however, may be useful as a baseline. Operative records must be reviewed looking for comments on intraoperative complications or observations on excessive bleeding or tissue quality.

When relevant, the functional status of each prolapsed organ should be clearly defined. Beyond a careful abdominal and pelvic examination, additional tests may be necessary, including urodynamics (with or without video), standing lateral voiding cystourethrogram (VCUG), dynamic defecography, or magnetic resonance imaging (MRI) of the pelvis. Lastly, the patient's sexual function, existing and expected, should be evaluated, as this may influence the surgical approach.

Often a single reason for recurrence of prolapse cannot be determined, and a careful search for any number of contributing factors must be made. These are summarized in Table 17.1, categorized in a similar fashion to risk factors for stress urinary incontinence (2). Note that some risk factors can both incite and promote recurrence of prolapse. Determining why the initial procedure failed can minimize the risk of a similar outcome following a second operation.

Correcting such risk factors that could jeopardize a second repair is essential. Examples

Table 17.1. Contributing factors to failure of prolapse repair

Type	Examples
Predisposing	Age Tissue quality
Inciting	Tissue disruption High-impact exercise Radiation Other pelvic surgery
Promoting	Obesity Constipation Pulmonary disease/chronic cough High-impact exercise
Decompensating	Medication (antiestrogens, immunosuppressants)

include treatment of chronic cough (owing to smoking, asthma, or other pulmonary conditions), bowel management for constipation, and weight reduction for obesity, all of which may require referral to other specialists prior to surgery. Additionally, the patient and her family or caregiver should be informed that to optimize postoperative healing, activities such as heavy lifting, straining, high-impact exercises, or sexual activity should be temporarily avoided. Recurrence after prolapse repair is a risk factor for further surgical failure, and the time between reoperations has been shown to decrease with each successive repair (1,3).

Clinical Scenarios

Anterior Vaginal Wall Recurrence

Recurrent Cystocele

Although anterior enterocele has been reported, the most common recurrent anterior vaginal compartment prolapse is a cystocele. Historically, cystocele repair has been managed with anterior colporrhaphy, paravaginal repair, or bladder suspension procedures. Failure rates for these techniques in large, published series of primary cystocele repair are summarized in Table 17.2. Results differ in regard to anatomic outcome, continence status, and outcome measure (supine physical exam or standing voiding cystourethrogram). Most studies have used a cystocele of Baden-Walker (4) grade 2—prolapse at the introitus with straining—or higher to define recurrence, though physical examination by the author alone may be biased, as reflected in one study noting a lower rate of success using an independent examiner (5). For the repair of a recurrent cystocele, the decision of which technique to choose is dictated by the location of the defect, the grade or stage of the cystocele, sexual function, and patient expectations.

Case Report 1

A 73-year-old woman who underwent vaginal hysterectomy, bladder neck suspension, anterior colporrhaphy, and rectocele repair 2 years ago presents with daytime frequency, nocturia, and voiding difficulties consistent with an obstructive pattern. She denies a history of constipation or straining with bowel movements. She is a nonsmoker, in good health, weighing 140 pounds, and no longer sexually active. On physical exam, an anterior vaginal wall defect is noted protruding to 4 cm beyond the hymenal ring, with a midline scar from prior anterior repair extending from the distal vagina to the vaginal apex. There is a loss of the lateral sulcus bilaterally, and support of the anterior wall along the course of the arcus tendineus corrects the cystocele. There is no recurrent rectocele or vault prolapse. A standing VCUG reveals a well-supported urethra from a prior bladder neck suspension, and confirms the grade 3 cystocele with the bladder base extending 5 cm below the symphysis pubis on true lateral views (Figure 17.1). Urodynamics shows improvement in pressure-flow studies with a vaginal pack in place reducing the cystocele, and no recurrent incontinence.

Diagnostic impression: Lateral defect cystocele.

Formal cystocele repair via plication of the pubocervical fascia (anterior colporrhaphy) is designed to correct a moderate- to high-grade cystocele caused by bladder herniation through a central anterior vaginal wall defect. Plication of the pubocervical fascia over the midline may weaken the existing lateral support of the vaginal wall resulting over time in a secondary cystocele, or worsen a previously unrecognized lateral defect associated with the central defect.

Management Options

The options for vaginal repair of a cystocele in this scenario should address the lateral, or

Table 17.2. Outcome data on primary cystocele repair

First author, year (ref.)	*n*	Mean follow-up	Adjunctive surgery	Recurrence definition	Recurrence rate (%)
			Anterior colporrhaphy		
Raz, 1991 (36)	46	34 mo	Four-corner suspension (46)	PE (Baden-Walker grade ≥2)	7
Kohli, 1996 (37)	27	13 mo	AC alone	PE (B-W grade ≥1)	7
	40	13 mo	AC + BNS		32
Cross, 1997 (38)	36	20 mo	Pubovaginal sling	PE (B-W grade ≥1)	8
Colombo, 2000 (39)	33	13.9 yr, RCT	USLF, PC	PE (grade 2–3 cystocele)	3
Sand, 2001 (10)	70	12 mo, RCT	AC alone vs. AC + mesh	PE (B-W grade ≥2)	43
Weber, 2001 (11)	33	23 mo, RCT	AC alone vs. AC + mesh	PE (POPQ stage ≥II)	30
Cugudda, 2002 (40)	18	53 mo	Burch (5)	PE (no grading system)	17
de Tayrac, 2002 (41)	28	36 mo	None	PE (not defined)	7
			Paravaginal repair		
Shull, 1989 (42)	149	NR	AC (7), abdominal cystocele repair (5)	PE (no change from preoperative exam)	5
Bruce, 1999 (43)	52	61	PVS (27)	PE (not defined)	8
Shull, 1994 (52)	62	20	AC (62)	PE (BW grade ≥2)	8
Scotti, 1998 (7)	40	39	Burch (35), SCP (27), AC (27)	PE ("lesser descent" NY)	3
Young, 2001 (6)	100	11	AC (100)	PE (B-W grade <1)	2 22 (midline)
Mallipeddi, 2001 (44)	45	20	AC (45)	PE (B-W grade ≥1)	3
			Bladder suspension procedures		
Raz, 1989 (45)	107	24	Four-corner	PE (B-W grade ≥2)	2
Dmochowski, 1997 (5)	47	37	Four-corner	PE (3rd party, grade ≥2), VCUG	40 (grade 1) 17 (grade 2)
Bai, 2002 (46)	42	12	Six-corner	PE (POPQ stage <II)	30
Costantini, 2003 (51)	37	62	Four-corner	PE (B-W grade ≥2)	0 (preop grade 1–2) 39 (preop grade 3)

AC, anterior colporrhaphy; ΔBA, change in point of greatest descent on anterior vaginal wall; BNS, bladder neck suspension; B-W, Baden-Walker halfway classification system; NR, not reported; NY, New York classification system; PC, posterior colporrhaphy; PE, physical exam; POPQ, pelvic organ prolapse quantification; PVS, pubovaginal sling; RCT, randomized, controlled trial; SCP, sacrocolpopexy; USLF, uterosacral ligament fixation; VCUG, voiding cystourethrogram.

paravaginal, defects to provide support to the bladder neck and base.

Paravaginal Repair. This procedure involves using interrupted sutures between the vaginal wall and the arcus tendineus fascia pelvis (ATFP) to support the vaginal wall laterally, and has been traditionally performed through an abdominal approach. Vaginal-paravaginal repairs have been reported, although technical difficulty has limited its widespread use in clinical practice (6,7). In the setting of a prior anterior colporrhaphy a paravaginal repair may not be ideal as the vaginal wall is pulled laterally in an opposing direction of the plication sutures, possibly undoing the midline repair, and excessive tension to reach the ATFP may result in another lateral defect recurrence. This concern is reflected in one series reporting cystocele recurrence through a midline defect in 22% of patients (6).

There is no literature reporting the outcome of a vaginal-paravaginal repair specifically in cases of recurrent cystocele. One report of 100 paravaginal repairs cited 14 patients who had undergone prior anterior repair, but did not examine their outcome as a subset (6). Adjunctive graft material has been described with the paravaginal repair for a group predominantly composed of patients with recurrent cystoceles. In a series of 33 women who underwent cadaveric dermal graft paravaginal repair (14 primary, 19 recurrence including six for stage II and 13 for stage III) for recurrent stage II or higher anterior vaginal wall prolapse (8), only one objective failure in six women (17%) with recurrent stage II cystocele was noted. However, the recurrence rate in those with preoperative stages III to IV prolapse was not reported.

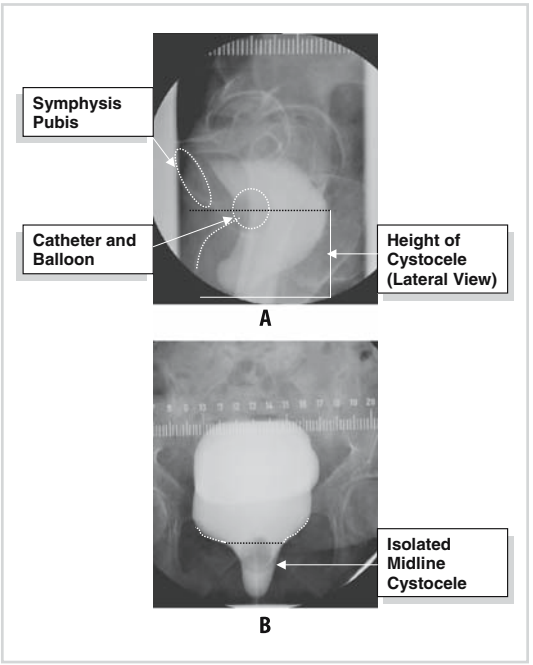

Figure 17.1. Radiographic images from standing, voiding cystourethrogram (VCUG) in a 73-year-old woman with recurrent cystocele (case report 1). A: Urethral angle by catheter and symphysis pubis are outlined (white dashed lines) in lateral straining view, as is lateral height of cystocele below the symphysis pubis. B: Following prior paravaginal repair, a midline herniation has formed (arrow) with lateral support preserved (white dashed line), as demonstrated on anterior-posterior view.

Anterior Colporrhaphy with Graft Interposition. The anterior colporrhaphy can be chosen to repair an isolated midline defect or in the case of a repeat midline procedure. In the recurrent cystocele after paravaginal repair, however, this may be challenging as the pubocervical fascia may already be attenuated or on tension laterally. In this situation, or in the case of a repeat colporrhaphy, many surgeons will choose to augment the repair with interposition of nonautologous tissues—cadaveric tissue (dermis or fascia lata), xenograft, or synthetics (mesh).

The success of tissue interposition is partially credited to surrounding tissue ingrowth, which further stabilizes the repair. In one prospective, randomized, noncontrolled trial involving 24 patients with two or more postsurgical recurrences of high-grade cystocele, Julian et al (9) found no recurrence in 12 women with anterior repairs reinforced with Marlex mesh compared to four of 12 in the control group. However, three mesh-related complications were noted over the 2-year follow-up period.

Another randomized trial enrolled 143 women with cystoceles to anterior colporrhaphy with and without absorbable mesh (10). Although the subset of patients who were considered to be at high risk owing to prior failed anterior colporrhaphy was small ($n = 21$), the author noted no difference in outcome between the mesh and no-mesh patients at 1-year follow-up. Furthermore, these high-risk patients were found to be no more likely to have a subsequent recurrence than the women who had primary repair of cystocele. A similar randomized trial enrolled women into three types of cystocele repair: standard anterior colporrhaphy auterial repair (AR), wide lateral dissection ("ultra") anterior colporrhaphy, or AR with delayed absorbable mesh. Using a definition of success as stage 0 to 1 (anterior wall more than 1 cm above the hymeneal ring), no differences between the three techniques at 2 years was noted, with an overall modest success rate ranging from 30% to 49% (11). Of the 109 women randomized, only nine (8%) had undergone a prior prolapse or incontinence operation, a subset too small for meaningful conclusions.

The use of adjunctive synthetic material for recurrent high-grade cystocele is becoming more widespread, despite the lack of long-term data on safety and durability. Very few reports have been released on the use of cadaveric or xenograft tissue (12,13) for cystocele repair and none specifically addressing patients with a recurrent cystocele.

Apical Vaginal Wall Recurrence

Recurrent Vault Prolapse

Although recurrence of vaginal vault prolapse is reported to occur less frequently than anterior compartment prolapse, vaginal repair of this condition is equally challenging. Recurrence rates for primary repair of vault prolapse after sacrospinous ligament fixation are listed in Table 17.3.

In one study, the incidence of vaginal vault prolapse after hysterectomy was found to be higher when the hysterectomy had been performed for genital prolapse than for other benign conditions (14). In contrast, a retrospective review of 78 women with recurrent prolapse by

Table 17.3. Outcome data on sacrospinous ligament fixation series

First author, year (ref.)	*n*	Mean follow-up (mos)	Adjunctive Procedures	Definition of recurrence	Apical Recurrence (%)
Richter, 1981 (19)	81	NR	None	PE (not defined)	0
Cespedes, 2000 (47)	28	17	AC (28), rectocele (28), enterocele (28), PVS (25)	PE (B-W grade ≥1)	4
Giberti, 2001 (48)	12	16	AC (8), PC (9), enterocele (1)	PE (not defined)	8
Nieminen, 2001 (22)	25	33	AC (23), PC (16)	PE (B-W grade ≥2)	11
	173		AC (15)	PE (mild,moderate, severe) at rest	12.7
Cruikshank, 2003 (49)	221	43	AC (43), PC (22), PVS (75)	PE (B-W at rest + Valsalva, no grade defined)	5
	301		AC (75), PC (61), PVS (76), PVR (78)	PE (ICS)	1
Maher, 2004 (29)	48	22, RCT	PC (44), enterocele (28)	PE (B-W grade ≥1)	31
Silva-Filho, 2004 (50)	158	64	None	PE (B-W grade >2)	2.5 vault 11 total

AC, anterior colporrhaphy; B-W, Baden-Walker halfway classification system; ICS, International Continence Society classification; NR, not reported; PC, posterior colporrhaphy; PE, physical examination; POPQ, pelvic organ prolapse quantification system; PVR, paravaginal repair; PVS, pubovaginal sling; RCT, randomized controlled trial; VH, vaginal hysterectomy.

Kenton et al (15) showed they were more likely to have had a hysterectomy for a nonprolapse indication.

Case Report 2

A 50-year-old, sexually active woman underwent mesh abdominal sacrocolpopexy for vault prolapse several years after an abdominal hysterectomy and bilateral salpingo-oophorectomy. Subsequently, she developed a mesh infection with small bowel obstruction, resulting in removal of the mesh and small bowel resection. She presents with a history of urgency, frequency, and recurrent urinary tract infections, and a bulge at her vaginal introitus. Pelvic exam confirms a complete vaginal vault prolapse descending 6 cm beyond the hymenal ring with an accompanying enterocele, rectocele, and cystocele (stage IV).

Diagnostic impression: Recurrence of complete vault prolapse after a mesh abdominal sacrocolpopexy complicated by mesh infection and bowel obstruction.

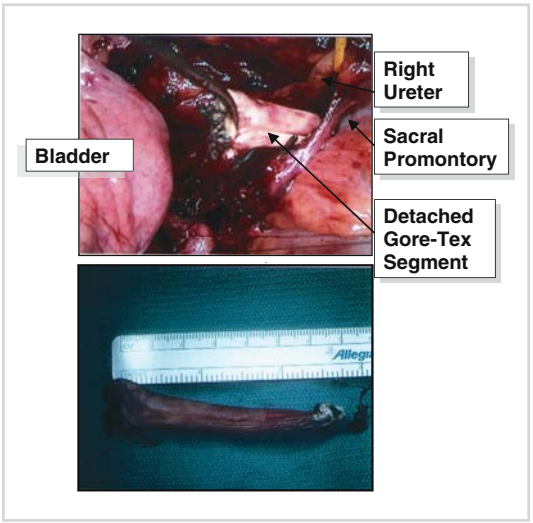

Figure 17.2. Intraoperative view (above) demonstrating a detached Gore-Tex graft from a previous mesh sacrocolpopexy (case report 2), with view following excision (below).

The mesh sacrocolpopexy (MSC) is a durable and effective repair for vaginal vault prolapse, with a success rate quoted at 78% to 100% (16). Nevertheless, vault prolapse after MSC recurs, with an estimated reoperation rate of 4.4% (16). Failure is most often attributed to mesh infection or erosion requiring removal, or detachment from the vaginal cuff or sacral promontory, as depicted in Figure 17.2. Detachment has been described in procedures using fascia lata, Teflon, and Gore-Tex. Despite an intact mesh attachment, one case of enterocele recurrence dissecting between the mesh and a split posterior vaginal wall has been described (17). Although recurrence after MSC is uncommon, a second

MSC may prove difficult owing to scar tissue, bowel adhesions, or prior infection precluding further use of mesh. Vaginal repair in the situation may prove challenging if the MSC was performed for a vault prolapse recurrence after vaginal repair.

Management Options

Several vaginal repair procedures can be contemplated and are described in the following paragraphs. In patients no longer sexually active or unfit for a more extensive repair, a colpocleisis may be a valid alternative option (vide infra). In the younger patient in case report 2, an obliterative procedure is not appropriate. The complication of mesh erosion and small bowel obstruction adds further complexity: an intraperitoneal vaginal approach may be severely compromised by adhesions, and a repeat abdominal approach to manage the adhesions or an extraperitoneal vaginal approach are safer options.

Sacrospinous Ligament Fixation. This extraperitoneal vaginal approach would not be compromised by the prior mesh erosion, although most techniques of sacrospinous ligament fixation (SSLF) add a vaginal repair of enterocele. The technique is described in Chapter 13.

The SSLF directs the vaginal axis posteriorly and uses a different point of fixation than the mesh sacrocolpopexy (18). However, one may still encounter difficulty in dissection of the pararectal space, particularly on the right side, as this is the more common side on which the SSLF is performed but is also the side where the mesh is placed lateral to the sigmoid colon. The posterior deviation of the vaginal axis may predispose the patient to a secondary cystocele, though there may still be adequate support if a mesh segment was placed anteriorly and is still intact.

The SSLF may be a reasonable anatomic choice in the correction of recurrent vault prolapse if the ischial spine and the coccygeus muscle are sufficiently cephalad from the hymeneal ring, optimally 8 to 9 cm above it. Most large series of SSLFs comment on patients who present with recurrent vault prolapse as part of the demographics, but do not examine the outcome of these individuals specifically. In the original series describing the technique in 78 patients, 54 (69%) had failed previous procedures, the majority having failed one (32/54, 59%) or two (15/54, 28%) repairs (19). A case series of 100 women who underwent SSLF reported that 84 had undergone an average of 1.8 prior procedures for pelvic relaxation (20). In another study on SSLF in 125 patients, 57 underwent previous nonhysterectomy gynecologic procedures, though none of these were reported for vaginal vault suspension (21). A series of 138 women reported that 57 (41%) had undergone an operation for genital prolapse before a SSLF, although no specific information on the nature of the prolapse was provided (22). The authors found that postoperative cuff infection was an independent risk factor for vaginal vault prolapse recurrence. Despite the fact that a prior history of failed prolapse repair is common in these large series, little has been explored with regard to the efficacy of this procedure in these patients specifically.

Bilateral Iliococcygeus Fascia Fixation. This is a second extraperitonal approach to apical prolapse that has been described by multiple centers. The procedure avoids the peritoneum with excessive scar tissue, and is described in Chapter 12. There are no data available on the outcome of this procedure in women with prior failures such as in case report 2.

Case Report 3

An 81-year-old woman has had severe symptoms of vaginal bulging, pressure, and voiding difficulties since a vaginal hysterectomy was performed for similar complaints 10 years ago. On examination she has complete procidentia of the vaginal vault coming 10 cm beyond the hymeneal ring, with a large amount of small bowel distending the prolapse and several small skin erosions (Figure 17.3). She has already had several pessaries fitted, but even a Gelhorn pessary falls out with any movement. She has not been sexually active for many years.

Although many of the apical procedures could work for this woman, including high uterosacral ligament suspension, sacrospinous ligament fixation, and even abdominal repairs, she may be a good candidate for an obliterative procedure. The patient must understand that these procedures are a compromise; she is able to correct the problem with an outpatient procedure and a rapid recovery and good long-term

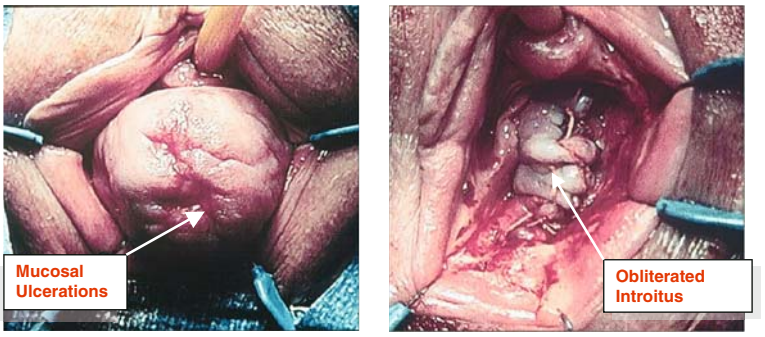

Figure 17.3. Preoperative image (left) of total vaginal eversion (case report 3) with visible mucosal ulcerations. Following colpocleisis (right), the introitus is obliterated and the prolapse is reduced.

durability, but she loses the ability to be sexually active per vaginum. These same patients are good candidates for a pessary, but this management strategy has already failed in this case.

Colpocleisis. Success rates for colpocleisis in regard to prolapse correction range from 97% to 100% at short-term follow-up (23–26). The patient population undergoing colpocleisis for vaginal eversion are often elderly, and long-term data are uncommon as many patients are lost to follow-up or expire during the follow-up period.

Owing to the advanced age of patients in most studies (mean 77–79 years), it is not surprising that a majority had a prior prolapse operation. Colpocleisis was performed on 33 women with posthysterectomy vaginal vault prolapse, and of these, 24 had been treated previously for prolapse, with a total of 40 prior pelvic repair operations performed, or an average of 1.6 per patient. A case series of 42 women who underwent colpocleisis or colpectomy reported 20 had prior prolapse repair procedures, five of these having two or more surgeries (25). A review of 92 women undergoing total colpocleisis found an association between prior hysterectomy and previous prolapse operations (26/55 posthysterectomy versus 2/37 with concurrent hysterectomy) (26).

Posterior Vaginal Wall Recurrence

Large Rectocele/Enterocele After Distal Rectocele Repair

Rectocele repair is most commonly performed with a posterior colporrhaphy, a site-specific repair, and more recently with tissue interposition. Rectocele recurrence is fairly infrequent but depending on its initial superior extent, a recurrence high near the posterior apex may be observed and may involve the rectum, small bowel, or both.

Case Report 4

A 58-year-old woman with a history of a vaginal hysterectomy 10 years ago and a posterior colporrhaphy for a symptomatic stage III rectocele 3 years ago, presents with a vaginal bulge. She reports moderate constipation partially controlled with stool softeners, no voiding complaints or urinary incontinence, and mild dyspareunia with intercourse. Physical exam reveals a well-healed posterior vaginal scar distally with the remaining posterior wall coming 2 cm beyond the hymeneal ring with apical descent to 3 cm above the hymenal ring. Dynamic defecography shows a large rectocele with a small enterocele component.

Diagnostic impression: Rectocele and enterocele after a distal rectocele repair.

Long-term success of the posterior colporrhaphy has been reported, with anatomic cure rates reported between 76% and 96% (10,27–29). Detection of recurrence is higher when defecography is used as an objective outcome measure (28). At long-term follow-up (5.1 years) of 25 women, recurrence of rectocele was detected in five women radiographically compared to only one on exam. These reports are summarized in Table 17.4.

Management Options

Repeat Posterior Colporrhaphy. If a recurrent rectocele is limited to the distal vagina or in the

Table 17.4. Outcome data on posterior vaginal wall prolapse repair

First author, year (ref.)	*n*	Mean Follow-Up	Definition of recurrence	Recurrence rate (%)	Dyspareunia (%)	Symptom Improvement (%)
			Posterior colporrhaphy			
Lopez, 2001 (28)	24	5.1 Y	PE (not defined) Defecography*	4 21	33	91
Maher, 2004 (29)	38	24 Mo	Improvement in POPQ point B_p	79	5	89
			Site-specific repair			
Cundiff, 1998 (30)	43	12 Mo (median)	PE (no change or worsening in POPQ stage)	18	19	87
Kenton, 1999 (32)	46	12 Mo	PE (POPQ point A_p at −1 or greater)	23	7	43–92
Porter, 1999 (31)	125	18 Mo	PE (B-W grade >2)	18	12	35–74

B-W, Baden-Walker halfway classification system; PE, physical examination; POPQ, pelvic organ prolapse quantification system.
*Outpocketing of the anterior rectal and posterior vaginal wall into the lumen of the vagina.

same location as the original prolapse, a second posterior colporrhaphy may be attempted, though the conditions that led to the first failure may result in another recurrence. The literature on rectocele repair by posterior colporrhaphy fails to differentiate patients operated for primary repair or for a recurrence, despite a substantial number having failed a prior posterior repair. In a large review of 231 women, previous posterior colporrhaphy was reported in 38 (16%) of patients (27). Similarly, a prospective cohort of 38 women with stage II or greater symptomatic rectoceles noted that nearly half (17, 45%) had already failed a rectocele repair (29). Despite failing to comment on this subset of patients, the objective success rate by defecography was 79% at 24 months.

Site-Specific Repair. The concern for postoperative dyspareunia owing to vaginal narrowing after posterior colporrhaphy has led more recently to a technique focusing on recognizing and specifically closing isolated defects in the rectovaginal fascia.

Successful anatomic outcome after site-specific repair has been reported between 82% and 86% (30–32). All of these studies report between 9% and 17% having failed at least one previous posterior colporrhaphy, with only 11 to 12 individuals in each trial meeting these criteria, which is too small for a valid subgroup analysis. This paucity of data makes it difficult to draw conclusions regarding the role of this procedure in treating a recurrent rectocele. In a recent review of women who underwent either site-specific repair ($n = 124$) or standard posterior repair ($n = 183$), the incidence of recurrence, defined as either vaginal prolapse beyond the midvaginal plane, beyond the hymenal ring, or as a symptomatic bulge, was significantly higher in the site-specific group (33).

Graft Interposition. Reconstruction of the posterior pelvic floor under no tension and without narrowing the vagina may prove challenging in some cases with a standard posterior plication or site-specific repair. The strength of the repair can be augmented with the use of nonautologous material, either graft (e.g., cadaveric dermis) or synthetic (mesh).

Experience with graft interposition is limited to small patient populations with short follow-up, although in one randomized prospective trial, the addition of an absorbable mesh did not affect the likelihood of rectocele recurrence at 1-year follow-up (10). In this trial, an overall success rate, defined as no rectocele beyond the hymenal ring, was reported in 90% of 132 subjects. Sixteen individuals had failed a prior posterior repair (10 with mesh, six without), but this group was felt to be numerically too small to examine their anatomic outcome. Dermal graft augmentation was studied in 30 patients, and resulted in a 93% surgical cure rate, defined as an A_p measurement of −0.5 or greater on the pelvic organ prolapse quantification (POPQ) score at a mean follow-up of 12.9 months (34). Eleven of these women had undergone previous posterior repair, but no data on secondary recurrence in these patients were reported. However,

an unacceptably high prevalence of wound dehiscence has led to modification of this technique with perforation of the graft (35).

Conclusion

In several series on prolapse repair, a substantial number of patients, sometimes more than half, present having already failed one or more reconstructive repairs for the same or related condition. Focus on these individuals with respect to anatomic and functional outcomes has largely been ignored in the literature presumably because of small numbers precluding refined subgroup analysis. Nevertheless, patients with prior failed prolapse repair are at risk for repeat failure. Thus, selection of the vaginal repair best suited to address their anatomy, with careful attention paid to a thorough preoperative evaluation, correction of risk factors for recurrence, a meticulous reconstruction, and a protected postoperative care, is critical for success in these difficult-to-treat patients.

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18

Intraoperative Complications of Vaginal Surgery

Gina A. Defreitas and Philippe E. Zimmern

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Approximately 70% of iatrogenic injuries to the genitourinary tract are not recognized at the time of operation (1). The long-term sequelae of these injuries include ureteral obstruction with loss of renal function and fistula formation. It is estimated that surgery for benign gynecologic conditions is responsible for 74% of genitourinary fistulas and over 90% of vesicovaginal fistulas in the United States (2). The vagina affords the urologist and urogynecologist an easily accessible, less morbid route for performing surgery to correct urinary incontinence and pelvic organ prolapse. But factors such as previous pelvic surgery, obesity, pelvic inflammatory disease, endometriosis, and pelvic irradiation can result in decreased organ mobility and impaired healing should an injury occur (3). The awareness of these risk factors for genitourinary injury, as well as the adoption of a few simple intraoperative precautions, can aid in their prevention and eventual recognition at the time of surgery. Early recognition of these injuries and proper postoperative management serve to decrease patient morbidity.

This chapter focuses on the intraoperative recognition and management of injury to the bladder, urethra, ureters, and rectum. Additional suggestions and recommendations for avoiding and managing the more common pitfalls encountered during transvaginal procedures, such as bleeding and lack of adequate exposure, are also discussed.

General Preoperative Considerations

A number of preventative strategies aimed at minimizing the chance of complications should be employed when performing vaginal surgery. If surgical misadventure does occur, then these simple precautions should allow the problem to be dealt with in an expeditious fashion (Table 18.1).

The general medical condition of the patient must be taken into account when planning any elective surgical procedure. Consultation and clearance should be sought from anesthetic and medical services whenever the patient has a condition that may decrease her ability to tolerate an anesthetic or may adversely affect the surgical outcome. In some situations, the patient's general health may influence the type of anesthetic administered (spinal vs. general), or, in the case of a Jehovah's Witness, may dictate the nature of the resuscitation that can be employed in the intraoperative and postoperative periods.

Preoperative broad-spectrum antibiotics should be considered to decrease the likelihood of postoperative infection. Preparation the day before surgery in the form of enemas to clear the

Table 18.1. Preoperative considerations in transvaginal surgery

General considerations	Vaginal surgery considerations
Health and ability to tolerate anaesthetic	Enemas to clear the rectum
Jehovah's Witness with refusal of blood and blood products	Antibiotic douches to decrease vaginal bacterial count
Preoperative antibiotics	Deep vein thrombosis prophylaxis
Discontinuation of antiplatelet agents and/or anticoagulants	Positioning in dorsal lithotomy position
	Perineal retractor
	Labial retraction sutures
	Headlight
	Trendelenburg position
	Continuous bladder drainage
	Vaginal packing

rectum and antibiotic douches to lower bacterial counts in the vagina may also serve to minimize the risk of postoperative infection, and thereby promote uneventful healing. Deep-vein thrombosis (DVT) prophylaxis in the form of low-dose subcutaneous heparin given before and every 12 hours after surgery (4) until the patient is ambulatory, as well as intermittent pneumatic calf compression (TED stockings) employed in the same manner (5), should be routine since the risk of DVT post–gynecologic surgery for benign conditions has been reported to be as high as 29.1% (4).

Every effort should be made to minimize the risk of excessive bleeding. Antiplatelet agents such as aspirin should be discontinued at least 7 to 10 days before surgery. Patients on long-acting anticoagulants should cease taking these medications until their coagulation parameters return to the normal range. If the risk of a thrombembolic event is too high to allow discontinuing anticoagulation, patients should be switched to a short-acting agent such as low-molecular-weight heparin, which can be stopped before surgery and resumed fairly promptly afterward.

Some vaginal surgeons have advocated obtaining preoperative imaging studies to detect aberrant anatomy in patients who have a history of pelvic surgery or inflammatory lesions (6). Whether or not performing intravenous urograms, computed tomography scans or magnetic resonance imaging to define the course of the ureters, or voiding cystourethrograms to outline the location of the bladder with respect to the symphysis pubis, serves to decrease the likelihood of lower urinary tract injury, however, is unknown (Figure 18.1).

Candy-cane or Allen stirrups can be used to place the patient in the dorsal lithotomy position. Care should be taken to avoid overflexion or overextension of the lower extremities, and all pressure points should be padded to avoid peripheral nerve injury secondary to positioning. The use of an egg-crate mattress should be considered in patients with neurologic problems, particularly if the procedure will take more than 1.5 to 2 hours. Prepping and draping for vaginal surgery should encompass not only the perineum but the lower abdomen up to the level of the umbilicus as well, in case an abdominal incision has to be made to repair a large bladder laceration or a ureteric injury. Exposure can be facilitated by the use of a weighted speculum in conjunction with a Lone Star, Stafford, Texas or Turner Warwick, Stafford, Texas retractor, which are specially designed for perineal surgery. Retraction sutures that incorporate the labia majora can also be employed (7). A headlight or a lighted retractor (Miyazaki-Marina Medical, Hollywood, Florida) may improve visualization in patients with a narrow, deep vagina or a hyperelevated urethra and bladder neck. Placing

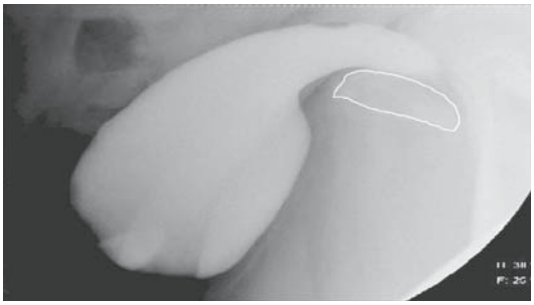


Figure 18.1. Lateral view of voiding cystourethrogram showing anterior wall of bladder overhanging pubic symphysis. Such anatomy suggests adherence of the bladder to the back surface of the pubic bone, with the potential for accidental cystotomy when entering the retropubic space during sling or suspension surgery.

the patient in the Trendelenburg position serves to better expose the anterior vaginal wall and allows the abdominal contents to fall backward and away from the suprapubic area, thereby making suture carrier or trocar passage less likely to cause bowel injury.

The bladder should be decompressed by placing a urethral catheter to straight drainage at the beginning of the procedure to decrease its chance of injury (8). In and out catheterization should be discouraged because the bladder can refill quickly with intraoperative intravenous fluid administration. The injection of sterile water, diluted epinephrine, or lidocaine beneath the vaginal wall in patients who have had previous vaginal surgery causing scarring may help define the plane of dissection, thereby decreasing the risk of urethral, bladder, or rectal injury.

Vaginal packing and absorbable suture should be available on the surgical setup from the start of the procedure in case the vaginal incision has to be closed and packed quickly to control excessive bleeding from the retropubic space.

Excessive Bleeding

The proportion of patients who require transfusion as a consequence of excessive bleeding from a vaginal procedure is less than 1% in most series (9,10), but the potential for massive blood loss should always be acknowledged. Sources of blood loss include periurethral vessels as well as vaginal and retropubic venous plexuses. Discrete arterial bleeders can be electrocoagulated or ligated with fine absorbable suture. Profuse bleeding from the urethra when separating the perivesical or periurethral fascia from the anterior vaginal wall is often an indication that one is not dissecting in the correct plane. The area of dissection should be reevaluated once blood loss is controlled to exclude an injury to the urethra or bladder and to redirect the course of the surgery.

Injury to the cavernosal veins can occur as the retropubic space is being cleared to pass a ligature carrier during the performance of a needle suspension procedure, or during urethrolysis. Bleeding from the ischiorectal fossa during rectocele repair may also be difficult to control. A good strategy to minimize blood loss during vaginal surgery is to perform those steps of the procedure that are at low risk for bleeding first, leaving those steps that are usually associated with potentially more bleeding until the end. For instance, when performing a urethrolysis with Martius labial flap placement, harvest the Martius flap first before entering the retropubic space to perform the urethrolysis, or in the case of a combined cystocele repair and sling procedure, fix the cystocele first, harvest and/or ready the sling material, and then enter the retropubic space to transfer the sling sutures or material.

Because profuse venous bleeding from the retropubic space is unlikely to respond to attempts at ligation or electrocoagulation, the best course of action is to complete any transfer of sutures or material that must occur, then close the vaginal incision with a running absorbable suture and pack the vagina. Blood will collect within the confines of the retropubic space and compress the injured venous plexuses. Should further work need to be done through the vaginal incision, the packing and sutures can be removed later, once the bleeding is under better control and the patient is stabilized. The anesthetist should be kept informed of excessive blood loss through the vaginal incision to manage resuscitative efforts accordingly. The vagina should remain packed at the end of surgery for 24 to 48 hours to help tamponade bleeding. Vaginal compression or tamponade can also be achieved by temporarily inflating a Foley catheter balloon underneath the vaginal pack (11). Aungst and Wagner (12) reported control of excessive retropubic bleeding from tension-free vaginal tape (TVT) insertion by placing a Foley catheter along the trocar insertion path and inflating the balloon within the space of Retzius. A nationwide analysis of TVT complications in Finland reported rates of blood loss over 200 mL and retropubic hematoma of 19 per 1000 cases each (13). The majority of these complications can be managed conservatively with intensive hemodynamic monitoring, and, in some cases, transfusion (14). Open drainage of a retropubic hematoma caused by venous plexus bleeding should be avoided, because such a maneuver may promote more hemorrhage. Major vessel injury, a rare complication of TVT insertion, should be treated with open ligation or embolization (9,15).

Bladder Injury

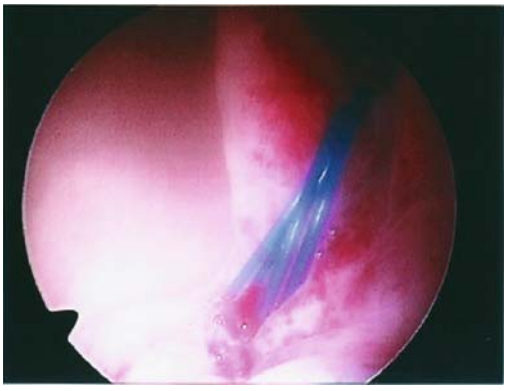
Bladder injury can occur during transvaginal surgery while dissecting in the plane between the anterior vaginal wall and the perivesical

fascia, but more commonly occurs when attempting to clear the retropubic space or pass a suture carrier or trocar during incontinence surgery (28). Bladder laceration can also occur when entering the vesicovaginal space during vaginal hysterectomy (3). Patient risk factors for bladder injury include previous retropubic surgery such as paravaginal repair or Marshal-Marchetti-Krantz colposuspension, previous cesarean section, and prior history of myomectomy (3). According to Mathevert et al (3), the incidence of bladder injury as a consequence of vaginal hysterectomy is approximately 1.7%. The risk of bladder perforation during transvaginal sling procedures ranges from 5% to 20% for the TVT to less than 5% for a conventional pubovaginal sling (16,17). The relatively high risk of bladder injury is not necessarily due to previous surgery in the case of the TVT, but is secondary to blind passage of the trocar through the retropubic space.

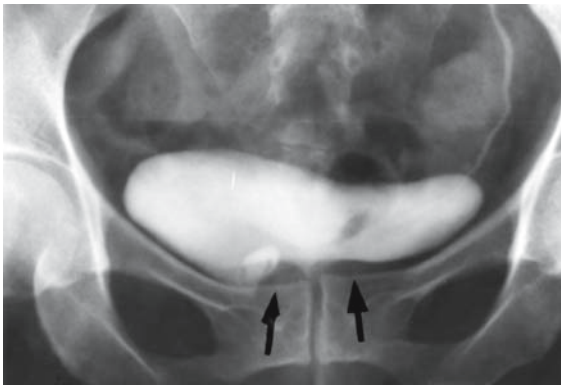
An intraoperative bladder injury is usually detected by the presence of bloody urine draining from the Foley catheter or urine leaking into the operative field, although neither of these signs may be present. On other occasions, the Foley bulb may be seen within the vaginal incision (8,18). Cystotomy during vaginal hysterectomy usually occurs at or above the trigone (19). If injury is suspected, the bladder can be filled with 400 to 600 cc of irrigation fluid mixed with indigo carmine or methylene blue to confirm the presence and location of a cystotomy (18). Intraoperative cystoscopy has been advocated as a means of increasing the detection rate of bladder injury and ureteric obstruction when performing incontinence surgery (6,20), but whether or not it should be performed routinely is still a matter of controversy. We recommend performing cystoscopy with a 70-degree lens or a flexible scope, because it adds little morbidity and time to the surgery and may detect unsuspected cases of suture entry because this event is not always accompanied by hematuria. The nonabsorbable sutures employed in a pubovaginal sling or bladder neck suspension should be removed and repositioned if they perforate the bladder (Figure 18.2A), because they can serve as a nidus for stone formation, which, in turn, can lead to recurrent urinary tract infection and irritative voiding symptoms (8) (Figure 18.2B).

Extraperitoneal injuries such as perforation with a suture carrier or a trocar usually heal spontaneously without any further treatment, although some surgeons leave a Foley catheter in the bladder for an extra day or two postoperatively. These injuries are dealt with by removing the offending suture, redirecting the suture carrier more laterally away from the margin of the bladder wall, and draining the bladder transurethrally or suprapubically. More extensive cystotomies may be closed transvaginally, although there is a risk of secondary vesicovaginal fistula formation (Figure 18.3), whereas bladder injuries that involve the trigone or ureters should be repaired through an abdominal approach (21).

The main principles to follow when repairing a cystotomy transvaginally include (1) evaluation of the extent of bladder injury by determin-



A



B

Figure 18.2. A: Perforation of the lateral bladder wall detected on cystoscopy after passage of sutures through the retropubic space. Note the blue Prolene suture within the cystotomy site and the lack of bleeding. These sutures need to be removed and passed again more laterally. B: Stone forming over exposed suture (arrows) causing recurrent urinary tract infection and irritative voiding symptoms.

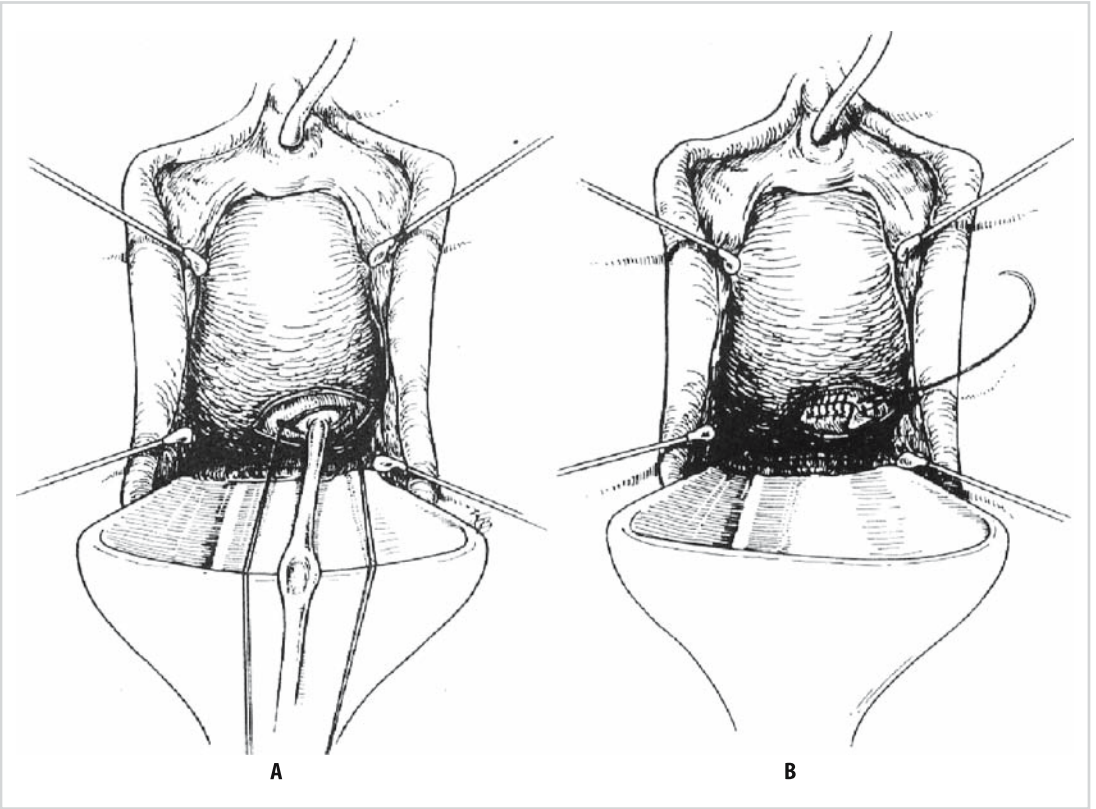


Figure 18.3. Transvaginal repair of bladder perforation. A: A Foley catheter placed in the perforation can be used to exert downward traction to bring the margins of the defect into better view for placement of corner sutures. B: The defect should be closed in two layers using fine absorbable suture. Suture lines should be nonoverlapping. (From Hernandez RD, Himsl K, Zimmern PE. Transvaginal repair of bladder injury during vaginal hysterectomy. J Urol 1994;152(6 pt 1):2061. Copyright 1994, with permission from the American Urological Association.)

ing the size, location, and number of perforations and determining trigonal or ureteric involvement (if either is involved, open repair is indicated); (2) identification and exposure of the margins of the perforation; (3) a two-layer tension-free watertight bladder closure with an interposition flap of well-vascularized tissue; (4) the use of postoperative antibiotic prophylaxis and anticholinergics to decrease the risk of infection and bladder spasms (18,22); and (5) a period of uninterrupted, prolonged postoperative bladder drainage facilitated by intraoperative placement of a urethral catheter and suprapubic tube (Table 18.2). Adherence to these tenets should help prevent the occurrence of a secondary fistula.

Table 18.2. Principles of transvaginal cystotomy repair

Determine size, extent, location, and number of bladder perforations
Exclude ureteric and trigonal involvement
Suprapubic tube placement
Adequate exposure of the perforation margins
Two-layer tension-free watertight bladder closure with interposition of well-vascularized tissue
Antibiotic prophylaxis and anticholinergics
Uninterrupted, prolonged postoperative bladder drainage

The first step in transvaginal cystotomy repair is to place a small Foley catheter in the perforation to exert downward traction and bring the margins into better view (Figure 18.3A) Catheter placement can be facilitated by threading it over a guidewire placed intravesically through the perforation during cystoscopy. Next, a suprapubic tube should be inserted. Because the bladder perforation will preclude bladder distention for placement of a punch trocar, using the Lowsley retractor may be the best way to insert the suprapubic tube safely at the bladder dome (22). When

the margins of the bladder perforation have been identified, they should be tagged with traction sutures or grasped with Allis clamps for easier identification (8,18). Devitalized tissue is rare in the case of iatrogenic injury, but if present, it should be excised before placing any closure sutures (18). The bladder defect should be mobilized from surrounding vaginal tissue to facilitate a tension-free closure using fine absorbable suture. A running layer to reapproximate the bladder mucosa should be checked for watertightness by filling the bladder under gravity via the suprapubic tube. Then a second layer consisting of interrupted, imbricated sutures through the muscularis at right angles to the underlying first-layer closure can be placed (Figure 18.3B). Advancement of the anterior vaginal wall over the repair site helps to prevent overlapping suture lines, thus decreasing the risk of a secondary vesicovaginal fistula (22). In the case of a large laceration or in patients with a history of pelvic radiation or previous bladder/vaginal surgery that may decrease blood flow to the bladder or vaginal wall, a Martius flap may be interposed between the bladder repair and the vaginal wall closure (23). Cystoscopy should be repeated at the conclusion of the bladder repair after injecting the patient with an ampule of indigo carmine to make sure there is no ureteric compromise. A urethral catheter is then placed for maximum bladder decompression.

The bladder has a good blood supply and usually heals rapidly, provided that the mucosal edges are reapproximated and continuous drainage is maintained. Anticholinergic bladder relaxants and antibiotics should be given postoperatively to prevent spasms causing tension at the suture line and bladder infection, respectively, both of which can compromise proper healing of the injury. The Foley catheter can be removed after 5 to 7 days in uncomplicated cases. If the injury is extensive, or the patient has a history of pelvic irradiation, a more prolonged course of bladder drainage is indicated. A voiding cystourethrogram should be considered prior to suprapubic tube removal to document bladder integrity (19).

Ureteric Injury

Injuries to the ureter are rare during transvaginal surgery (28) and are generally the result of obstruction secondary to kinking or suture entrapment (27). Stanhope et al (24) reported the incidence of ureteric obstruction to be 0.35% (18/5179) for benign gynecologic surgery. Other investigators have found ureteric injury to occur in 2.5% of benign gynecologic operations and 3% to 6% of Burch procedures (5,22).

Ureteral obstruction can occur secondary to kinking at the ureterovesical junction upon uterosacral plication, if colporrhaphy plication sutures are placed too laterally during cystocele repair at the level of the trigone, or during transvaginal enterocele closure with purse-string sutures. Such sutures, when tied over the midline, may draw the ureters medially, kinking them off. This is often indicated on cystoscopy by distortion of the bladder base or trigone, which makes visualization of the ureteric orifices more difficult. Rarely, ureteric lacerations may occur when dissecting past the level of the trigone along the anterior vaginal wall.

Preoperative stenting in patients who are at higher risk of ureteric injuries or who have a solitary kidney should be considered to aid in identification of the ureters during surgery. Women with conditions that tend to distort the bladder trigone such as very large cystoceles or prior anterior colporrhaphy may benefit from this strategy, although stent placement in these patients can be a challenge.

Petit and Petrou (6) state that the ureter is palpable transvaginally in the 10 or 2 o'clock position after opening the anterior cul-de-sac during vaginal hysterectomy, and therefore can be avoided when dividing the cardinal vascular pedicles.

Many vaginal surgeons advocate cystoscopy with intravenous indigo carmine to increase the detection rate of ureteric obstruction (6,20). Harris et al (20) found the incidence of unsuspected bladder and ureteric injuries diagnosed by intraoperative cystoscopy to be 4%. Detractors of this practice cite the increased operative time and cost, the possibility of causing urinary tract infection, and the extra training required for pelvic surgeons as reasons to avoid routine cystoscopy. Others point out that cystoscopic bladder inspection does not guarantee the recognition of all lower urinary tract injuries, and is dependent on the expertise and thoroughness with which the examination is carried out (25).

Cystoscopy is carried out after passing sutures or a trocar through the retropubic space or after placing plication stitches. It should be performed after each maneuver that places the ureters at

risk of injury so that one can more effectively detect the source of ureteric compromise and correct it before moving on to the next step in the procedure. In the case of patients who have had previous abdominal surgery such as total abdominal hysterectomy or abdominal-perineal rectal resection in which the ureters may be injured or tied off, consideration should be given to performing cystoscopy with indigo carmine before the vaginal procedure to exclude a previous unrecognized silent ureteric injury. An ampule of indigo carmine is administered to the patient intravenously and the ureteric orifices are inspected for the appearance of blue-tinged urine. If no efflux of urine occurs within 10 minutes of dye administration despite adequate hydration and possibly the administration of a diuretic, the ureters may be obstructed. The appearance of urine outflow may take some time, particularly in older women, in women with a large cystocele that may have caused ureteric kinking, and in cases of chronic renal insufficiency. Obstruction should definitely be suspected if ureteric peristalsis with the absence of urine efflux or poor urine efflux is seen. Applying traction to the sutures can help determine which of them lie in close proximity to the obstructed ureter (8). The offending sutures should be removed and the ureter reexamined for urine outflow. Intraoperative ureteric imaging in the form of retrograde pyelography or intravenous urography can also be used to diagnose ureteric obstruction or laceration (Figure 18.4). Intravenous urography is performed by injecting the patient with 60 cc of contrast media and taking a 10-minute film on the surgical table to look for hydroureter or extravasation of contrast into the pelvic or abdominal cavity (26). Management of ureteric injury may involve stenting, percutaneous nephrostomy tube insertion, or ureteric reimplantation. Secondary complications such as ureteric stricture and ureterovaginal fistula may necessitate more complex reconstructive procedures such as a Boari flap and ileal ureter, which are beyond the scope of this chapter.

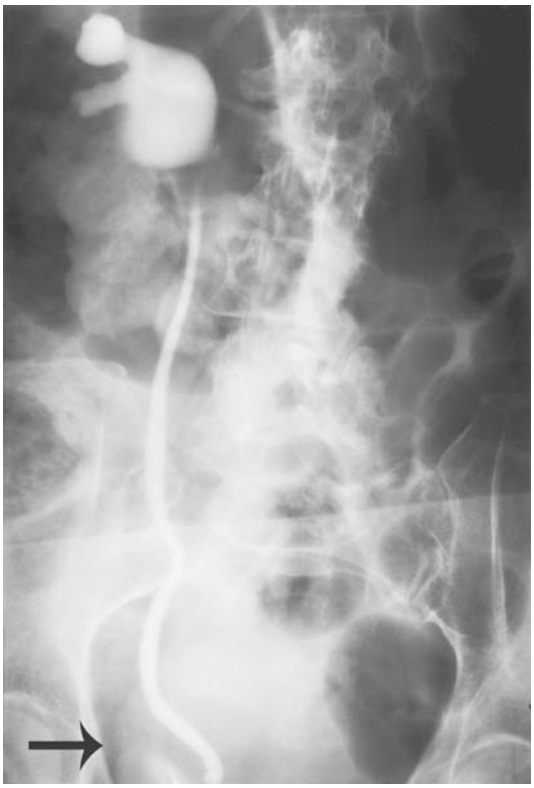


Figure 18.4. Intraoperative retrograde pyelogram showing ureteric kinking as a consequence of placing plication sutures too laterally during the performance of high levator myorraphy.

Urethral Injury

Transvaginal injury to the urethra usually occurs while dissecting in the plane between the anterior vaginal wall and periurethral fascia or during urethral diverticulectomy, particularly in patients who have had previous vaginal surgery. In most cases, urethral damage can be avoided by infiltrating under the anterior vaginal mucosa with normal saline, diluted epinephrine, or local anesthetic to better open up the dissection plane. Such injuries can be identified by performing intraoperative urethroscopy with a 0-, 5-, 25-, or 30-degree lens (18). Large urethral lacerations, however, can be recognized by the appearance of the catheter in the incision.

Small urethral injuries should be repaired over a 14- or 16-French (F) Foley catheter using fine (5-0 or 6-0) absorbable suture. Loupe magnification may aid in identifying the edges of the injury and placement of sutures. Making sure that the catheter is mobile within the urethra and can be removed with ease is recommended after closure to ensure that it has not been incorporated into the suture line. Alternatively, the injury can be closed over a urethral sound, which is then replaced with a urethral catheter. The

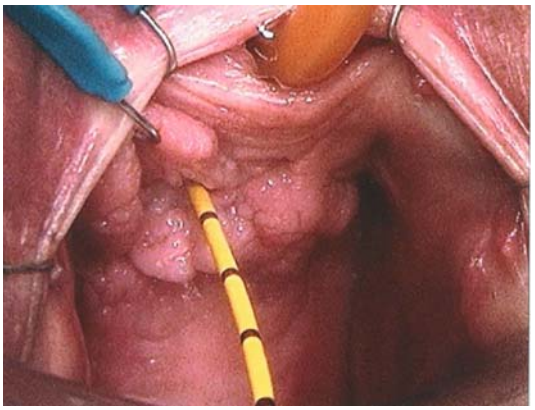


Figure 18.5. Urethrovaginal fistula after urethral diverticulum repair. Fistula tract is cannulated by a small 5-French open-ended ureteral catheter.

urethral mucosa repair should be checked for water-tightness by retrograde filling alongside the catheter through a 5F or 8F feeding tube. If identified, the overlying periurethral muscular layer should then be reapproximated using fine absorbable suture. Larger defects may require closure with a vaginal flap and interposition of a Martius labial fat pad or fascial graft interposition to prevent a secondary urethrovaginal fistula (Figure 18.5).

Rectal Injury

Mathevert et al (3) found the incidence of rectal injury to be 0.5% in 285 consecutive cases of vaginal hysterectomy for benign conditions, 69% of which occurred during posterior repairs done in conjunction with hysterectomy. These investigators found no postoperative complications related to rectal injury. All injuries were repaired in two layers using running absorbable suture without leaving a drain. Twenty-five percent of patients who sustained injuries to the rectum had had a previous posterior repair compared with 2.5% of the overall case series. To prevent rectal laceration, either the placement of a pack in the rectum before the start of the surgery or intraoperative access to the rectum with an O'Connor drape (condom drape) can aid. If an injury to the rectum is suspected, the area should be examined with a finger in the rectum and a finger in the vaginal incision. Alternatively, with the patient in the Tredelenburg position, the vaginal cavity can be filled with irrigation fluid and air instilled into the rectum using a catheter and Toomey syringe. The presence of bubbles in the fluid on injection of air through the catheter indicates a breach in the rectal wall. Rectal injuries should be repaired at the time of discovery to avoid rectovaginal fistula formation.

Conclusion

The vaginal surgeon should have comprehensive knowledge of how to deal with the occurrence of bladder, ureteric, urethral, or rectal injury. Preexisting factors that may put the patient at higher risk for surgical complications should be identified, and meticulous planning and preparation should be carried out to minimize their occurrence. The principles of transvaginal repair of injuries to the bladder, ureters, urethra, and rectum are a tension-free closure in multiple layers with nonoverlapping suture lines, interposition of well-vascularized tissue, and good bladder drainage in the form of urethral or suprapubic catheters. Adherence to these tenents helps prevent fistula formation.

Although extensive discussion of the medicolegal implications of surgical misadventure is beyond the scope of this chapter, some general points should be mentioned. A thorough preoperative discussion with the patient and her family about the potential complications of vaginal surgery ensures that they are well informed of the surgical risks, and will help prepare them for any adverse event that may occur. The importance of obtaining immediate consultation in the form of a senior colleague or the appropriate surgical specialist when an intraoperative complication is suspected or recognized cannot be overemphasized in terms of minimizing adverse sequelae for the patient and satisfying legal requirements for the standard of care. Furthermore, documentation of the preoperative discussion, the intraoperative steps taken to repair an injury, and the experts consulted should be clear and detailed to avoid medicolegal problems.

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Part VII

Other Reconstructive Vaginal Procedures

19

Vesicovaginal and Urethrovaginal Fistulas

Roger Dmochowski and Harriette Scarpero

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In developed countries, modern obstetric care has substantially limited the risk of vesicovaginal fistulas. In these areas, fistulas are usually the consequence of complications of gynecologic or other pelvic surgery with secondary etiologies such as inflammatory bowel disease and malignancy being responsible for a minority of cases. In developing countries, birth trauma accounts for the majority of fistulas (1,2). Necrosis of the bladder base and urethra is induced by prolonged labor, which results in tissue loss that is often marked (90).

Despite the worldwide prevalence of genitourinary fistulas in woman, optimal management remains nonstandardized. Unfortunately, literature evidence that evaluates the timing of intervention, type of surgical repair and approach, and associated management issues (such as preoperative preparation, necessity and type of interposition material, method and timing of postoperative urinary drainage) is based on clinical series or case studies and lacks definitive randomized control analysis. Therefore, most of the diagnostic and therapeutic management of women with genitourinary fistulas arises from single-surgeon experience with personal case series (88). Despite the obvious limitations of this corpus of literature, reasonable conclusions can be drawn regarding the approach to fistulas in women.

Specific Etiologies and Incidence

The most common cause of nonobstetric vesicovaginal fistulas is routine abdominal (open or laparoscopic) or vaginal hysterectomy. Approximately 75% of nonobstetric genitourinary fistulas are subsequent to this cause (3–7). Fistulas noted after hysterectomy are thought to be due to poor host tissue quality (prior radiation, chronic steroid use, prior surgery, associated pelvic inflammation/abscess), unrecognized direct bladder trauma (complicated by bladder overdistention postoperatively), inadvertent suture placement through the bladder wall producing tissue necrosis, or thermal injury from electrocautery (either as an isolated factor or in association with direct surgical injury) (8). Tissue necrosis promotes fibrosis and induration, finally resulting in an epithelial or mucosal lining of the fistula tract (9).

The causative role of gynecologic surgery has been well demonstrated in multiple literature sources. Goodwin and Scardino (10) reported 32 patients with fistulas as a direct result of gynecologic intervention. Tancer (6) studied 151 patients with fistulas and found that 137 (91%)

were postsurgical, of which 125 caused by gynecologic surgery. The most common procedure accounting for fistula was hysterectomy in 110 (73%) of cases (99 of which were transabdominal in approach). Hilton (13) reported his personal experience with 140 urogenital fistulas, 100 of which had been associated with pelvic surgery, and 79 followed hysterectomy. Several factors have been thought to contribute to the risk of fistula formation after hysterectomy: prior cesarean section, intrinsic uterine disease (bulky fibroid tumors, endometriosis), and prior ablative treatment for carcinomas (pelvic radiation therapy) (11). The incidence of fistula after hysterectomy is generally accepted to be 0.1% to 0.2% (12). More recent meta-analysis of the gynecologic literature suggests that the rate of iatrogenic ureteral injury during hysterectomy approaches a crude occurrence rate of 6.2 per 1000 cases, whereas bladder injury occurs at 10.4 per 1000 cases. In the United Kingdom approximately 150 fistula repairs are performed per year (13). Overall risk of fistula occurrence after hysterectomy in United Kingdom is 1/1300 operations (0.08%). The risk following laparoscopic-assisted vaginal hysterectomy is 1% (10–12). Rates associated with other types of procedures include between 1% and 4% for fistulas in radical hysterectomy, with or without radiation (14–16), and 10% following pelvic exenteration (17).

Malignancy (uterine, cervical, lower gastrointestinal, and, least likely, vesical) has also been found to be a contributing factor in some cases (18), with radiation (19,20), gastrointestinal surgery (low anterior resection) (21), inflammatory bowel disease and urinary tuberculosis, schistosomiasis, and actinomycosis (22). Rarely endometriosis can produce a vesicovaginal fistula (23). Some data are now emerging suggesting that inflammatory bowel disease accounts for up to 40% of fistulas in the developed world, with Crohn's disease accounting for an increasing percentage of the overall total (7). Symmonds's (4) experience at the Mayo Clinic revealed only 5% of 800 vesicovaginal fistulas to be due to obstetric causes. Unusually, foreign bodies such as catheters, pessaries, diaphragms, and intrauterine devices also may lead to fistula formation (25). Iatrogenic CO_2 laser therapy for cervical disease has resulted in bladder fistula (26). Autoimmune diseases such as Behçet's have also been noted to be causative, due to extensive vasculitis related bladder wall necrosis (27). Blunt (vehicular accident) and penetrating trauma also account for occasional cases (28).

Presentation and Evaluation

Timing and characteristics of patient presentation are extremely variable. Patients may present while in the hospital with fever, prolonged ileus, excessive pain, hematuria, or flank pain (if a simultaneous ureteral injury also is present) (9). High-volume urinary loss through a large or complex fistulous tract may produce continuous or total incontinence. Fistula drainage may also be minimal and intermittent and mistaken for postoperative stress incontinence. In some cases delayed presentation of a fistula may occur. This may represent the inherent variability of tissue breakdown associated with operative trauma (incomplete necrosis induced by suture or tissue tension alone or in conjunction with preexistent ischemia arising from prior radiation or systemic disease). Hilton (7) noted that only 4% of 100 patients presented within 1 day after surgery, with the majority developing spontaneous urinary loss between 5 and 14 days after surgical intervention. Occasionally fistula recurrence is noted months to years after successful surgical repair due to impaired tissue viability from surrounding perioperative changes (29).

Patients with urethrovaginal fistulas arising from excessive tissue imbrication during anterior repair, suture incorporation from suspension procedure, foreign-body erosion (sling material), or urethral catheter trauma may not develop symptoms until catheter removal has occurred. Characteristically incontinence arising from a urethrovaginal fistula is episodic unless the fistula extends across the bladder neck, in these cases severe and total incontinence is usually encountered. In the presence of a competent urethral sphincteric mechanism, a urethrovaginal fistula may also be totally asymptomatic and detectable only on physical examination. Cyclic urinary incontinence is usually associated with vesicocervical or vesicouterine fistulas (Youssef's syndrome) (30,31).

Spontaneous vaginal discharge in any woman who has received radiation therapy for pelvic malignancy can be indicative of de novo fistula presentation. Fistulas may develop up to 20 years postradiation (32,33). In 18 previously irradiated patients, Hilton (13) noted that

urinary loss commenced between 1 and 30 years after surgery. Therefore, time of presentation may be extremely variable and the potential diagnosis should be considered in any postsurgical patient. Presentation greater than 30 years postdelivery has been reported with occasional obstetric fistulas (34).

Peritoneal fluid may leak from a vaginal cuff through a peritoneal sinus tract may produce persistent clear vaginal discharge after hysterectomy (posthysterectomy pseudoincontinence) (35). Vaginal cuff revision has been shown to render resolution to this bothersome symptom (36). Other causes of clear vaginal discharge after hysterectomy include fallopian tube fluid drainage (37) and lymphatic fistula (38). The other etiologic considerations for postoperative vaginal drainage include urinary loss from bladder dysfunction (detrusor instability or poor bladder compliance), ectopic ureteral drainage, ureteral vaginal fistula, fistulous communication between uterus and lower urinary tract, spontaneous vaginal/cervical secretions, and vaginal infections (39). Acute renal failure has been noted due to bladder eversion through a large vesicovaginal fistula (40). Rarely, a congenital fistula related to renal hypoplasia and uterus didelphys may also cause spontaneous urinary discharge (41).

Physical examination is a crucial diagnostic component in the evaluation of a woman with a suspected genitourinary fistula. Vaginal examination should not only attempt to identify the fistulous tract in relationship to the vaginal axis (so as to assess reasonability of vaginal approach), but also assess the overall vaginal capacity (including vault caliber, fibrosis, or depth abnormalities), vaginal mucosal integrity (estrogen effect and friability of surrounding tissues), and the presence or absence of significant induration or fibrosis around the suspected tract, which may preclude adequate mobilization for surgical closure purposes. The most common location for a fistulous tract after hysterectomy is at or near the level of the vaginal cuff secondary to suture placement during cuff reconstruction. The corresponding fistulous lesion usually is noted on the posterior wall of the bladder (usually well above the trigone) (42). Less commonly, extensive electrocautery application to the vesicovaginal septum may produce fistulous lesions more distally at the level of the trigone or bladder neck. Routine physical examination will often demonstrate pooling of urine in the vaginal fornices posteriorly as well as at the vaginal apex. If a fistula tract is not readily identified, dyes (such as oral phenazopyridine—Pyridium) may be given to confirm vaginal drainage. A tampon may be placed in the vagina after oral Pyridium. A simultaneous vaginal examination with the bladder filled with a dye impregnated fluid such as methylene blue may assist in localization of the fistula.

Cystoscopy is a crucial adjunct to demonstrate the location and size of the fistula as well as proximity to one or both ureteral orifices. Cystoscopy may also be used to assess bladder mucosa for edema and persistent necrosis, which may complicate planned surgical repair (Figure 19.1). In the patient with a prior history of pelvic malignancy (cervical, uterine, vaginal) biopsy of the fistula tract is crucial in determining the appropriate therapeutic approach for these patients. Biopsy can be performed either by a vaginal or cystoscopic approach. The authors have found that vaginoscopy performed at the time of cystoscopy also assists in identifying complicating factors such as vaginal synechiae and unanticipated vaginal fistulous components (retained foreign bodies, multiple vaginal tracts, and excessive vaginal edema) (43).

Intravenous urography is useful to detect ureteric injury and to identify congenital ureteric anomalies. Symmonds (4) reported a 10% risk of a simultaneous ureteral component with vesicovaginal fistulas. The authors' experience suggests that this rate is higher than encountered by most referral centers. The cystogram phase of the IVP (intravenous pyelogram) may also suggest the presence of a fistula if vaginal

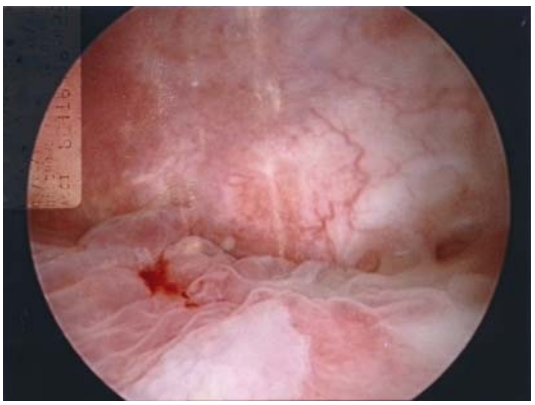


Figure 19.1. Cystoscopic view of multiple fistula tracts with surrounding bladder mucosal edema.

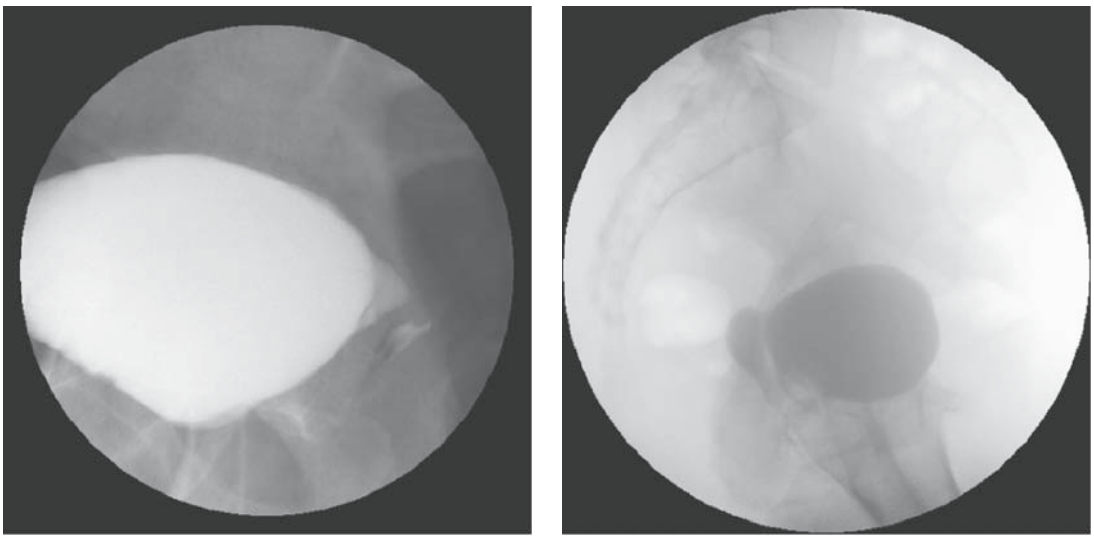
opacification arising from urinary pooling or extravasation is noted. Ureteral obstruction often is not found in the presence of a complex vesicovaginal fistula. The absence of hydronephrosis in this case arises from spontaneous decompression of the ureter into the fistula, producing a falsely negative urogram. Retrograde pyelography remains the study with highest diagnostic accuracy for diagnosing the site of a ureterovaginal fistula or the possibility of a combined uretero- and vesicovaginal fistula, although no direct studies have evaluated this diagnostic technique against other imaging modalities.

Voiding cystourethrography (VCUG) may demonstrate other lower urinary tract abnormalities that may impact upon surgical reconstruction (vesicoureteral reflux, cystocele, urethral diverticulum) (Figure 19.2). Occasionally contrast examination of the vagina (vaginography) may help demonstrate an irregular fistulous tract. Zimmern et al (44) described the procedure for injecting contrast material through the vagina with a large balloon occluding the vaginal introitus.

Occasionally, more advanced imaging studies (such as computed tomography [CT] or magnetic resonance imaging [MRI] scanning) are indicated to localize a fistula site and determine regional tissue integrity. These circumstances most commonly arise in the case of fistulas resulting from malignant causes such as uterine or cervical cancer or in patients who have experienced postsurgical complications arising from the initial causative surgical procedure (pelvic abscess or urinoma).

Hilton (45) evaluated the role of urodynamics in women with lower urinary tract fistulas. In 30 women with fistulas, a diverse group of urodynamics diagnoses were established: 47% with genuine stress incontinence, 44% with detrusor instability, and 17% with poor bladder compliance. However, none of these findings was predictable on the basis of the patient's symptoms. Urodynamics may be quite difficult to successfully perform in women with lower genitourinary fistulas due to operational issues such as continuous loss of infusant during testing, which makes determination of bladder capacitance and other storage factors impossible to assess. Also, as yet no evidence exists suggesting that urodynamics can be predictive of postoperative stress incontinence after fistula repair.

The authors use a combination of modalities for diagnosis and characterization of lower urinary tract fistulas. These include the identification of urinary loss on physical evaluation that is extrasphincteric (often using urinary dyes as adjuncts), intravenous urography, cystoscopy, and assessment of lower ureteral integrity (either intravenous urography or retrograde pyelography). Adjunctive tests such as



A B

Figure 19.2. A: Radiograph of small fistula on cystogram. B: Larger fistula tract with significant pooling of contrast in vaginal vault.

VCUG, urodynamics, or specialized imaging (MRI or abdominal CT) are indicated in a minority of cases or in special circumstances. The diagnostic paradigm should be individualized for each case, with the appreciation that the goals of the evaluation are not only to identify but also to characterize the fistulous lesion so as to determine the ideal interventional strategy. Personal experience allows special emphasis to be placed on cystoscopy to evaluate fistula location and size as well as to define surrounding tissue status (quality of vascular supply, presence, and degree of edema). Analysis of literature evidence suggests that no one test provides the ultimate analysis of fistulous disease (Figure 19.3).

Although evaluation schema may be useful for classifying fistulas, these taxonomies invariably rely on fistula definition on the basis of etiology, location, or complexity (involvement of multiple urinary entities—bladder, urethra, ureter, or juxtaurinary structures, such as intestines). Although these taxonomies are acceptable for literature reporting, it is the authors' recommendation that every fistula be managed in an individual manner, including consideration of all pertinent data so as to formulate that management

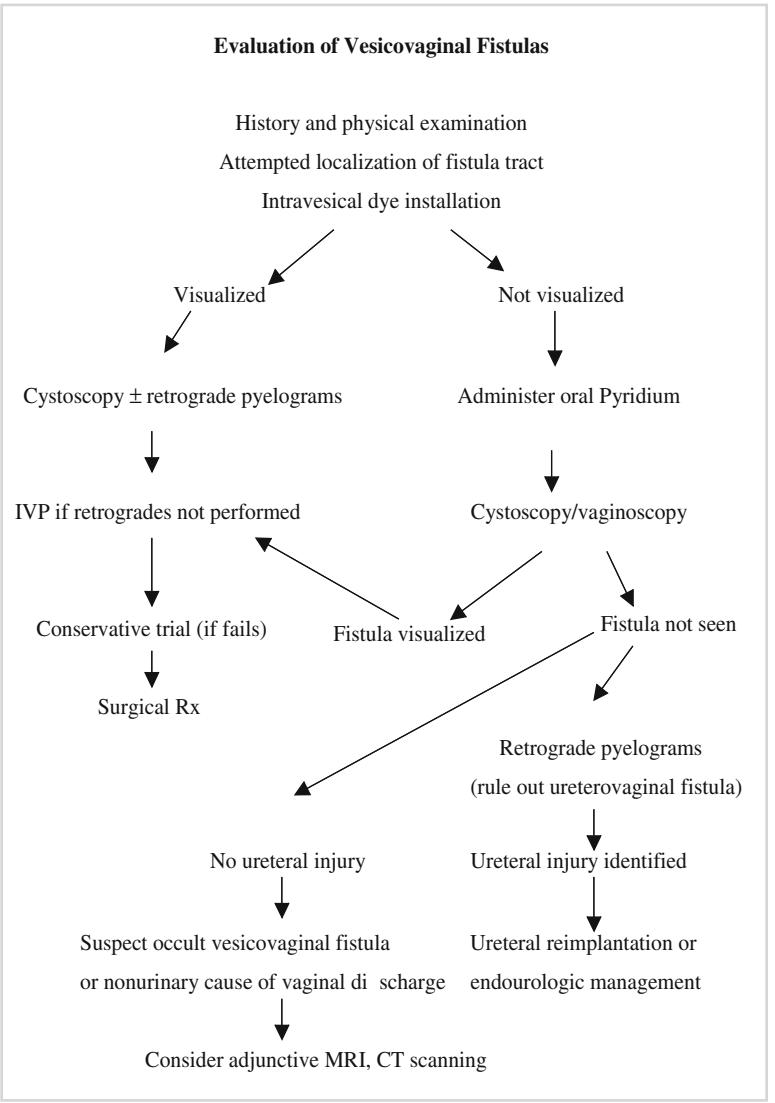


Figure 19.3. Proposed algorithm for diagnosis and assessment of vesicovaginal fistulas. Adapted from Dmochowski RR. Surgery for vesicovaginal fistula, urethrovaginal fistula, and urethral diverticulum. In: Walsh P, et al, eds. Campbell's Urology, WB Saurnders Philadelphia, Pennsylvania, 8th ed. 2002.

approach most appropriate for the individual under consideration.

Treatment

Conservative Management

Regardless of the timing of presentation, conservative therapy may be considered as an option in the appropriately selected woman. This management strategy, which usually includes associated additional catheter drainage, must be balanced against patient desires and wishes, as most fistula sufferers want nothing more than immediate and complete resolution of their condition.

The most basic technique uses continuous urethral catheter drainage supplemented with anticholinergics. A variety of conservative techniques may be curative and may be considered in patients with single fistula tracts that are less than 1 cm in size, and that are not associated with complicating factors such as prior radiation. Tancer (6) reported three of 151 patients with spontaneous closure of fistula using this strategy. The authors have had success using this strategy in three of 50 fistulas. Often, however, the patient has already undergone a trial of catheter drainage at the time of initial urologic evaluation and therefore further catheter drainage is not indicated. No definitive evidence suggests the optimal time for catheter drainage. Complete fistula resolution has occurred as late as 8 weeks after surgery with these methods (46,47).

Another possible conservative therapy utilizes electrofulguration of the fistula tract (48–50). Small case series have yielded 65% (11/17) resolution when this technique is used with complementary bladder drainage for 2 weeks. The magnitude of current intensity should be minimal. Physical abrasion of the fistula tract may also be attempted using a metallic or other sharp-edged object. The concept of this technique is physical disruption of the tract with resultant inflammatory response and subsequent coaptation of the fistula. As another minimally interventive option, McKay (51) used cystoscopic suture closure of a vesicovaginal fistula, with no secondary incision.

Recently, the use of tissue adhesives has been used as a sealant for fistula tracts. Evans et al (52) reported the use of fibrin sealant for five patients who had complex vesicovaginal fistulas. All five were successfully managed without complication. The authors have had no successes in three patients so managed.

Surgical Therapy

Timing of Intervention

Waiting periods of at least 3 to 6 months before intervening with surgical therapy have been previously advocated (11,53,54). This now largely historic approach was founded upon the concept of compete resolution of tissue inflammation arising from the initial surgical injury prior to attempted surgical correction. Relatively recent advocacy of an individualized approach without an observational period has established a trend for substantially quicker intervention. Several authors have reported superb results with early interventions (33,55–58). Fistulas identified within the first 24 to 48 hours postoperatively can be safely repaired immediately; however, the presence of complicating factors such as sepsis or other issues may preclude this approach.

Fistula tracts identified days to weeks after surgery require careful planning and selection. Fistulas at the vaginal apex may be successfully managed with a transvaginal approach. Ninety-four percent (15 of 16) in one series were cured, with all seven patients who were less than 3 months from initial surgery being managed successfully (56). A fistula that occurs in a previously radiated field requires periodic reassessment, given the propensity of these lesions to change (enlarge, become necrotic) with time, especially if primary repair is contemplated. Alternatively, wide excision and tissue interposition may be used in this circumstance if an observational approach is not indicated (59).

Preoperative Preparation

Other than optimizing attempts at conservative therapy, no evidence supports any specific preoperative preparation for patients undergoing fistula repair. Most authors support the use of perioperative antibiotic therapy to ensure a sterile environment. However, a recent random-

ized controlled trial evaluating the use of antibiotic prophylaxis for fistula surgery showed no benefit to using perioperative antibiotics (60). Estrogen replacement therapy has also been used in those patients with a poor-quality vaginal hormonal environment (33). Other preoperative preparations may be individualized according to the presenting scenario (need for bowel preparation when the possibility of a bowel component is identified).

Route of Surgical Repair

Surgical approaches used for vesicovaginal fistulas include combined abdominal/vaginal, vaginal, or abdominal (open or laparoscopic) approaches. The applicable approach is contingent on several factors, including the location of the fistula (position related to apex), the quality of the tissue, and surgeon preference. Vaginal surgery is more rapid and results in less morbidity and more rapid recovery; however, the vaginal route is difficult in patients with a significant degree of fibrosis, pelvic immobility, or with large tracts in close proximity to the ureteral orifices. The abdominal approach should be utilized for any patient with a complicated presentation (prior history of abscess or associated abdominal pathology, a poorly visualized fistula tract, a narrow or immobile vagina, and any fistula with close proximity to a ureteral orifice). Laparoscopic repair has the promise of the advantages of open abdominal repair with less morbidity. Other variables to be considered include type of suture, method of urinary drainage, and the use of tissue interposition graft. No definitive evidence in the literature suggests any superiority for any of these variables over other available options.

Although the use of interposition grafts for fistula repair has common practice, no randomized trials evaluating surgical repair with or without the use of interposition material have been performed. Although the most commonly used grafts include omental fat, labial fat pad, or peritoneum, less commonly used grafts include posterior cervix (61), vaginal pedicled flap (62), free graft of anterior abdominal wall fat (63), broad ligament (64), bladder mucosa autograft (65,66), pedicled myocutaneous vertical rectus abdominus flaps (67), and simultaneous augmentation with ileum (68,69).

Vaginal Approach

The vaginal approach entails an incision from which an anterior vaginal wall mucosal flap may be used for coverage. The goal of the technique is tension-free closure, which uses either polyglycolic acid or polydioxanone suture and nonoverlapping multiple closure lines. Although some experts prefer interrupted suture lines, the authors prefer a running, watertight closure. Interposition tissue may be mobilized from deepithelialized vaginal mucosa, labia, or peritoneum if the fistula repair is tenuous or there is concern regarding apposition of suture lines (Figure 19.4).

A suprapubic catheter may be placed and urinary drainage supplemented with a urethral catheter (70). Ureteral catheterization should be performed with cystoscopic assistance prior to fistula closure, if the fistulous communication occurs in proximity to the ureteral orifices. Optimal visualization is dependent on tissue mobility. The use of lateral relaxing incisions may help operative visualization and the approach to the fistulous tract (44). Traction sutures placed on either side of the fistula may provide additional mobility and traction for lesions at the vaginal apex.

Several case series suggest that the Martius interposition graft provides satisfactory interposition graft material (71–75). Several authors have used this graft as an adjunct to repair that is associated with complicated incontinence with excellent results (76,77). If this is not obtainable, alternative graft sources include a peritoneal flap or interposition grafts utilizing gracilis muscle tissue or rotational gluteal flaps. The peritoneum can be freed from the posterior aspect of the bladder and easily advanced to cover the layers of the closure as well (58).

Alternative vaginal approaches exist. The Latzko technique of proximal vaginal fistula repair involves excision of the vaginal epithelium around the fistula site and a modified colpocliesis with several layers of absorbable sutures from anterior to posterior wall obliterating the upper vagina (78). No actual excision of the fistula tract occurs during this procedure; however, the loss of vaginal capacity excludes this technique as an option in sexually active women.

Another less involved technique was that first described by Sims. This method uses a saucerization method in which a small depression is created in the vaginal wall and the fistula tract is

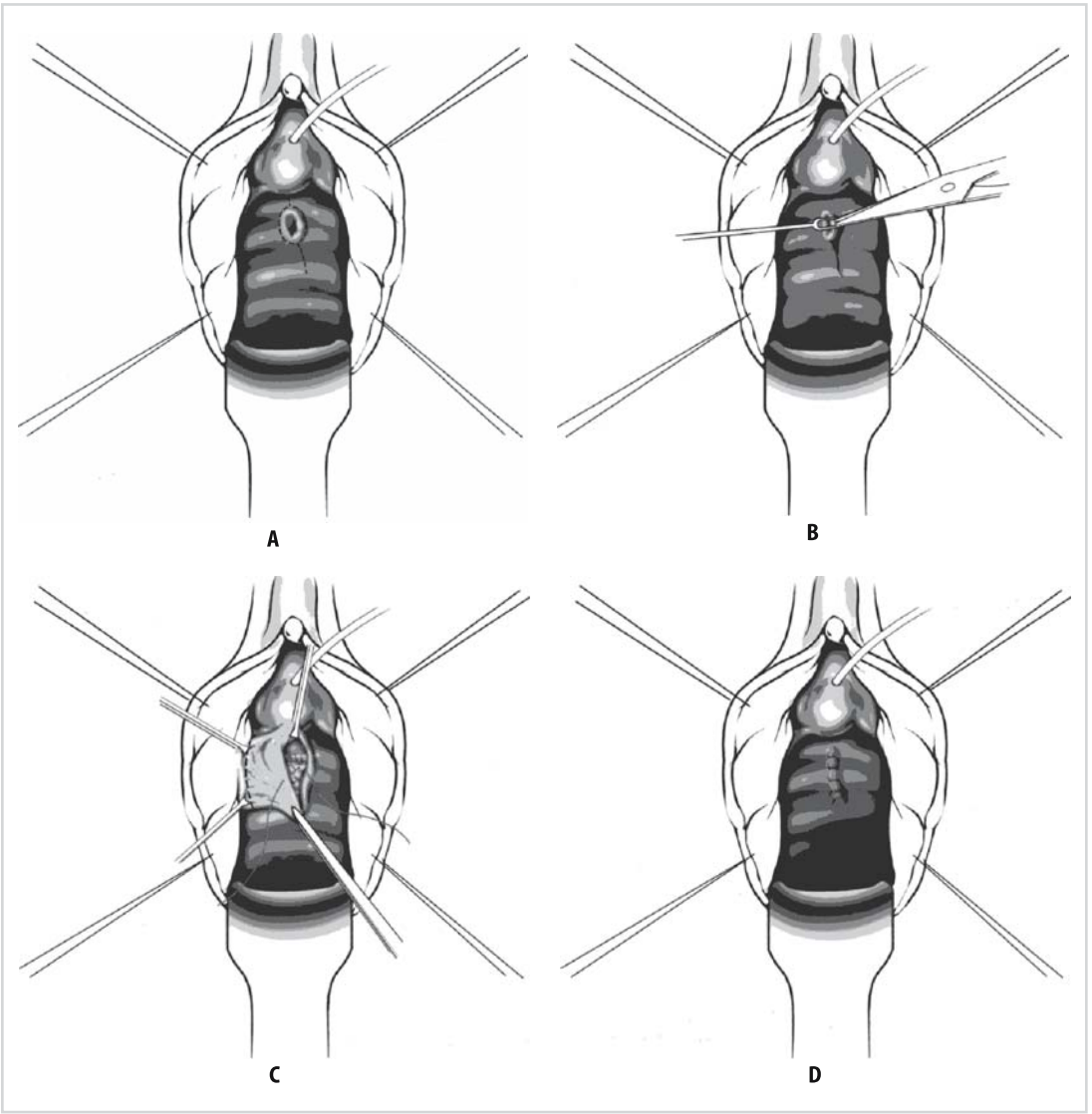


Figure 19.4. A: View of circumscribing incision for vaginal approach to vesicovaginal fistula. Note the extension of the incision proximally under the bladder base. B: Fistula is dissected away from surrounding normal vaginal tissues. Surrounding vaginal tissues are sharply dissected for subsequent coverage purposes. C: Figure demonstrating closure of vesical component of fistula tract. Dissection plane marked laterally for purposes of delivering interposition graft into operative site to avoid direct suture line to suture line apposition. D: Completed closure of vaginal incision, which may be either running or interrupted.

closed with a single row of sutures. This technique, while rapid and simple, should be reserved for special circumstances in which more formal repair is not obtainable (42).

Abdominal Approach

Essentially all fistulas that involve the bladder (aside from those with a urethral component) may be closed with an abdominal approach. If a patient requires bladder augmentation or ureteral reimplantation or if other factors militate against the vaginal approach, then this is the preferred surgical approach. This technique was popularized by O'Conor et al (53,79). After an abdominal incision is performed, the bladder is bisected to the site of fistula (Figure 19.5). The bladder and vagina are separated from each other by dissecting along the vesicovaginal

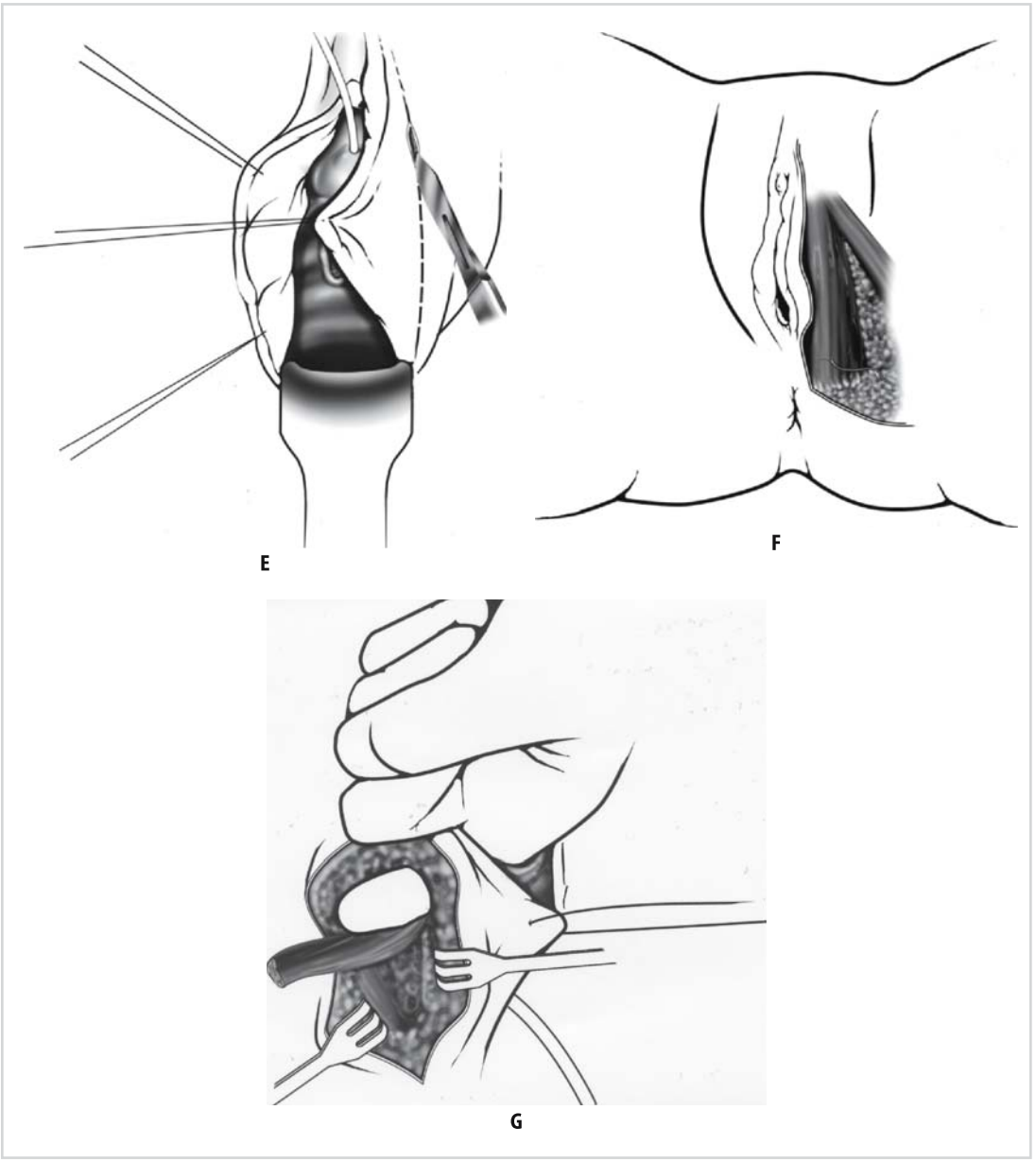


Figure 19.4. E: For interposition purposes, the Martius labial graft is ideally situated. Incision line on labia majora demonstrates correct orientation of dissection. F: Completed dissection demonstrating fibrofatty graft on posterior vascular pedicle. G: Dissection plane, which allows transposition of graft from harvest site to fistula site.

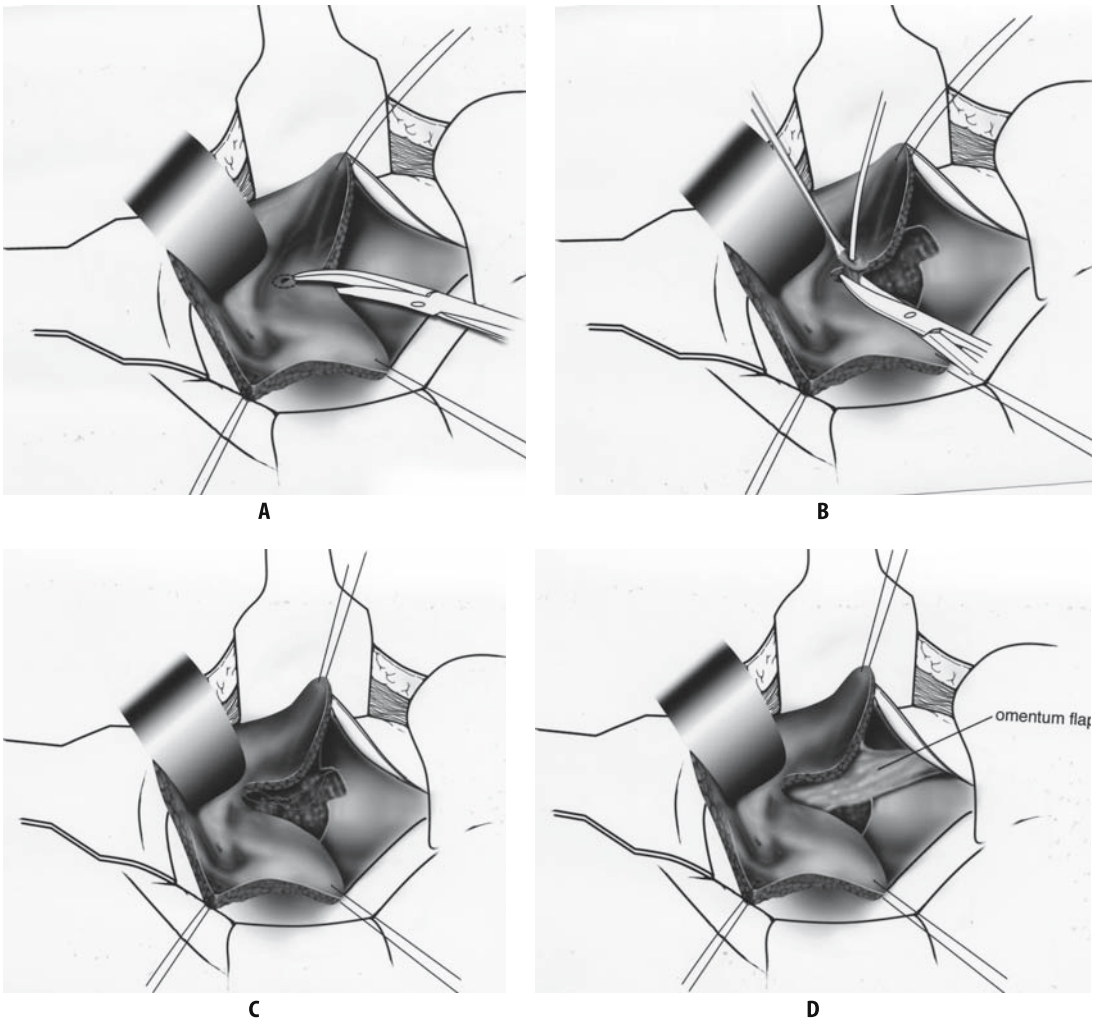


Figure 19.5. A: The urinary bladder is bivalved to the level of the fistula site as shown. B: At the level of the fistula site, the fistula is circumscribed and completely excised. When possible a sound or other guide can be placed through the fistula for purposes of tract identification. C: Completed resection of fistula demonstrating closure of vaginal component of tract. Subsequently interrupted sutures will be placed around this site for purposes of interpostition graft fixation. D: Omental flap fixed into position between vesical and vaginal components of fistula tract. Bladder closure will now proceed with a two-layer running technique.

septum, which represents the crucial component of the procedure for relieving tension on subsequent suture lines. Complete excision of the fistula tract is fundamental to this technique. If the tract is extensively indurated, a posterior bladder flap may be mobilized to repair the defect (80). Separate closure of the vagina and bladder are performed utilizing absorbable sutures (polydioxanone or polyglycolic) and may be performed intra- or extraperitoneally.

Wein et al (81) described the use of an omental graft based on the right gastroepiploic artery and noted adequate length and tension-free apposition of this tissue between the vaginal and vesical components of the fistula repair. This technique has been duplicated by other authors (82,83). The omentum is secured between the bladder and vagina with 3-0 or 4-0 polyglycolic acid sutures.

The majority (greater than 90%) of abdominal fistula repairs can be performed with one procedure using this method. Reported success rates with this approach are approximately 85% to 90% and have been reported by numerous authors

(54,80,84–87). Raz et al (33) reported a success rate of 93% (64/69) for vesicovaginal fistulas, two thirds of which had failed one to three prior repairs. Nesrallah et al (87) reported a 100% success rate using the O'Conor transabdominal supratrigonal technique in 29 patients. Other authors have reported similar results (Table 19.1).

Eilber et al (58) recently reported a 10-year experience with interposition graft use in 120 patients undergoing vaginal repair of fistula after vaginal closure of the fistula site. In 83 women a peritoneal graft was used, in another 34 a Martius graft was interposed, and in three a labial interposition was applied. The success rates were 96%, 97%, and 33%, respectively. No intraoperative complications occurred (58).

Although the above-referenced case series are reflective of diverse populations and techniques, an inescapable conclusion is that the first attempted fistula repair is the most successful. Successive repairs produce progressively less cure. Secondary and tertiary repairs depend on tissues of diminished integrity and occur in less than salubrious surgical environments. Large obstetric fistula series clearly demonstrate this fact, with success rates decreasing from 81% with the first repair to 65% with secondary or tertiary repairs. The authors have noted in their series of 12 repeat repair patients (all of whom had fistulas initially resulting from hysterectomy) that, although the resolution rates were still above 90%, more extensive abdominal procedures were necessary and postoperative convalescence was more difficult (mainly due to a high rate of detrusor overactivity, possibly the result of extensive dissection and bladder mobilization).

Table 19.1. Table of selected series of fistula repairs: results of fistula repairs, including timing of repair

Author (date)	Number of patients	Success (%)	Fistula duration before surgery	Surgical technique
Collins (1960)	24	16 (67)	20 (<2 mos) 8 (>4 mos)	24 vag
Eisen (1974)	29	26 (90)	29 (>3 mos)	29 abd
Persky (1979)	7	6 (86)	7 (<10 wks)	6 abd/1 vag
Tancer (1980)	45	42 (93)	8–16 wks	43 vag/1 abd/1 sp
Wein (1980)	34	30 (88)	>3 mos	34 abd
Keetel (1982)	168	(94)	>3 mos	156 vag/6 abd/6 com
Bisada (1983)	7	7 (100)	NS	7 abd
Cruikshank (1988)	11	11 (100)	<1 mo	9 vag/1 abd/1 comb
Lee (1988)	182	178 (98)	15 < 2 mos 167 > 2 mos	15 vag/130 vag/37 abd
Elkins (1990)	23	21 (91)	>2 mos	23 vag
Wang (1990)	16	15 (94)	7 < 3 mos 9 > 3 mos	16 vag
Blandy (1991)	25	25 (100)	12 < 1.5 mos 13 > 1.5 mos	25 abd
O'Conor (1991)	77	70 (91)	>2 mos	77 abd
Raz (1993)	19	16 (84)	>2 mos	19 vag
Demnirel (1993)	26	(88)	>3 mos	8 vag/18 abd
Kristensen (1994)	18	17 (94)	>2 mos	18 Abd
Brandt (1998)	80	(96)	>1 mos	80 abd
Iselin (1998) (108)	20	20 (100)	<1 mo	20 vag
Leng (1998) (109)	25	23 (92)		
Nesrallah (1999)	29	29 (100)	>6 wks	29 abd
Langkilde (1999) (110)	30	30 (100)		23 abd 7 vag
Mondet (2001) (111)	28	24 (85)		28 vag
Eilber (2003)	120	117 (95)	1–12 yrs	All vag, different interpositioal grafts
Kam (2003) (112)	20	85 (17)		20 abd
Ou (2004)	16	15 (94)		2 cons 2 lap 6 abd 6 vag

abd, abdominal; comb, combined abdominal and vaginal approach; cons, conservative; lap, laparoscopic; spon, spontaneous closure; vag, vaginal.

Laparoscopic Approach

Laparoscopy provides an alternative approach for fistula repair. Fistula location and preoperative evaluation determine the utility of this approach. Nehzat et al (91) reported a successful repair of a laparoscopically caused fistula in a single patient. In a larger series, Ou et al (92) evaluated retrospectively the value of laparoscopic repair as compared to vaginal or abdominal repair in 16 patients. Only two patients actually underwent laparoscopic repair, and both repairs were successful; however, one patient had a prolonged hospitalization. Although in principle an elegant option for fistula closure, no studies of any significant patient size support the laparoscopic approach (93,94).

Complicated Vesicovaginal Fistulas

Complicated vesicovaginal fistulas can be defined as large fistulas (3 to 5 cm or greater in diameter), recurrent fistulas, fistulas associated with prior radiation therapy or malignancy, and those that occur in compromised operative fields due to poor healing or host characteristics. Lesions that involve the trigone, bladder neck, or urethra also usually are considered complex.

A vesicovaginal fistula that occurs in a radiated field is at substantial risk for compromised healing due to microvascular injury induced by radiation effect. Biopsy should exclude recurrent tumor prior to definitive closure. Bladder capacity as well as compliance should be identified to determine the need for possible bladder augmentation as an adjunctive procedure. If the bladder capacity is adequate, a vaginal approach may be utilized that avoids intraperitoneal risks of operating in the radiated pelvis. In the presence of prior radiation, interpositional grafts should always be considered. If local graft is not available, then gracilis interposition may be an option (95). Prior radiation therapy may increase the risk of vesicovaginal fistula despite the use of the aforementioned tissue interventions (33,95). Overall results range around 50% successful closure, but Bissada and Bissada (59) achieved 80% successful closure in their group of 10 postradiation patients.

Reconstruction of radiated fistulas often involves the use of a variety of augmenting interpositional tissues including fibrofatty labial interposition tissues, anterior/posterior bladder flaps (autografts), myocutaneous flaps including rectus, sartorius, gluteus, and gracilis muscle flaps, as well as combined myocutaneous flaps as adjuncts to repair of the complex vesicovaginal fistula (33,59,96–103).

Urethrovaginal Fistulas

Urethrovaginal fistulas are variable in presentation. These lesions may be very small pinpoint areas or may present as complete urethral and bladder neck loss with total urinary incontinence. This circumstance most commonly results from prior gynecologic surgery, with anterior repair and urethral diverticulectomy comprising the most common inciting procedures; however, urethral erosion due to sutures or sling materials represents an increasingly vexing etiology (58). Birth trauma is a rare cause of urethrovaginal fistulas. Prolonged obstructive labor, however, remains a major cause of urethral injury in developing nations (104).

Techniques used for urethrovaginal fistula closure are very similar to those utilized for transvaginal vesicovaginal fistula repair (105). However, complete excision of the fistula tract is to be avoided, but rather circumscribed and oversewn. Complete urethral loss is a more daunting surgical challenge and a multiplicity of techniques has been described for it (100). These techniques usually employ some type of flap utilizing vaginal, bladder, or alternative tissue in an onlay versus tubularized reconstruction. The onlay flap technique uses the universally retained dorsal urethral plate as an anchor for onlay graft fixation. Simultaneous stress incontinence procedures should be performed to obviate the risk of postoperative incontinence (100). The authors routinely use an autologous sling in this circumstance for the dual purpose of obviating incontinence due urethral sphincteric dysfunction and as an interposition graft over the repair.

Operative Technique

Urethrovaginal Fistula

Small to intermediate-size fistulas may be managed with a tension-free layered closure. The occasional rare, distal fistula may be

managed with extended meatotomy (113). Complete reconstruction is necessary for large fistulas with extensive loss, including those that involve the bladder neck.

The fistula tract is circumscribed but not excised and the margins are apposed, without tension, utilizing 3-0 or 4-0 running absorbable suture. Redundant vaginal epithelium should be removed to allow an adequate vaginal flap and avoid overlapping suture lines. A second layer incorporates the overlying periurethral facial tissues and utilizes a Lembert technique and 3-0 absorbable suture.

Interpositional tissue should be considered whenever the closure lines or vaginal tissues are of questionable quality (105,106). The author would recommend that interpositional tissue be used routinely to bolster the repair. The procedure is then completed with the anterior vaginal flap closed over the previous suture lines utilizing running dissolvable sutures.

If substantial urethral discontinuity exists, reconstruction using a vaginal flap may be performed. A segment of vaginal epithelium, usually located immediately adjacent to the defect, is mobilized on a pedicle and tubularized on the existing dorsal urethral plate over a stenting catheter (107). An interposition graft is used as a covering layer prior to closure.

Postoperative Care

Uncomplicated fistula repairs should be drained with either urethral or suprapubic catheters for 10 to 14 days postoperatively. Although still commonly used, dual-catheter drainage (both urethral and suprapubic) is not necessary after the first few postsurgical days. The authors routinely use single-catheter drainage at the time of hospital discharge. Complicated repairs or those repairs with special circumstances may require two catheters and longer periods of urinary drainage (3 weeks).

Suction drains are crucial in the immediate postoperative time frame, but these can usually be discontinued within 48 to 72 hours after surgery. Routine perioperative antibiotic coverage is used at our center, with low-dose oral suppression used during the time of catheter drainage. During this time frame, anticholinergics are used to suppress detrusor overactivity (oral or rectal suppository formulations are used).

A postoperative contrast cystogram is obtained at 2 to 3 weeks to document successful fistula repair. If persistence of fistulous communication is noted, a trial of continued catheter drainage (an additional 2 to 3 weeks) is recommended.

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20

Urethral Diverticula and Other Periurethral Masses

Eric S. Rovner and William I. Jaffe

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Urethral diverticula may represent some of the more challenging diagnostic and reconstructive cases in urology. Women with lower urinary tract symptoms, pelvic pain, or vaginal masses are often referred to a urologist or gynecologist as diagnostic dilemmas. A portion of these patients are subsequently found to have urethral diverticula. However, urethral diverticula represent only one of several types of pathologic periurethral masses presenting in the female. Given the rather wide spectrum of lesions and conditions that present in this manner, proper characterization is necessary prior to formulating a therapeutic plan. Often, although not invariably, urethral diverticula and other periurethral masses are treated surgically. These cases are approached individually and a successful repair often may employ a variety of reconstructive maneuvers including flaps and grafts. The operating surgeon, therefore, should be prepared to be flexible and alter the operative plan accordingly with the findings at operation.

This chapter reviews the relevant anatomy and pathophysiology pertinent to urethral diverticula, discusses diagnostic evaluation and management, and reviews common benign female periurethral lesions other than urethral diverticula.

Embryology and Anatomy of the Female Urethra

Development of the genital system and urinary tract are closely related in utero. By the 7th week of gestation, the urorectal septum has fused with the cloacal membrane to divide the terminal hindgut, or cloaca, into a ventral urogenital sinus and the rectum dorsally. The urogenital sinus is essentially composed of three parts: the cranial vesical portion, which becomes the urinary bladder; a middle pelvic portion, which becomes the entire urethra in the female (and

the posterior urethra in the male); and the phallic portion, which contributes to the epithelium of the vagina.

In the 6th week of gestation, both male and female genital duct systems are present. In the absence of testosterone, the mesonephric (wolffian) ducts begin to regress. The mesonephros distal to the ureteric bud becomes absorbed into the dorsal urogenital sinus and leads to the formation of the bladder trigone. The ureteric orifices become separate from the mesonephric ducts, which migrate caudally toward the future vaginal vestibule before degenerating. Remnants of the wolffian system may persist as the epoophoron, paroophoron, and Gartner's duct. Due to the proximity of the two ductal systems, these remnants are located within müllerian structures and are particularly important in the development of some periurethral masses.

In the absence of müllerian inhibiting substance, the paramesonephric (müllerian) ducts arise from invaginations of mesothelium lateral to the mesonephric ducts. The cephalad ends of the müllerian ducts open into the coelomic cavity, whereas the distal ends fuse, pass ventral to the mesonephric ducts, and form the uterovaginal primordium. These structures eventually give rise to most of the female reproductive system including the fallopian tubes, uterus, and proximal vagina.

The normal female urethra is approximately 3 to 4 cm in length, suspended to the pelvic sidewall and pelvic fascia (tendinous arc of the obturator muscle) by a sheet of connective tissue termed the urethropelvic ligament. The urethropelvic ligament is composed of two layers of fused pelvic fascia that surround the urethra and extend toward the pelvic sidewall bilaterally (Figure 20.1). This structure can be considered to have an abdominal side (the endopelvic fascia) and a vaginal side (periurethral fascia). Within and between these two leaves of fascia lies the urethra. The urethral lumen is lined by an epithelial layer, which is the transitional type proximally and the nonkeratinized stratified squamous type distally. There is a thick, vascular lamina propria/submucosal layer that contains the periurethral glands. These glands exist over the entire length of the urethra posterolaterally, with the majority draining into the distal third of the urethra. Skene's glands are the largest and most distal of these glands and are homologous to the prostate. They drain lateral to the urethral meatus. The urethra has several muscular layers: an internal longitudinal smooth muscle layer, an outer circular smooth muscle layer, as well as a skeletal muscle layer. The skeletal muscle component spans much of the length of the urethra but is more prominent in the middle third. It has a U-shaped configuration, being deficient dorsally. Ventral to the urethra but separated from it by the periurethral fascia lies the anterior vaginal wall.

Urethral Diverticula

Pathophysiology and Etiology

Urethral diverticula (UDs) represent an epithelialized cavity dissecting within the confines of

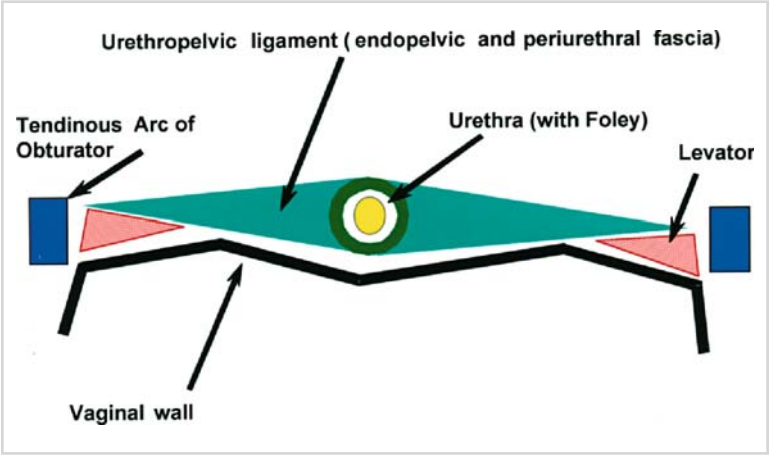


Figure 20.1. Representative anatomy of the mid-urethra in a coronal plane.

the fascia of the urethropelvic ligament (1). This defect is often an isolated cyst-like appendage with a single discrete connection to the urethral lumen, termed the neck or ostia (Figure 20.2). However, complicated anatomic patterns may exist and in certain cases the UD may extend partially ("saddlebag" UD) or circumferentially about the urethra (2).

The periurethral glands are now felt to be the probable site of formation of UD (1). Huffman's (3) anatomic work with wax models of the female urethra was critical to the early understanding of the pathophysiology of UD and the involvement of the periurethral glands. Accordingly, in over 90% of cases, the ostia is located posterolaterally in the middle or distal urethra, which corresponds to the location of the periurethral glands (4,5).

A major debate in the earlier part of the 20th century focused on whether UDs were congenital or acquired lesions. Although this condition exists in children, the diagnosis may represent a different clinical entity from adult female UD. Diverticula in the pediatric population have been attributed to a number of congenital anomalies including an ectopic ureter draining into a Gartner's duct cyst and a form fruste of urethral duplication (6–8). Congenital anterior urethral diverticulum is a well-described entity in boys (9). The vast majority of UDs, however, are likely to be acquired and are diagnosed in adult females with most patients presenting between the fourth and seventh decades of life (10). In two large series of UD, there were no patients reported who were younger than 10 years of age (11,12), arguing against a congenital etiology for these lesions. Although it is possible that there exists a congenital defect in patients that results in or represents a precursor to UD that then only becomes symptomatic later in life, this has never been demonstrated.

There are multiple theories regarding the formation of acquired UD including childbirth, instrumentation/trauma, outlet obstruction, and infection of the periurethral glands. For many years, UDs were felt to be most likely due to trauma from vaginal childbirth (13). However, up to 20% to 30% of patients in some UD series are nulliparous (10,14), which may significantly discount parity as a risk factor. Trauma with forceps delivery, however, has been reported to cause UD (15), as has the endoscopic injection of collagen (16).

Although there are probably other unknown factors that may facilitate the initiation, formation, or propagation of UD, infection of the periurethral glands seems to be the most generally accepted common etiologic factor in most cases. Peters and Vaughn (17) found a strong association with concurrent or previous infection with *Neisseria gonorrhoeae* and UD. However, the initial infection and especially subsequent reinfections may originate from a variety of sources including *Escherichia coli* and other coliform bacteria, as well as vaginal flora. Urethral diverticula have been attributed to infection, obstruction, and subsequent rupture of the periurethral glands into the urethral lumen. This concept was first popularized by Routh (18) over a century ago and has now become the most widely accepted theory regarding the formation of female UD.

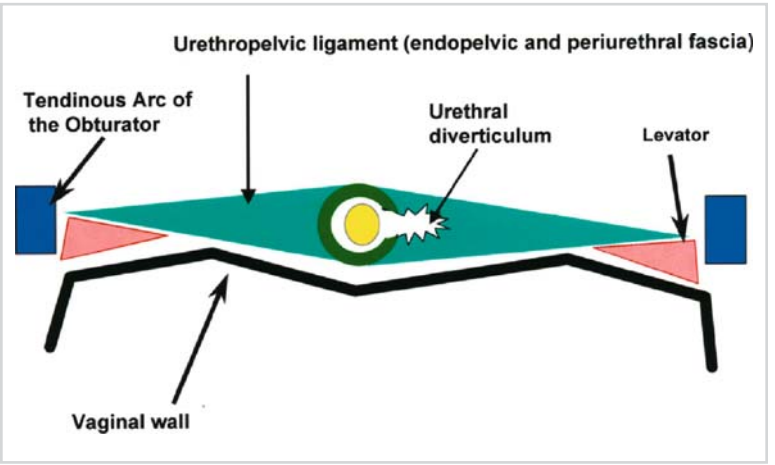


Figure 20.2. Diagram of urethral diverticulum. The urethral diverticulum forms within and between the layers of the urethropelvic ligament.

Reinfection, inflammation, and recurrent obstruction of the neck of the cavity are theorized to result in patient symptoms and enlargement of the diverticulum. This proposed pathophysiology appears to adequately explain the anatomic location and configuration of most UDs and is supported by the work of Huffman noted previously. However, it should be noted that Daneshgari and colleagues (19) reported noncommunicating urethral diverticula diagnosed by magnetic resonance imaging (MRI). Whether this lesion represents a forme fruste of UD or simply an obstructed UD ostia is unclear.

Prevalence

Moore (20) stated that UD as an entity is "found in direct proportion to the avidity with which it is sought." Although today not considered a rare lesion, fewer than 100 cases of UD had been reported in the literature prior to 1950. With the development of sophisticated imaging techniques including positive pressure urethrography in the 1950s, the diagnosis of UD became increasingly common. The true prevalence of female UD, however, is still not known. It is reported to occur in up to 1% to 6% of adult females (1); however, the majority of UD series reported in the literature are from urban referral centers and thus are subject to considerable bias. Furthermore, determination of the true prevalence of UD would require appropriate screening and imaging of a large number of symptomatic and asymptomatic adult female subjects, and this has not been reported to date. In 1967 Andersen (21) reported the results of positive pressure urethrography on 300 women with cervical cancer but without lower urinary tract symptoms (LUTS) and found UD in 3%. Endorectal coil MRI was performed on 140 consecutive female patients with LUTS, and the incidence of UD was approximately 10% (22). However this represented a series of *symptomatic* females at a tertiary referral center and therefore likely is not reflective of general population. Some earlier series suggested a racial predilection, with African Americans being six times as likely to develop UDs as their Caucasian counterparts (11). This has not been reproduced in more modern series, and may be due to referral bias at urban academic centers (23).

Presentation, Evaluation, and Diagnosis

The presenting symptoms and signs in patients with UD are protean. The classic "three D's" of dysuria, dyspareunia and postvoid dribbling are certainly not universal complaints. Although presentation is highly variable, the most common symptoms are irritative (frequency, urgency, and dysuria) LUTS. Dyspareunia will be noted by 12% to 24% of patients (11,12). Approximately 5% to 32% of patients will complain of postvoid dribbling (10,11). Recurrent cystitis or urinary tract infection is also a frequent presentation in one third of patients (10,11). Multiple bouts of recurrent cystitis should alert the clinician to the possibility of a UD. Other complaints include pain, hematuria, vaginal discharge, obstructive symptoms or urinary retention, and incontinence (stress or urge). Up to 20% of patients diagnosed with UD may be completely asymptomatic. Patients may also present with a tender anterior vaginal wall mass, which upon gentle compression may reveal retained urine or purulent discharge per the urethral meatus. It is important to note that the size of the UD does not correlate with symptoms. In some cases, a very large UD may result in minimal symptoms, and conversely, some UDs that are nonpalpable may result in considerable patient discomfort and distress. Finally, symptoms may wax and wane and even resolve for long periods of time. The reasons for these exacerbations and remissions are poorly defined but may be related to periods of infection and inflammation.

As many of the symptoms associated with UD are nonspecific, patients may often be misdiagnosed and treated for years for a number of unrelated conditions before the diagnosis of UD is made. This may include therapies for interstitial cystitis, recurrent cystitis, vulvodynia, endometriosis, vulvovestibulitis, and other conditions. In one series of 46 consecutive women eventually diagnosed with UD, the mean interval from onset of symptoms to diagnosis was 5.2 years (24). In this series, women consulted with an average of nine physicians prior to the definitive diagnosis being made despite the fact that 52% of women had a palpable mass on exam. This underscores the importance of a thorough pelvic exam in female patients complaining of LUTS or other symptoms that may be associated with UD.

The diagnosis and complete evaluation of UD can be made with a combination of a thorough

history, physical examination, appropriate urine studies including urine culture and analysis, endoscopic examination of the bladder and urethra, and selected radiologic imaging. A urodynamic study may also be utilized in selected cases.

During physical examination the anterior vaginal wall should be carefully palpated for masses and tenderness. The location, size, and consistency of any suspected UDs should be recorded. Most UDs are located ventrally over the middle and proximal portions of the urethra corresponding to the area of the anterior vaginal wall 2 to 3 cm inside the introitus. However, UDs may also be located anterior to the urethra or extend partially or completely around the urethral lumen. These particular configurations may have significant implications when undertaking surgical excision and reconstruction. Urethral diverticula may also extend proximally toward the bladder neck. These UDs may produce distortion of the bladder outlet and trigone of the bladder on cystoscopy or on radiographic imaging, and special care should be taken during surgical excision and reconstruction due to concerns for intraoperative ureteral injury as well as the potential development of postoperative voiding dysfunction and urinary incontinence. More distal vaginal masses or perimeatal masses may represent other lesions including abnormalities of Skene's glands. The differentiation between these lesions sometimes cannot be made on the basis of a physical examination alone and may require additional radiologic imaging. A particularly hard anterior vaginal wall mass may indicate a calculus or cancer within the UD and mandates further investigation. During physical examination, the urethra may be "milked" distally in an attempt to express purulent material or urine from within the UD cavity. Although often described for the evaluation of UD, this maneuver is not successful in producing the diagnostic discharge per urethral meatus in the majority of patients (23). The vaginal walls are assessed for atrophy, rugation, and elasticity. The distal vagina and vaginal introitus are assessed for capacity. A narrow introitus can make surgical exposure difficult and may require an episiotomy. Finally, provocative maneuvers to elicit stress incontinence should be performed as well as an assessment of the presence or absence of any vaginal prolapse.

Cystourethroscopy is performed, both in an attempt to visualize the UD ostia as well as to rule out other causes of the patient's LUTS. A specially designed female cystoscope can be helpful in evaluating the female urethra. The short beak maintains the discharge of the irrigation solution immediately adjacent to the lens and thus aids in distention of the relatively short (as compared to the male) urethra, permitting improved visualization. It may also be advantageous to compress the bladder neck while simultaneously applying pressure to the diverticular sac with an assistant's finger. Luminal discharge of purulent material can often be seen with this maneuver or with simple digital compression of the UD during urethroscopy. The success in identifying a diverticular ostia is highly variable and is reported to be between 15% and 89% (10,11,23). As a note of caution, patients with UD are often highly symptomatic, and endoscopic examination can be very difficult to initiate or complete. Notably, a positive exam may help in surgical planning; however, the failure to locate an ostia on cystourethroscopy should not influence the decision to proceed with further investigations or surgical repair.

For patients with UD and urinary incontinence or significant voiding dysfunction, a urodynamic study can be helpful (25–27). Urodynamics may document the presence or absence of stress urinary incontinence (SUI) prior to repair. Approximately 50% of women with UD will demonstrate SUI on urodynamic evaluation (10,28). A videourodynamic study combines both a voiding cystourethrogram and a urodynamic study, thus consolidating the diagnostic evaluation and decreasing the number of required urethral catheterizations during the patient's clinical workup. In addition, videourodynamic evaluation may be able to differentiate true stress incontinence from pseudoincontinence related to emptying of a urethral diverticulum with physical activity.

For patients undergoing surgery for UD with coexistent symptomatic SUI demonstrated on physical examination, or urodynamically demonstrable SUI, or those found to have an open bladder neck on preoperative evaluation, concomitant anti-incontinence surgery can be offered. Multiple authors have described successful concomitant repair of urethral diverticula and stress incontinence in the same operative setting (10,28–30). Alternatively, on urodynamic evaluation, a small number of patients may have evidence of bladder outlet obstruction due to the obstructive effects of the UD on the urethra.

It should be noted that SUI may coexist with obstruction (31), but nevertheless both conditions can be treated successfully with a carefully planned and executed operation.

Imaging

Critically important to the success of surgical treatment of female UD is high-quality preoperative imaging. Aside from its utility as a diagnostic entity, radiologic imaging should also provide an accurate reflection of the relevant anatomy of the UD, including its relationship to the proximal urethra and bladder neck.

A number of imaging techniques have been applied to the study of female UD, and no single study can be considered the gold standard or optimal imaging study for the evaluation of UD. Each technique has relative advantages and disadvantages, and the ultimate choice of diagnostic study in many centers often depends on several factors, including local availability, cost, and the experience and expertise of the radiologist. Currently available techniques for the evaluation of UD include double-balloon positive-pressure urethrography (PPU), voiding cystourethrography (VCUG), ultrasound (US), and MRI with or without an endoluminal coil (eMRI).

Positive-Pressure Urethrography and Voiding Cystourethrography

Classically, double-balloon PPU had been considered to be the best study for the diagnosis and assessment of female UD (10,12,32,33). In this technique, a highly specialized catheter with two balloons separated by several centimeters is inserted into the female urethra. This catheter contains a channel within the catheter that exits through a side hole between the two balloons. The one balloon is positioned adjacent to the external urethral meatus and the other balloon is situated at the bladder neck. Both balloons are inflated, creating a seal about the urethral lumen. Contrast is then infused through the channel under slight pressure distending the urethral lumen between the two balloons and forcing contrast into the UD, thereby opacifying the cavity. This highly specialized study provides outstanding images of the urethra and UD and, importantly, unlike VCUG, is not dependent on the patient successfully voiding during the study. However, PPU is not widely performed clinically. It is a complicated study requiring a very specific type of modified urethral catheter as well as expertise in the performance and interpretation of the study by the radiologist. Furthermore, it is invasive, requiring catheterization of the female urethra, which, in the setting of acute inflammation commonly seen with female UD, can cause considerable patient discomfort and distress. Finally, noncommunicating UD (19) and loculations within existing UD cannot be visualized with PPU because the contrast will not enter and fill these areas in the absence of a connection to the urethral lumen.

As an alternative to PPU, VCUG may provide excellent imaging of UD (Figure 20.3). It is widely available and is a familiar diagnostic technique to most radiologists. Although VCUG is probably the most widely used study for the diagnosis and evaluation of patients with known or suspected UD, it has several limitations. First, VCUG is invasive, requiring catheterization of the urethra for bladder filling. This can result in considerable patient discomfort and may risk translocating bacteria from an infected UD into the bladder during catheterization, resulting in bacterial cystitis. This is also a risk of PPU. Importantly, successful imaging of the UD occurs only during the voiding phase of the VCUG with subsequent filling of the urethra. Occasionally, only the postvoid film demonstrates the UD (34–36). Not uncommonly, patients are somewhat inhibited or otherwise unable to void during VCUG for a variety of reasons, including pain from the initial urethral catheterization. Unfortunately, in the absence of contrast entering the urethra, opacification of

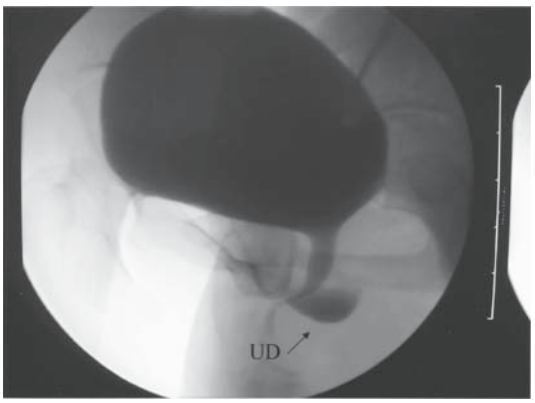


Figure 20.3. Voiding image from a voiding cystourethrography (VCUG) demonstrating a urethral diverticulum.

the diverticulum does not occur. Furthermore, an inability to generate an adequate flow rate during the VCUG will result in suboptimal filling of the UD and an underestimation of its size and complexity. Finally, some UD may not opacify following a technically successful VCUG due to acute inflammation of the ostia or neck of the diverticulum or because the diverticulum does not otherwise communicate with the urethral lumen. These noncommunicating UDs exist within the urethropelvic ligament and can be successfully imaged with cross-sectioning techniques such as MRI (19).

Three studies have compared VCUG with PPU and concluded that PPU is a more sensitive test for UD than VCUG (37–39). In one study of 32 patients, VCUG failed to demonstrate the UD in 69% of patients, whereas PPU failed to demonstrate the lesion in only 6%.

Ultrasound

This study has also been advocated for the preoperative assessment of UD (40–48). Transvaginal and transurethral techniques have been described. Transvaginal imaging often provides information regarding the size and location of UD. It is relatively noninvasive and, like all US imaging, does not expose the patient to radiation. Another significant advantage of US is that successful imaging of UD does not require voiding. However, US does not always produce detailed high-resolution images that demonstrate precise surgical anatomy, and furthermore this study can be somewhat operator dependent. Transurethral and three-dimensional US techniques are evolving and may provide an incremental improvement in resolution (49). But similar to PPU and VCUG, the transurethral techniques are invasive as the US probe is placed per urethra and can cause patient discomfort and bacterial seeding of the lower urinary tract.

Magnetic Resonance Imaging

As an alternative to the radiologic investigations noted previously, MRI permits relatively noninvasive, high-resolution, multiplanar imaging of UD. Additional advantages of MRI, compared to PPU and VCUG, are that successful imaging of UD is wholly independent of voiding and that it is free from ionizing radiation. Surface-coil (50,51) and endoluminal techniques (22,39,52,53) have been described. Endoluminal imaging (eMRI) places the magnetic coil into a body cavity adjacent to the area of interest. This location produces an improved signal-to-noise ratio and high-resolution imaging of these areas (52,53). For the evaluation of UD, the coil is placed intravaginally or intrarectally (Figure 20.4). Both surface coil MRI and eMRI appears to be superior to VCUG and/or PPU in the evaluation of UD (51,52,54). but the

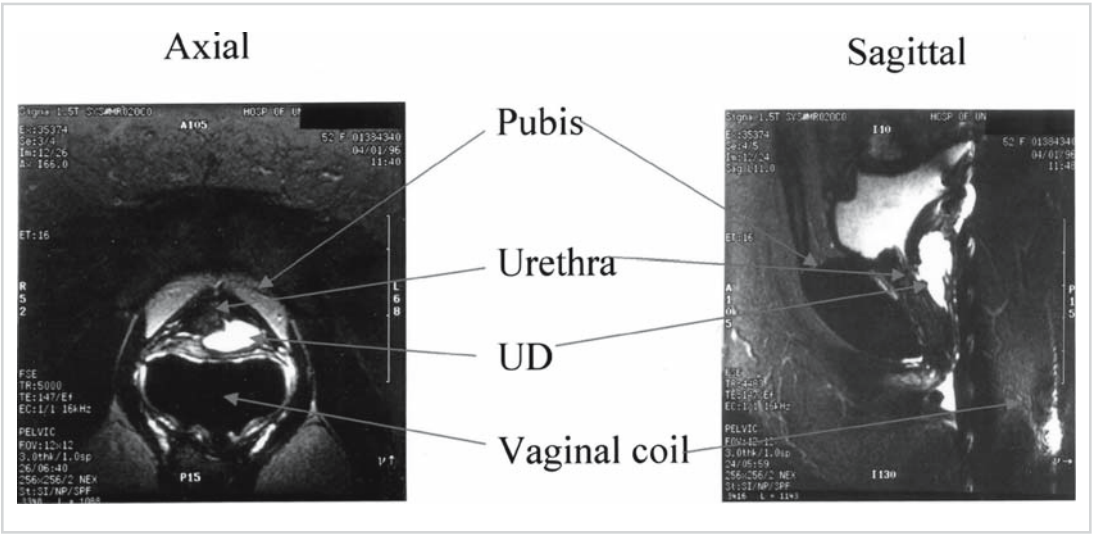


Figure 20.4. Endoluminal MRI (eMRI) demonstrating the relevant anatomy of a patient with a urethral diverticulum.

technology is expensive and not widely available. Contraindications to MRI for UD are few; these include metallic foreign-body fragments, claustrophobia, and an inability to tolerate the endoluminal probe. Notably, if the UD cavity is completely decompressed during the MRI, the lesion will not be seen. Some authors have recommended that the patient void just prior to MRI to ensure that the diverticulum is distended and therefore imaged (22).

Classification

Although not yet widely adopted, a classification system for UD has been proposed by Leach et al (55). This staging system for UD, termed the L/N/S/C3 classification system, is similar to that used for cancer staging and is based on several characteristics of UD including location, number, size, anatomic configuration, site of communication to the urethral lumen, and continence status of the patient. This system attempts to standardize description of UD but as of yet has not been prospectively applied or validated in other authors. Another classification scheme utilized the location of the UD as the primary determinant of surgical approach, with distal lesions undergoing marupialization and more proximal lesions undergoing excision and reconstruction (56).

Finally, a classification system proposed by Leng and McGuire (57) divides UDs into two categories based on the presence or absence of a preserved periurethral fascial layer. In some patients with UD who have undergone prior vaginal or urethral surgery, the periurethral fascial layer may be deficient resulting in a pseudodiverticulum. These authors suggest that the recognition of this anatomic configuration has important implications for surgical reconstruction. These patients may require additional reconstruction or interposition of a tissue flap or graft to buttress the repair and prevent recurrence or postoperative urethrovaginal fistula formation.

Surgical Repair

Indications for Repair

Although often highly symptomatic, not all urethral diverticula mandate surgical excision. Some patients may be asymptomatic at presentation, with the lesion incidentally diagnosed on imaging for another condition or perhaps incidentally noted on routine physical examination. Other patients may be unwilling or medically unable to undergo surgical removal. Very little is known regarding the natural history of untreated urethral diverticula. Whether these lesions progress in size, symptomatology, or complexity with time is unknown. For these reasons, and due to the lack of symptoms in selected cases, some patients may not desire surgical therapy. In addition, there are multiple reports in the literature of carcinomas arising in UD (58–67), and it is possible that certain carcinomas arising in UD are asymptomatic and may not be prospectively identified on radiologic imaging. Thus patient counseling and ongoing monitoring is necessary in patients who elect primary nonoperative management.

Symptomatic patients, including those with dysuria, refractory bothersome postvoid dribbling, recurrent urinary tract infections (UTIs), dyspareunia, and pelvic pain in whom the symptoms can be attributed to the UD, may be offered surgical excision. Those with UD and symptomatic stress urinary incontinence can be considered for a concomitant anti-incontinence procedure at the time of UD excision (see later discussion).

Alternative Techniques

A variety of surgical interventions for urethral diverticula have been described including marsupialization (68,69), endoscopic incision (70–73), fulguration (74), coagulation (75), and excision with reconstruction. Most commonly, a complete excision and reconstruction is performed as described below. However, for distal lesions, a transvaginal marsupialization as described by Spence and Duckett may reduce operative time, blood loss, and recurrence rate (68,69,76). However, during this procedure, care must be taken to avoid aggressively extending the incision proximally, which could potentially damage the proximal and distal sphincteric mechanism. Therefore, this approach is only applicable to UD in very select cases involving the distal third of the urethra and is not commonly performed.

Excision and Reconstruction

Preoperative Preparation

Prophylactic antibiotics can be utilized for a period of time preoperatively to ensure sterile urine at the time of surgery. Patients can also be encouraged to strip the anterior vaginal wall following voiding, thereby consistently emptying the UD and preventing urinary stasis and recurrent UTIs. This may not be possible in those with noncommunicating UD or in those who have significant pain related to the UD. Application of topical estrogen creams for several weeks prior to surgery may be beneficial in some patients with postmenopausal atrophic vaginitis in improving the overall quality of the tissues with respect to dissection and mobilization. Preoperative parenteral antibiotics are often administered especially for those with recurrent or persistent UTIs.

Patients with symptomatic SUI can be offered simultaneous anti-incontinence surgery. Preoperative videourodynamics may be helpful in evaluating the anatomy of the UD, assessing the competence of the bladder neck, and confirming the diagnosis of stress urinary incontinence. In patients with SUI and UD, Ganabathi et al (10) and others (77) have described satisfactory results with concomitant needle bladder neck suspension in these complex patients. More recently, pubovaginal fascial slings have been utilized in patients with UD and SUI with satisfactory outcomes (24,29,30).

Further complicating these cases may be associated symptoms such as pain, dyspareunia, voiding dysfunction, UTIs, and urinary incontinence. These associated symptoms are often, but not always, improved or eliminated with surgical repair. Therefore, the importance of appropriate preoperative patient counseling regarding surgical expectations cannot be overemphasized.

Procedure

Complex urethral reconstructive techniques for the repair UD have been described. Fall (78) described the use of a bipedicled vaginal wall flap for urethral reconstruction in patients with UD and urethrovaginal fistula. Laterally based vaginal flaps have also been utilized as an initial approach to UD (79,80). The technique described herein is similar to that published by Leach and Raz (81) as well as Young and Raz (1). The principles of urethral diverticulectomy are well described (Table 20.1).

The patient is placed in the lithotomy position with all pressure points well padded. A weighted vaginal speculum and Scott retractor with hooks aid in exposure. A posterolateral episiotomy may also be beneficial in some patients for additional exposure, although the midurethral (and therefore somewhat distal in the vaginal canal) location of most UD usually preclude the need for this type of adjunctive procedure. A Foley catheter is placed per urethra and a suprapubic tube is often utilized for optimal unobstructed postoperative urinary drainage.

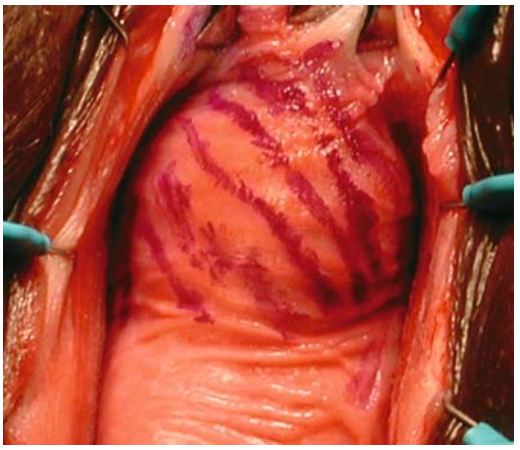
An inverted-U is marked out along the anterior vaginal wall with the base of the U at the level of the distal urethra and the limbs extending to the bladder neck or beyond (Figure 20.5A). Care is taken to ensure that the limbs of the U are progressively wider proximally (toward the bladder neck) to ensure adequate vascularity at the distal lateral margins of the anterior vaginal wall flap. Injectable saline can be infused along the lines of the incision to facilitate dissection. An anterior vaginal wall flap is created by careful dissection in the potential space between the vaginal wall and the periurethral fascia. The use of sufficient countertraction during this portion of the procedure is important in maintaining the proper plane of dissection. Care is taken to preserve the periurethral fascia and avoid inadvertent entry into the UD.

A distinct layer of periurethral fascia is usually interposed between the vaginal wall and the UD. Preservation of this layer is paramount in order to prevent recurrence, close dead space, and avoid urethrovaginal fistula formation postoperatively. Pseudodiverticula have been described where this layer of tissue is considerably attenuated or even absent (57). In these patients, an

Table 20.1. Principles of transvaginal urethral diverticulectomy

Mobilization of a well-vascularized anterior vaginal wall flap
Preservation of the periurethral fascia
Identification and excision of the neck of the UD or ostia
Removal entire UD wall or sac (mucosa)
Watertight urethral closure
Multilayered, nonoverlapping closure with absorbable suture
Closure of dead space
Preservation or creation of continence

UD, urethral diverticula.



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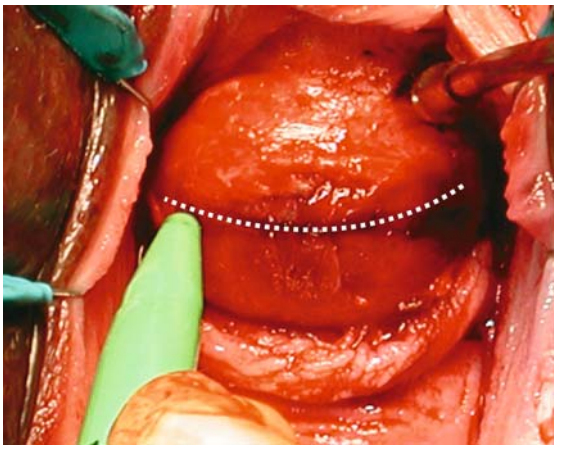

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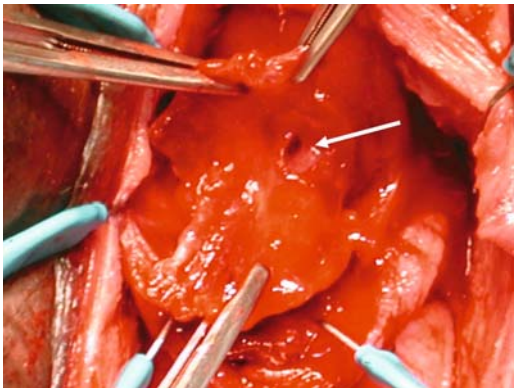

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Figure 20.5. A: An inverted-U incision is marked by cross-hatching on the anterior vaginal wall. Retraction is aided by the use of Allis clamps and a ring retractor with hooks. B: A transverse incision is made in the periurethral fascia. The dotted line represents the intended incision line overlying the one drawn by the marker. The anterior vaginal wall flap has been reflected posteriorly and is seen folded on itself at the lower end of the image. C: The walls of the UD have been dissected off the overlying periurethral fascia and are seen grasped in the forceps. The ostia is identified (white arrow).

interpositional flap or graft, such as a pubovaginal sling, may be utilized for reconstruction.

The periurethral fascia is incised transversely (Figure 20.5B). Proximal and distal layers of periurethral fascia are carefully developed avoiding entrance into the UD. The UD is then grasped and dissected back to its origin on the urethra within the leaves of the periurethral fascia. In many cases it is necessary to open the UD to facilitate dissection from the surrounding tissues. The ostia or connection to the urethra is identified and the walls of UD are completely removed (Figure 20.5C). Every effort should be made to remove the entire mucosalized surface of the UD in order to prevent recurrence (10,43). This may involve removing small adherent or inflamed portions of the urethral wall especially in the area of the ostia. All abnormal tissue in the area of the ostia should be removed if possible to ensure that no mucosal elements of the UD wall remain, which could result in postoperative urine leakage and recurrence. The Foley catheter is usually seen following complete excision of UD. The urethra can be reconstructed over a 16-French Foley catheter and should be closed in a watertight fashion with absorbable suture. The closure should be tension-free. Uncommonly, a UD may extend circumferentially around the urethra and require segmental resection of the involved portion of the urethra and complex reconstruction (2,82).

The excess periurethral fascia is trimmed and then the flaps are reapproximated with absorbable suture in a perpendicular orientation to the urethral closure line to minimize overlap and the risk of postoperative urethrovaginal fistula

formation. Care is taken to secure the periurethral fascial flaps in such a way as to close all dead space.

If desired, a fibrofatty labial (Martius) flap can be harvested at this point and placed over the periurethral fascia as an additional layer of closure (42). Indications for such a flap are not universally agreed upon. However, in those patients with poor-quality tissues, attenuated periurethral fascia, or in whom significant inflammation is encountered intraoperatively, a well-vascularized adjuvant flap such as a Martius flap may reduce the risk of wound breakdown and subsequent complications.

The anterior vaginal wall flap is then replaced and reapproximated with absorbable suture. This completes a three-layer closure (four layers if a Martius flap is utilized). An antibiotic impregnated vaginal pack is placed.

Postoperative Care

Antibiotics are continued for 24 hours postoperatively. The vaginal packing is removed and the patient discharged with both urethral and suprapubic catheters. Antispasmodics are used liberally to reduce bladder spasms. A VCUG is obtained at 14 to 21 days postoperatively. If there is no extravasation, the catheters are removed. If extravasation is seen, then the urethral catheter is reinserted and repeat VCUGs are performed weekly until resolution is noted. In the vast majority of cases, extravasation will resolve in several weeks with this type of conservative management (83).

Complications

Careful adherence to the principles of transvaginal urethral diverticulectomy should minimize postoperative complications. Nevertheless, complications may arise (Table 20.2). Common complications include recurrent UTIs, urinary incontinence, or recurrent UDs. Urethrovaginal fistula is a devastating complication of urethral diverticulectomy and warrants special mention. A fistula located beyond the sphincteric mechanism should not be associated with symptoms other than a split urinary stream. As such, an asymptomatic distal urethrovaginal fistula may not require repair, although some patients may request repair. Conversely, a proximal fistula located at the bladder neck or at the midurethra in patients with an incompetent bladder neck will likely result in considerable symptomatic urinary leakage. These patients should undergo repair with the use of an adjuvant tissue flap such as a Martius flap to provide a well-vascularized additional tissue layer. The actual timing of the repair relative to the initial procedure is controversial. Meticulous attention to surgical technique, good hemostasis, avoidance of infection, preservation of a well-vascularized anterior vaginal wall flap, and multilayered closure with nonoverlapping suture lines should minimize the potential for postoperative urethrovaginal fistula formation.

Table 20.2. Complications of transvaginal urethral diverticulectomy

Complication (% range of reported incidence)
Urinary incontinence (1.7–16.1%)
Urethrovaginal fistula (0.9–8.3%)
Urethral stricture (0–5.2%)
Recurrent UD (1–25%)
Recurrent urinary tract infection (0–31.3%)
Other
Hypospadias/distal urethral necrosis
Bladder or ureteral injury
Vaginal scarring or narrowing: dyspareunia, etc.

Some patients have persistence or recurrence of their preoperative symptoms postoperatively. The finding of a UD following a presumably successful urethral diverticulectomy may occur as a result of a new UD, or alternatively, as a result of recurrence. Recurrence of UD may be due to incomplete removal of the UD, inadequate closure of the urethra or residual dead space, or other technical factors. Repeat urethral diverticulectomy surgery can be challenging, as anatomic planes may be difficult to identify.

Urethral Diverticula and Associated Conditions

Malignant and benign tumors may be found in urethral diverticula. Both are quite rare, and less than 100 cases of carcinoma within UD have been reported in the English-language literature (63). The most common malignant pathology is adenocarcinoma, followed by

transitional cell and squamous cell carcinomas. There is no consensus on proper treatment in these cases, and recurrence rates are high with local treatment alone. In addition, nephrogenic adenoma and endometriosis have been described within urethral diverticula (84,85).

Calculi within UD are not uncommon and may be diagnosed in 4% to 10% of cases (24,86,87), and is most likely due to urinary stasis or infection. This may be suspected by physical exam findings or noted incidentally on imaging evaluation. The presence of a stone will not significantly alter the evaluation or surgical approach and can be considered an incidental finding.

Urethral diverticula has also been reported to present during pregnancy. Moran et al (88) reported four cases of UD diagnosed during pregnancy. Conservative treatment included antibiotics and aspiration or incision and drainage. Two women delivered vaginally, and the other two delivered via cesarean section for unrelated reasons. In one patient, drainage was performed during labor to facilitate delivery. Three of the four women had definitive repair performed after delivery. It is not known if pregnancy is associated with formation of UDs, although patients may be more likely to become symptomatic during this period.

Periurethral Masses Other Than Urethral Diverticula

Periurethral masses other than UD comprise a wide spectrum of conditions that must be differentiated from each other and UD. It may often be possible to make a definitive diagnosis based on history and physical exam alone; in other cases, judicious use of radiographic and cystoscopic studies will be necessary to exclude UD.

Vaginal Leiomyoma

Vaginal leiomyoma is a benign mesenchymal tumor of the vaginal wall that arises from smooth muscle elements. It commonly presents as a smooth, round mass on the anterior vaginal wall (Figure 20.6). It is an uncommon lesion with approximately 300 cases reported in the literature (89). In a recent series of 79 patients with periurethral masses, four (5%) were found to have leiomyoma (90). These masses were all apparent on physical examination as freely mobile, nontender masses on the anterior vaginal wall. Symptoms, if they exist, are usually related to the size of the lesion and include a mass effect, obstruction, pain, and dyspareunia. They commonly present in the fourth to fifth decade. Like uterine leiomyoma, these lesions are usually estrogen dependent and have been demonstrated to regress during menopause (91). Excision or enucleation via a vaginal approach is recommended to confirm the diagnosis, exclude malignant histology, and alleviate symptoms.

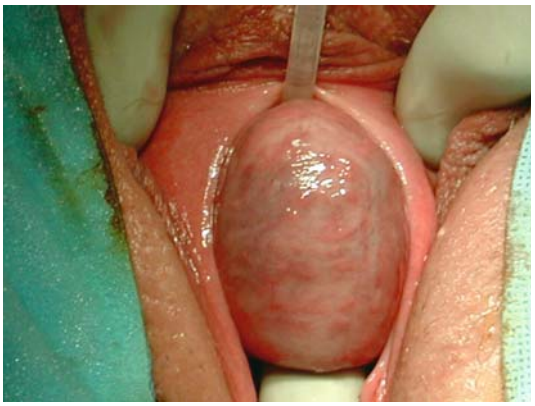

Figure 20.6. Large anterior vaginal wall leiomyoma.

Skene's Gland Abnormalities

Skene's gland cysts and abscesses are similar lesions that are differentiated based on clinical findings (Figure 20.7). Both lesions generally present as small, cystic masses just lateral or inferolateral to the urethral meatus. They may be lined with transitional or stratified squamous epithelium. Abscesses may be extremely tender and inflamed, and in some cases purulent fluid can be expressed from the ductular orifice. Skene's gland cysts are not uncommonly noted in neonatal girls and young to middle-age women (92). Symptoms may include dysuria, dyspareunia, obstruction, and pain. Differentiation from UD can often be made on physical examination, as these lesions are located relatively distally on the urethra in the region of the urethral meatus as compared to UDs, which most commonly occur over the middle and proximal urethra. Various treatments for Skene's

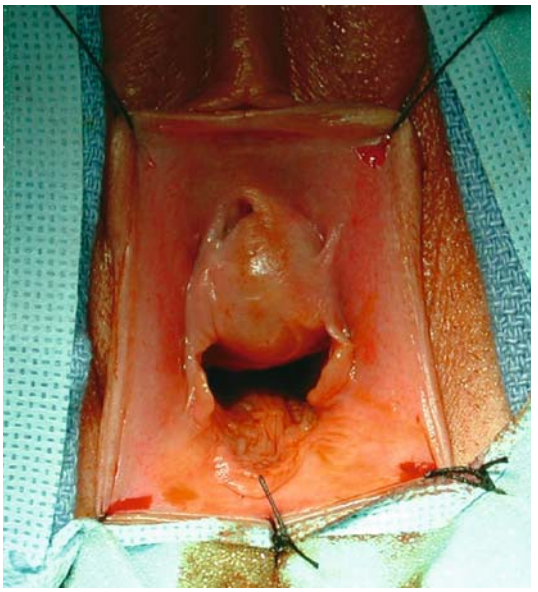

Figure 20.7. Skene's gland cyst in a 19-year-old woman. Note the large periurethral mass with displacement of the urethral meatus.

glands abnormalities have been described, including aspiration, marsupialization, incision and drainage, and simple excision.

Adenocarcinoma arising in Skene's glands has been reported. Because of homology with the prostate, these patients may demonstrate elevated prostate-specific antigen (PSA) levels that normalize with treatment (93).

Gartner's Duct Cysts

Gartner's duct cysts represent mesonephric remnants and are found on the anterolateral vaginal wall from the cervix to the introitus. Because these are mesonephric remnants, they may drain ectopic ureters from poorly functioning or nonfunctioning upper-pole moieties in duplicated systems. They have also been reported with single-system ectopia, although this is much less common in females (94,95). It is not clear what proportion of patients with Gartner's duct cysts will have ipsilateral renal abnormalities, but upper tract evaluation is recommended. In contrast, approximately 6% of subjects with unilateral renal agenesis will have a Gartner's duct cyst (96). Up to 50% of patients with Gartner's duct cysts and renal dysplasia may also have ipsilateral müllerian duct obstruction (97).

Treatment depends on symptoms and association with ectopic ureters. If the lesions are asymptomatic and are associated with a nonfunctioning renal moiety, they can be observed. Aspiration and sclerotherapy has been successful (98). Simple excision or marsupialization has also been recommended for symptomatic lesions. If the cyst is associated with a functioning renal moiety, treatment must be individualized.

Vaginal Wall Cysts

Vaginal wall cysts usually present as small asymptomatic masses on the anterior vaginal wall (99). They may arise from multiple cell types: mesonephric (Gartner's duct cysts), paramesonephric (müllerian), endometriotic, urothelial, or epidermoid (inclusion cyst). A specific diagnosis cannot be reliably made until the specimen is removed and examined by a pathologist. The histologic subtype is usually of little consequence, although epidermoid cysts are usually associated with previous trauma or vaginal surgery. Pradhan and Tobon (100) described the pathologic characteristics of 43 vaginal cysts in 41 women removed over a 10-year period. The derivation of the cyst was müllerian in 44%, epidermoid in 23%, and mesonephric in 11%. The remainder were Bartholin gland type, endometriotic, and indeterminate. As with other periurethral masses, they must be differentiated from UD. Treatment is usually by simple excision in symptomatic patients.

Urethral Mucosal Prolapse

Urethral prolapse presents as a circumferential herniation or eversion of the urethral mucosa at the urethral meatus. The prolapsed mucosa commonly appears as a beefy red "doughnut"-shaped lesion which completely surrounds the urethral meatus. It may be asymptomatic or present with bleeding, spotting, pain, or urinary symptoms. It is commonly noted in two separate populations: postmenopausal women and prepubertal girls. Although thought to be more common in young African-American girls, more recent series do not confirm this predilection (101,102). In children, it is often causally related to the Valsalva

maneuver or constipation. Eversion of the mucosa may then occur due to a pathologically loose attachment between smooth muscle layers of the urethra (103). Etiology is much less clear for postmenopausal women, although it has been epidemiologically linked to estrogen deficiency. Treatment may be medical or surgical. Medical treatment involves topical creams (estrogen, anti-inflammatory) or sitz baths. Various surgical techniques have been described including cauterization, ligation around a Foley catheter, and complete circumferential excision. Circumferential excision with suture reapproximation of the remaining urethral mucosa to the vaginal wall can be performed with few complications. Rudin et al (102) reported outcomes in 58 girls with urethral prolapse. Medical treatment was initially successful in 20 patients in whom there were five recurrences. The remaining 38 patients failed initial conservative management and underwent surgical excision with four complications including urethral stenosis in two. Jerkins et al (104) found superior results in surgically treated patients when compared with medical management or catheter ligation.

Urethral Caruncle

Urethral caruncle is an inflammatory lesion of the distal urethra that is most commonly diagnosed in postmenopausal women. It usually appears as a reddish exophytic mass at the urethral meatus that is covered with mucosa. These lesions are often asymptomatic and noted incidentally on gynecologic examination. When irritated they may cause underwear spotting or become painful. Less commonly they may cause voiding symptoms. Etiologically they are related to mucosal prolapse. Chronic irritation contributes to hemorrhage, necrosis, and inflammatory growth of the tissue, which corresponds to the histology of excised lesions. If the lesion is atypical in appearance or behavior, excision may be warranted to exclude other entities. Intestinal metaplasia, tuberculosis, melanoma, and lymphoma have all been reported to either coexist with or mimic urethral caruncles (105–109).

There is a paucity of literature regarding optimal treatment of urethral caruncle. Most authors recommend initial conservative management with topical estrogen or anti-inflammatory creams and sitz baths. Large or refractory lesions may be managed with simple excision. The tip of the lesions should be grasped and traction employed to fully expose the base of the caruncle. The lesion can then easily be excised. If a large defect remains, the mucosa may be reapproximated with absorbable suture. In most instances, the urethral mucosa will heal around a Foley catheter, which may be left in place for several days.

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21

Bladder Neck Closure

Aaron D. Berger and Christopher E. Kelly

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Bladder neck closure (BNC) is a procedure that, although not performed frequently, can be very beneficial for an appropriately selected patient. The traditional role of BNC was in the female patient with a neurogenic bladder, destroyed bladder neck, and patulous urethra from long-term indwelling catheter drainage (1–4). Other options for urethral reconstruction using vagina or bowel have been reported, but are very complex, and attempts to create a patent and continent outlet are often unsuccessful (5). Other indications for the procedure have included bladder neck destruction from pelvic trauma, labor and delivery complications, and multiple failed surgical interventions to treat incontinence or urethrovaginal fistulas (6). Bladder neck closure can be combined with other procedures such as creation of a continent catheterizable stoma both separately or in combination with augmentation cystoplasty for patients with small capacity bladders or refractory detrusor overactivity (6–8). If the patient is unwilling or unable to perform intermittent catheterization, urinary drainage can be managed with a suprapubic tube or an ileovesicostomy (9). In early reports, BNC was often unsuccessful, but refinements in patient selection and surgical technique have significantly improved patient outcomes (13).

Indications

Patients with neurogenic bladders are the primary candidates to undergo a BNC. Central and peripheral nervous system disorders such as multiple sclerosis, spinal cord injury, and dementia can cause bladder dysfunction resulting in the need for chronic catheter drainage. Over time, the indwelling urethral catheter can cause destruction of the urethra via pressure necrosis. This process is typically seen in patients who have had indwelling catheters for 5 years or longer; however, urethral damage has been reported in as little as 6 months. As the urethra becomes progressively more damaged, the functional urethra shortens and the bladder neck widens, which leads to progressively worse incontinence around the catheter. This process is exacerbated by the frequent bladder spasms that many of these patients suffer from. Incontinence brings the use of increasingly larger catheters in an attempt to prevent urinary leakage around the catheter. However, with every increase in catheter size, the urethral damage also worsens. Incontinence in this patient population is a serious complication as continuous wetness of the perineum can lead to skin breakdown and ulcer formation.

There are several indications for BNC in the nonneurogenic population as well. These include

severe incontinence from intrinsic sphincter deficiency that is refractory to other treatments, recurrent urethrovaginal fistulas, and urethral damage from multiple failed anti-incontinence surgeries.

Patient Evaluation

The preoperative evaluation should begin with a thorough history and physical examination, paying close attention to any history of prior abdominal or pelvic surgery, lower extremity contractures, incontinence, and perineal skin breakdown. An assessment should also be made at that time about the patient's willingness and ability to perform intermittent catheterization if a continent cutaneous diversion is planned. This should begin with a discussion about the patient's manual dexterity, and if she is unable to perform clean intermittent catheterization on her own, then a reliable caregiver must be willing and available.

Upper urinary tract imaging should be performed by ultrasound, intravenous urography, or contrast-enhanced computed tomography. If upper tract abnormalities are detected, a cystogram or voiding cystourethrogram (VCUG) should be performed to evaluate for the presence of vesicoureteral reflux and bladder diverticuli. Cystoscopy should be performed on any patient who has been managed with a chronic indwelling catheter to rule out the presence of malignancy or calculi.

Urodynamics to evaluate bladder function is mandatory in any patient who will be given a continent catheterizable stoma. It is important to determine whether detrusor overactivity or poor bladder compliance exist prior to performing such a diversion. If filling pressures are dangerously elevated at physiologic volumes or if overactivity is severe and refractory, an augmentation cystoplasty should be considered at the time of BNC. Finally, a urine culture should be obtained and appropriate preoperative antibiotics administered.

Surgical Technique

Vaginal Approach

The vaginal approach to BNC should be used for patients who will be managed with suprapubic tube drainage. The patient should be given perioperative antibiotics, placed in the dorsal lithotomy position, and have the vagina and lower abdomen meticulously prepped and draped in a sterile fashion. A 20- or 22-French Foley suprapubic catheter should then be placed using a Lowsley retractor (10). To do this, the patient is placed in the Trendelenburg position and the bladder is catheterized and filled with saline as much as possible. Then, keeping as much saline in the bladder as possible, the curved Lowsley retractor is placed through the urethra and pointed toward the anterior abdominal wall, approximately 1 to 2 cm superior to the pubic symphysis. A small incision is made in the skin to expose the retractor, which is then opened and the deflated Foley catheter is placed in the jaws of the retractor. The jaws are then closed and the catheter is delivered into the bladder. The catheter position is confirmed by either cystoscopy or manual irrigation.

A circumscribing incision is then made around the urethral opening and extended on the anterior vaginal wall in an inverted-U shape as shown in Figure 21.1. A vaginal flap is then raised using sharp dissection to free the anterior vaginal wall from the underlying perivesical fascia as shown in Figure 21.2. The dissection is then continued to free the urethra from its lateral and anterior attachments. Hydrodissection into the periurethral tissue can facilitate dissection. The endopelvic fascia is then opened sharply on both sides of the bladder neck, which is then freed from its pubic and lateral pelvic wall attachments. The pubourethral ligaments are then transected to completely free up the bladder from its attachments (Figures 21.3), which is essential in achieving a tension-free BNC.

The ureteral orifices are then identified by the administration of intravenous indigo carmine. Any scarred urethra that remains should be excised to provide healthy, well-vascularized tissue for the subsequent closure. The bladder neck is then closed in a vertical fashion with absorbable 2-0 or 3-0 polyglycolic acid sutures (Figure 21.4). The bladder should then be filled with saline through the suprapubic tube to ensure that the closure is watertight. A second layer of sutures is then placed in a horizontal direction and incorporating enough bladder neck and anterior bladder wall to bring the closed bladder neck up behind the pubic symphysis (Figure 21.5). A labial fat pad graft (e.g., Martius flap) can be created and positioned to

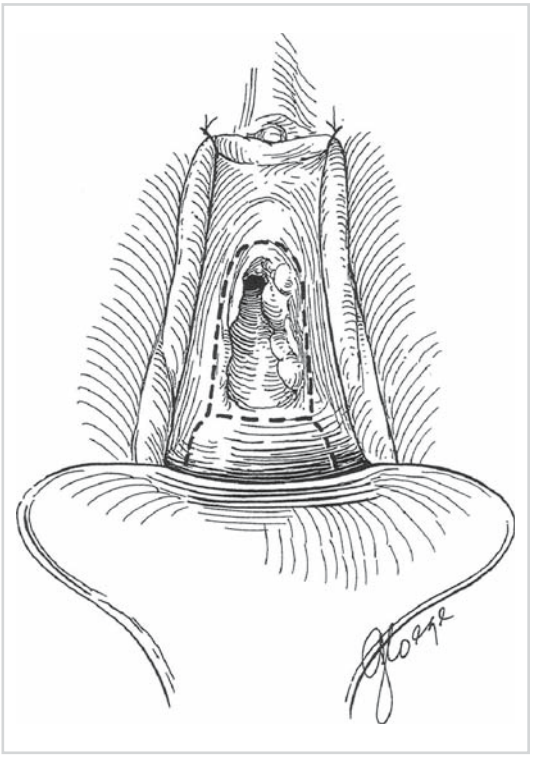

Figure 21.1. Diagram showing recommended incision for transvaginal closure of the bladder neck. (From Raz S. Female Urology, 2nd ed. Philadelphia: WB Saunders, 1996. Copyright 1996, with permission from Elsevier.)

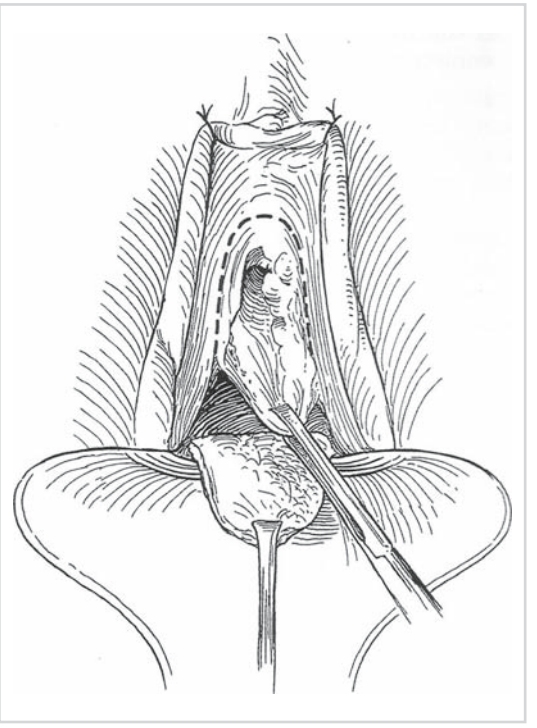

Figure 21.2. The anterior vaginal wall flap is elevated and retracted with an Allis clamp. The bladder neck is then grasped and the incision around the bladder neck is extended laterally. (From Raz S. Female Urology, 2nd ed. Philadelphia: WB Saunders, 1996. Copyright 1996, with permission from Elsevier.)

lie between the BNC and the anterior vaginal wall (Figure 21.6); this aids in healing and minimizes the risk of a vesicovaginal fistula. If a Martius flap is employed, the vertical labial incision is closed with absorbable suture and a Penrose drain. Finally, the inverted U-shaped vaginal flap is trimmed, advanced, and sewn in place with a running 3-0 absorbable suture as seen in Figure 21.7. An antibiotic-impregnated vaginal pack should be placed and left for the first 24 hours postoperatively. The suprapubic catheter should be irrigated to ensure patency. The immediate use of anticholinergics to prevent bladder spasms may prevent suture line disruption and failure of BNC (5,11).

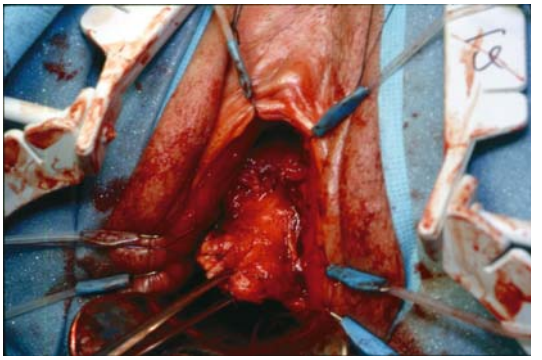

Figure 21.3. The bladder neck is completely mobilized by dividing the pubourethral ligaments.

Abdominal Approach

The abdominal approach to BNC is preferable for patients who will be undergoing a simultaneous augmentation cystoplasty and creation of a continent catheterizable stoma, or in patients who have failed a prior attempt at vaginal BNC. Ideally, the patient should be placed in the low lithotomy position to allow access to the vagina; however, if lower extremity contractures are

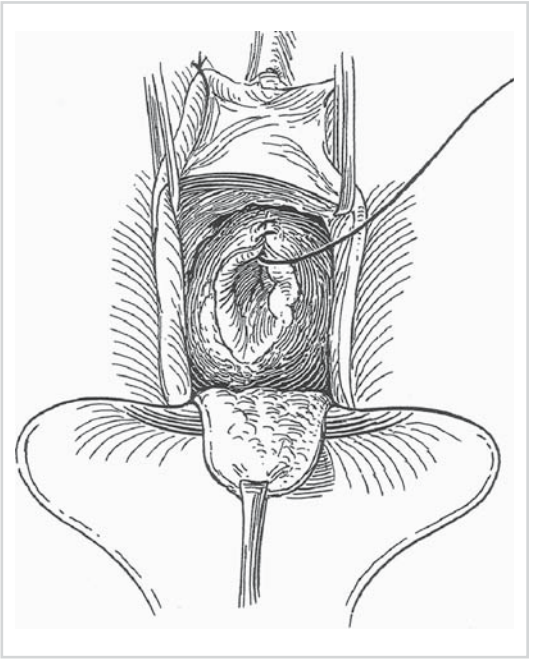

Figure 21.4. Primary closure of the bladder neck is done in a vertical fashion with a running suture. A second layer of closure is then performed in a horizontal fashion, which brings the closed bladder neck into a position behind the symphysis pubis. (From Raz S. Female Urology, 2nd ed. Philadelphia: WB Saunders, 1996. Copyright 1996, with permission from Elsevier.)

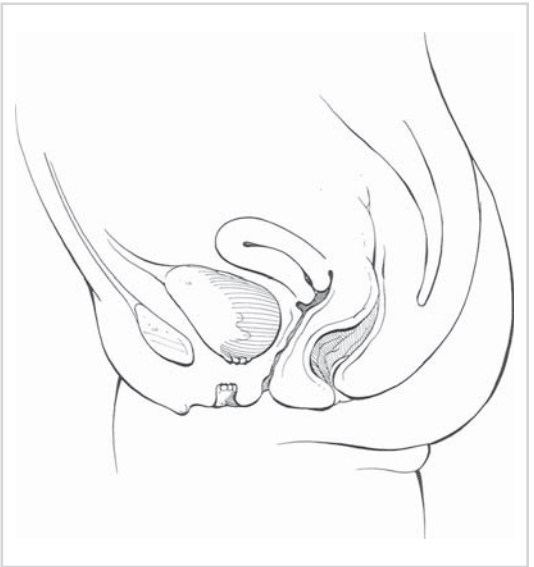

Figure 21.5. Lateral pelvis view showing the closed bladder neck in a position behind the symphysis pubis. (From Graham SD. Glenn's Urologic Surgery. Philadelphia: Lippincott-Raven, 1998.)

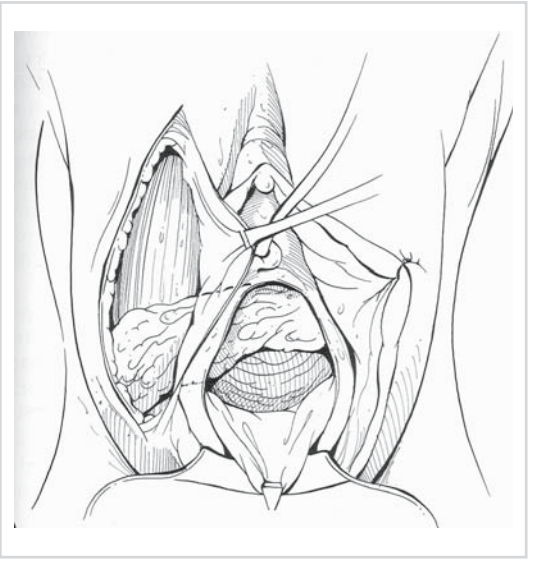

Figure 21.6. Diagram showing a Martius flap tunneled beneath the labia minora. This provides a protective tissue layer for the closed bladder neck. (From Graham SD. Glenn's Urologic Surgery. Philadelphia: Lippincott-Raven, 1998.)

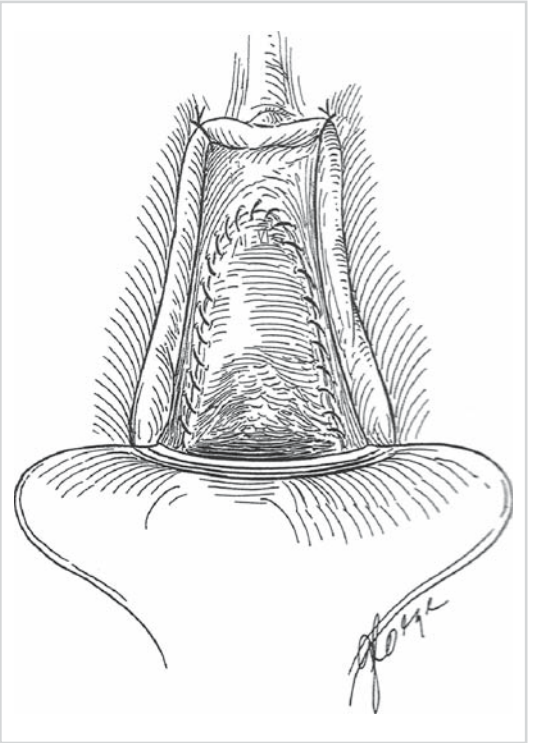

Figure 21.7. The inverted-U shaped vaginal flap is then advanced and sutured in place to close the vaginal defect. (From Graham SD. Glenn's Urologic Surgery. Philadelphia: Lippincott-Raven, 1998.)

present, the patient may be placed supine. A Foley catheter should be placed and either a midline infraumbilical or a Pfannenstiel incision can be utilized. The rectus muscles are retracted laterally and the space of Retzius is developed. A self-retaining retractor should be used to provide adequate exposure and keep the peritoneum superior to the operative field. The deep dorsal vein is ligated and the anterior bladder neck is transected. Indigo carmine should be administered to identify the ureteral orifices. The posterior bladder neck is then dissected free of the anterior vaginal wall with sharp dissection or electrocautery. Placing a pack or hand in the vagina can facilitate urethral dissection (11). Once the entire bladder neck is freed, the edges are trimmed down to healthy tissue. A vaginal approach may assist in the circumferential excision of the distal urethra. Any additional procedures such as an incontinent vesicostomy, catheterizable efferent limb, or augmentation cystoplasty should be performed at this time. A large-bore suprapubic tube should then be placed through a stab incision in the bladder dome. Closure of the bladder neck in two layers is then completed as described for the vaginal approach.

Complications

Failure of BNC, with resulting persistent urinary leakage, may be caused by poor tissue quality and wound healing, high intravesical pressures secondary to drainage catheter obstruction, or refractory bladder spasms. The most common complication of BNC is vesicovaginal fistula, with a reported incidence between 6% and 25% (11). If a fistula is suspected, filling the bladder with saline and methylene blue may aid in locating the opening of the fistulous tract. If a small fistula occurs in the early postoperative period, continued urinary diversion with suprapubic cystostomy or nephrostomy tubes can be considered to permit fistula closure. Reoperation, if needed, should be performed with the use of pedicled flaps (Martius or omental) placed between the bladder neck and vagina.

Loss of bladder access is another possible complication. There are various causes depending on the type of efferent urinary diversion used. Inadvertent suprapubic tube loss with subsequent tract closure may occur; bladder access should be reestablished with a flexible cystoscope or with a guidewire under fluoroscopic guidance. If this technique does not work, a new percutaneous suprapubic tube can be placed once the bladder is distended. Inability to catheterize, stomal leakage, and parastomal hernias are all possible complications of continent catheterizable stomas and can be managed with stomal revision.

Outcomes

Published series on BNC are small and have great variablilty in technique, making long-term outcomes and complications difficult to evaluate. Several series report continence rates ranging from 75% to 100% and reoperation rates as low as 7% (1,2,4,6,7,12). Table 21.1 shows the published long-term surgical results of the various techniques described.

Conclusion

Refractory incontinence is a challenging clinical problem that can greatly impact a patient's quality of life. Many of these patients have had long-term indwelling Foley catheters or have had multiple anti-incontinence surgeries. Bladder neck closure, while not the first-line treatment for severe incontinence or recurrent fistulas, is a safe and effective option for the appropriately selected patient.

Table 21.1. Outcomes of the reported series of bladder neck closure

First author, year (ref.)	No. of patients	Approach	Diversion	% continent
Feneley, 1983 (1)	24	Transvaginal	Suprapubic tube	83
Zimmern, 1985 (4)	6	Transvaginal	Suprapubic tube	100
Jayanthi, 1995 (2)	28	Abdominal	Continent vesicostomy	96
Hensle, 1995 (6)	13	Abdominal	Continent vesicostomy	92
Reid, 1978 (7)	10	Abdominal	Continent vesicostomy	80
Hoebeke, 2000 (12)	17	Abdominal	Continent vesicostomy	100

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