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Advances in Reconstructive

Vaginal Surgery

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Carl W. Zimmerman, MD

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Title: *Advances in Reconstructive Vaginal Surgery, 1st Edition*

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Dedication

To my parents Steve and Mileva, who helped me to achieve my desire to become a physician, and to my wife Patricia, who helped me become a better physician and pelvic reconstructive and vaginal surgeon.

S. Robert Kovac

This book is gratefully dedicated to all of my family, especially to Janice, my wife. She has actively encouraged me, shared my dreams, and patiently endured throughout my career.

Carl W. Zimmerman

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Preface

For untold generations, women have experienced vaginal relaxation that occurred years after childbearing. Women were also the first to recognize the initial feeling of relaxation that preceded the more noticeable and uncomfortable degrees of prolapse. Some women performed removal of this protrusion through self-inflicted vaginal hysterectomy. The fact that some women recovered from this self-inflicted procedure eventually encouraged gynecologic surgeons to perform planned vaginal hysterectomy. Willughby, P. *Observations in Midwifery*, edited from the original MS by Henry Blenkinsop, 1863. Yorkshire, England: SR Publishers Ltd; 1972.

Surgical repair of genital prolapse had progressed to the point of being somewhat successful by the end of the nineteenth century. However, reduction of the offending bulge was the goal of these early surgeries, not restoration of normal anatomy. At that time, normal functional vaginal anatomy was not really well-understood. The risks of reparative vaginal surgery today are minimal so that patients who are annoyed or distressed by genital prolapse can be confident that any degree of prolapse can be corrected by restorative vaginal surgery. Compensatory procedures that reduce the bulges, such as midline plication procedures of the anterior and posterior segments of the vagina, must be considered as relics of the past. Failure rates from such procedures are unacceptable and may alter the normal form and function of the vagina.

Operating through the vagina is the prerogative and imperative of the gynecologic surgeon. This basic point led to the concept of this book. Vaginal surgery is, without question, the most minimally invasive way to perform most, if not all, gynecologic procedures. Vaginal operations are performed through a natural orifice. We believe that successful reconstruction of pelvic organ prolapse depends on the proper understanding of pelvic anatomy and the restoration of that anatomy. With few special exceptions, we believe that changes in vaginal support anatomy are best identified and repaired through the vagina and with dissections that are performed in the retroperitoneal spaces than those that access the peritoneal cavity with large or small incisions. Certainly the operative strain on the patient is lessened. The chapters on repair of the various segments of the prolapsed vagina outline techniques to correct the anatomy causing cystoceles, rectoceles, and enteroceles. These surgeries restore the fascial breaks that cause these conditions back to their original attachment to the pericervical ring within the interspinous diameter. Healthcare is becoming more expensive; therefore, in order to be cost-effective, surgery should be performed correctly, the first time.

The chapters on hysterectomy reflect our longstanding beliefs, now documented by clinical evidence, that the vaginal approach to hysterectomy can be successfully and safely performed on most patients who require uterine removal, with better medical and economic outcomes than other approaches promoted to women. Despite the plethora of evidence supporting the use of vaginal hysterectomy, we believe the advancement of this operation appears to be retarded by uninformed authority and physician inertia.

Every year there are concerns that the vaginal approach to gynecologic surgery will be lost as there are fewer teachers of this science and art. However, it appears that each generation of gynecologic surgeons seems to rediscover the many benefits of the vaginal approach. Hopefully, this book will add to the education of future generations of vaginal surgeons.

We acknowledge with sincere praise the work of David Nichols and Clyde Randall, whose classic textbook helped pave the way for reconstructive and vaginal surgery. Gratitude is expressed to each contributing author for their expertise and clarity in communicating and writing their chapters. Particular thanks are expressed to our publisher, Lippincott Williams & Wilkins; our editors, Nicole Dernoski and Ryan Shaw; our artist, Joyce Lavery; and to our editorial specialist, Donna Roth, for patience, encouragement, and help.

S. Robert Kovac MD

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Foreword

The subject of this book, more than any other subject, defines what gynecologic surgery is about. Providing patients' relief from the discomforts and embarrassments of various degrees and types of uterine prolapse and vaginal relaxations has stimulated the inventive genius of gynecologic surgeons for over 100 years and will continue to do so for many years to come. This, and related subjects in vaginal surgery, has become sufficiently special and complex to require a separate rendering from a general textbook of gynecologic surgery. Vaginal surgery is a special part of gynecologic surgery. Many vaginal operations require special technical skills and training in order to offer consistently good long-term results and to offer the benefits of the vaginal approach to the patient. The benefits to the patient include lower operative morbidity, easier and quicker procedures, better restoration of anatomy and function, and better results in the long-term. These are valid reasons to choose the vaginal approach, and they deserve special recognition and emphasis.

If, because of lack of experience or technical skill, a gynecologic surgeon is unable to give a patient the advantage of the vaginal approach, then the patient should be referred to another more experienced and technically skilled gynecologic surgeon without hesitation. This is not an admission of inadequacy, but rather a desire to provide the advantages of vaginal surgery to each patient when appropriate as determined by a careful evaluation of many factors.

When relaxation of the pelvic floor and uterine prolapse exist, structural weakness of the pelvic floor tissues also exists, sometimes generally throughout the pelvis and sometimes site specific in single or multiple sites. The choice of the most appropriate reparative operation requires a very careful identification and evaluation of all anatomical defects, assessment of the patient's general health, appropriate special studies, improvement in the patient's health and in the health of tissues to be dissected, and recognition of the health care team's ability to secure the patient's cooperation in operative and postoperative recovery (smoking cessation, weight control, perineal exercises, etc.). Rarely is such an operation urgent. The patient can take advantage of the time before surgery to improve the results of surgery. Unfortunately, despite correct preoperative preparation, correct choice of operation, and skillful technical performance of the procedure, the long-term success may depend on the intrinsic strength of pelvic tissues, or lack of it.

We must not forget that relief of the patient's symptoms is the gold standard of success. An operation cannot be considered successful if the patient's symptoms are not relieved, even though the anatomy is restored. Remember that it is difficult to make an asymptomatic patient feel better by operating on her, but, unfortunately, it is possible to make her feel worse. Postoperatively, some patients may develop symptoms related to coital function, bladder function, bowel function, and even be more likely to develop more severe degrees of prolapse and relaxations in the future as pelvic support tissues weaken over years. It is unwise to subscribe to the idea that it is easier to fix minimal degrees of asymptomatic anatomical relaxations now rather than wait until they become more pronounced and possibly also symptomatic. Many patients live many years with minor relaxation problems that never get worse, never become symptomatic, and never require surgery. In this regard, Dr. Richard TeLinde's advice should be remembered when asked when to operate on patients with vaginal relaxation problems, â€œwhen they ask me to,â€• which is an indication that patients knew best when surgery is required for relief.

It is reasonable to assume that, in most patients, posthysterectomy prolapse of the vaginal walls, including the vaginal vault, can be prevented by providing proper support to the vagina when hysterectomy is done, either abdominally, vaginally, or laparoscopically. There may be a few patients with special inherent problems (such as connective tissue abnormalities, severe chronic lung disease with chronic cough, chronic intractable constipation with straining, etc.) who are destined to have prolapse of the vagina in spite of good surgical judgment and surgical techniques. It is likely more common when hysterectomy is done for uterine prolapse without providing proper support and direction to the vaginal apex, or with failure to detect and correct an enterocele. The exact incidence of posthysterectomy vaginal vault prolapse is unknown, but may be about 0.1. An important objective for gynecologic surgeons is to reduce this number to the absolute minimum. The upper portion of the vagina is normally supported posteriorly in the presacral area by endopelvic fascia and the levator ani complex, an important anatomical point when choosing an operative technique that will restore normal vaginal anatomy and axis in a patient who is having a hysterectomy and especially a reconstructive operation.

Controversy as to the best surgical management of female organ prolapse exists today and will continue in the future. A variety of surgical techniques should be mastered in order that the best operation or combination of operations can be used depending on the characteristics of each patient. Sometimes the findings at operation may dictate changes in the operation planned. Eventually, all surgical techniques must be carefully evaluated so that anatomic and functional results will continue to improve in the future. Admittedly, however, it is difficult to perform the usual randomized studies with matched controls when so many variables are involved. It is especially difficult when the skill of the individual surgeon is one of the greatest variables.

One must not forget that for some patients an operation may not be the most appropriate solution to the problem. For many years, a properly fitting pessary has provided satisfactory relief of symptoms in some patients. Certainly, pessaries may cause problems if improperly fitted or neglected. Sometimes, symptoms can be relieved by a combination of limited vaginal surgery and pessary use. In patients whose medical condition does not allow major vaginal reconstructive surgery, correct pessary use may achieve good results. Perhaps more time should be spent teaching the art of pessary use. When patients are offered an alternative to surgery, some may try a pessary for a while to see if it provides sufficient comfort and relief. If not, surgery can then be done. *Advances in Reconstructive Vaginal Surgery* should also include a consideration of effective nonsurgical methods of management.

Gynecologic surgeons who are truly devoted to mastering reconstructive vaginal surgery would find their work more interesting and rewarding if they took the time to review the history of the subject. It is important to know what has gone before, what has worked and what was abandoned, and why. A review of the history of the treatment of utero-vaginal prolapse includes important highlights that parallel the history of gynecologic surgery in general. The history begins in ancient times when uterine procedentia was treated by painting the vaginal walls with various caustic agentsâ€"even red, hot pokers were used to cause scarring of the vaginal walls. Some women were suspended by their feet upside down for hours. When surgery became safer after asepsis and anesthesia were discovered, various surgical procedures were tried. Older gynecologists of today will barely remember the Watkins-Wertheim interposition operation, the Manchester-Fathergill operation, the Spalding-Richardson Composite operation, the Kelly Plication operation, ventral fixation of the uterus and numerous other techniques of uterine suspension, and other operations rarely performed today. These and other operations are examples of the inventive genius of gynecologic surgeons as they struggled through the early 20th century to help patients with uterine prolapse and vaginal relaxation problems. Vaginal hysterectomy with anterior and posterior colporrhaphy became the operation of choice in the last century until it was recognized that it was not a satisfactory operation in all patients, especially those with advanced degrees of prolapse. Something more was needed to achieve permanently good results. Recently, great progress has been possible due to advances in suture technology, and a better understanding of the anatomy of female reproductive organ support and reasons why support fails.

For this inaugural edition of *Advances in Reconstructive Vaginal Surgery*, the editors have chosen an impressive group of experts to write a chapter on his or her special area of interest. Such a scholarly rendition represents an enormous effort.

The gynecologic surgeon who becomes thoroughly familiar with various aspects of the subject of reconstructive vaginal surgery, who appreciates the history of the development of various operative techniques, and who thoroughly masters the technical details of performing operations vaginally on properly selected patients, can feel enormous pride in his or her achievement. The challenge is enormous, and the personal satisfaction is tremendous when the patient is permanently relieved of the indignity and suffering associated with uterine prolapse, vaginal relaxations, and associated problems.

The editors, authors, artists, and publishers can be proud of this important addition to the literature of gynecologic surgery.

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1

Operative Anatomy for the Vaginal Surgeon

Robert M. Rogers Jr

The vaginal surgeon requires an understanding of gynecologic anatomy completely different from that of the surgeon operating through an abdominal incision. The orientation changes from one looking downward into a supine patient to one looking horizontally into the vagina and pelvis of a patient in the dorsal lithotomy position. Instead of a view from above, perpendicular to the long axis of the body and pelvis, the vaginal surgeon looks directly into the long axis of the body (Fig. 1.1). This change of view can disorient the surgeon's understanding of surgical anatomy tremendously! The purpose of this chapter is to reorient the anatomic understanding of vaginal surgeons and teach them another way of approaching gynecologic pelvic anatomy. The anatomy described herein is what the vaginal surgeon sees and feels when dissecting vaginally. In addition, the anatomy is described in order to allow surgeons to visualize and orient in their minds the structures that they cannot see or feel but that surround the field of vaginal dissection.

Anatomic Orientation for the Vaginal Surgeon

By convention, all anatomic descriptions refer to the patient who is standing in the upright position, facing forward. Although the terminology remains the same, the terms of anatomic description need to be reoriented in the vaginal surgeon's mind as he or she, sitting or standing, faces the vaginal introitus of the patient in the *dorsal lithotomy position. Anterior* directs the operator toward the lower anterior abdominal wall or pubic crest (toward the ceiling). *Posterior* directs the surgeon toward the rectum and the lower portion of the sacrum and coccyx (toward the floor). *Superior* directs the pelvic surgeon toward the promontory of the sacrum and the upper abdominal cavity (that is, cranial toward the patient's head). *Inferior* directs the operator down toward the perineal body or the surgeon's chest. The terms *lateral* and *medial* are well understood. *Sagittal* refers to a plane or anatomic section that divides the pelvis into a right-sided part and a left-sided part. The sagittal plane courses along the body's longitudinal axis and is perpendicular to the plane of the anterior abdominal wall. *Coronal* or *frontal* refers to a plane or anatomic section parallel to the long axis of the body and parallel (not perpendicular) to the frontal plane of the anterior abdominal wall, sectioning the pelvis into an anterior view (upward to the ceiling) and a posterior view (downward toward the floor). However, when describing the vaginal walls, the vaginal surface supporting the urethra and bladder is known as the anterior vaginal wall and the vaginal surface overlying the anal canal and rectum is known as the posterior vaginal wall. These descriptions are standardized, since the orientation of the lower third and upper thirds of the vagina have different anatomic orientations in the pelvis (Fig. 1.2).

Superficial Pelvic Anatomy by Observation and Palpation

The surgeon is guided primarily by only two senses of the five available-sight and touch. Hearing may be used in receiving information, such as in teaching or in warning (â€œDon't cut that!â€•). Taste is never an option in surgery. Hopefully smell will not be stimulated during vaginal surgery, although it may be in rectal injury. Learn to develop the senses. *The senses of observation and palpation need to be taught and appreciated in vaginal surgery.* In addition, the vaginal surgeon must possess a passion and excitement, that is have the â€œheart,â€• for performing this specialized and

challenging type of surgery. These attributes of skilled vaginal surgeons must not be overlooked (1).

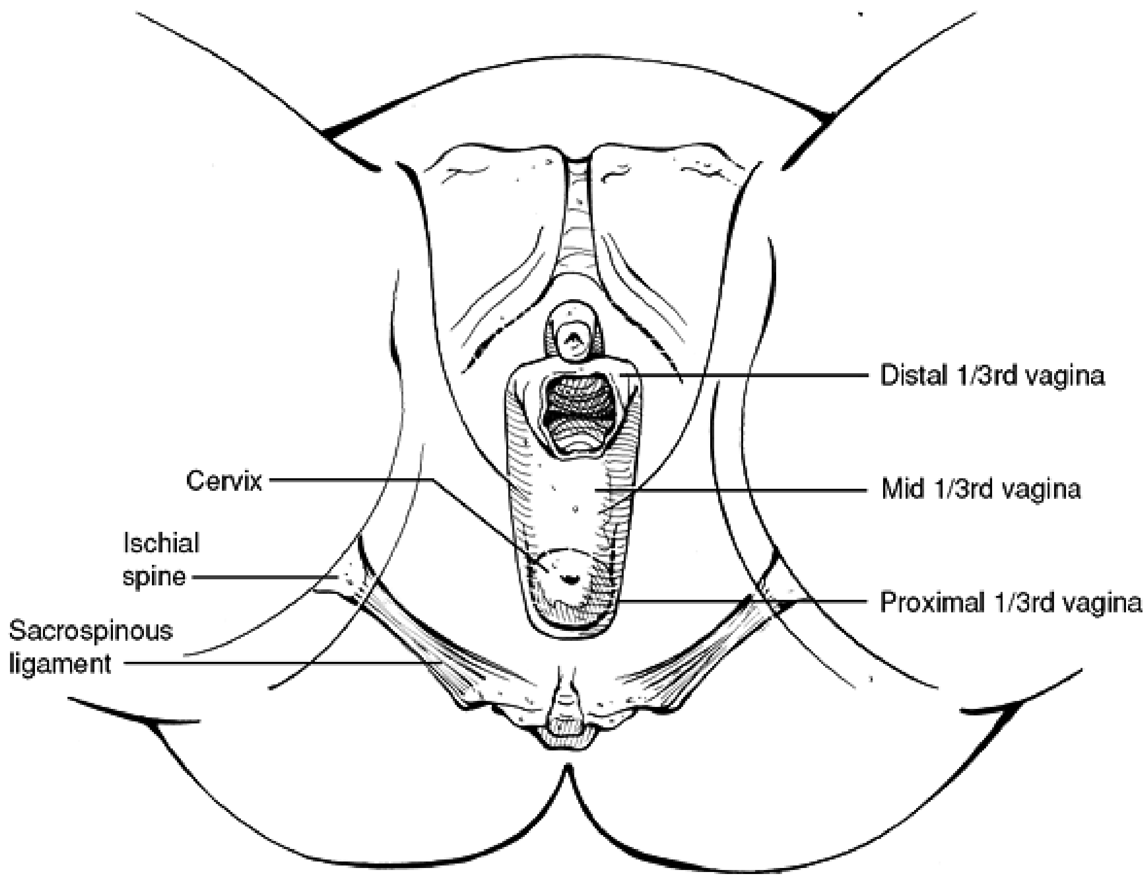


Figure 1.1 Anatomic orientation of the female pelvis to the operating surgeon.

The anatomy herein is described as discovered in the living patient, starting in the surgeon's office. With the patient in the dorsal lithotomy position, the surgeon observes the labia, vaginal introitus, perineal body, and anus. In the nulliparous patient, these structures are â€œnormalâ€• in appearance and position (Fig. 1.3). The perineum is slightly concave due to the pull of the rectovaginal septum from the apex of the perineal body to the uterosacral ligaments bilaterally. Palpate these perineal structures after requesting permission from the patient and after explaining the whys and how of the examination.

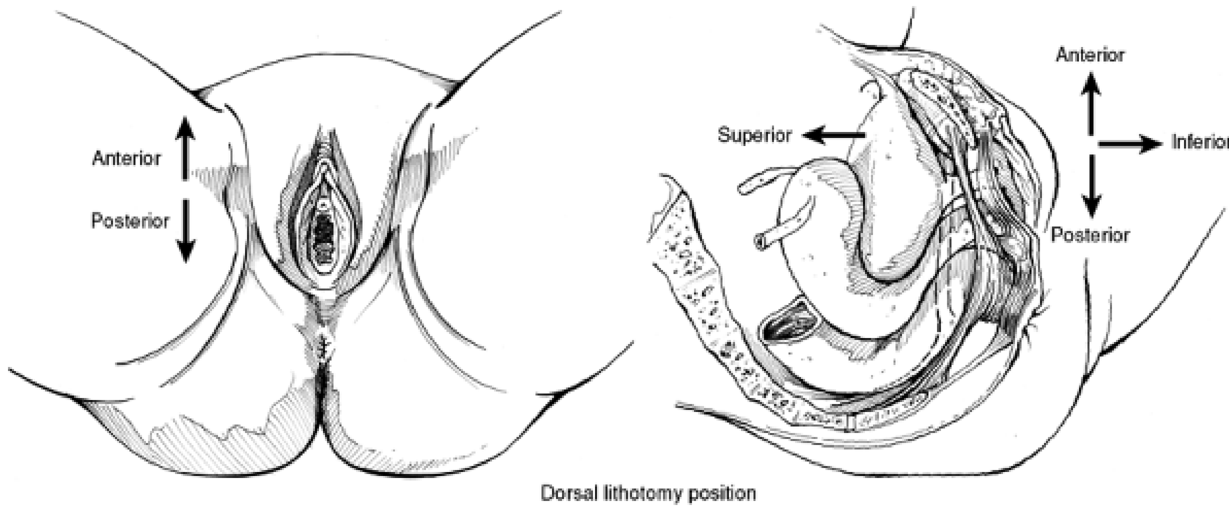


Figure 1.2 Anatomic directions in the dorsal lithotomy position.

The examiner must always be alert and sensitive to the patient's feelings, and determine when parts of the examination are appropriate in the office or clinic exam room, or more appropriately performed in the operating room with the patient sedated or asleep. *The physician should request the patient's permission* for her examination when she is alert in the office or clinic, regardless of whether the examination is performed in the office, procedure room, or the operating room. This applies to all

potential examiners. A chaperone should be present because of the intimate nature of this type of physical examination. The examination is performed with the hand gloved and lubricated. The examiner must always be sensitive to the patient's tolerance of the awkwardness of the situation and the various maneuvers of palpation.

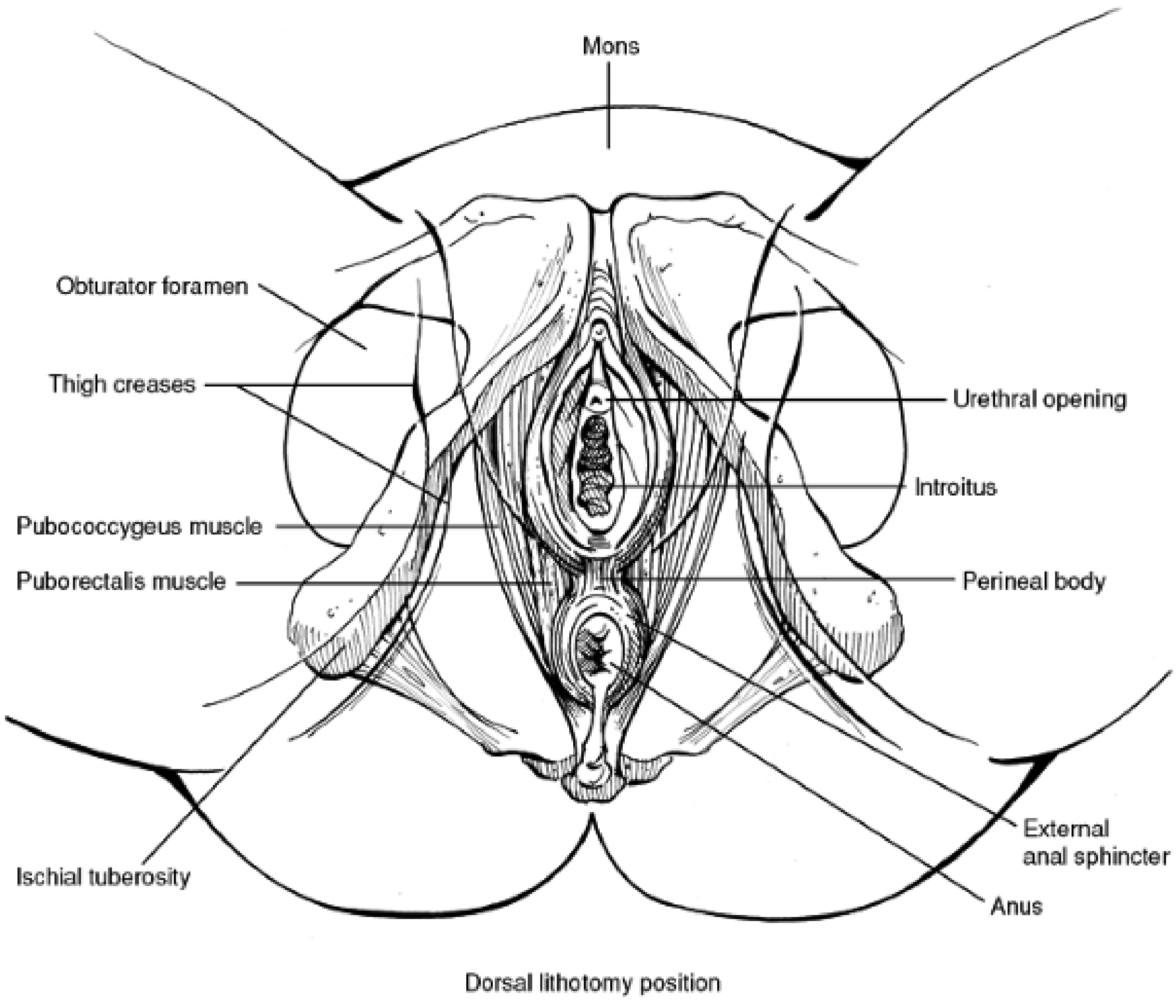


Figure 1.3 External female genitalia-mons, urethra, vaginal introitus, perineal body, thigh creases, ischial tuberosities, anus, and muscles around the lower one third of the vagina. See text.

During the examination, the physicians should ask themselves questions. This attribute of intellectual curiosity drives the practitioner to increase his understanding. Where is the anus and perineal body located in relation to the ischial tuberosities? In the nulliparous woman, they are 1 to 2 cm superior to the plane of the ischial tuberosities. This is where these anatomic features should be found after reparative surgery. The proper anatomic positioning of the rectum, anus, and perineal body may help restore â€œnormalâ€• defecatory function.

Palpate the consistency of the muscles and the overlying tissues, both with the patient relaxed and with contraction of the muscles of the vaginal introitus. Palpate these muscles with the fingers in the vagina and on the perineal body. What happens? Compare the contraction of these muscles in younger, nulliparous women to older women who have had several vaginal deliveries. How do these muscles and tissues move and feel? These muscles are the pubococcygeus and puborectalis portions of the levator ani, and are located surrounding the lower one third of the vagina and also have some attachments to the perineal body. These attachments also function in the support and action of the perineal body. Note their feel, both bulk and strength on contraction. Note the origins of these muscles from the pubic body and anterior portion of the pelvic sidewall. Are the overlying tissue layers adherent to the underlying muscles or do they slide easily and to what degree? The lateral vaginal walls should slide easily, whereas the anterior and posterior walls are fixed to the urethra anteriorly and to the perineal body posteriorly. Palpate the pubic arch to the inferior pubic rami and to the ischial tuberosities, especially in the operating room after the patient is asleep. Note the thigh creases lateral to the vulva. Obviously, note any abnormal appearances of the outer perineal structures and record them. Evaluate and treat any abnormal lesions seen. Surgeons should always learn and build a knowledge base by correlating their readings of articles and texts with their own continuing observations and palpations in all patients, both â€œnormalâ€• and with support defects.

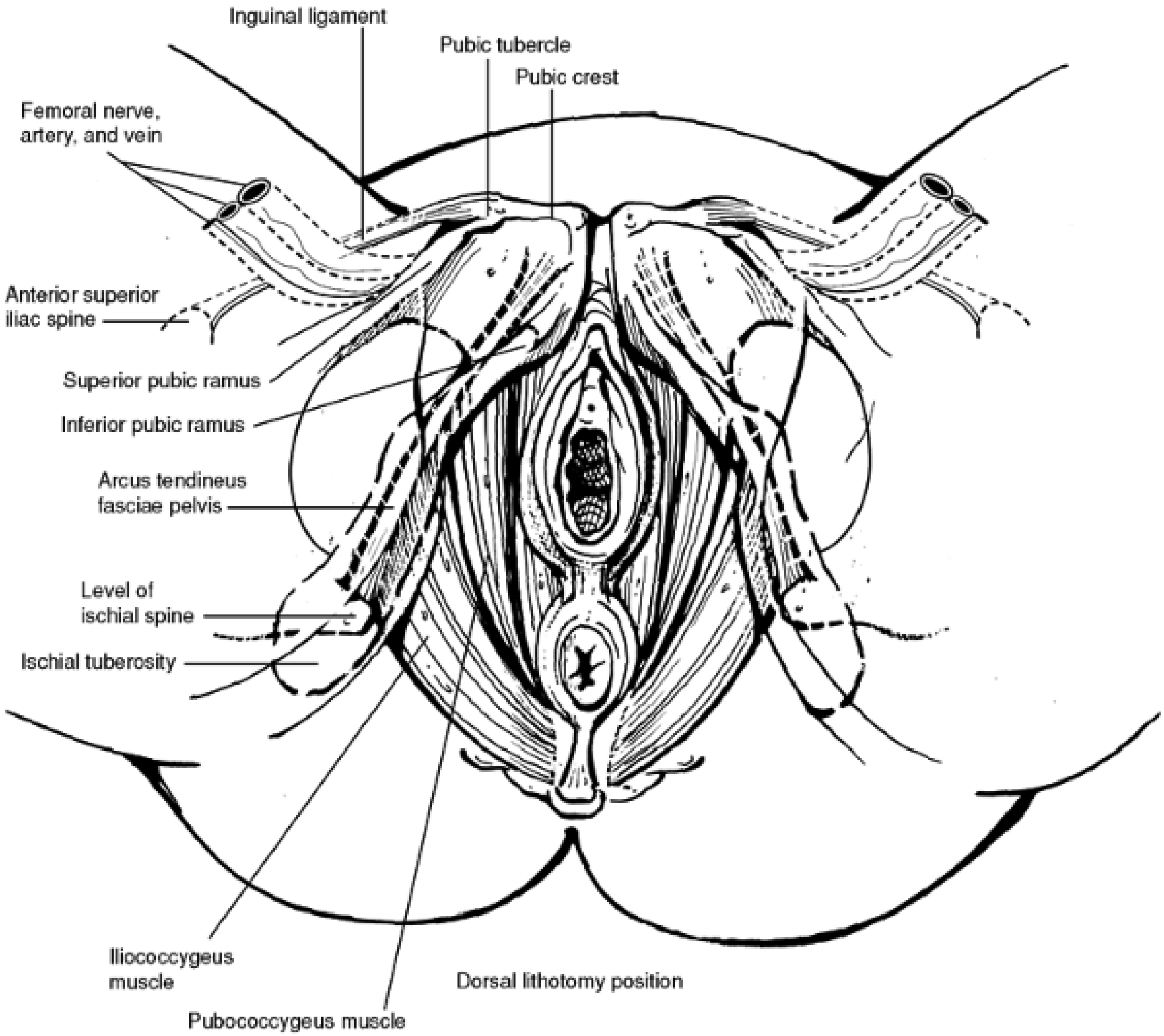


Figure 1.4 Superficial vaginal examinationâ€"anterior superior iliac spine, inguinal ligament, femoral nerve, artery, vein, pubic tubercle, pubic crest, superior pubic ramus, inferior pubic ramus, pubic arch, ischial tuberosity, obturator foramen, ischial spine, arcus tendineus fasciae pelvis, and anterior vaginal wall. See text.

Palpate the anterior superior iliac spine of the anterior abdominal wall and follow the inguinal ligament to the pubic tubercle (Fig. 1.4). Palpate the pulsations of the femoral artery in the groin, just inferior to the midportion of the inguinal ligament. Palpate the pubic tubercle and pubic crest. Feel the beginning of the superior pubic ramus as it leaves the central pubic body and courses laterally and posteriorly. Place a finger in the vagina and the thumb of the same hand on the thigh crease. Feel the inferior pubic ramus and palpate the medial edge of the obturator foramen, anteriorly near the pubic body and posteriorly near the ischial tuberosity.

Next, palpate the pubic arch and move posteriorly along the vaginal sidewall to the ischial spine. What is the directional orientation of the nulliparous vagina? Normally in the dorsal lithotomy position, the nulliparous vagina is horizontal for 3 cm, then ski-slopes down toward the ischial spines, taking a 45-degree angle posteriorly (Fig 1.4). Note the distance from the arch to the spine, normally 7 to 10 cm. What does the spine feel like? Is it sharp, dull, flat, short? Where does it point? Each woman will have her own characteristic ischial spine. The reparative vaginal surgeon should reconstruct the pericervical ring and attach it to the uterosacral ligaments at the level of the ischial spines. At the ischial spine is where the cardinal-uterosacral ligament complex merges with the pubocervical fascia and rectovaginal fascia to prevent anterior, apical, and high posterior vaginal wall prolapses.

Palpate through the vaginal epithelium laterally and feel the pelvic sidewall from the ischial spine to the pubic arch. In the nulliparous patient, one feels a â€œbanjo stringâ€• running from the spine to arch. This is the arcus tendineus fasciae pelvis or fascial white line of vaginal and bladder paravaginal suspension. Run the gloved fingers along the

underside of the superior pubic rami. Approximately 4 cm lateral to the pubic arch is the obturator notch, through which travels the â€œrubber bandâ€• of the obturator artery, vein, and nerve. Be gentle!

With the patient's permission, perform a gentle rectal examination with a well-lubricated gloved finger (Fig. 1.5). Palpate the perineal body. Note that the anal canal as well as the lower third of the vagina fuse with the perineal body, which is approximately 3 to 4 cm in height. Move posteriorly and palpate the coccyx and lower portion of the sacrum. Appreciate the right angle of the rectoanal junction. Palpate the ischial spine and the sacrospinous ligament as it descends medially from the spine to the lower part of the sacrum. Palpate gently the upper and lower edges of the sacrospinous ligament as well as the superior and inferior surfaces. What are their dimensions in length and thickness? The sacrospinous ligament tapers laterally to insert upon the ischial spine, but fans out medially to insert upon the lower third of the sacrum. It is tough and fibrous with distinct lower and upper borders.

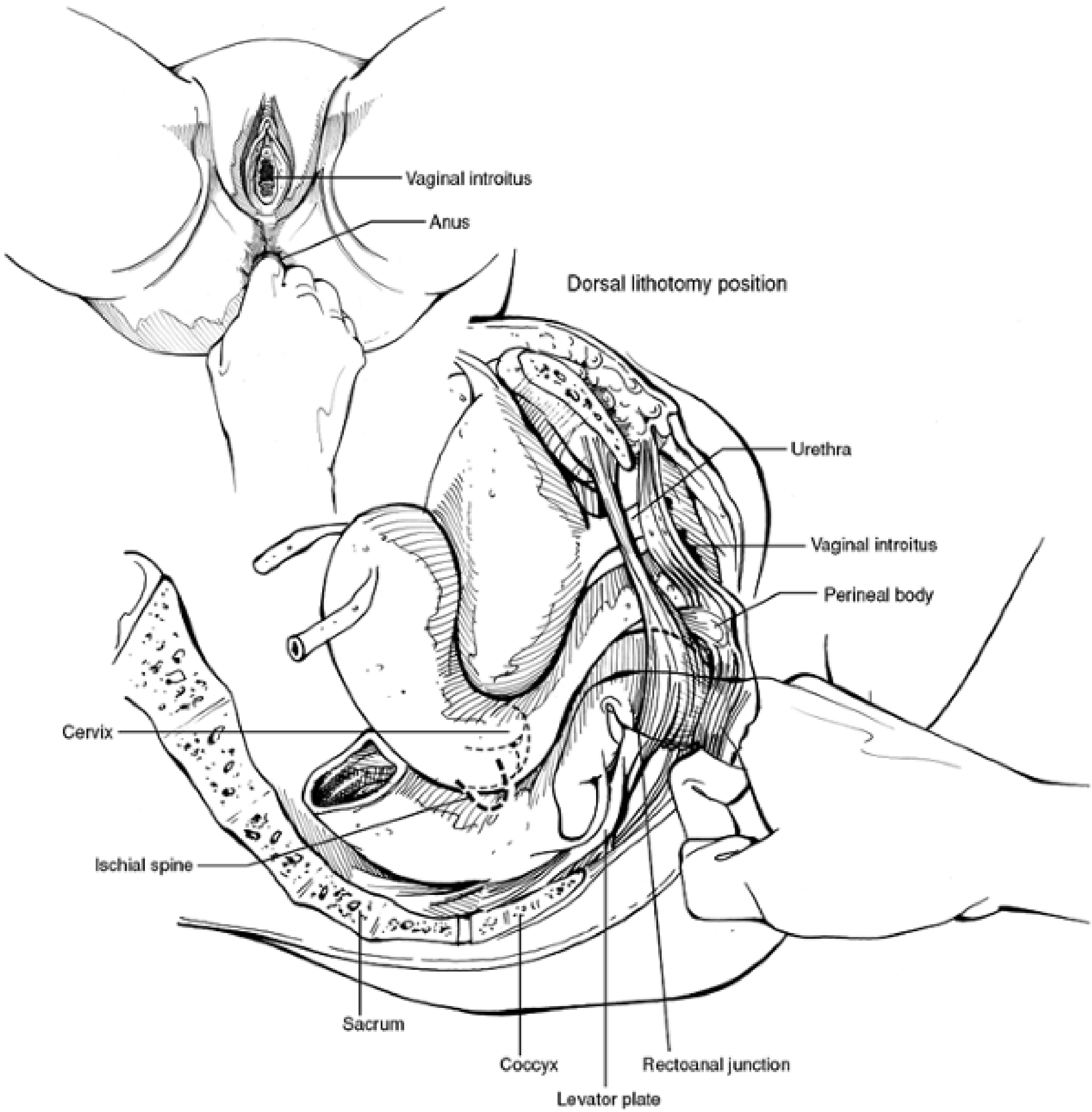


Figure 1.5 Rectal examinationâ€"anus, rectoanal junction, rectum, perineal body, vaginal introitus, ischial spine, coccyx, sacrum, levator ani muscles, levator plate.

Ask the patient, â€œPlease squeeze *my* finger with *your* rectum.â€• Feel the movement, firmness, and strength of the

levator plate as the levator ani muscles contract between the rectoanal junction and the coccyx. The levator plate is only 4 cm long, but is a crucial component in the mechanism for preventing uterine and vaginal prolapses. The other important component in prevention of vaginal prolapse is the integrity of the perineal body and the closure of the vaginal introitus during times of physical stress in the pelvis (Fig. 1.3). Move the finger laterally to appreciate the flatness and firmness of the iliococcygeus muscle as it travels to the pelvic sidewall and attaches to the obturator internus muscle via the arcus tendineus levator ani, or muscle white line (not palpable).

Again, some portions of the anatomic pelvic examination are appropriate for some patients in the office or clinic setting, whereas other observations and palpations are better suited when the patient is sedated or asleep. In all cases, the physician and student examiners should obtain the patient's permission for examinations. In addition, the clinician will learn more and more as he or she continues to learn pelvic anatomy from articles, texts, illustrations, photographs, and, most importantly, from his or her own observations, palpations, and dissections on surgical patients. This is an active mental process of self-education that soon becomes a lifelong habit. Just as surgical skills and judgement must be mastered by perfect practice of repetitive movements and decision making, the understanding and skillful use of surgical anatomy must constantly be updated and reoriented in the surgeon's mind.

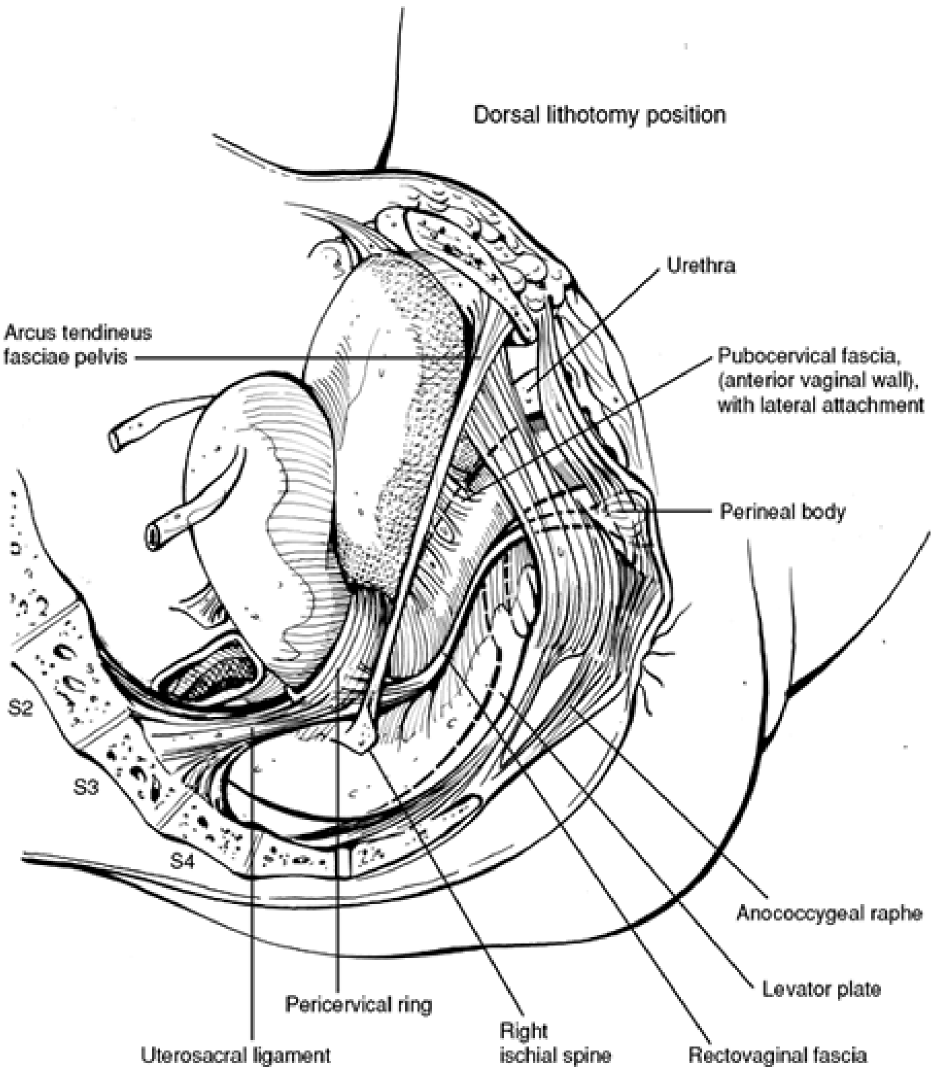


Figure 1.6 Anterior vaginal wall and lateral connectionsâ€"vaginal epithelium pubocervical fascia, anterolateral sulcuses pubic arch to ischial spine, arcus tendineus fasciae pelvis, fascia endopelvina, pericervical ring, attachments to cardinal and uterosacral ligaments. See text.

Dissectional Anatomy for the Vaginal Surgeon

Think of the *vagina* as a tube lined on the inside with skin (Fig. 1.6). Vaginal epithelium is actually nonkeratinized stratified squamous skin without glands. This vaginal skin is not â€œmucosaâ€•! Intimately fused with this skin is an outer fibromuscular coat of visceral connective tissue enveloping

blood vessels, lymph channels, and visceral nerves, and containing smooth muscle. This connective tissue is physiologically alive and is responsible for the transverse rugations seen on the anterior and posterior vaginal walls. The lateral walls are suspended and attached to the pelvic sidewalls by lateral wings or septa of visceral connective tissue. These transverse lateral septa form the anterolateral sulcuses seen in the nulliparous vagina. This is evident by observation of the upper two thirds of the vagina from the pubic bone to the ischial spines. The anterior portion of the fibromuscular coat of the vagina and these transverse vaginal septa are surgically known, as seen at the time of surgical dissection, as the *pubocervical fascia*. The pubocervical fascia is the white, shiny coating of the vaginal wall and cervix seen at time of a laparoscopic or abdominal paravaginal defect repair procedure, Burch retropubic colposuspension, or, even, during surgical dissection of the bladder flap during a cesarean delivery (2).

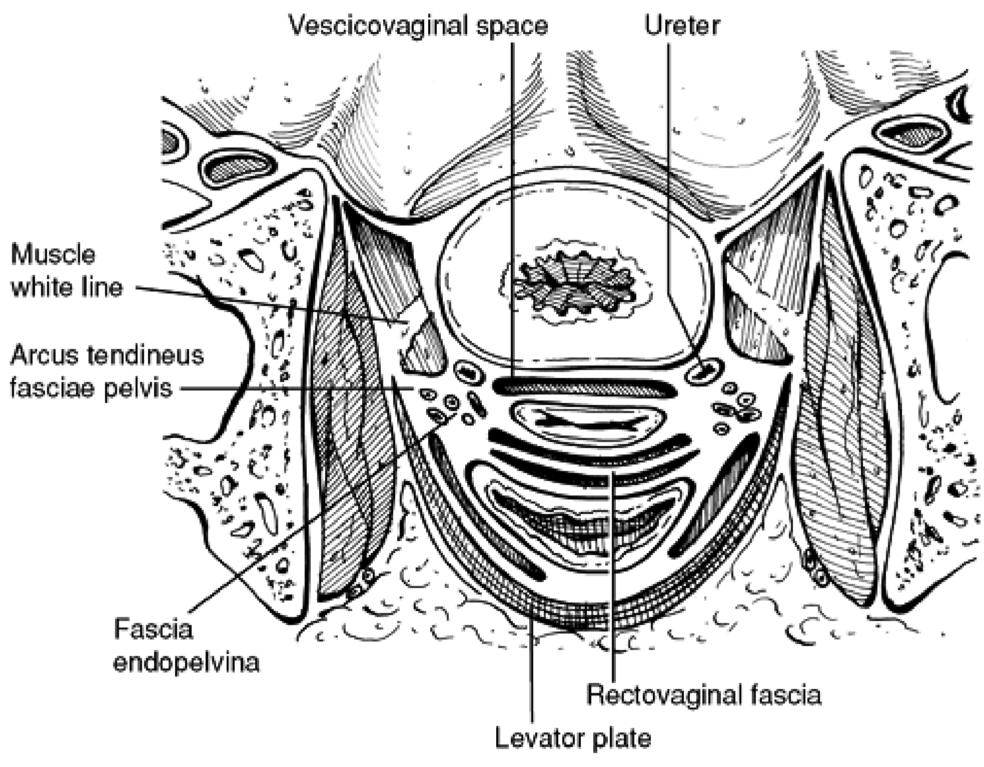


Figure 1.7 Frontal section through upper and middle thirds of the vagina. See text.

There are visceral connective tissue capsules surrounding the bladder and the rectum (Fig 1.7). As with the vagina, lateral septa tether these capsules to the pelvic sidewall. Between the pubocervical fascia and the visceral fascial capsule surrounding the bladder is the *true vesicovaginal space.* Between the visceral capsules of the vagina and the rectum in the rectovaginal space is a separate anatomic suspensory layer termed the *rectovaginal fascia* (3). Anatomically all of these lateral septa and the rectovaginal fascia meet and fuse to become a band of connective tissue from the pubic arch to the ischial spine, named the *fascia endopelvina* (4,5). This band is approximately 1 cm wide. The lateral edge of the *fascia endopelvina* inserts onto the *arcus tendineus fasciae pelvis*, which is a thickening of the parietal fascia of the levator ani muscles, and travels from the pubic arch to the ischial spine. The fascia endopelvina is felt laterally in the true vesicovaginal space, and then dissected by the vaginal surgeon when performing a vaginal-paravaginal defect repair procedure.

The vaginal surgeon may consider the anatomy surrounding the vagina in terms of thirds of its length from the introitus to the level of the ischial spines. This includes the anterior, lateral, and posterior vaginal walls. The vagina is shaped like an â€œHâ€• in cross-section where the anterior and posterior walls have collapsed onto each other, forming a flattened, longitudinal potential space. The *vaginal anterolateral sulcuses* are formed by the attachment of the pubocervical fascia of the upper two thirds of the vagina to the fascial white lines on the pelvic sidewall. The *posterolateral sulcuses* are formed by the attachment of the rectovaginal fascia to the *arcus tendineus fasciae rectovaginalis* in the middle third of the vagina, and then to the *arcus tendineus fasciae pelvis* (fascial white line) in the upper third of the vagina (6) (Fig. 1.8).

The vagina is approximately 6 to 7 cm in length anteriorly from the introitus to the front of the cervix, which protrudes from the apex of the upper third of the vagina. The cervix is found at the level of the ischial spines, but pulled slightly anteriorly by the tension of the upper portion of the cardinal ligaments. The supravaginal part of the cervix is surrounded by visceral connective tissue called the *pericervical ring* (Fig.

1.6). Into this ring attaches the suspensory visceral connective tissues of the cardinal ligament-uterosacral ligament complexes laterally; the pubocervical fascia anteriorly; and the rectovaginal fascia posteriorly. The integrity of the pericervical ring and its important attachments is believed to prevent uterine/vaginal prolapse and enterocele formation (7). In addition, the intact pericervical ring positions the upper vagina (proximal to the urogenital hiatus) over the levator plate, which is believed to be the major support in the pelvis for prevention of pelvic organ prolapse. Again, the pubocervical fascia is a gross surgical term for the fibromuscular coat surrounding and fused with the vaginal epithelium. Upon dissection in the true vesicovaginal space by the vaginal surgeon, the

pubocervical fascia is the white, shiny connective tissue on the other side of the vaginal flap. Other vaginal surgeons dissect the pubocervical fascia away from the vaginal epithelium and continue dissection underneath the pubocervical fascia to the pelvic sidewall in order to identify paravaginal defects from the vaginal route.

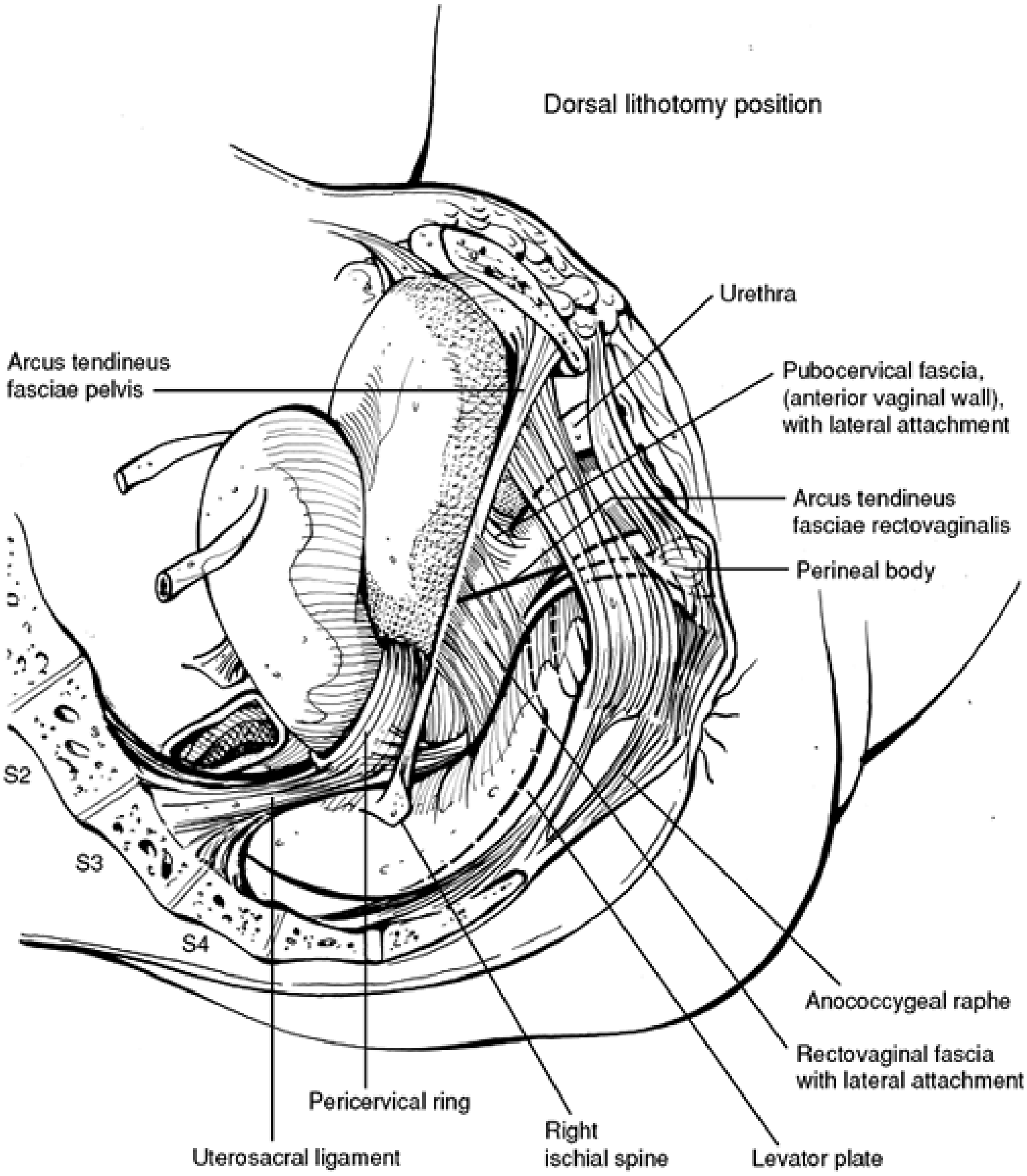


Figure 1.8 Posterior vaginal wall and lateral connectionsâ€”pubic arch to ischial tuberosities; lower third and perineal body, middle third and arcus tendineus fasciae rectovaginalis; upper third and arcus tendineus fasciae pelvis; ischial spine, posterolateral sulcuses of vagina. See text.

The important concept of the pericervical ring and its surrounding attachments of supporting visceral connective tissues has resulted in significant improvement of surgical procedures in the last 10 years for the patient with vaginal support defects.

Dr. A. Cullen Richardson from Atlanta, Georgia, studied and refined this concept on multiple cadaveric dissections in the 1980s and early 1990s. He taught that distinct detachments or site-specific defects in the supports to the pericervical ring were responsible for uterine/vaginal vault prolapse and enterocele (7). Therefore, he reasoned, procedures that reconstructed the pericervical ring and its surrounding attachments would restore â€œnormalâ€• anatomy and repair the vaginal prolapse and accompanying enterocele. Initial clinical reports have confirmed the utility of these concepts (8). However, recent studies and reports in the literature question the validity of the anatomic pericervical ring and the concept of site-specific defects as the etiology of vaginal prolapse (9,10,11). Our understanding of pelvic organ prolapse continues to evolve. Because reparative vaginal surgeons can only repair â€œdamagedâ€• connective tissues, clinicians have largely ignored the important contributions of the pelvic floor muscles, somatic and visceral innervations, skeletal posture, and other factors involved in the whole picture of pelvic organ support and function.

Anatomic Orientation of the Vagina and Pelvic Organs

In the patient in the *dorsal lithotomy position*, the following anatomic orientation of the vagina is seen (Fig. 1.9). The urethra, the lower third of the vagina, and the anal canal are more horizontal. Each is approximately 3 cm in length. The bladder, the upper two thirds of the vagina, and the

rectum are more vertically oriented, with the angulations occurring at the junction of the outer third and middle third of the vagina. In other words, the finger enters the vagina or anal canal horizontally, and then, sharply slopes down to the level of the ischial spines. The lower third of the vagina is vertically oriented in the standing, nulliparous patient, or horizontally oriented in the nulliparous patient in the *dorsal lithotomy position*. The upper two thirds of the vagina are more horizontally oriented in the standing, nulliparous patient, or more vertically oriented in the patient in the *dorsal lithotomy position*. The upper two thirds of the vagina are oriented more distinctly with contraction of the levator muscles and plate. The middle third of the vagina is suspended over the muscular levator plate.

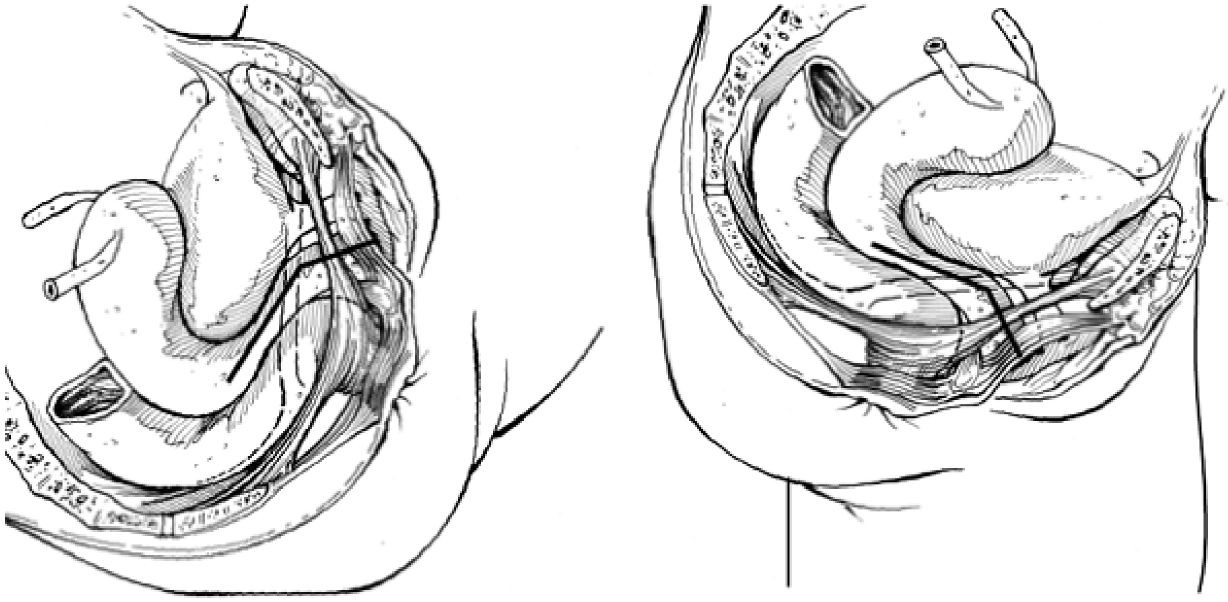


Figure 1.9 Orientation of vaginaâ€"dorsal lithotomy position and standing.

Upon stress, the upper third of the vagina and cervix are also pushed into the muscular backstop of the levator plate. When fully functioning and strong, this is called the â€œflap-valveâ€• mechanism of pelvic floor support and is a major deterrent to the progression of uterine and vaginal prolapse.

The anterior vaginal wall can be considered in the following anatomic schematic perspective. Overlying the lower third of the vagina is the urethra, which is approximately 3 cm in length. The external urethral meatus is located underneath the pubic arch, just outside of the hymeneal caruncles. The urethra and visceral connective tissue of the vagina are fused, without a natural cleavage plane. The trigone of the bladder is found on the middle third of the vagina. Normally, the vaginal surgeon can palpate the filled Foley catheter bulb in the trigone in the middle third of the vagina. The ureters enter the bladder at the junction of the middle third and upper third of the vagina. The dome of the bladder rests on the upper third of the vagina and cervix, and lower uterine segment.

The posterior vaginal wall can also be considered in thirds (Fig. 1.8). The lower third is fused with the perineal body. The upper two thirds are angulated with the lower third and â€œski-slopeâ€• down toward the ischial spine. The length of the posterior wall is 9 to 10 cm because it courses underneath the cervix toward the lower sacrum and coccyx. Coursing just posterior to the vaginal epithelium and its attached fibromuscular coat of visceral connective tissue is the separate rectovaginal fascia. The rectovaginal fascia attaches to the apex of the perineal body, at the junction of the lower third and middle third of the posterior vaginal wall. In the middle third, the rectovaginal fascia attaches to the pelvic sidewall levator ani muscles by a thickening of the parietal fascia named the *arcus tendineus fasciae rectovaginalis* (6). In the upper third of the vagina, the rectovaginal septum fuses with the medial edge of the fascia endopelvina, as previously described. The rectovaginal fascia also connects with the uterosacral ligaments at about the level of the ischial spines.

The *ureters* travel laterally to medially on the upper third of the vagina, across the anterolateral vaginal fornices. The ureters extend inferiorly from the pelvic brim toward the ischial spines, where they course just next to the uterosacral ligaments. One to 2 cm superior and medial to the ischial spines, the ureters travel underneath the uterine arteries and form a â€œknee-bendâ€• 1 to 2 cm lateral to the cervix before traversing the upper third of the vagina. Therefore, the operator should be wary of placing sutures laterally in the fibromuscular coat of the vagina in its upper third near the ischial spine, as when performing paravaginal defect

repairs. Vaginal surgeons must be able to perform cystoscopy to check ureteral functioning at the end of surgery.

The ureters have a surrounding visceral connective tissue coat containing some elastin. Because of the mild elasticity surrounding the ureters, paracervical surgical dissection allows the ureters to release laterally and superiorly away from the cervix without scarring in this area. Thus, the uterine vessels are better isolated away from the ureters in vaginal hysterectomies compared to abdominal hysterectomies (12). However, paracervical dissection may not mobilize the ureters when paracervical scarring exists from endometriosis or prior â€œuterosacral nerve ablation/ transectionâ€• procedures.

The Anatomy of Surgical Dissection of the Anterior

Vaginal Wall

A superficial longitudinal incision, or anterior colpotomy, from underneath the urethra to the cervix or vaginal apex, along the anterior vaginal wall demonstrates the dissectional anatomy. The depth of incision determines the anatomic plane developed. This incision can be superficial and separate the underlying pubocervical fascia (fibromuscular coat) from the vaginal epithelium, or, this anterior colpotomy incision can incise the entire anterior vaginal wall and enter safely into the true vesicovaginal space (Fig. 1.10).

At the lower third of the vagina underneath the mid-urethra, the incision enters into the thickened pubocervical fascia. This area is just superior to the perineal membrane, the area of the â€œurogenital diaphragm.â€• Sharp dissection superiorly and in the direction laterally toward the inferior pubic ramus proceeds in the pubocervical fascia overlying the vaginal epithelium. Eventually, the dissection enters the areolar anterior recess of the ischioanal fossa and follows the medial border of the inferior pubic ramus to the junction of the inferior pubic ramus with the body of the pubic bone. This is palpable with the finger in the vagina. The â€œfeelâ€• of the pubic body is confirmed by following the underside of the superior pubic ramus to the body of the pubic bone. Each of ipsilateral superior and inferior pubic rami converge centrally at their respective pubic body. The two pubic bodies, right and left, are connected centrally by the pubic symphysis. This dissection is performed with the inside-to-outside transobturator placement of a midurethral sling in cases of stress urinary incontinence with a hypermobile urethra.

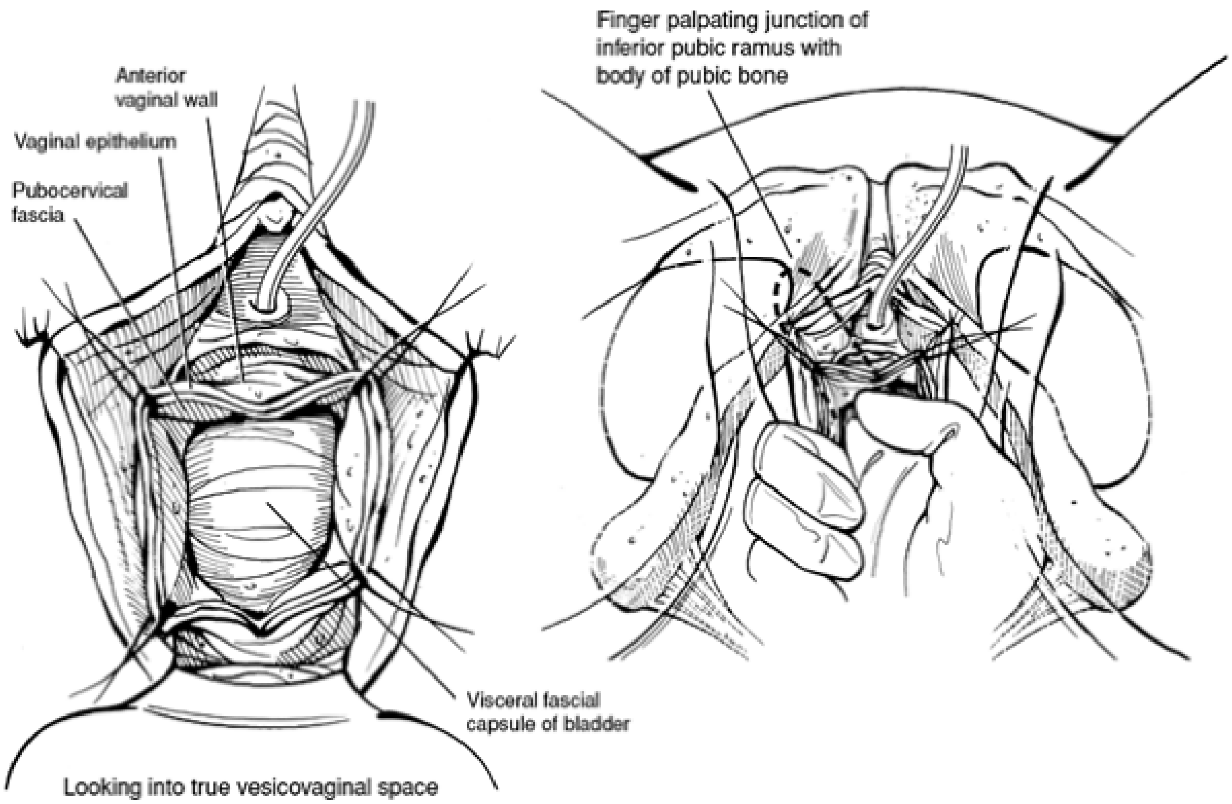


Figure 1.10 Dissection of the anterior vaginal wall and paraurethral areas. See text.

Paraurethral dissection anteriorly just behind the pubic bone enters into the retropubic space of Retzius by perforating the pubocervical fascia laterally, near the fascial white

line. This dissection is performed when passing a suburethral sling anteriorly to pass through the anterior rectus fascia as it inserts onto the pubic crest. This dissection at times can be bloody due to the vasculature in the pubocervical fascia and the perivesical plexus of veins surrounding the urethra and bladder in the retropubic space.

Dissection in the middle third of the anterior vaginal wall can be either superficial in the fibromuscular coat of the vagina or deeper into the true vesicovaginal space. The dissection in the deeper vesicovaginal space separates the vaginal wall from the overlying trigone. This dissection may be performed as part of a traditional anterior colporrhaphy. Traditional plication of the visceral fascial coat surrounding the detrusor muscle may irritate the visceral innervations contained within the trigone and result in *de novo* detrusor hyperactivity manifested as urinary urge symptoms. In addition, plication of the bladder fascia may also draw the ureters centrally and kink them as they course in the bladder wall. Some reparative surgeons perform plication of the bladder, whereas others do not.

Further dissection laterally in the true vesicovaginal space is easy and avascular until the surgeon's finger feels resistance in a band of visceral connective tissue near the pelvic sidewall. This thickened tissue runs from the pubic arch to the ischial spine and is the fusion of the connective tissue supports of the bladder and the pubocervical fascia as they course laterally to the arcus tendineus fasciae pelvis or fascial white line. This is the fascia endopelvina, which has been discussed. There is vasculature that runs longitudinally in the fascia endopelvina, and, thus, bleeding can occur. This more lateral dissection is performed in preparation for placing sutures in the parietal fascia of the levator ani and obturator internus muscles for repair of a paravaginal defect.

The more superficial dissection of the vaginal wall simply skims the vaginal epithelium from the pubocervical fascia in varying thicknesses. This dissection can result in bleeding due to the vasculature contained within this visceral connective tissue.

Dissection in the upper third of the vagina centrally can be superficial or deep, as described previously for the middle third dissection. Likewise, the deeper, more lateral dissections in the vesicovaginal space are avascular until the resistance of the fascia endopelvina is reached. Again, the breaking apart of this band may result in venous and small arteriole bleeding. As mentioned, some vaginal surgeons will dissect the pubocervical fascia from the vaginal epithelium. In addition, remember the ureters course across the anterolateral vagina in this area. One way to kink the ureter is with the paravaginal stitches placed in the obturator fascia near the ischial spine, and then aggressively attached to the visceral fascia on the side of the bladder; this should be avoided. The ureter courses in the visceral connective tissues leading to the bladder, on top of the visceral connective tissue (fibromuscular coat) intimately fused with the vaginal epithelium. Cystoscopy must be consistently performed during these surgeries in order to ensure bilateral ureteral function.

The Anatomy of Surgical Dissection of the Posterior Vaginal Wall

Concerning posterior vaginal wall dissection, the vaginal surgeon should remember the lower third of the vagina is fused to the fibromuscular perineal body. The perineal body is shaped like a pyramid with the base between the introitus and anus. Its apex is approximately 3 to 4 cm high and found at the junction of the lower third and middle third of the posterior vaginal wall. Therefore, an incision in the lower third simply allows the surgeon to clear away scar tissue from previous episiotomies and reconstruct the perineal body to its former configuration and height. When doing so, the surgeon should restore the position of the anus to the level of or slightly superior to the ischial tuberosities. This is best accomplished by reattaching the rectovaginal fascia to the apex of the perineal body, and then to the uterosacral ligaments at the level of the ischial spines. In reparative vaginal surgery, reconstruction of the perineal body is believed to be essential in restoring â€œnormalâ€• anatomy and anatomic function to the vaginal introitus (Fig. 1.11).

Dissection in the upper two thirds of the posterior vaginal wall allows the surgeon to find the rectovaginal fascia, which is found passively adherent to the underside of the vaginal epithelium, not on top of the rectal muscularis. Usually in problems of pelvic support, the rectovaginal fascia has torn away from the uterosacral ligaments and is bunched up near the apex of the perineal body. Attention must be exercised so that the operator does not mistake the broken edge as having torn away from the apex of the perineal body, and thus, mistakenly attach it to the perineal body instead of the uterosacral ligaments at the level of the ischial spines. A finger in the rectum and use of forceps on the rectovaginal fascia assists the surgeon in determining the proper anatomic reattachment of the rectovaginal fascia. In many cases of posterior vaginal wall prolapse (rectocele), traction toward the ischial spines on the dissected rectovaginal fascia pulls the perineal body and anus to the level of the ischial tuberosities. Occasionally the rectovaginal fascia is detached from the apex of the perineal body and must be reattached. In addition, lateral attachment to the parietal fascia of the levator ani muscles is also indicated.

Lateral dissection in the posterior compartment of the vagina is performed bluntly and easily with the finger underneath the rectovaginal fascia. This maneuver opens the pararectal space until the ischial spine is reached. The vasculature is contained in the visceral connective tissue coat surrounding the rectal muscularis. Lateral sutures in the parietal fascia of the levator ani muscles are anatomically

safe to place. In the upper third of the vagina, the pubocervical fascia and rectovaginal fascia fuse with the lateral attachments of the bladder and rectum to form the fascia endopelvina, which then inserts laterally to the arcus tendineus fasciae pelvis or the fascial white line.

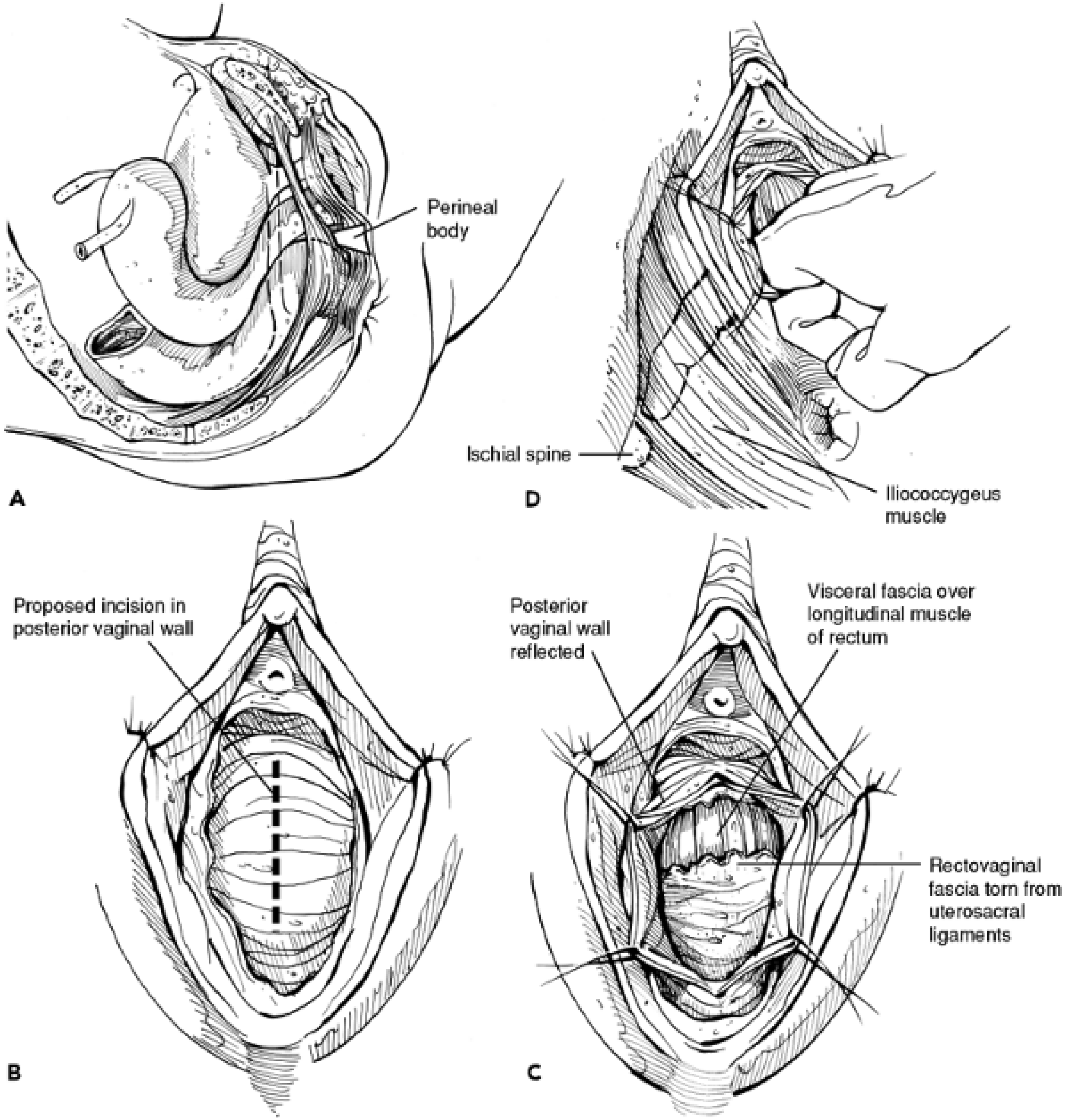


Figure 1.11 Dissection of the posterior vaginal wall. See text.

The Anatomy of a Vaginal Hysterectomy

In the performance of a vaginal hysterectomy, the surgeon incises the cervix around its supravaginal portion. The incision is made at the junction of the smooth surface of the cervix and the rugae of the anterior vaginal wall. The incision is extended circumferentially, laterally and posteriorly in the same junction of smooth cervix and rugated vaginal epithelium. The transverse vaginal rugations indicate that viable visceral connective tissue is present on the vaginal epithelium. The anterior incision is made in order to dissect the pubocervical fascia away from its fusion with the anterior part of the pericervical ring of visceral connective tissue. With dissection down along the cervix and lower uterine segment, the operator can centrally incise the supravaginal septum and then the vesicouterine fold of peritoneum in order to retract the bladder away from the uterus. The supravaginal septum is the midline reflection of the visceral connective tissue surrounding the bladder to the pericervical ring. Remember that the visceral

connective tissue is located between the peritoneum and the pelvic viscera, such as the cervix and bladder.

Dissection through the supravaginal septum can be tedious. If the surgeon dissects too deeply, he or she simply digs into the myometrium. If the surgeon dissects too anteriorly, he or she may perforate and enter the bladder 2 to 3 cm above the central area of the trigone. This dissection requires a â€œfeel,â€• especially in patients who have had cesarean deliveries and scarring of the bladder to the lower uterine segment. However, this is *not* a contraindication to performing a vaginal hysterectomy. Any entry into the bladder in this location simply requires recognition and closure with two layers of absorbable suture with several days of catheter drainage of the bladder. Performance of cystoscopy is mandatory to ensure closure of the entry site and bilateral ureteral function.

Laterally, the cervical incision begins the process of mobilizing the cardinal ligaments and uterosacral ligaments, with the ureter away from the pericervical ring. Likewise, the posterior extension incises the rectovaginal fascia away from the pericervical ring. Because of the presence of the rectovaginal fascia between the rectum and the visceral fascial coat surrounding the vagina, there is no tissue analogous to the supravaginal bladder septum. Therefore, entry into the posterior cul-de-sac is usually easily accomplished by using heavy scissors in cutting through the posterior vagina as it approaches the cervix. Occasionally, cul-de-sac adhesions can challenge the surgeon. The rectum can be adherent here, and, therefore, entered by sharp dissection. Because the rectum should have been mechanically cleansed preoperatively, the surgeon can mobilize the rectum, thoroughly lavage the surgical field, and close the entry site with two layers of absorbable suture. The patient should have antibiotics for 24 hours and the stools kept soft. Be sure to fully explain the entry to the patient and her family, answer all questions objectively, document, and follow the patient closely for any symptoms or signs of peritonitis. In most cases the patient should heal uneventfully.

In continuing the vaginal hysterectomy, several paracervical pedicles are formed to further detach the wide attachments of the cardinal ligaments to the pericervical ring. Within the base of the cardinal ligaments are the uterine vessels as well as the ureters. Release of the lower portion of the cardinal ligaments helps to skeletonize the uterine vessels, while releasing the ureters and allowing them to retract away from the cervix and lower uterine cervix, as mentioned. Except in cases of scarring, the risk of injury to the ureters during vaginal hysterectomy is significantly less than during abdominal hysterectomy (12).

The broad ligaments are relatively avascular and need not be clamped, but can be sharply dissected to the adnexal pedicles. Many vaginal surgeons, however, continue to clamp the broad ligaments and tie off these pedicles. The round ligaments, uteroovarian ligaments, and the tubes need to be ligated and cut to remove the uterus and cervix from the surgical field.

Structural Anatomy of the Female Pelvis

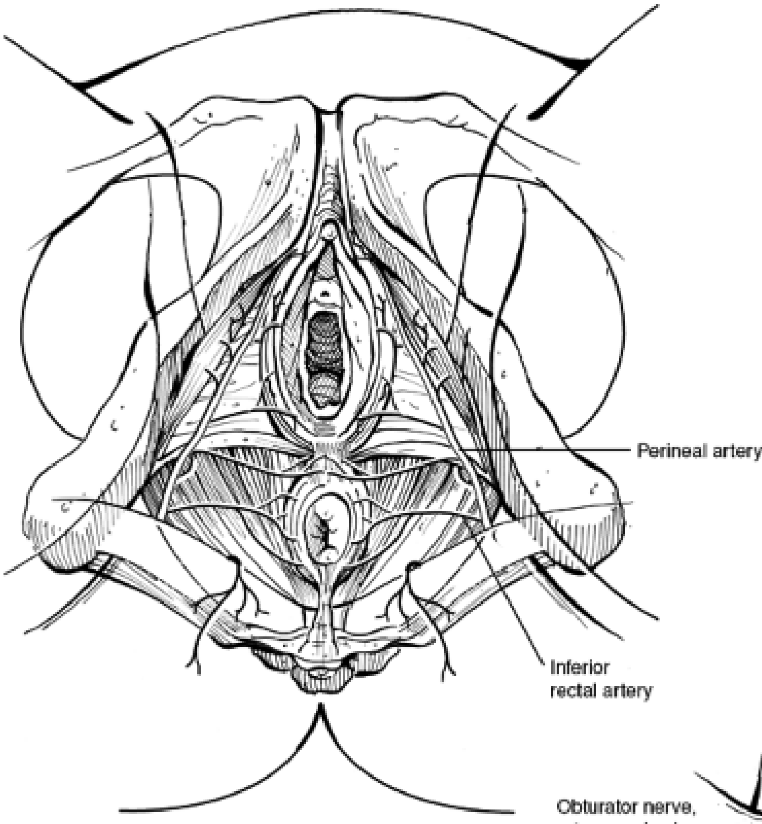
The *vasculature* of the female pelvis enters the pelvis over the pelvic brim at the sacroiliac juncture (Fig. 1.12). The vasculature is derived from two sourcesâ€”the ovarian vessels from the upper aortic region and the internal iliac arteries and veins from the common iliacs. Surrounding and traveling with these vessels are the many tiny visceral nerves and lymph nodes and channels. All these anatomic structures are enveloped and supported by visceral connective tissue sheets and sheaths, further filled in with fatty deposits of areolar tissue, and course in the pelvic sidewall between the parietal peritoneum and the parietal fascia. The parietal fascia covers the muscles of the pelvic basin.

The *common iliac arteries* bifurcate into the external and internal iliac arteries at the pelvic brim overlying the sacroiliac joints. The external iliac artery and accompanying vein travel on the medial edge of the psoas muscle overlying the medial, bony shelf of the ilium. These vessels then exit the pelvis underneath the inguinal ligament to enter the anterior thigh and become the femoral artery and vein. The internal iliac artery and accompanying vein travel along the bony border of the greater sciatic foramen toward the ischial spine. However, before they reach the level of the ischial spine, the artery and vein form their anterior branches. Therefore, for the vaginal surgeon, the internal iliac vessels travel in visceral connective tissue toward him or her, yet are superior to the level of the ischial spines.

However, several branches of the internal iliac vessels do travel in relation to the ischial spine. The *obturator vessels* travel 5 to 6 cm anterior to the spine, across the anterior part of the obturator internus muscle to enter into the obturator notch. The *internal pudendal vessels* exit the pelvis through the greater sciatic foramen, course just around and posterior to the ischial spine, within 2 cm, and then, through the lesser sciatic foramen, enter into the pudendal canal. The pudendal or Alcock's canal is situated along the medial surface of the obturator internus muscle, inferior to the levator ani muscles in the ischioanal fossa. The *inferior gluteal vessels* course at the middle edge of the posterior (upper edge) border of the sacrospinous ligament. Therefore, there are two avascular or â€œsafeâ€• areas of suture placement near the ischial spine. The first is along the sidewall, consisting of the iliococcygeus fascia and the parietal fascia of the obturator internus muscle. The second is in the midportion of the sacrospinous ligament, 2 to 3 cm medial to the ischial spine (to avoid the internal pudendal vessels and pudendal nerve) and away from its upper or posterior edge (to avoid the inferior gluteal vessels and nerve).

Each *ureter* travels into the true pelvis over the pelvic brim, across the bifurcation of the common iliac artery, and courses toward the ischial spine. However, the ureter does not reach the level of the ischial spines. Again, the ureter begins its â€œknee-bendâ€• 1 to 2 cm anterior and superior to the ischial spine, and then travels across the

anterolateral fornix of the vagina, around the supravaginal portion of the cervix. The vaginal surgeon is most likely to kink the ureter when attaching the vaginal cuff laterally to sutures anchored to the pelvic sidewall near the ischial spine, as in a vaginal paravaginal defect repair; or when attaching the uterosacral ligament sutures to the vaginal cuff when performing a uterosacral vaginal cuff suspension. Another possible injury to the ureter may occur with aggressive ligation of the infundibulopelvic ligament during adnexectomy, especially if the ovaries are scarred to the pelvic sidewall. Tension on the proximal portion of the infundibulopelvic ligament can pull the ureter into the clamp or suture tie. Cystoscopy is recommended in all these cases to ensure bilateral ureteral functioning.



Dorsal lithotomy position

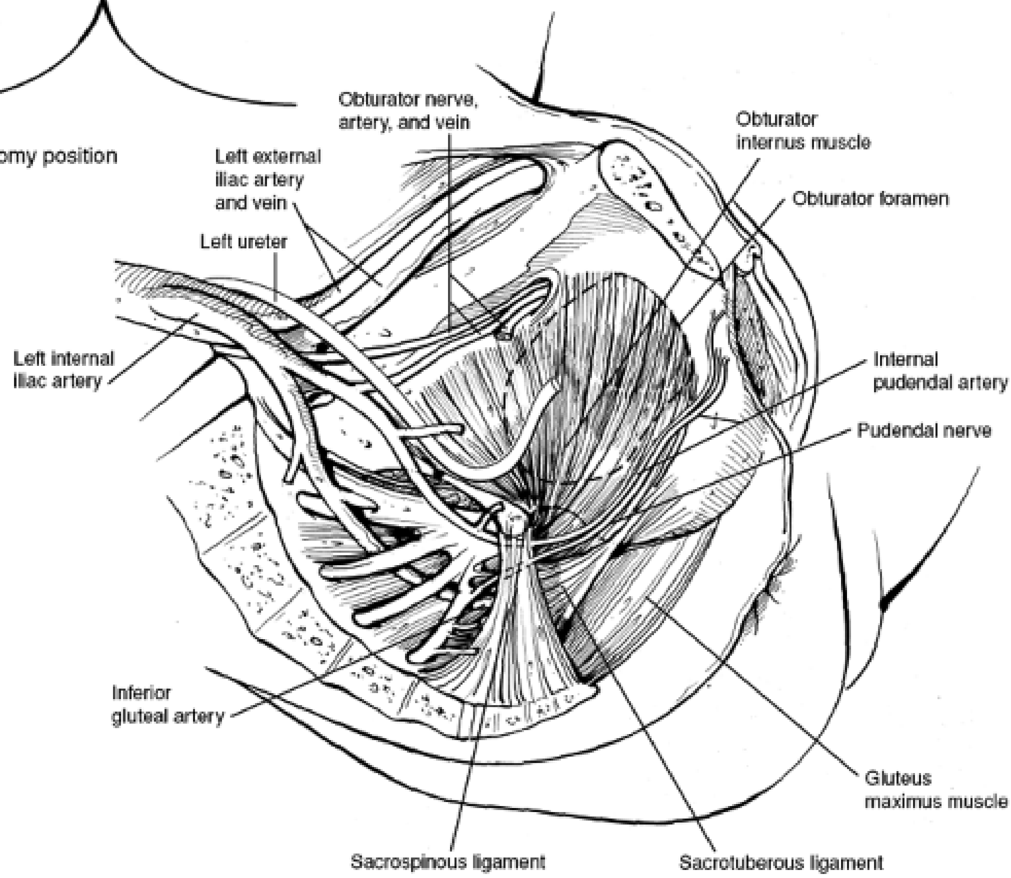


Figure 1.12 Vasculature (enveloped in the visceral connective tissues) and ureter in the dorsal lithotomy position.

What are the *somatic nerves* that the vaginal surgeon must know about to avoid nerve compromise, pain, and injury (13,14) (Fig. 1.13)? In positioning the lower extremities, the femoral nerves, the sciatic nerves, the lateral femoral cutaneous nerves, and the obturator nerves are of greatest concern. When performing surgery near the sacrospinous ligament, the sacral plexus of nerves, the inferior gluteal, and the pudendal nerves are of greatest concern. When passing instruments and sutures through the anterior abdominal wall near the pubic bone, the ilioinguinal and iliohypogastric nerves are to be avoided.

The *femoral nerve* is the second largest nerve in the body. It has a relatively poor blood supply. It courses in the iliopsoas groove at the iliac crest to the midpoint posterior to the inguinal ligament before entering the anterior thigh. Because the iliac bone is adjacent to the iliopsoas groove and femoral nerve, sustained lateral pressure on the psoas muscle from a lateral abdominal retractor or lateral blade from a self-retaining retractor in a transverse abdominal incision can compress this nerve and compromise its function. Therefore, the operator should ensure that no retractors are placed on the psoas muscle during abdominal surgery.

In patient positioning in the dorsal lithotomy position, excess hyperflexion of the hip can compress the femoral nerve against the inguinal ligament, especially in the thinner woman. When positioning patients in leg supports, the operator should avoid hyperflexion of the hips and ensure that good femoral pulses are present in the groin, inferior to the inguinal ligaments. In this manner, the operator has indirect evidence that there is not too much flexion and compression of the femoral nerves. However, these precautions may not be sufficient to prevent injury to femoral nerves already compromised by subclinical neuropathies or systemic diseases that affect nerve functioning, such as diabetes.

The *sciatic nerves* are relatively fixed anatomically in the gluteal region of the buttocks. Again, excessive hyperflexion of the hips can stretch the sciatic nerves and cause injury, which can be manifested as a temporary â€œfoot-drop.â€• This is another reason to avoid hyperflexion of the hips and thighs during patient positioning for vaginal surgery.

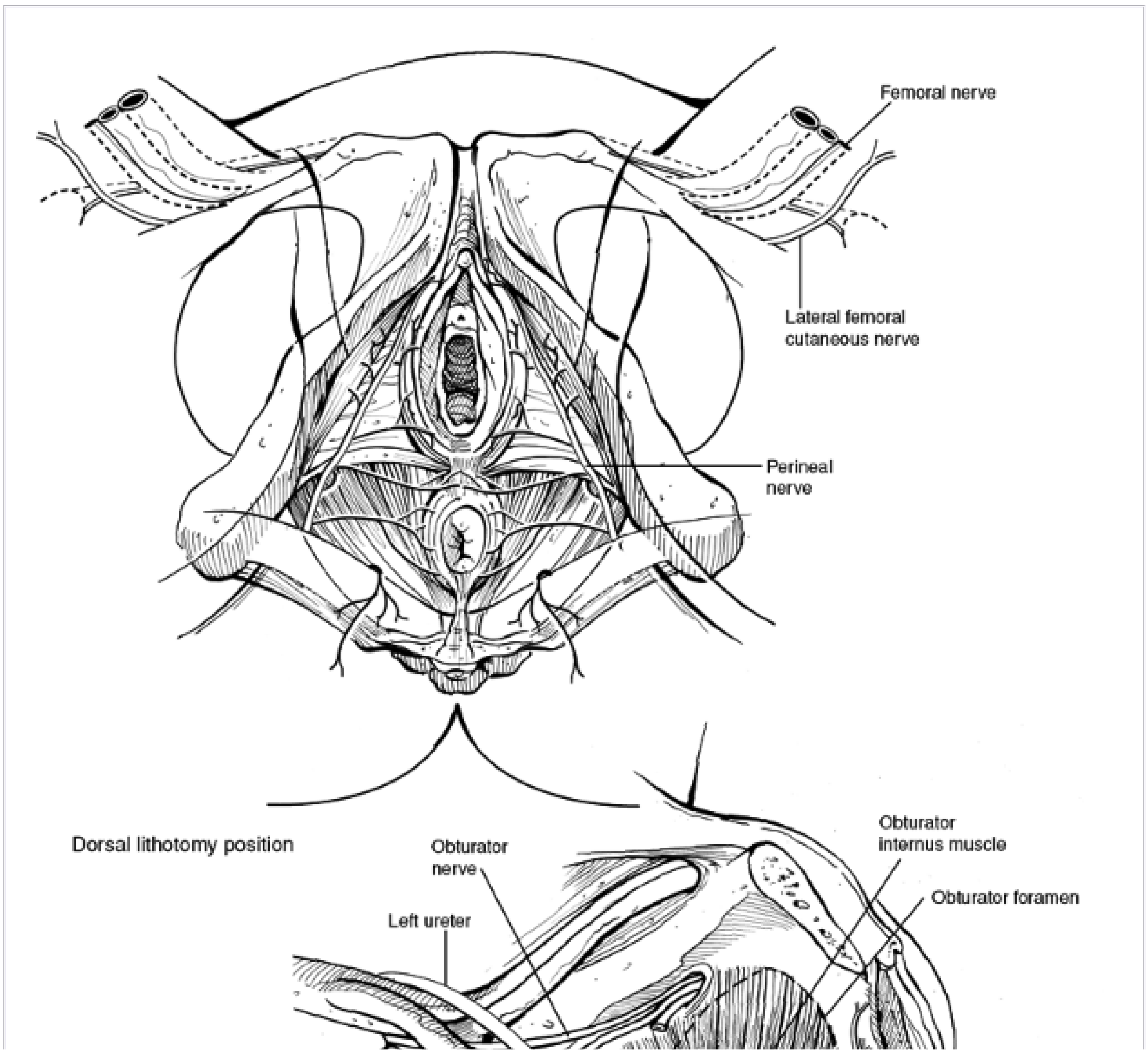
The *lateral femoral cutaneous nerve* travels laterally, on top of the iliacus muscle and exits the pelvis posterior to the inguinal ligament just medial to the anterior superior iliac spine. Again, hyperflexion can compress and stretch this nerve causing pain along the lateral aspect of the thigh to the knee. This clinical picture is called meralgia paresthetica.

The *obturator nerve* courses in the substance of the psoas muscle until the pelvic brim, where it leaves this muscle medially to enter the pelvis. This nerve then travels along the anterior aspect of the obturator internus muscle in the obturator space. It is encased in loose, fatty areolar tissue that hides its presence. This nerve exits the pelvis through the obturator canal and enters the medial aspect of the thigh to innervate the adductor muscles. Over abduction of the thighs in positioning for vaginal surgery may stretch these nerves and cause inner thigh discomfort. This is rarely seen.

The *sacral plexus of nerves* is a somatic plexus, one on each side of the pelvis, overlying each piriformis muscle. This plexus is located just posterior to the posterior edge of the sacrospinous ligament. Therefore, no sutures or instruments should be placed above the upper edge of the sacrospinous ligament toward the sacrum in order to avoid injuring the sacral plexus of nerves, as well as the inferior gluteal artery, vein, and nerve. The *inferior gluteal nerve* is directly from the sacral plexus and courses just posterior to the upper edge of the midsegment of the sacrospinous ligament.

The *pudendal nerve*, accompanied by the internal pudendal artery and vein, exits the pelvis by coursing inferior to and near the ischial spine. It then enters into the ischioanal fossa via the lesser sciatic foramen. These pudendal vessels and nerve are then encased in the fibrous pudendal canal of Alcock. This canal travels obliquely along the obturator internus muscle in the ischioanal fossa, inferior to the levator ani muscles. When suturing the sacrospinous ligament, the operator should stay at least 2 to 3 cm medial to the ischial spine. When passing instruments through the ischioanal fossa, the operator should stay away from the muscular lateral border of the obturator internus muscle with its pudendal (Alcock's) canal.

The *ilioinguinal and iliohypogastric nerves* travel through the aponeuroses of the lateral and anterior abdominal wall, and then course approximately 3 cm medial to the ischial spine. The iliohypogastric nerve travels in the subcutaneous tissues to innervate the cutaneous areas of the upper labia majora and upper, medial aspect of the thigh. The ilioinguinal nerve travels through the inguinal canal to innervate a similar cutaneous area. The external opening of the inguinal canal is found 2 cm superior and 2 cm lateral to the pubic tubercle. When passing instruments, sutures and/or mesh through the anterior rectus fascia near the pubic crest, the operator should stay within the boundaries set by the pubic tubercles in order to avoid entrapping these nerves with a suture or mesh.



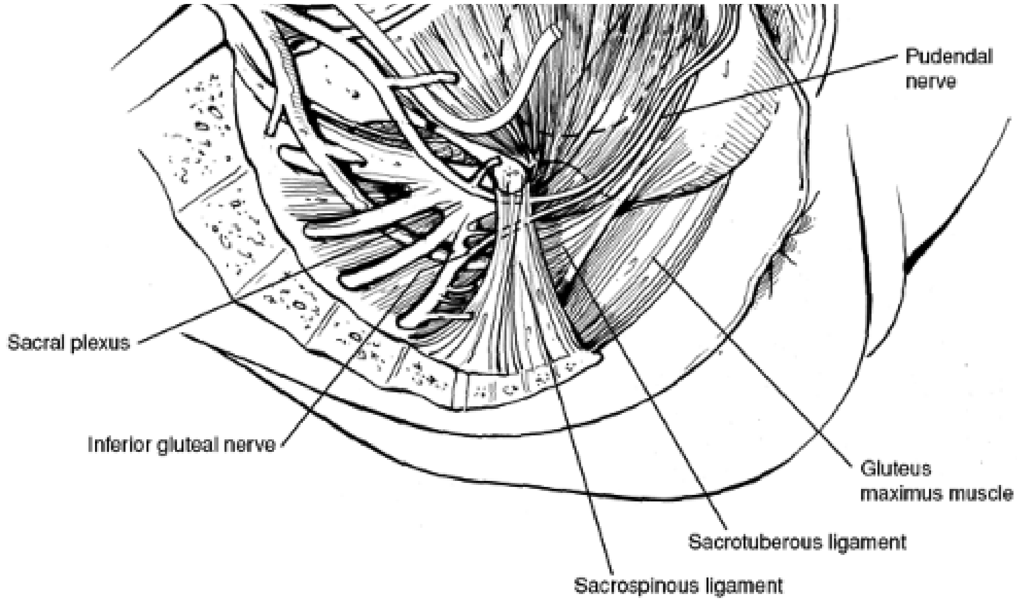


Figure 1.13 Somatic nerves and relations to muscles and viscera in the dorsal lithotomy position.

The Visceral Connective Tissues of the Female Pelvis

The organs in the female pelvis are surrounded by visceral connective tissues, also called endopelvic fasciae, that suspend and orient them anatomically within the pelvis. The suspensory purpose of these visceral connective tissues is to position the pelvic organs over the levator plate for pelvic organ support. Simultaneously, these same connective tissues surround and support the visceral arteries and veins, visceral nerves, and lymph nodes and channels that service these organs. The visceral connective tissue is called various names in the literature such as endopelvic fascia, visceral fascia, cellular connective tissue, pelvic ground substance, and condensations. The pelvic visceral connective tissues form a three-dimensional meshwork composed primarily of collagen, elastin, and smooth muscle. This meshwork exhibits some elasticity but then breaks.

This concept of breaks in the continuity of the visceral suspensory fascia is the basis for the present-day explanation of pelvic organ prolapse and site-specific support (suspensory) defects. This is in direct contrast to the former concept that the visceral suspensory fascia stretches and attenuates, and, therefore, is repaired by plicating these tissues to their original length. This former concept arose from observations of pelvic organ and vaginal prolapses. Indeed, the vaginal epithelium and peritoneum can stretch endlessly, as is frequently observed. However, the intervening visceral connective tissue sheets and sheaths develop breaks when stretched beyond their limits. These breaks cannot be readily seen, since they are located between and hidden by the attenuated and stretched epithelium and attenuated and stretched peritoneum. As mentioned earlier, the concept of site-specific breaks in the continuity of the visceral support network is now undergoing careful evaluation in the literature.

The visceral connective tissue suspensory network is continuous and interdependent from the pelvic brim to the pelvic sidewalls to the perineal membrane and perineal body. Reparative vaginal surgeons can only find the â€œbrokenâ€• sites in the continuity of this visceral suspensory network and reattach the visceral connective tissue to where it originally detached, usually with permanent sutures. Again, an important purpose of this network is the suspension of the pelvic organsâ€”bladder, cervix and upper vagina, and rectumâ€”over the muscular levator plate.

In the standing, nulliparous woman, the upper two thirds of the vagina and rectum are oriented in a more horizontal plane, overlying the levator plate. The levator plate is approximately 4 cm in length, from the rectoanal junction to the coccyx. When tensed and contracted, the dynamic levator plate forms a strong, effective horizontal base upon which the rectum and upper vagina are securely supported to prevent prolapse at the many instances of increased abdominopelvic pressures. This of course assumes the visceral suspensory network is intact. The levator plate is the tendinous insertion of the levator ani muscles in the midline of the posterior portion of the pelvis. The strength of the levator plate can be appreciated by the examiner in the office exam room during rectal examination, with the patient's permission.

With Valsalva stress, the force generated in the abdominopelvic cavity is directed downward, perpendicular to the long axis of the vagina and rectum. The levator plate, which is physiologically responsive, contracts and strengthens to counter the downward force. Thus, the cervix and upper vagina and rectum are entrapped between the downward Valsalva force and the upward tensing levator plate (Fig. 1.14). This â€œflap-valveâ€• backstop action is the key mechanism that prevents pelvic organ prolapse. The other is the firm closure of the urogenital hiatus by the contraction of the pubococcygeus muscles and the action of the perineal body.

Therefore, pelvic organ prolapse is caused by a poorly functioning levator plate or levator ani muscles, and/or failure of the pelvic organ suspensory network of visceral connective tissues. Breaks in the visceral connective tissue network and damage to the musculature and its somatic innervations in the female pelvis occur during vaginal childbirth most commonly, but can also occur with chronic straining such as in chronic constipation, chronic cough from cigarette smoking, chronic obstructive pulmonary disease and asthma, and chronic heavy lifting. Breaks in the visceral connective tissue suspensory network can also occur in sudden forceful events such as falls, automobile accidents, and high-impact sports and exercises. The sustaining mechanism is the pelvic organ entrapment by the strong levator plate. The suspensory connective tissues are strong enough to suspend the weight of the pelvic organs alone, but not with the frequent added weight of persistent Valsalva forces bombarding the pelvic organs from above. With a damaged and poorly functioning levator plate, the suspensory connective tissues gradually fatigue and begin to fracture and then break. Thus, the pelvic organs soon slide down the ineffectual levator plate and prolapse down into and out of the vagina.

Commentary

Successful vaginal surgeons are masters of the anatomy of vaginal and pelvic dissection. During vaginal procedures, they actively search for anatomic landmarks and pay active attention to the sight and feel of the tissues that they are dissecting. This knowledge of â€œnormalâ€• dissectional anatomy and surrounding anatomic relations is crucial to the surgeon faced with difficult dissections in distorted anatomy due to pathologic states. Confidence with anatomic relationships and techniques of dissection allows the surgeon to perform procedures in a safe and efficient manner. Thus, their patients are better served with a minimum of complications.

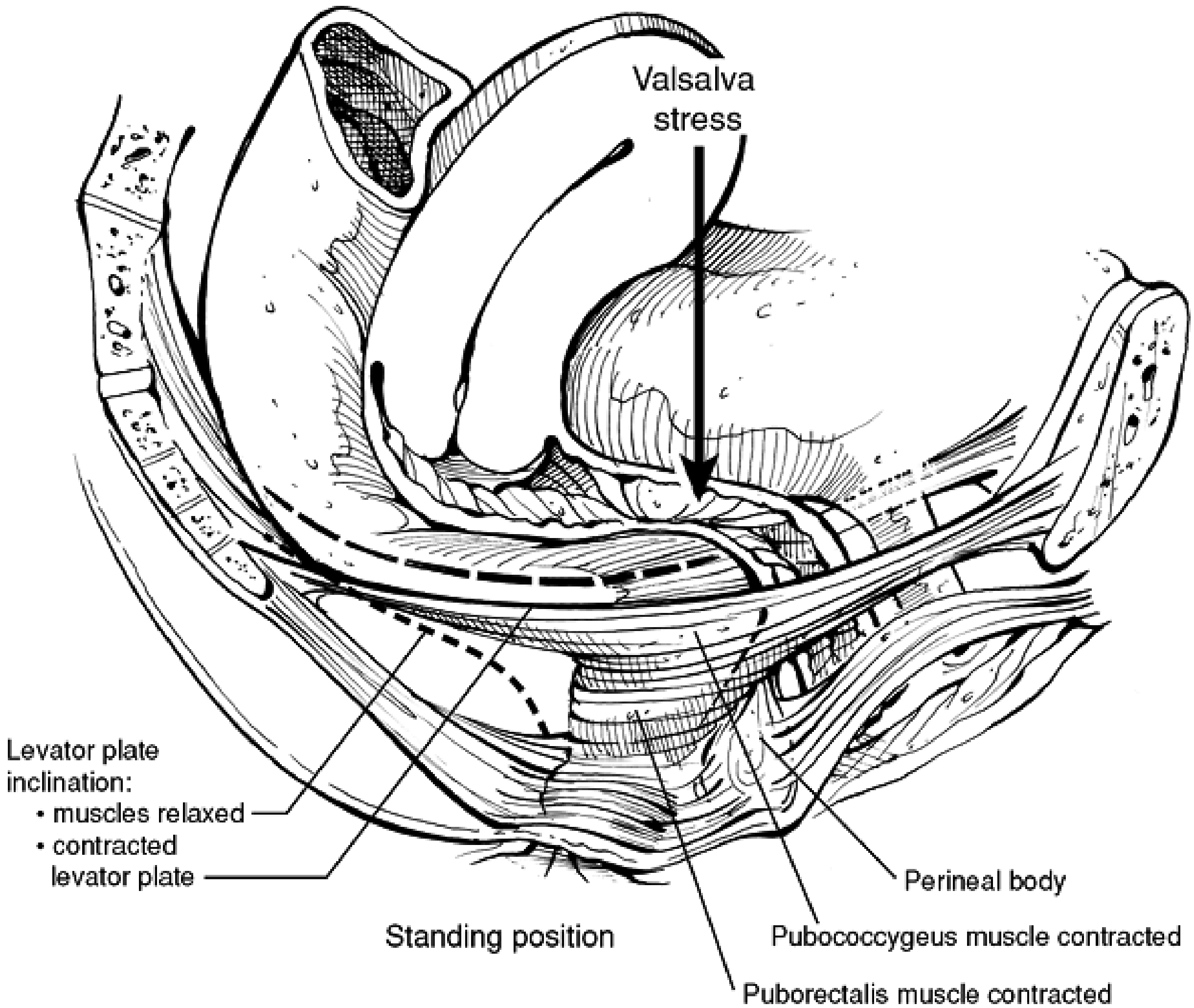


Figure 1.14 â€œFlap Valveâ€• mechanism of vaginal support (before and after Valsalva stress).

The vaginal surgeon must visualize the three-dimensionality of the pelvic surgical anatomy in the dorsal lithotomy position of the patient. This is difficult to do without an active mind focused on learning and understanding. The alert pelvic surgeon will consistently observe, question, study, and persist to gain this working knowledge. Years of active effort are required to process, organize, and understand all the information within this complex and confusing subject. Just as technical skills can be taught and mastered through focused study and consistent repetition, so can one's working knowledge of surgical/dissectional anatomy. It's well worth the effort!

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2

Applied Anatomy and Physiology of Female Pelvic Floor Support Disorders: The Identification of Site-Specific Defects and their Associated Pathophysiology

Thomas M. Julian

Throughout a woman's life, pelvic floor anatomy and physiology change because of many contributing factors. Major known risks such as heredity, aging, childbirth, ovarian failure, and other contributors like nutritional deficiency, physical activity, chronic constipation, and other factors, some probably as yet unrecognized, affect both the position (anatomy) and function (physiology) of the pelvic floor. Bothersome symptoms include alterations in comfort, the ability to retain or eliminate urine or feces, and sexual behavior and are referred to as pelvic floor dysfunction. Although traditionally described separately, changes in position (pelvic organ prolapse) and alterations in function are an interrelated process. Separating position and function clinically should be abandoned in favor of an integrated approach now called female pelvic floor medicine. To do this effectively the clinician must be alert to what he or she hears and sees when taking the patient history and performing the physical examination (1).

Functional Anatomy and Physiology of the Pelvic Floor

Between the perineal skin and caudal peritoneal cavity is the pelvic floor, made up of the uterus, vagina, urethra, bladder, and anorectum with the muscles, connective tissues, vessels, and nerves that maintain the normal position and function of these organs. The interactions of these structures provide storage and evacuation of urine and feces, a receptacle for intercourse, and a channel for childbirth.

The *bony pelvis* anchors the muscles and organs through its attachment to a connective tissue network of varying

density commonly described as fascia and ligaments. The bony pelvis influences the pelvic floor function both obstetrically and at the time of surgical repair. A narrow subpubic arch and converging lateral pelvic sidewalls, characteristics of the anthropoid pelvis, exist in 25% of white and 50% of African American women. This pelvic configuration is generally thought to provide better anterior support for pelvic organs than the pelvis with a wide pubic arch and parallel sidewalls, the gynecoid pelvis, present in about 50% of white women. Conversely, obstetric labor disorders occur more frequently and it is more difficult to operate transvaginally when the subpubic arch is narrow and the sidewalls converge. Compensatory posterior room in the pelvis may alleviate the problem in labor but not for operative vaginal delivery or transvaginal pelvic surgery. Estimating the adequacy of the female pelvis for vaginal delivery and transvaginal surgery is done using estimates from clinical examination. Patients with spina bifida or other forms of caudal regression often lack fully developed pelvic skeletons, muscles, connective tissue support, and innervation. Pelvic organs in these situations are predisposed to pelvic floor dysfunction disorders, especially pelvic organ prolapse.

Muscles and Fascia

The pelvic floor is a broad reference to the two-part fibromuscular support structure formed by the perineum and pelvic diaphragm. The perineum has a superficial and a deep compartment. The caudal or *superficial perineal compartment* contains the ischiocavernosus muscles, bulbocavernosus muscles, portions of the transverse perineal muscle, external anal sphincter muscle, and perineal body. This compartment supports the distal urethra, vagina, and anus.

The superficial perineal compartment provides none of the sphincter function for the urethra, but it supports the distal urethra, allowing aiming of the urine as a stream, and can significantly alter this function when conditions or operations distort or amputate it. The posterior connective tissue insertions of the bulbocavernosus muscles, transverse perineal muscle, external anal sphincter, and fascial attachments to the coccyx form the perineal body. The perineal body is the caudal attachment site for the posterior rectovaginal fascia (septum) of Denonvilliers. In addition to the support provided, the perineal body provides most of the bulk of the perineum, which contributes sexually, cosmetically, and hygienically to the individual. The external anal sphincter is a significant part of the three-looped anal continence mechanism. Although the puborectalis and internal anal sphincter muscles contribute some of the closure pressure to the continence mechanism, in the absence of these two structures, the external anal sphincter alone, especially when voluntarily exercised, can maintain rectal continence in most individuals.

The cephalad or *deep perineal compartment* contains the majority of the deep transverse perineal muscle and the underside of the dense fascial membrane called the urogenital diaphragm or pelvic membrane that separates the deep perineum from the pelvic diaphragm (Fig. 2.1). The pelvic membrane is triangular and attaches to the inferior pubic rami laterally, passes to the pubic arch ventrally, and covers the anterior pelvic outlet, except where the urethra and vagina pass through it. The pelvic membrane anchors the vagina distally and the anterior perineal body. It prevents descent of the pelvic floor with increases in intra-abdominal pressure (Fig. 2.2). When the perineal membrane becomes detached from its bony insertions, the perineum and vagina descend with straining.

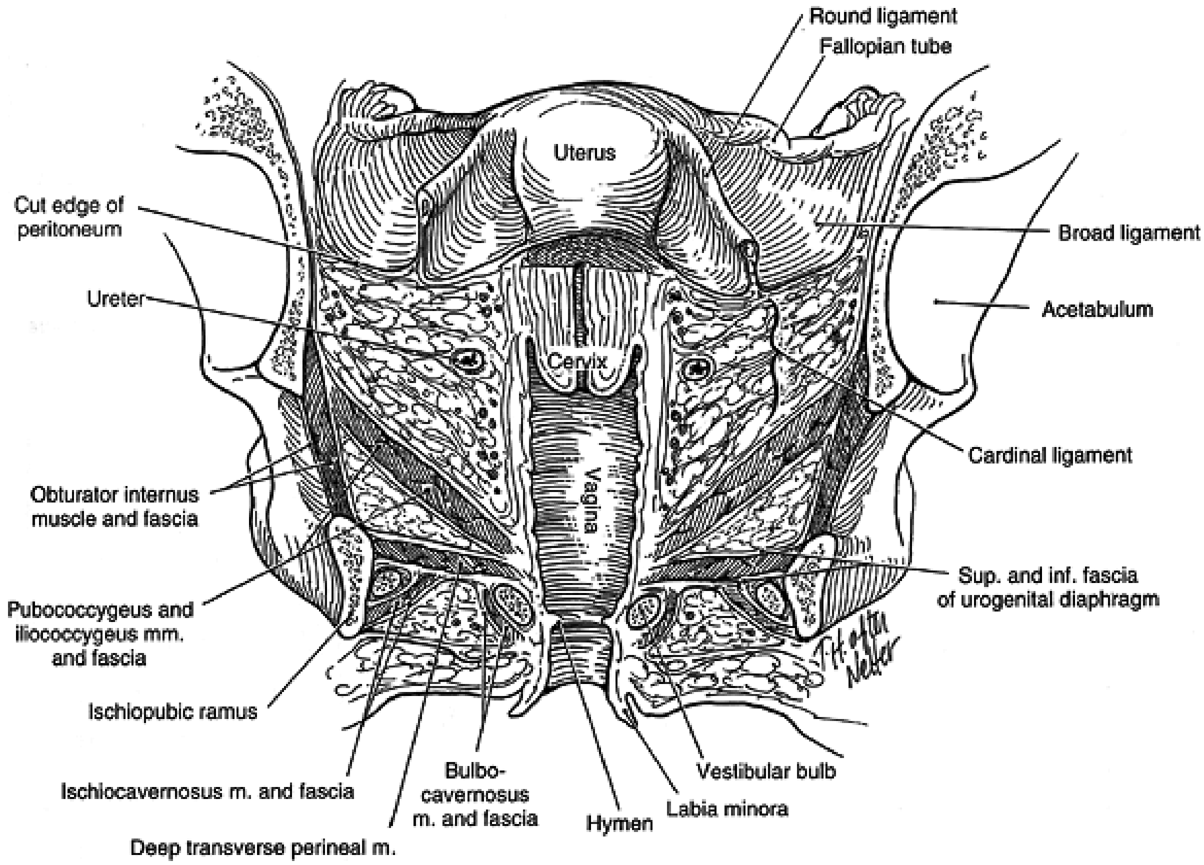

Figure 2.1 Coronal view of pelvic anatomy demonstrating the connective tissue and muscular supports of the female pelvis. (From, Anderson JR, Genadry R. Anatomy and embryology. In: Berek JS, ed. *Novak's Gynecology.* 13th ed. Philadelphia: Lippincott Williams & Wilkins, 2002:77 , with permission.)

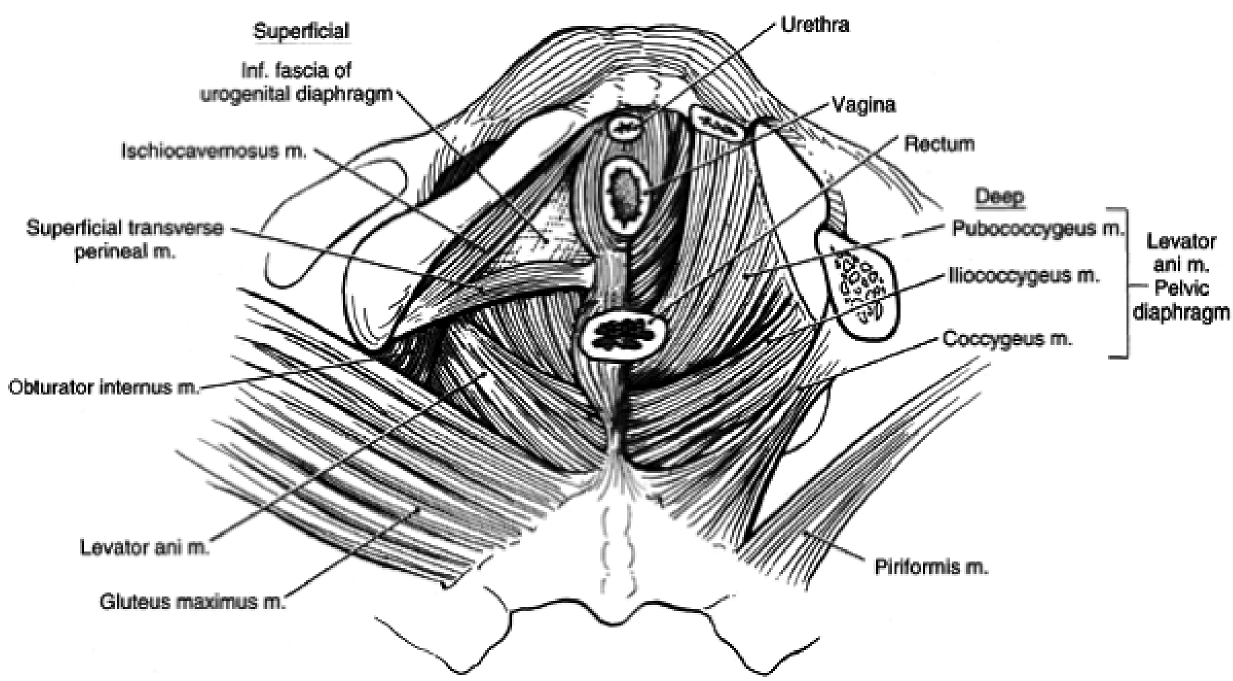

Figure 2.2 An upward looking view of the female pelvic floor. The view on your right shows the lower pelvic floor removed to illustrate the pelvic diaphragm. (From,
Anderson JR, Genadry R. Anatomy and embryology. In: Berek JS, ed. *Novak's Gynecology.* 13th ed. Philadelphia: Lippincott-Raven, 1996:76
, with permission.)

The *upper pelvic floor (pelvic diaphragm)*, beginning with the cephalad pelvic membrane, consists mainly of the components of the levator ani muscle and its fascial coverings. A U-shaped muscle originates from the pubic rami on either side of the midline and laterally attaches to the arcus tendineus; the levator ani muscle passes around the rectum, opens anteriorly, and covers most of the pelvic inlet. The levator ani muscle is the major support of the bladder, vagina, and rectum, which all pass through the open portion of the Uâ€”the genital *(levator) hiatus*.

The resting tone of the levator ani muscle holds the vagina and upper anal canal shut. It is the constant high pressure generated by the puborectalis (pubococcygeus) portion of the levator muscle that prevents stool from passing into the rectum before evacuation. Its resting tone pulls the anorectal junction toward the symphysis, creating the *anorectal angle* (approximately 90 degrees) and holds the rectum shut. The puborectalis mechanism even allows patients with disrupted anal sphincters to maintain some fecal continence, but it is a combination of the internal and external anal sphincters that maintains continence above the external anal sphincter. The portion of the levator ani muscle raphe that passes from the external anal sphincter to the coccyx is the levator plate, which serves as support for the upper vagina, uterus, and rectum (Fig. 2.2).

The vagina is a pliable epithelial-lined tube attached at its margins to the surrounding connective tissues. The most caudal one third of the vagina fuses through its connective tissue to the urethra anteriorly, laterally to the levator ani muscle fascia, and posteriorly to the perineal body. The distal one third is constricted as it traverses the urogenital hiatus at the levator ani muscles. In the standing, adult woman the upper vagina above the opening in the genital hiatus travels dorsally at about a 60-degree angle with the horizontal. The middle and upper vagina, like the other pelvic viscera, are supported laterally by visceral connective tissue or fascia that interdigitates with the connective tissue coverings of the levator muscle. These visceral connective tissue attachments are known to gynecologic surgeons as endopelvic fascia, but would probably be more accurately called fibromuscular or fibroelastic connective tissue. These attachments hold the upper vagina in a midline, nearly horizontal position above the cephalad surface of the levator ani muscle over the levator plate. The midvaginal connective tissue attachments, extending laterally and posteriorly, thicken to form the arcus tendineus fasciae pelvis (white line).

The cephalad vagina and the uterus are supported mainly by the uterosacral ligaments, cardinal ligaments, and anterior endopelvic fascia (*pubocervical fascia*). The posterior vaginal wall attaches to the endopelvic fascia of the pelvic diaphragm, which extends down the rectovaginal septum to the perineal body as the fascia of Denonvilliers. These fascial attachments tether the vagina to maintain normal organ position (Fig. 2.3). The cervix penetrates the anterior vaginal wall, making the anterior wall shorter than the posterior wall, about 9 cm and 11 cm, respectively (2,3).

In the normal female pelvis the internal genitalia, base of the bladder, and rectal wall do not descend through the genital hiatus but are supported above the levator muscle.

With increased intra-abdominal pressure, these supports hold the uterus and vagina over the levator plate and are fixed to the sacrum and pelvis sidewalls. When pelvic organ prolapse occurs, the genital hiatus is usually widened, and the connective supports do not keep the pelvic organs in place, allowing them to descend caudally into the vaginal lumen or completely through the vaginal opening.

The Fibroelastic Connective Tissue Sheath (FECTS)

An Identifiable Pelvic Fascia

Studies of pelvic connective tissue show that many gynecologists and anatomists favor the term endopelvic fascia, whereas others considered it incorrect to call the connective tissue within the pelvis fascia (4,5,6). My own observations

in the cadaver laboratory have shown that in pelvic dissections of nulliparous female cadavers there is a dense connective tissue overlying the pelvic floor that extends to the pelvic sidewalls and perineum. It is a sheet of connective tissue across the entire pelvis, attaching the muscles and viscera to the bony pelvis. This connective tissue sheath is thickest at the arcus tendineus fasciae pelvis and the uterosacral ligaments, but its course could be followed intact even in the less dense areas surrounding the urethra and vaginal tube. There is an anatomic plane separating the vagina from the overlying bladder and underlying rectum that has a tough overlying connective tissue sheath. It is this connective tissue sheath, described separately by Richardson et al. and later Baden and Walker, which is the crucial structure leading to the concept of site-specific pelvic support defects and their surgical repair (7,8).

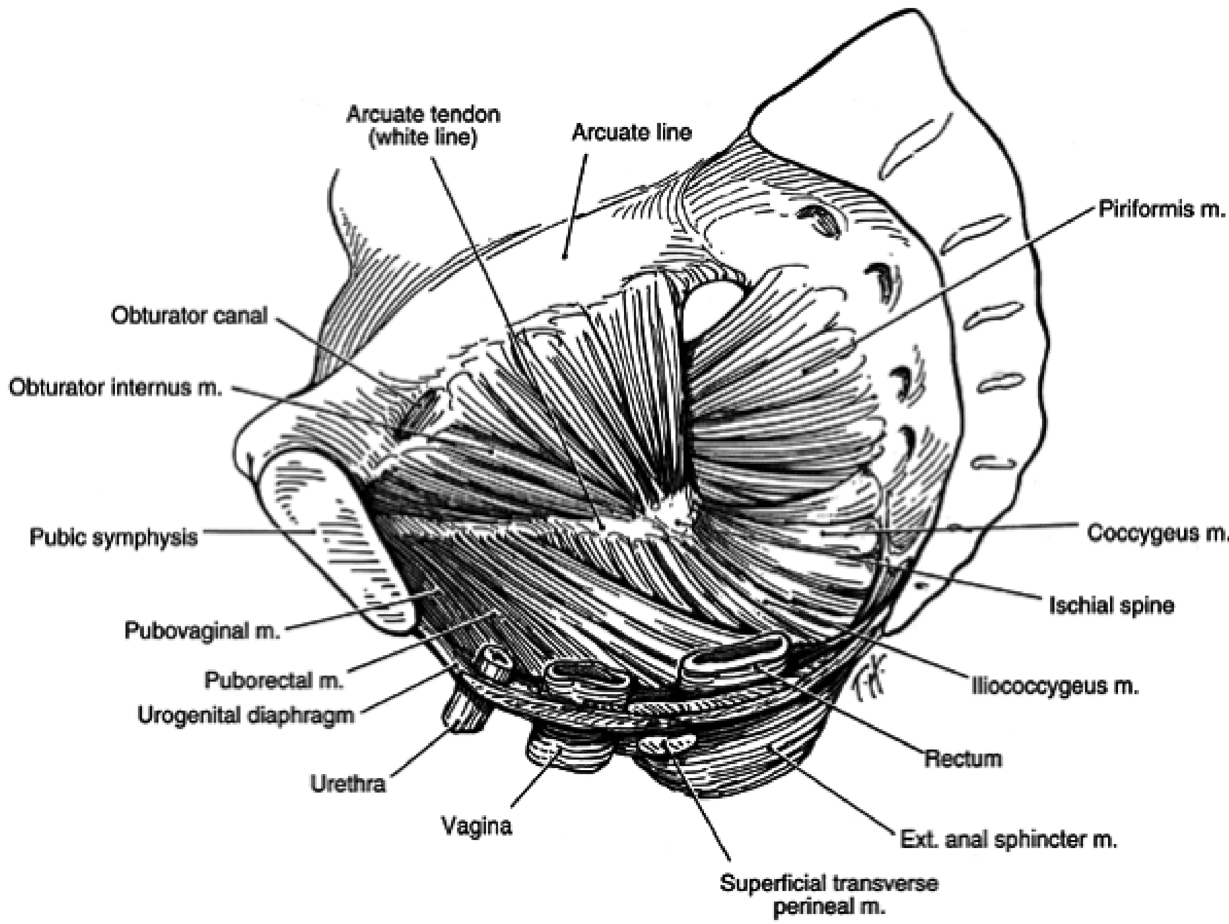

Figure 2.3 A sagittal view of the pelvic floor and deep perineal compartment. (From,
Anderson JR, Genadry R. Anatomy and embryology. In: Berek JS, ed. *Novak's Gynecology.* 13th ed. Philadelphia: Lippincott-Raven, 1996:77
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Identifiable Pelvic Support Defects

For many years pelvic organ prolapse was thought to be associated solely with attenuated or stretched pelvic connective tissues. Richardson et al. and Baden and Walker independently observed that pelvic support defects are associated with discrete breaks in the supporting connective tissue sheaths (7,8). They were able to identify by physical examination techniques breaks in the underlying connective tissue of the vagina. These breaks became known as site-specific defects and could be repaired by joining the connective tissue breaks.

The Evolution of Site-Specific Defect Repairs

The first modern report of a pelvic support defect resulting from broken fascial supports and repaired with site-specific reattachment was Richardson's description of the paravaginal defect, a discrete break in the lateral connective tissue holding the vagina at the arcus tendineus fasciae pelvis, or white line. It was not until many years after this report that the concept of vaginal support being lateral and not just central was accepted, and, therefore, repair should not be confined to just central plication of the tissue underlying the anterior vaginal epithelium. Richardson repaired the defect through an abdominal incision. Over the ensuing years Richardson described breaks that occurred centrally and laterally in both the anterior and posterior vaginal connective tissue sheath, at the vaginal apex, anteriorly in the pubocervical connective tissue, and posteriorly in the vagina at the attachment of the rectovaginal septum to the perineal body (7,9).

Identifying Vaginal Support Defects on Examination

Vaginal Topogram

Baden and Walker, working and reporting independent of Richardson, described similar defects and suggested that each defect be identified and recorded using what he referred to as a vaginal topogram. The topogram described six sites for analysis and repair: urethrocele, cystocele, uterus,

culdocele, rectocele, and perineum; and could serve as a plan for surgical repair (8) (Fig. 2.4).

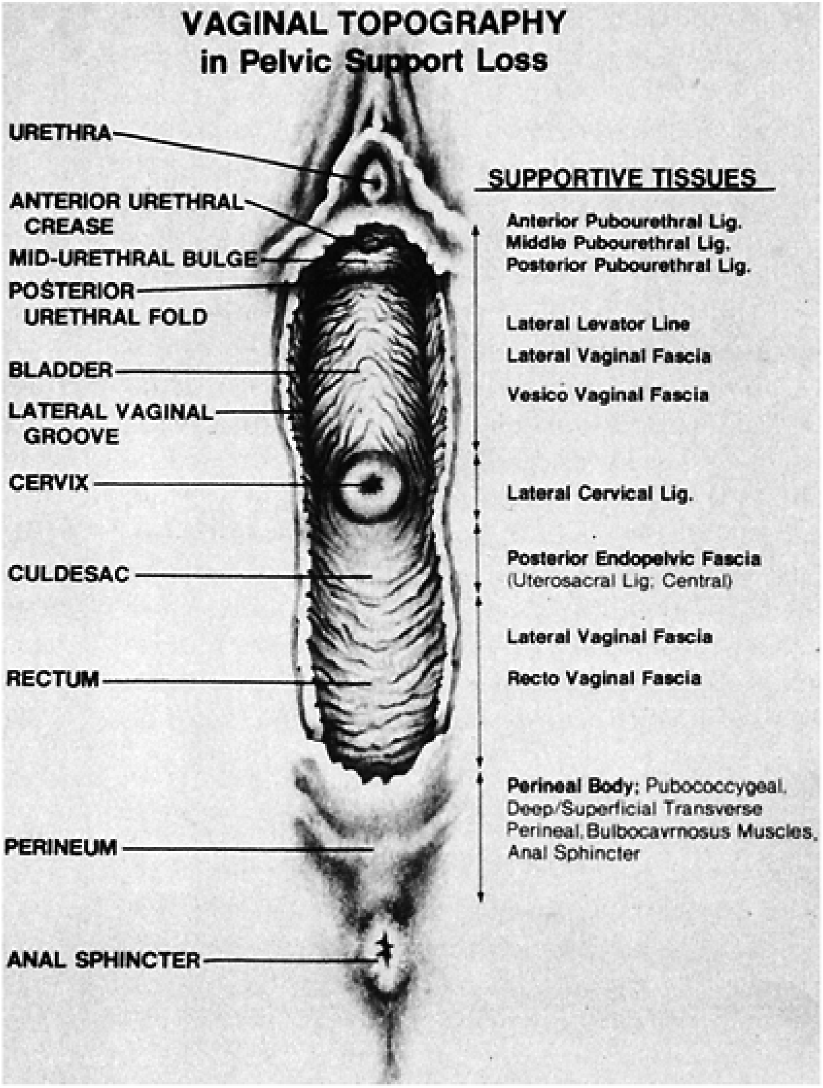

Figure 2.4 Baden topogram: A vaginal topogram can serve as a way to record examination findings and as a guide to make an operative site-specific defect plan for repair of vaginal supports. (From:
Baden WF, Walker T. *Surgical Repair of Vaginal Defects*. Philadelphia: Lippincott, 1992:27
, with permission.)

Diagnosis of Pelvic Support Defects

Each of the potential repair sites is assessed, usually in the following order: (i) urethra, (ii) lateral anterior vaginal wall (paravaginal defect), (iii) central anterior vaginal wall, (iv) vaginal apex (anterior/posterior enterocele or detachment at the pericervical connective tissue ring at the apex), (v) central posterior vaginal wall, (vi) lateral posterior vaginal wall, (vii) rectal sphincter muscle, and (viii) perineum.

To assess *urethral hypermobility* with the patient in the dorsal lithotomy position, simple observation with the patient straining most often will demonstrate downward urethral rotation of the entire urethra. When the degree of hypermobility is difficult to assess, such as in the obese patient, in whom it is difficult to see, or the previously operated patient in whom mobility is often more subtle, the Q-tip test can be performed. The cotton-tipped end of a wooden tailed applicator is lubricated and placed into the urethra to just below the urethrovesical junction. With the patient relaxed, the urethra is elevated using the ring forceps to a normal anatomic position, generally with the applicator tail becoming nearly parallel to the floor. The patient is asked to strain and hold. The arc measured in degrees transcribed from the horizontal by the tail of the wooden applicator indicates the severity of the hypermobility. To be considered hypermobile the arc should be >30 degrees (10).

Some examiners may err in assessing urethral hypermobility by evaluating the applicator tail in the urethra when the urethra is at maximum descent, not first replacing the urethra to the near horizontal position before asking the patient to strain. Without replacing the urethra before the straining, it may appear as if there is no urethral mobility.

Although urethral hypermobility is associated with urinary stress incontinence, it is not diagnostic for the condition. However, other measures of function can give the examiner significant information. For example, the patient with little or no urethral hypermobility who leaks urine with a cough stress test is more likely to have Type III incontinence (intrinsic sphincter deficiency). The urethral sphincter may either be very weak or the urethra is scarred open from prior surgery. Patients with these findings are at increased risk for surgical failure when treating urinary stress incontinence, a fact that may aid in patient counseling (11,12).

The patient whose stress test is positive shortly after voiding, who has low residual urine, is also at risk for greatly compromised urethral sphincter function (13). Office assessments of bladder function including patients with a history consistent with stress incontinence, bladder capacity of 400 mL or greater, postvoid residual volume of 50 mL or less, and positive cough stress test have genuine urinary stress incontinence and are unlikely to benefit from further urodynamic testing (14).

Women with large anterior compartment defects on examination, who are continent of urine, may experience incontinence after surgery to repair the anterior compartment defect. The anterior segment prolapse, which served as an obstruction to voiding or provided a urethral backstop to maintain continence, is absent after surgery (15). These patients may give a preoperative history of having trouble starting urination, or they at one time have had stress incontinence that improved or resolved over time (with worsening prolapse acting as a valve to prevent urine loss). Using a pessary to reduce the prolapse can serve as a diagnostic test of how continence might be affected by surgery; urodynamics alone, without a maneuver to reduce the prolapsed organ during testing, may not (16,17).

Site-specific vaginal support defects can be diagnosed in a systematic manner using a series of physical examination maneuvers (8,18). During these diagnostic maneuvers, the examiner who understands pelvic support anatomy and physiology should be able to recognize problems and plan treatment more appropriately. Simply put, knowing what

is broken allows the caregiver to choose the best treatment. The lack of pelvic support also involves damage to the underlying pelvic muscles and nerves, which cannot always be objectively assessed or fully restored by any diagnostic or therapeutic intervention.

With the patient in the dorsal lithotomy position the diagnostic *first maneuver*, a quick general assessment, is performed by placing a Graves speculum gently into the vagina, advancing it to the vaginal apex, and opening the speculum blades. With the patient straining, the speculum is slowly withdrawn as the examiner observes for descent apically, anteriorly, and posteriorly in the vagina. This gives a general impression of the defects present (descent of the apex, anterior wall, and posterior wall). In addition to an impression of descent of these three segments, the examiner assesses the vaginal epithelium for rugosity and atrophy. Rugosity, or the transverse ridges in the vagina, is an indication that the underlying connective tissue sheath is present and still attached to the overlying vaginal epithelium. If there is no rugosity, the area with a smooth appearance either overlies an area where the underlying connective tissue sheath gaps because of a specific break, or there may be such poor quality connective tissue it cannot be used in surgical repair, and grafting may be necessary to achieve an adequate surgical result.

After this initial survey, the speculum is removed from the vagina, and the set-screw holding the anterior and posterior speculum blades is removed. The posterior speculum blade is reinserted, first against the posterior vaginal wall, all the way to the vaginal apex. This permits examination and assessment of the anterior vaginal wall. Later during the examination placing the blade against the anterior vaginal wall to the apex allows a similar assessment of the posterior wall.

One or two ring forceps are used during examination to simulate the normal vaginal supports. Determining how the ring forceps must be placed to prevent the vaginal wall from descending when the patient strains tells the examiner the location and type of underlying connective tissue defect present and whether exercise, a pessary, or surgical repair is indicated to help the patient.

Each pelvic floor site is described in terms of descent from its expected normal anatomic position. The oldest methods for doing this involve grading systems that indicate the site (anterior vaginal wall, vaginal apex, cervix, posterior wall) of descent and the severity of descent (mild to severe) graded by pelvic organ mobility. Mild pelvic organ prolapse is descent of the presenting segment to or just beyond the ischial (obstetric) spines; severe prolapse usually indicates descent beyond the vaginal introitus or even complete eversion of the vagina. Because many of these evaluation methods were imprecise, the Baden-Walker Halfway System, an outgrowth of their own earlier vaginal profile, was developed, but entailed a slightly more intricate numbering system to identify specific defect sites and objectively quantify the degree of vaginal descent (8).

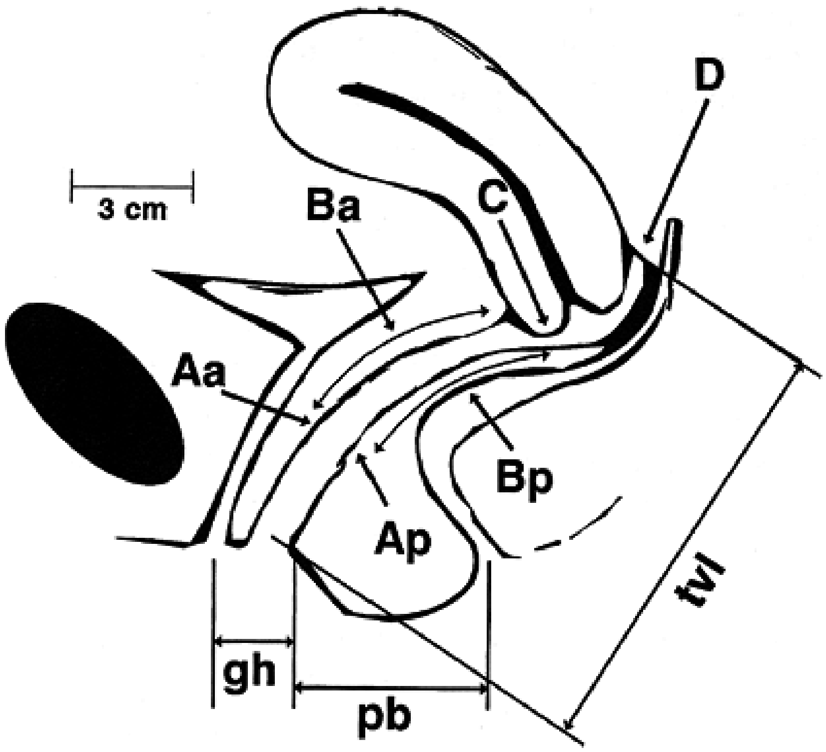

Figure 2.5 POP-Q There are site points labeled Aa, Ba, C, D, Bp, and Ap that correspond to points above or below the hymeneal remnants and are stated in centimeters above (negative) or below (positive) that point. The genital hiatus (gh), perineal body (pb), and total vaginal length (tvl) are also listed as lengths in centimeters. They are used to quantify pelvic organ support anatomy. (From: Bump RC, Mattiasson A, Bo K, et al. The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction. *Am J Obstet Gynecol.* 1996;175:12
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In 1996, the more descriptive and complex Pelvic Organ Prolapse Quantification (POP-Q) was adopted by the International Continence Society, American Urogynecology Society, and the Society of Gynecologic Surgeons. POP-Q was developed to standardize the description of pelvic organ prolapse and allow better communication its study (19). POP-Q describes nine measurements Aa, Ba, C, D, Bp, Ap, the genital hiatus (gh), perineal body (pb), and total vaginal length (tvl) (Fig. 2.5). These measurements are made in centimeters with the patient straining and recorded on a nine-cell grid, representing a sagittal plane through the center of the vagina that can be converted into stages I-IV. Measures on the anterior and posterior vaginal walls are expressed as distances above or cephalad (expressed as negative numbers) or distal or caudad (expressed as positive numbers) from the hymeneal remnants. Aa and Ba are on the anterior vaginal wall; Ap and Bp are on the posterior vaginal wall. C is the distance from hymen to the leading edge of the cervix, and D is the distance to the posterior fornix. The advantage of a grading system to the individual surgeon is that it should provide baseline and postoperative measures to assess outcome. Drawbacks to the POP-Q system are that it is more difficult to learn than the Baden-Walker system, and it does not describe site-specific defects. A simple grading system that assesses before and after results in a site-specific manner helps plan the operation and that shows the surgeon which procedures did and did not work over time would be ideal. For the

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purposes of this discussion, site-specific descriptions will be used.

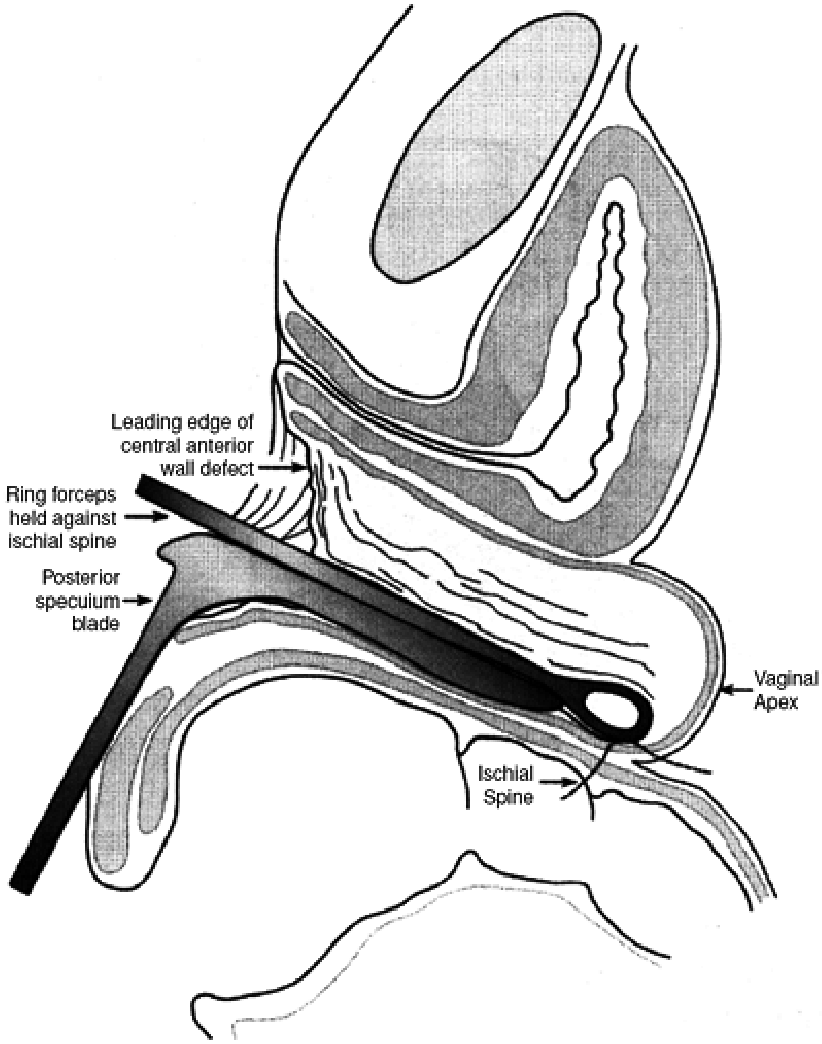

Figure 2.6 Paravaginal defect reduced with forcepsâ€"The examiner checks for a paravaginal defect by inserting the posterior speculum blade along the posterior vaginal wall to the apex. The tips of an opened ring forceps are placed at each ischial spine against the lateral vaginal sulci. The patient is asked to strain. If this maneuver completely reduces the anterior wall descent, an isolated paravaginal defect is present. If it does not there is a central defect present. (From, Julian TM. Physical examination and pretreatment testing of the incontinent woman. *Clin Obstet Gynecol.* 1998;41:667
, with permission.)

Anterior Vaginal Wall Defects

When anterior vaginal wall descent is present, the posterior speculum blade is placed against the posterior vaginal wall. As the *second maneuver*, an open ring forceps is held along the lateral vaginal sulci with the tips of the forceps against the ischial spine, one tip against each spine (Fig. 2.6). The patient strains. If the anterior vaginal wall no longer descends, there is a *paravaginal defect*. The ring forceps is removed, closed, and reinserted separately against each sulcus. If supporting just one side reduces the descent completely, the paravaginal defect is unilateral.

If the defect is reduced partially, or not reduced at all by the initial paravaginal defect maneuver, it is likely there is a *central defect* in connective tissue of the anterior vaginal wall. The *third maneuver* diagnoses the central defect: the closed ring forceps is held with the shaft placed flatly against the midline anterior vaginal wall to just below (2 cm) the vaginal apex. If the bulge is reduced with straining, there is an isolated central defect (Fig. 2.7).

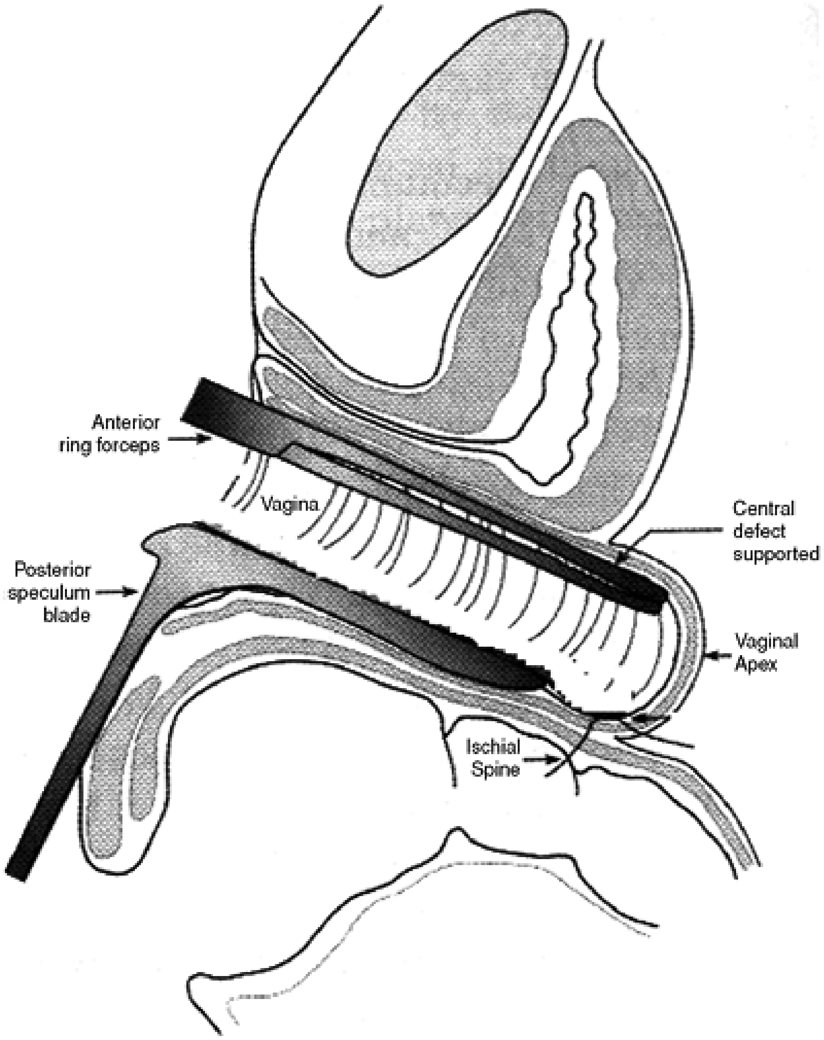

Figure 2.7 Reduction of the central defectâ€"If placing a single, closed ring forceps in the anterior wall vaginal midline from just below the apex reduces the defect completely, there is an isolated central defect. (From, Julian TM. Physical examination and pretreatment testing of the incontinent woman. *Clin Obstet Gynecol.* 1998;41:667, with permission.)

If neither of the second two maneuvers alone completely reduces the anterior vaginal wall descent, it is likely there is a *combined paravaginal and central defect*. The *fourth maneuver* is performed to make this diagnosis. The central anterior vaginal wall and lateral sulci are simultaneously supported using two ring forceps: one at the spines and the other centrally. If this reduces the defect completely, both central and paravaginal defects are present (Fig. 2.8).

Paravaginal defects can also be diagnosed upon insertion of the speculum to begin an examination. When the blades are opened, the lateral vaginal walls bulge into one or both sides between the blades of the speculum, making the cervix difficult to see. It is the paravaginal defect in the underlying connective tissue sheath that causes this appearance (Fig. 2.7).

Apical Vaginal Defects

When the speculum was initially placed and withdrawn slowly as the patient strained, the examiner should have

been able to determine if the vaginal apex descended. This can be repeated with a ring forceps held against the anterior wall (as in diagnosis of the central defect) and the posterior speculum blade in place against the posterior vaginal wall. The patient strains and the anterior and posterior supporting instruments are slowly withdrawn as the apex is observed for descent. If the apex descends more than 2 cm, it is likely that there is a defect of the pericervical connective tissue ring, either the anterior pubocervical fascia or the posterior attachment of the uterosacral ligaments.

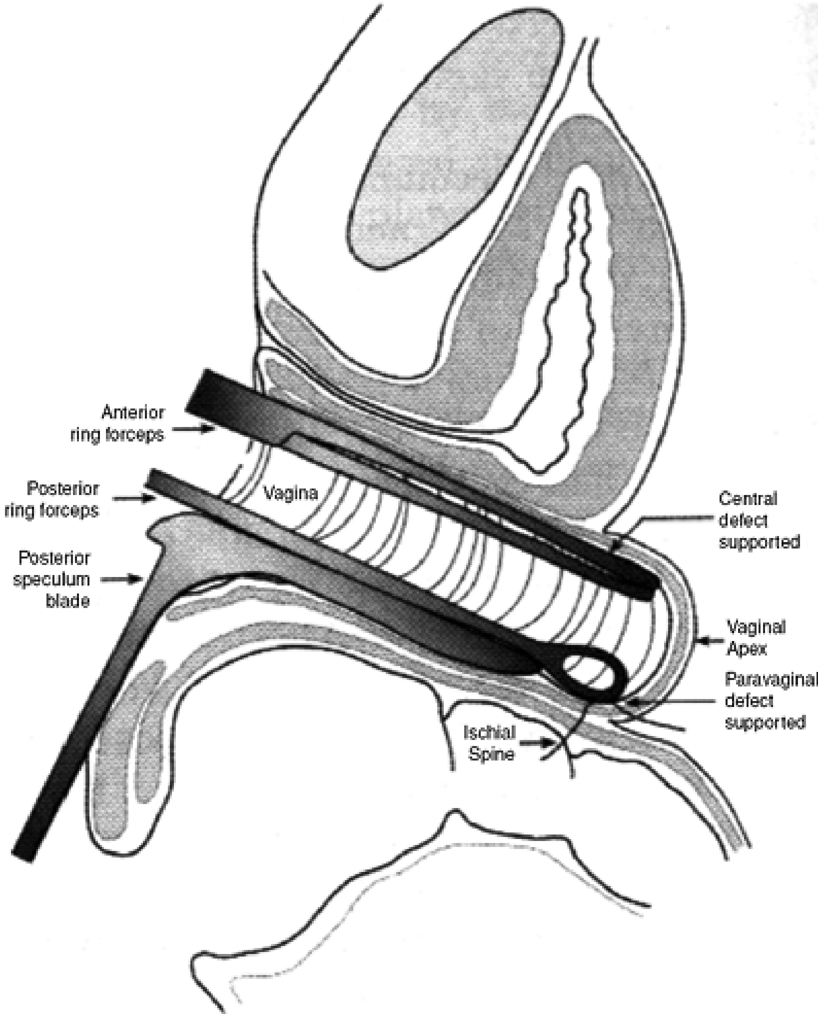

Figure 2.8 Simultaneous reduction of the paravaginal and central defectâ€”The examiner can confirm coexisting central anterior vaginal vault defects by supporting the central anterior vaginal wall and paravaginal areas simultaneously and asking the patient to strain. If these maneuvers prevent anterior vaginal wall descent, both central and paravaginal defects are present. (From, Julian TM. Physical examination and pretreatment testing of the incontinent woman. *Clin Obstet Gynecol.* 1998;41:668
, with permission.)

To confirm this, the *fifth maneuver* holds the apex toward the midsacrum, the normal anatomic position of the apex, with a ring forceps. If the patient strains and this maneuver reduces the defect, an apical defect is present. The pericervical connective tissue ring consists of the uterosacral ligaments posteriorly, cardinal ligaments laterally, and the attachment of these structures to the pubocervical fascia or anterior portion of the fibroelastic connective tissue sheath of the vagina. Richardson referred to these defects as the transverse defect anteriorly (detached pubocervical fascia) and enterocele posteriorly (detached uterosacral ligaments and posterior rectovaginal septum) (9). Neither is really an isolated defect, but these defects indicate a loss of contiguity of the pericervical connective tissue ring (apical endopelvic fascia).

An apical defect (enterocele) is often difficult to diagnose or is misdiagnosed as an anterior segment (cystocele) or posterior segment (rectocele) defect. In reality, neither is an isolated phenomenon, but each is described separately out of convention rather than a true understanding of the pathophysiology. When the speculum is initially placed to begin examination or with a ring forceps held anteriorly and centrally and the speculum blade posteriorly, and the patient is straining, an enterocele/rectocele complex will often produce a â€œdouble bump sign.â€• This looks like a superior and inferior bump at the top of the open speculum (Fig. 2.9).

The *sixth maneuver* helps differentiate what have traditionally been referred to as enterocele and high rectocele; although in reality they are the same connective tissue defect, a detachment of the distal uterosacral ligaments from the vaginal apex or proximal rectovaginal septum. To differentiate these two (rectocele from enterocele) the examiner places one index finger in the patient's rectum and the other index finger in the patient's vagina. Moving the examining fingers gently back and forth, the enterocele sac can be felt to slide between the examining fingers. If the defect is limited to the fascia of the rectovaginal septum, the sliding sensation is not present (Fig. 2.10). Some examiners perform this maneuver with the patient standing, feeling this position more accurately and easily demonstrates the abnormal findings.

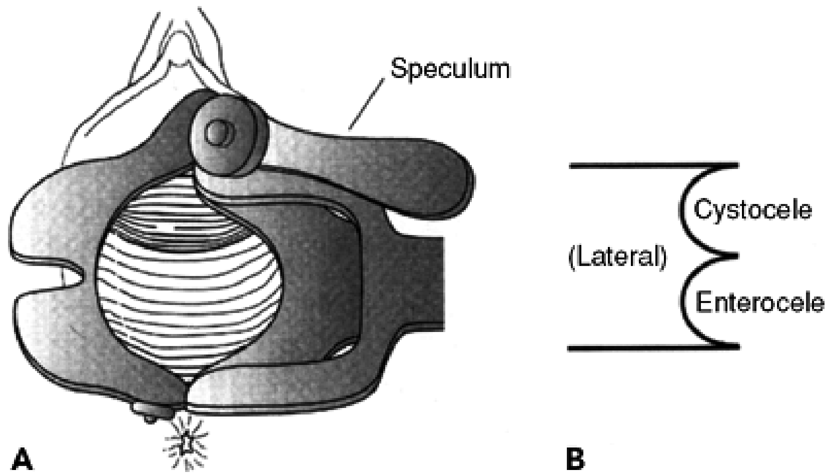

Figure 2.9 Double bump sign within the speculumâ€"With a speculum in the vagina, opened and turned 180 degrees, a â€œdouble bumpâ€• is seen. The posterior bump is the enterocele. (A) Front view; (B) Lateral view. (From, Julian TM. Pelvic support defects. In: *Precis: An update in Obstetrics & Gynecology*. 2nd ed. Washington, DC: American College of Obstetricians and Gynecologists, 2001:48
, with permission.)

The *seventh maneuver* is performed only when anterior enterocele (anterior transverse apical defect) is suspected. This is a bulge of peritoneum directly behind the bladder resulting from the anterior peritoneum being fused to the posterior bladder and being pushed through an anterior detachment of the pericervical connective tissue ring with increases in intra-abdominal pressure. Examiners confuse

this with descent of the anterior segment. As a result at the time of surgery, the sac of anterior peritoneum is not recognized and therefore not opened with failure to close the underlying fascial defect.

The two defects can be differentiated by placing a bent uterine sound in the bladder and palpating the tip of the sound within the bladder and not within the bulging mass behind the bladder. This mass is a peritoneal sac descending through the transverse anterior apical vaginal wall defect (Fig. 2.11). This maneuver may be painful and usually is reserved until the patient is under anesthesia at the time of surgical repair. The anterior enterocele is uncommon and most often found in patients who have had an anterior segment vaginal suspension procedure, most commonly urethropexy.

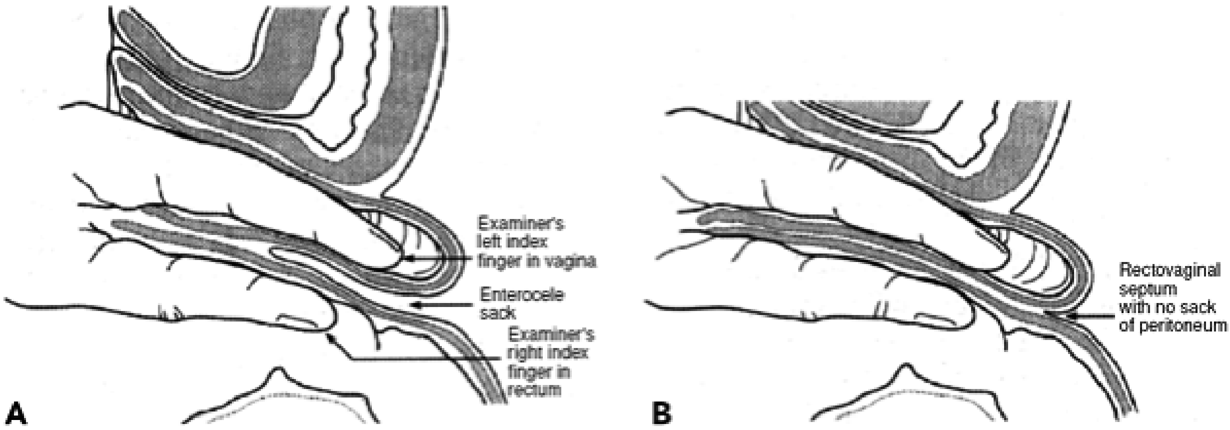

Figure 2.10 Differentiating an enterocele from a high rectocele. (From, Julian TM. Physical examination and pretreatment testing of the incontinent woman. *Clin Obstet Gynecol.* 1998;41:669
, with permission.)

Posterior Vaginal Wall Defects

The posterior vaginal wall defect (rectocele) is more complex anatomically than previously thought and in most cases cannot be repaired by the traditional posterior vaginal wall central plication operation. This operation has been largely replaced by site-specific posterior vaginal wall defect repair. The rectocele defect is often a combination of breaks in the posterior rectovaginal connective tissue sheath underlying the posterior vaginal wall epithelium. Referred to as the fascia of Denonvilliers, rectovaginal septum, or posterior vaginal wall fascia, the connective tissue sheath can be broken centrally, laterally, apically, at its attachment to the perineal body, or in any combination of these locations. Each of these breaks is identifiable during examination (Fig. 2.12).

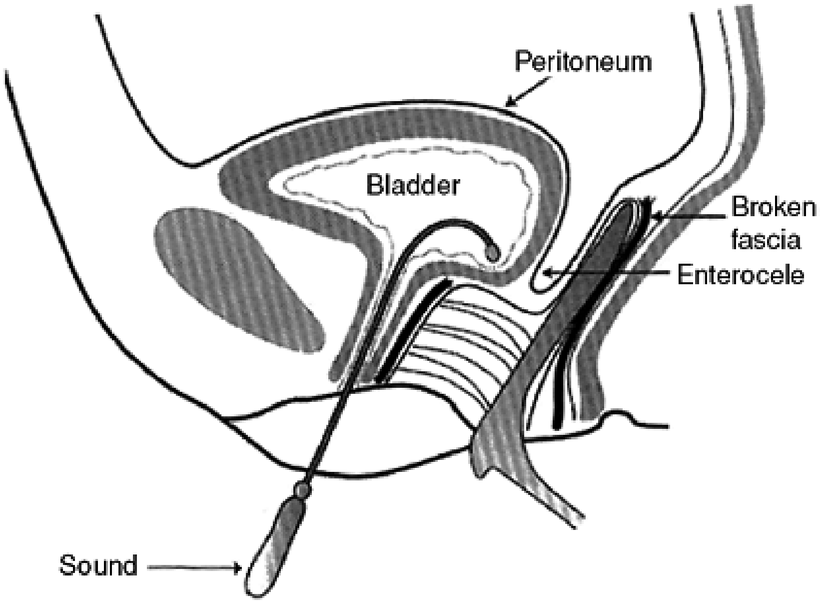

Figure 2.11 The anterior enteroceleâ€”A bent uterine sound is passed into the urethra and gently pushed in contact with the posterior bladder wall to identify the bladder wall in relation to the anterior enterocele defect. (From, Julian TM. Pelvic support defects. In: *Precis: An Update in Obstetrics & Gynecology*. 2nd ed. Washington, DC: American College of Obstetricians and Gynecologists, 2001:47
, with permission.)

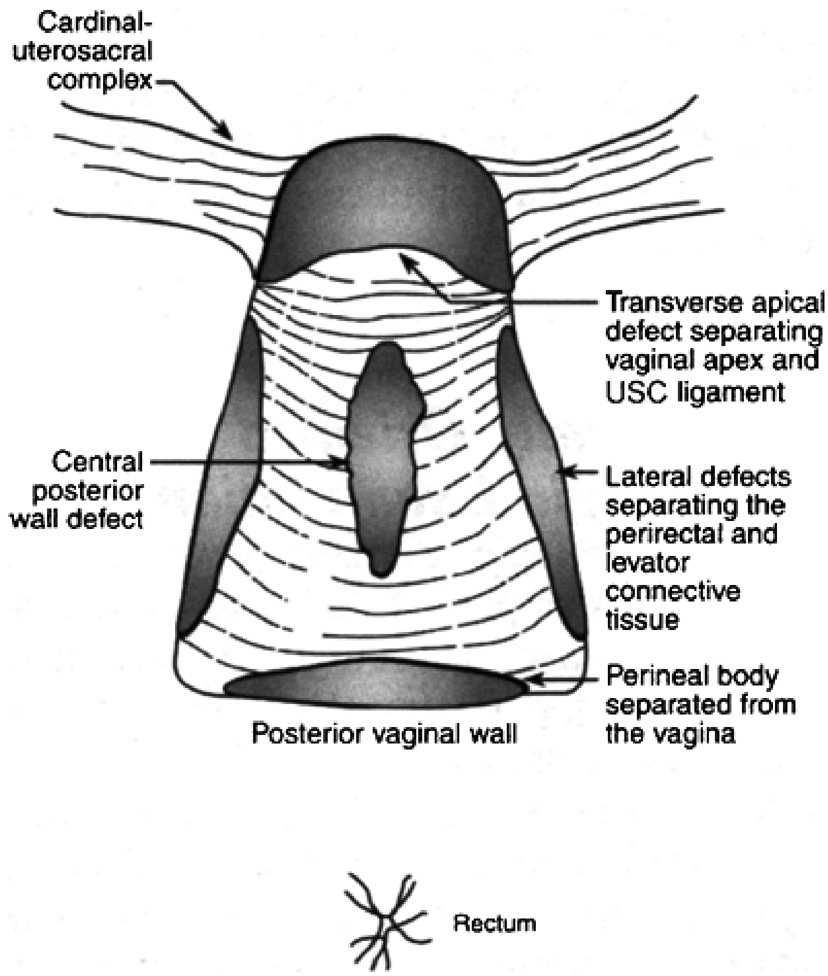

Figure 2.12 Posterior vaginal wall defectsâ€"The fascial defects of a rectocele are lateral, central, apical, or detachments at the perineal body. Any or all of these defects may be present. (From,
Julian TM. Physical examination and pretreatment testing of the incontinent woman. *Clin Obstet Gynecol.* 1998;41:669
, with permission.)

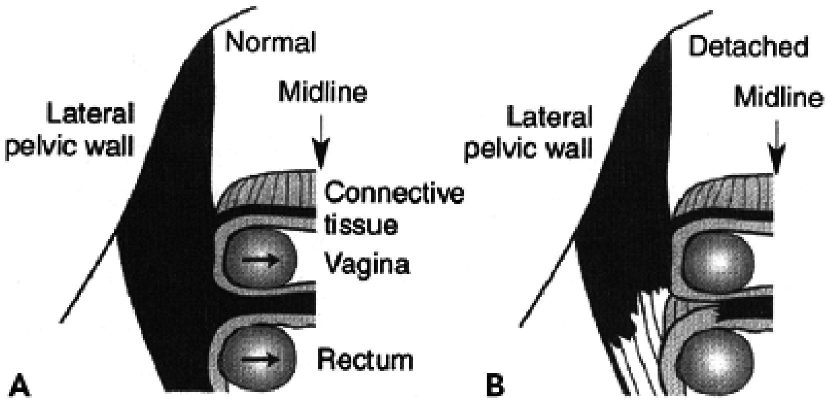

Figure 2.13 The examiner's index fingers are inserted into the rectum and vagina (marked with arrows). Grasping the lateral sulcus gently and pulling to midline (A), a lateral defect in the rectovaginal septum is mobile and moves toward the midline with the examining fingers (B). Both sides of the vagina are examined. (From,
Julian TM. Pelvic support defects. In: *Precis: An update in Obstetrics & Gynecology*. 2nd ed. Washington, DC: American College of Obstetricians and Gynecologists, 2001:49
, with permission.)

The patient with a lateral posterior vaginal wall defect can be diagnosed using an *eighth maneuver*. With one of the examiner's index fingers in the patient's rectum and the other index finger in the vagina, the two fingers are placed against the lateral sulcus of the posterior vaginal wall. The examiner gently exerts pressure with one finger against the other and pulls the intervening tissue toward the midline. When there is a lateral fascial defect, the vagina is mobile and moves toward the midline with the examining fingers. Both sides of the vagina are similarly examined (Fig. 2.13A, B). Intraoperatively this defect can be demonstrated by placing a finger in the patient's rectum and sweeping from the 3 o'clock position moving counter clockwise or the 9 o'clock position moving clockwise. The examiner will feel the finger push into the defect and see the broken fascial edges for repair (Fig. 2.14).

The *ninth maneuver* identifies detachment of the rectovaginal septum at the perineal body. Using the posterior speculum blade to elevate the anterior vaginal wall, the examiner's finger in the patient's rectum is slowly moved cephalad from the anal verge with gentle pressure applied toward the vaginal lumen. When there is a detachment of the rectovaginal septum from its perineal body attachment, the examiner feels a give just above the introitus and sees the posterior vaginal wall bulge upward (Fig. 2.15).

Most patients do not have a defect at the perineal body attachment of the rectovaginal septum. Most defects begin at the cephalad-most portion of an old episiotomy scar. The defect is often found in the large or recurrent rectocele and is a result of the detachment of the cephalad-most portion of the rectovaginal septum fascia from its attachments to the uterosacral ligaments. To reduce this defect surgically, reconnection of the rectovaginal septum to the uterosacral ligaments is performed. Sometimes these two defects can be differentiated or at least suspected from the patient history. The patient, who splints with her finger in the vagina to push out stool, either reaches high or low into the vagina. Reaching high into the vagina suggests a buildup of stool secondary to the detachment of the rectovaginal septum at the uterosacral ligaments, reaching low into the vagina suggests a defect at the perineal body.

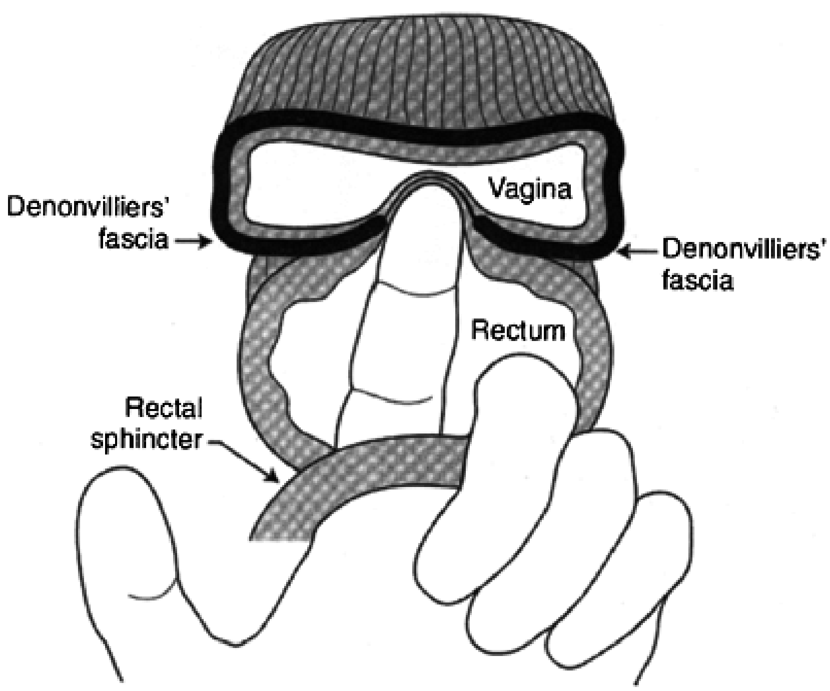

Figure 2.14 As the examiner's finger sweeps gently from the lateral to the central area of the rectovaginal septum, the finger is felt to pop into the vaginal lumen just beyond the fascial edges. The broken edges can then be grasped and reapproximated. (From,
Julian TM. Pelvic support defects. In: *Precis: An update in Obstetrics & Gynecology*. 2nd ed. Washington, DC: American College of Obstetricians and Gynecologists, 2001:49
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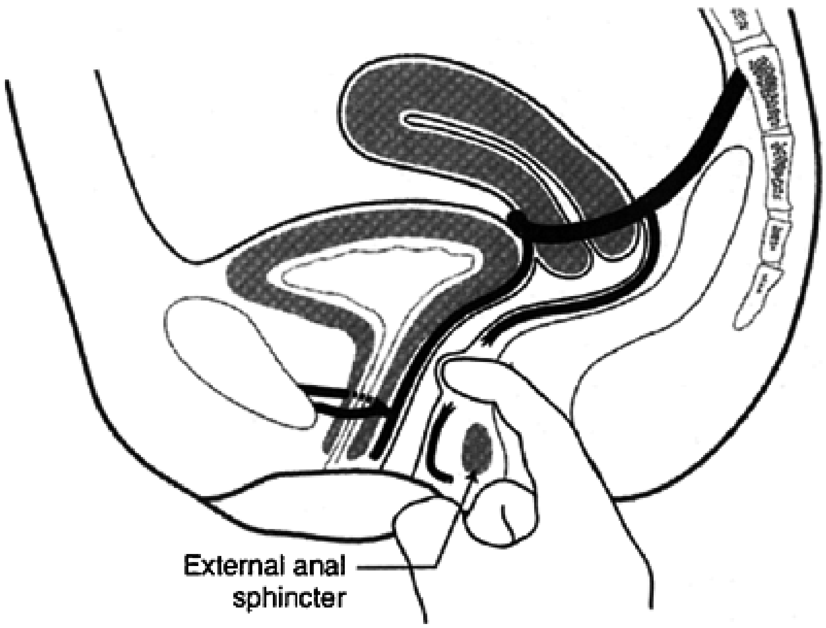

Figure 2.15 To detect a fascial defect of the rectovaginal septum at the perineal body, the examiner's finger is advanced from the anus proximally, maintaining contact with the anterior rectal wall. If there is a distal break in the septum, the examining finger pops into the defect proximal to the external anal sphincter. (From,
Julian TM. Pelvic support defects. In: *Precis: An Update in Obstetrics & Gynecology.* 2nd ed. Washington, DC: American College of Obstetricians and Gynecologists, 2001:48
, with permission.)

The *tenth maneuver* identifies detachment of the rectovaginal septum from the uterosacral ligaments by placing

traction on the posterior vaginal cul-de-sac transrectally and simultaneously using the same examining finger to palpate the uterosacral ligaments. When the uterosacral ligaments are still attached to the posterior rectal septum, the cul-de-sac descends minimally with this maneuver. If there is a detachment of the septum, the examining finger can be felt to â€œhookâ€• over the top of the broken septum and into the vaginal bulge.

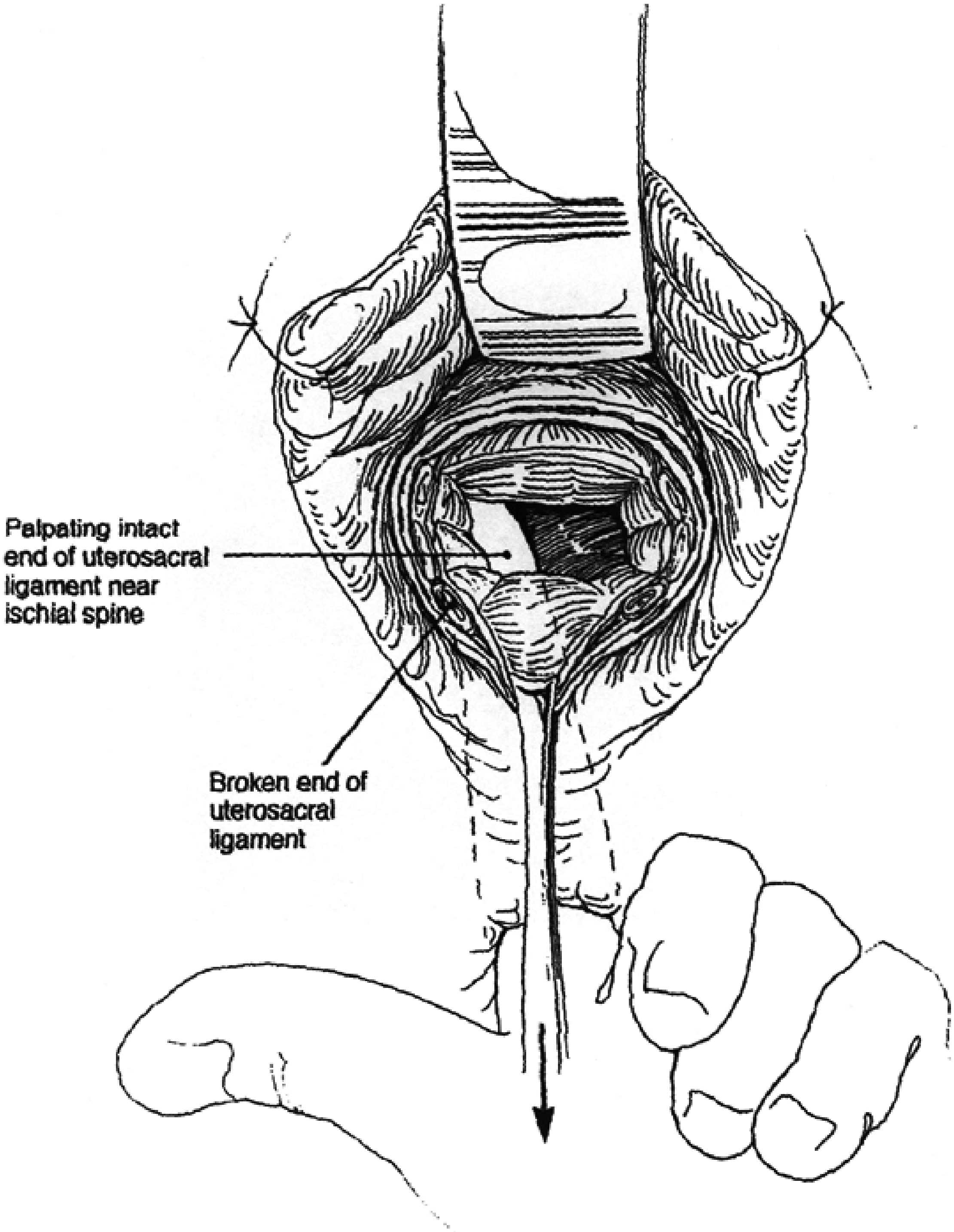

Figure 2.16 Finding the intact uterosacral ligaments at the time of vaginal hysterectomyâ€"The surgeon places a finger in the patient's rectum and draws the finger from far lateral to medial until the uterosacral ligament on traction is

palpable. (From,
Rogers RM Jr, Julian TM. Vaginal vault prolapse and enterocele: prophylaxis, and anatomic restitution during vaginal surgery. *Oper Tech Gynecol Surg.* 2001;6:130, with permission.)

This also demonstrates that the intact portion of the uterosacral ligaments are not the structures clamped and divided at the time of vaginal hysterectomy with significant prolapse. What is clamped and divided at that time are the detached (broken) ends of the ligament, the ends that have pulled away from the vagina or cervix. This break always seems to occur at the vaginal apex leaving the detached end on the descending apex and the intact uterosacral ligament high in the pelvis and attached to the sacrum.

At the time of pelvic reparative surgery after the uterus has been removed, traction on the open posterior cul-de-sac puts tension on the intact uterosacral ligaments. Using an intrarectal examining finger, the examiner sweeps the finger from far laterally (3 and 9 o'clock positions) toward the midline. The intact portion of the uterosacral ligament can be easily palpated, usually all the way to the sacrum, as a firm bandlike structure. The intact portion can be grasped and used to suspend the anterior and posterior vaginal apex (Fig. 2.16).

For the *eleventh maneuver* the examiner's index finger is placed in the patient's rectum to palpate the external anal sphincter circumferentially. If the sphincter cannot be palpated anteriorly because of a break (usually resulting from obstetrical trauma), then it can almost always be palpated posteriorly. Having the patient perform a rectal squeeze makes the sphincter easier to identify. Most rectal sphincter

defects are located anteriorly. Often there is an external dimple in the perianal skin, overlying the broken end of each side of the rectal sphincter, that helps identify the end at the time of surgical repair.

Rectal sphincter strength is assessed by intrarectal palpation of the sphincter with the index finger and simultaneous external palpation with the examiner's thumb during a voluntary anal squeeze by the patient. The examiner subjectively assesses the strength of squeeze. This obviously requires the examiner to have experience identifying normal and abnormal sphincter strength. If the patient can mount a contraction anywhere in the sphincter, the sphincter can usually be made at least partially functional surgically.

The *twelfth diagnostic maneuver* requires the patient to elevate the perineum. With normal support the perineum is drawn upward above the ischial tuberosities by the network of connective tissue that extends from the perineal body to the uterosacral ligaments. The perineum should not descend below the level of the tuberosities with straining. A tear along the rectovaginal septum that detaches the perineal body will result in descent of the perineum to below the ischial tuberosities when the patient strains (20,21).

By history the detached perineum (associated with perineal descent syndrome) presents as an inability to pass stool. Often the patient relates having to expend extreme force to evacuate stool and may literally spend hours on the toilet because of the feeling of rectal fullness. Paradoxically the external anal sphincter may contract even tighter with these expulsive efforts and the patient develops a damaged pudendal nerve and, at times, an intrarectal ulcer.

Repairing a break in the rectovaginal septum by standard colporrhaphy without repairing its attachment to the perineal body may result in a worsening of perineal descent. The severe chronic stool retention worsens, rather than improves, after what appear to be an anatomically successful repair of the rectocele. On examination the rectocele seems to be gone, but the perineal descent persists. The examiner must be alert to the history of difficult evacuation (usually with normal soft stool), the examination finding of perineal descent, and the pocket or defect where stool seems to fill on the perineum. Pulling downward on this wide bridge of skin between the posterior introitus and anus demonstrates only rectal wall and overlying perineal skin. There seems to be no underlying connective tissue or muscle.

If asked, the patient often can demonstrate how she must push up on the perineum to evacuate stool rather than splinting within the vagina. Failure to reconstruct the perineal body and reattach the continuum of connective tissue from the perineal body to the rectovaginal septum to the uterosacral ligaments posteriorly results in worsening of symptoms (20,21).

Conclusion

Therapy, both medical and surgical, is best guided by a clinician who can recognize the underlying pathophysiology. Although most of this chapter describes the diagnosis of site-specific defects, the underlying pathophysiology is often identified only when the caregiver is alert to the history and examination that results from these defects. Surgery can repair the breaks in the underlying connective tissue sheath but cannot restore the damaged muscle or nerves. No matter how gifted a surgeon is, the hands will never correct what the head does not understand.

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3

Evaluation and Management of Pelvic Organ Prolapse

Carl W. Zimmerman

Pelvic organ prolapse is the downward displacement of any of the central pelvic organs through the urogenital hiatus. Damage to the supportive and suspensory elements of the pelvic floor and endopelvic fascia is required for the development of prolapse (1). The various components of pelvic organ prolapse qualify as hernias. In most cases, childbirth is a necessary but not a sufficient cause for the development of these conditions (2,3,4,5,6,7,8,9,10,11). Prolapse primarily affects the quality of the patient's life (12,13,14,15,16). Even in large and chronic cases, dangerous complications are infrequently encountered. Management of prolapse should be based on the degree that it interferes with the patient's daily life. In this chapter, common signs and symptoms, history and physical examination, and management will be discussed.

Signs and Symptoms

Pelvic organ prolapse often develops in an insidious way (12,17). Although some patients describe an index event followed by the rapid development of a protrusion, many individuals will note a gradual and progressive onset of the condition. This progression may occur over a period of several years and only be brought to the clinician's attention when significant symptoms occur. A complete external prolapse that is asymptomatic may be tolerable to the patient, and even though surgical correction may be offered, the patient may decline this option. Conversely, if a patient has significant urinary incontinence, surgical therapy may be sought in the presence of minimal degrees of prolapse. The patient's perception of her symptoms and quality of life are key factors in determining the type and timing of intervention.

Anterior vaginal segment prolapse may involve the urethra or the floor of the bladder. Consequently, the most common presenting symptoms are urinary. Disruptions of the support of the urethra are manifested in the form of stress or mixed urinary incontinence (11,18). The exact anatomic mechanism involved with stress incontinence is a matter of debate. Classically, many clinicians have ascribed the development of this symptom to damage of the pubourethral ligaments and consequent rotational descent of the mid to proximal urethra. Anatomically, rotational descent of the urethra is an urethrocele. More recently, disruptions of the lateral paravaginal attachments of the pubocervical septum have assumed increased importance in the etiology of urinary incontinence. The paravaginal disruptions prevent the connective tissue of the pubocervical septum from serving as an occluding base that closes the urethra when pressure is exerted from above (19). Childbirth certainly contributes to the development of stress urinary incontinence; however, the condition may develop in nulligravid patients. For example, the condition is common in female paratroopers. Sudden decelerations at the time of deployment of the parachute and at landing are speculated to be the causative events. Some women report stress incontinence that began in childhood and persists into adulthood. Menopause may also precipitate this condition as a result of tissue atrophy in an environment of estrogen depletion. Although the exact anatomic or clinical cause of stress incontinence cannot be determined in every case, involuntary loss of urine with increased intra-abdominal pressure is one of the leading presenting

symptoms in patients with anterior vaginal prolapse. Even when the bladder has recently been emptied, coughing, straining, or sudden movements often cause enough leakage of urine to erode significantly the patient's quality of life (20).

Prolapse of the bladder floor is a cystocele. Historically, attenuation and central distention of the pubocervical septum as a result of childbirth was believed to cause this condition (21,22). Lateral paravaginal detachments and proximal transverse defects in the pubocervical septum are now known to cause anterior vaginal prolapse. Prolapse of the bladder occurs when the midvaginal lateral attachment and the connection between the proximal pubocervical septum and the pericervical ring are disrupted. Cystocele causes little or no pain; however, pressure may be a presenting complaint. Because the floor of the bladder drops below the level of the internal urethral orifice, incomplete emptying of the bladder is the most common presenting complaint. Incomplete voiding leads to frequency of urination and nocturia. Persistence of incomplete emptying leads to the development of urgency symptoms and subsequently to urge incontinence. Urinary tract infections may occur, require treatment, and eventually develop into chronic infections that are difficult to treat. Patients may sense that they have emptied incompletely and resort to the Valsalva maneuver in an effort to complete micturition. Any activity that causes the patient to fix the respiratory diaphragm and to bear down repeatedly to void will eventually enlarge the cystocele and any other type of prolapse that may be present. Heavy lifting, straining, coughing, and straining at defecation are examples of common events that may worsen prolapse.

Prolapse of the superior vaginal segment involves the uterus or hysterectomy scar and the cul-de-sac of Douglas (21,22). Uterine prolapse occurs when the suspensory axis of the uterovaginal complex is damaged. Most frequently due to the forces of labor, disruption of the suspensory axis occurs in the pelvic diameter between the ischial spines (2,8). At this level, the continuity of the uterosacral ligaments, the pericervical ring, and the proximal rectovaginal septum is interrupted. With a loss of uterosacral suspension and posterior displacement, the cervix will eventually descend through the urogenital hiatus. A sense of pressure, exacerbated by lifting, straining, or sexual activity frequently accompanies this condition. Collision dyspareunia may also occur. A feeling of heaviness or cramping may persist for some time after intercourse. Descent of the cervix through the introitus is called procidentia. The hymenal ring at the introitus is the fixed landmark used to divide prolapse into complete and incomplete classifications. When a prolapse becomes complete, it is much more likely to be sufficiently troublesome to cause the patient to seek surgical intervention (12). Posthysterectomy vaginal prolapse is very common. Unless a specific and intentional attempt was made at the time of hysterectomy to reattach the uterosacral ligaments to the vaginal cuff, prolapse is likely to occur at some subsequent point in the patient's lifetime.

Herniation of cul-de-sac peritoneum containing small bowel is an enterocele (22). An enterocele is present when the abdominal parietal peritoneum is in direct contact with the vaginal epithelium. This condition is due to a disruption of the connection of the proximal rectovaginal septum to the uterosacral ligaments laterally and the pericervical ring centrally. As the enterocele enlarges, traction may develop on the mesenteries of the abdomen. For this reason, enteroceles are the only central pelvic hernias that commonly cause significant discomfort. The pain is perceived as deep in the central and lower abdomen. This discomfort usually is worse after long periods of activity in a standing position. Pain may also be increased when the patient uses Valsalva maneuver to assist in defecation or micturition. The relatively inaccessible location of the anatomic disruption that causes enteroceles is a significant challenge for the pelvic reconstructive surgeon.

Posterior vaginal prolapse involves the anterior rectal wall and the perineum. Pocketing of the anterior rectal wall into the vagina is called a rectocele (22). This prolapse occurs as a result of the same proximal separation of the rectovaginal septum that causes enteroceles. Contrary to traditional teaching and thought, rectoceles and enteroceles descend through the same fascial defect. Perineal descent also results from the proximal disruption of the rectovaginal septum. Rectoceles, enteroceles, and perineal descent occur because the suspensory axis of the vagina is disrupted within the interspinous diameter. Rectoceles have a very specific and recognizable pattern of symptoms. Entrapment occurs as the leading edge of a bowel movement descends from the rectal ampulla into the anus. An intact rectovaginal septum functions to guide effectively the leading edge of a stool toward the anus. Once the bowel movement becomes entrapped within the rectocele pocket, the Valsalva maneuver is used by the patient. As a result, the bowel contents combined with downward pressure cause the rectocele to enlarge and symptoms to worsen over time. This condition is known as obstructed defecation syndrome and frequently results in a patient complaining of constipation. Enlargement of the enterocele and rectocele allows the disrupted rectovaginal septum to retract distally and to worsen the perineal descent.

Proximal disruption of the rectovaginal septum causes both rectocele and enterocele and allows the development of perineal descent. All three of these conditions are a result of disruption of the connection between the rectovaginal septum and uterosacral ligaments. This disruption allows downward displacement of all portions of the suspensory axis that are located distal to the interspinous diameter (see Chapter 17, Fig. 17.1). Perineal descent is an uncomfortable condition because the patient sits on the pressure sensitive soft tissue of the anal verge that has fallen. The anatomic location of the normally suspended perineum is cranial to the plane defined by the ischial tuberosities. These substantial

bony structures are designed to support the weight of the body without discomfort because no pressure is exerted on the anus.

Disruptions of the perineum usually have an obstetric etiology and frequently are iatrogenic. Most women who have undergone vaginal delivery have some evidence of attenuation or scarring on the perineum. If the damage sufficiently injures the external anal sphincter, fecal incontinence is the result. Although anal incontinence is always troublesome to the patient, a skillful history is often required to elicit the full extent of this type of symptom. Patients are more frequently incontinent of gas than of liquid bowel contents. Incontinence of solid stool may occur with severe disruptions.

Physical examination of the prolapse patient should involve more than an examination of the vaginal canal (18). A careful and complete medical and surgical history will reveal helpful findings in many cases. Any condition or activity that increases the physical load on the pelvic floor will predispose patients to the development of pelvic organ prolapse (4). Examples include obesity, osteoporotic kyphosis, constipation, chronic cough, lifting, and straining (20,23,24). Identification and management of these conditions and factors can potentially prevent the progression of an incipient prolapse if the patient is properly educated and motivated. Postoperative patients also benefit from management of conditions that stress the pelvis. Prevention of stress on the pelvic floor is one of the basic treatments of prolapse and should be continued indefinitely. Control of chronic cough, cessation of smoking, weight loss, prevention of osteoporosis, treatment of constipation, and avoidance of heavy lifting are all valuable interventions in prolapse patients. Strengthening the shoulder girdle, legs, and low back helps to prevent straining and the resultant pressure on the pelvic floor that causes pelvic organ prolapse to develop. Weakened or defective connective tissue predisposes the patient to prolapse (7). Patients with a history of multiple hernias, regardless of location, probably have a hereditary tendency to develop prolapse. Patients receiving chronic steroid therapy are at high risk for progression of prolapse and for failure of operative therapy.

Intact pelvic anatomy is dependent on the pelvic diaphragm, functional pelvic nerves, and normal connective tissue structures and attachments (4,8,9,12,25,26,27,28). During childbirth, intense pressure is exerted on all of these components of the pelvis. Studies have shown that the pudendal nerve is frequently stretched to the point of damage during the process of delivery. The muscles of the pelvic diaphragm are also subjected to enough pressure to create avulsive tears and separations. This damage is known to lead eventually to atrophy of portions of these vital support structures, especially in the presence of pudendal nerve damage (3). Damage of this type to the pelvic diaphragm of parous women has been demonstrated with magnetic resonance imaging studies (26). Lack of the supportive function of the pelvic diaphragm increases the likelihood of prolapse and of failure if surgery is performed. Myopathies and neuropathies are prevalent contributing causes of prolapse, and currently these conditions have no effective treatments. All women, especially those with prolapse, should recognize the value of protection and strengthening of the muscular pelvic floor (29,30,31,32). Pelvic floor voluntary contractions, popularized by Dr. Arnold Kegel, are valuable adjuncts to all other forms of treatment and prevention for pelvic organ prolapse (30). Kegel contractions can be performed at any time during the patient's day. A particularly valuable way to habituate patients to do these exercises is to combine them with voiding. Upon completion of voiding, the patient is instructed to lean as far forward as feasible. This action elevates the bladder floor and contributes to complete emptying of the bladder. Often this modification in the individual's position results in a secondary and tertiary void due to the change in the orientation of the bladder floor. A beneficial decrease in the amount of residual urine is the result of this maneuver. After voiding is completed and while still leaning forward, the patient performs a series of isometric Kegel pelvic floor contractions. Frequently, this series of steps will contribute to the resolution of urge symptoms, increase the amount of time between voids, help prevent urinary tract infections, and decrease the number of episodes of nocturia. Teaching the patient the proper way of contracting her pelvic floor muscles, especially during periods of stress on the pelvic floor, empowers the patient to participate actively in the conservative management of her prolapse.

History and Physical Examination

A thorough evaluation of the prolapse patient by history and physical examination greatly assists in the management of the problems associated with these conditions (18). Because prolapse affects urinary, bowel, and sexual function, the caregiver must be sensitive and skillful in persuading the patient to share her symptoms. The role that these symptoms have in the continuum of prolapse should be explained to the patient in a way that she can understand. Frequently, the patient will be asked to discuss matters that she has never discussed with her family or closest friends. In fact, she may believe that no one else has similar problems. Questionnaires may assist in the process of taking a history, especially if they are supplied to the patient before her visit. The answers to quality-of-life questions may be used to guide the discussion and may permit the patient to share details that could be difficult for her to verbalize. Validated quality-of-life forms are available from various sources (33).

Patients must have sufficient cardiopulmonary reserve to tolerate pelvic reconstructive surgery. Evaluation of physical capabilities may be supplemented by communication with appropriate healthcare providers. Histories of significant cardiac disease, myocardial infarction, or pulmonary

disease are examples of conditions that need to be objectified before consideration of a major surgical procedure. Pulmonary embolism is a major risk factor in all types of pelvic surgery, especially in those cases that require prolonged dorsal lithotomy positioning. Prior to surgery, the surgeon should recognize risk factors for embolism and use proper intervention during and after the surgical procedure.

A morbidly elevated body mass index increases many attendant risks of surgery. The patient should be informed that a significant weight loss may be a useful way for her to demonstrate a commitment to the requirements of recovery and permanent lifestyle restrictions. In a similar way, a diabetic may be asked to stabilize control of her blood sugar before surgery can be offered. For example, a normal major fraction of glycosylated hemoglobin (HbA1c) may be required. Many other chronic health conditions impact the pelvic floor and the ability of the patient to withstand surgery. The clinician should evaluate the patient's health with the pelvic floor in mind. Changes should be suggested that decrease the likelihood of a complication or an unsuccessful outcome if surgery is required.

Altered urinary function frequently accompanies prolapse. Stress urinary incontinence (SUI) is the involuntary loss of urine when increased pressure is placed on the pelvic floor (34,35). This condition is one of the leading presenting complaints in patients with prolapse. The degree of SUI tolerance is highly individual and often related to lifestyle or personal expectations. If the incontinence is minimal, infrequent, or situational, the patient is likely to resist surgical intervention. If the incontinence is sufficient to require the use of pad or adult diaper protection, surgical intervention is almost certain to be sought. Many patients develop SUI during pregnancy only to have it resolve with the completion of parturition. The symptom may not return until later in life with menopause being the most likely time of recurrence. Patients with SUI associate loss of urine with specific events such as coughing, sneezing, lifting, or straining. Gradual worsening typifies the natural history of the condition. Less frequently, patients associate the onset of SUI with an index event that has placed a significant stress on the pelvic floor. The patient should be educated in the spectrum of management strategies in order to empower her to decide on the course of treatment that best suits her needs.

Urge incontinence is the involuntary loss of urine associated with a sudden need to void (34,35). This complaint may or may not be associated with prolapse. Frequently, patients have components of both urge and stress incontinence. Skillful interpretation of history and an evaluation using urodynamic techniques help to objectify findings in such patients. Urge symptoms may be situational. Examples of inciting events include exposure to cold air, the sound or sight of water, or arriving at home. The urge to void is sudden in these situations and overpowers the compensatory control efforts of the individual. Loss of urine may be minimal or involve a complete emptying of the bladder. Urge symptoms frequently coexist with prolapse when a significant cystocele is present. As a result, the bladder floor is lower than the urethral orifice and voiding may be incomplete. Residual urine may sufficiently stimulate the bladder to allow development of urge symptoms. Interventions that increase the ability of the bladder to empty help control or eliminate the uncontrollable urge to void. Smokers and patients with interstitial cystitis are particularly prone to this condition. Surgical repair of a cystocele is a useful way to decrease residual urine volumes.

Bowel symptoms are associated with pelvic organ prolapse. The most common presenting symptom is obstructed defecation syndrome. In this condition, the leading edge of a descending bowel movement is entrapped within a rectocele. Anterior pocketing of the rectal wall is always present in a rectocele. The proximal disruption of the rectovaginal septum causes the rectocele and the pocketing. The patient may use the term constipation as a synonym for difficult defecation. In obstructed defecation syndrome, the leading edge of the descending bowel movement becomes entrapped whether constipation is present or not. Many individuals self-discover that support or pressure on the perineum or inside the distal vaginal wall permits more efficient defecation. This process is called splinting and should be encouraged.

Fecal incontinence is common in pelvic organ prolapse patients (35). Various degrees of this problem exist. Patients may be incontinent of gas, liquid, or solid bowel contents. Especially in the parous patient, disruption of the anal sphincter is the most common etiology for this condition. Pudendal and sacral nerve neuropathies need to be considered as potential causes of fecal incontinence. Patients who have diabetes, a history of trauma, back problems, or an inability to voluntarily contract their pelvic floor muscles may have a neurologic component causing fecal incontinence.

Sexual dysfunction may accompany pelvic organ prolapse (16). This topic is complex. Urinary incontinence, fecal incontinence, altered body image, or mechanical difficulties consummating intercourse may all contribute to the problem. A major goal of any treatment for pelvic organ prolapse is compensation or correction of altered anatomy. Elimination or successful management of the problems listed previously may result in a significant sexual lifestyle improvement. Obtaining a sexual history is an art that requires time, trust, and experience. Realistic expectations for sexuality are a critical component for the pelvic reconstructive surgeon. Anorgasmia, for instance, is unlikely to resolve after corrective pelvic surgery. Mechanical difficulties secondary to a large prolapse are more likely to disappear. Dyspareunia from obstetric scarring or from previous anatomically distorting pelvic surgeries may also resolve if properly corrected.

Pelvic pain is not a common symptom in pelvic organ prolapse. Patients with a significant degree of pain should be carefully evaluated for identifiable causes. Incomplete urinary emptying may cause pain by precipitating bladder spasm. If the bladder empties more completely, this pain may improve after successful pelvic floor rehabilitation or surgery. Similarly, obstructed defecation syndrome may lead to painful bowel spasm or painful pelvic pressure. If corrected, this painful symptom may resolve. In general, prolapse of the central pelvic organs through the urogenital hiatus only causes an annoying pressure sensation. The only exception is the enterocele. If sufficiently large, an enterocele may exert enough traction on the mesenteries of the abdomen to cause periumbilical pain.

Especially in an advanced prolapse, altered axis, depth, and caliber of the vagina are frequent in the postoperative patient (36,37,38). If the practitioner has a detailed understanding of the function, needs, and desires of the prolapse patient, a cooperative understanding of the consequences of treatment may be more accurately outlined. This process allows the patient to make better informed choices regarding treatment.

A complete surgical history is important to the evaluation of the patient with prolapse. A history of hiatal, umbilical, inguinal, or ventral hernia may alert the caregiver to a propensity for weak connective tissue. Hysterectomy is a known risk factor for pelvic organ prolapse. Unless expertly performed to include prophylactic suspension, removal of the uterus leaves a defect in the proximal anterior vaginal wall that is very difficult to completely close. Previous prolapse procedures are highly significant. They raise the risk for future failure and frequently involve significant anatomic distortion or scarring. Previous intra-abdominal procedures, depending on their details, may be accompanied by internal anatomic distortions or adhesions. Procedures on the back carry risks related to neurologic impairment of the pelvis. This list is incomplete; however, it should sufficiently illustrate the type of thought pattern needed in evaluating a surgical history related to prolapse.

Conservative measures may offer significant improvement to the prolapse patient. The routine use of forward leaning Kegel pelvic floor contractions, described previously in this chapter, is an example of an intervention that may be very helpful to the patient. Shoulder, leg, and low back strengthening helps women accomplish more activities without straining or placing repeated stresses on the pelvic floor.

Physical examination of the prolapse patient should be complete. Of course, the full scope of physical examination and diagnosis cannot be described in this textbook. Generally, any condition that has the potential to exert increased pressure on the pelvic floor, disrupt the muscle strength of the body, disrupt the neurologic integrity of the pelvis, or weaken the connective tissue of the pelvis has the potential to be an etiology of pelvic organ prolapse. Every woman has a urogenital hiatus. This opening, located in the most dependent portion of the trunk of the body, is large enough to allow the passage of a term-sized infant. Because of its location, this hiatus bears the weight of all the abdominal contents (Fig. 3.1). The potential for disruptions of normal pelvic anatomy is increased when the respiratory diaphragm is fixed and significant pressure is exerted downward on the pelvic floor. The seasoned examiner will automatically recognize conditions that predispose to prolapse and understand their role in successful management and treatment.

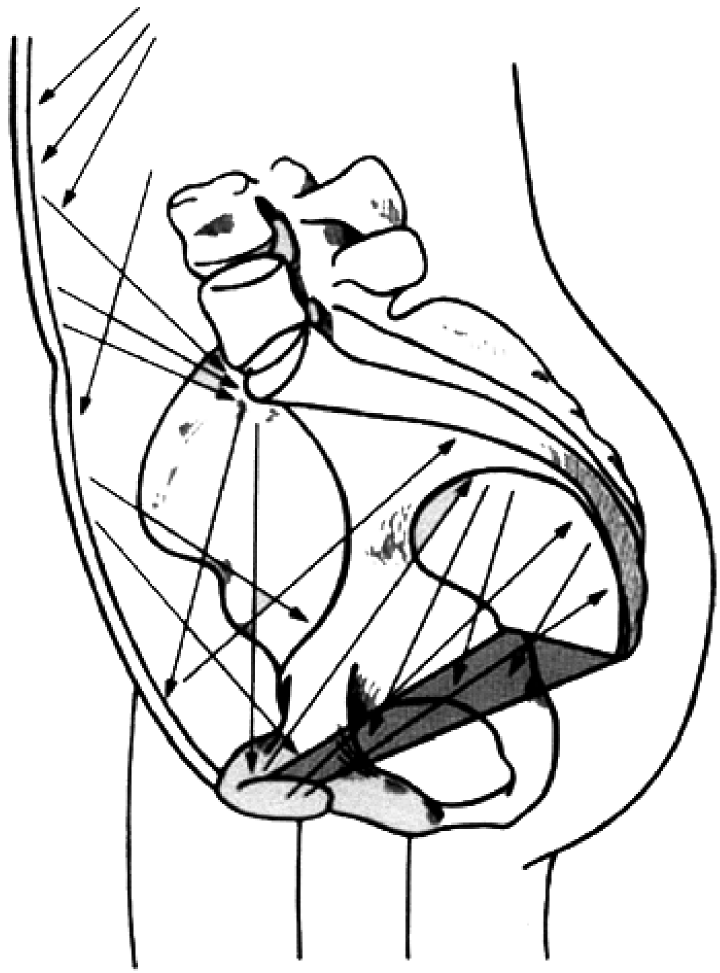


Figure 3.1 Vectors of force are exerted directly on the pelvic floor and urogenital hiatus. (From, frontpiece,
Zacharin RF. *Pelvic Floor Anatomy and the Surgery of Pulsion Enterocele.* Wein New York, Springer-Verlag: 1985
, with permission.)

A normal cranial nerve examination helps to rule out central nervous system conditions that could contribute to pelvic floor neuropathy. Observing the patient's gait helps to evaluate mobility, flexibility, strength, and the integrity of key sacral nerve roots. Sacral nerve roots 2, 3, and 4 are necessary for dorsiflexion and spread of the toes.

The abdomen should be inspected for evidence of intra-abdominal disease or masses. A large abdominal mass or ascites may increase the load on the pelvic floor and convert an incipient prolapse into a clinically evident condition. Obviously such pathology may be significantly more threatening than the presenting condition. Previous surgical scars may give valuable evidence of a propensity to herniation or the condition of the peritoneal cavity. Examination of the groin for inguinal herniation is recommended.

Femoral pulses should be documented. Poor vascular supply to the legs may preclude prolonged placement in the dorsal lithotomy position. Flexibility and the ability to externally rotate at the hip are necessary for positioning during surgery.

The pelvic examination for prolapse includes the basic elements of a normal gynecologic evaluation. The presence of other disease processes may delay or alter the treatment of prolapse. For example, a large pelvic mass or significant degree of pelvic pain may require entry into the abdomen and preclude a primary vaginal approach. During the examination, the patient should be made as comfortable as possible. Correct positioning, comfortable room and instrument temperature, and proper covering of the body contribute to the physical comfort of the patient. Continuous verbal contact with the patient maximizes her mental comfort. If possible, the examiner should assure the patient that he/she recognizes the problem that the patient has described. When a patient's description of her prolapse does not match the findings on examination, the patient should be encouraged to perform any maneuver needed to demonstrate the full extent of the problem. Repeated Valsalva maneuvers, change to a standing position, or a trip to the restroom may be required (39). When desired or appropriate, a mirror may be used to further involve the patient in the interactive examination.

Knowledge of normal pelvic anatomy allows for more complete assessment of the distortions caused by pelvic organ prolapse. A complete and systematic evaluation is necessary to recognize all components of prolapse. The vaginal canal may be divided into anterior, superior, and posterior segments. In most cases of symptomatic prolapse, one vaginal segment may be considered dominant. The dominant segment will occupy the most dependent position within the urogenital hiatus. When the dominant segment is reduced, other codominant, secondary, or incipient segments of prolapse will likely be apparent. If a dominant prolapse is repaired in isolation, other segments are likely to descend at some subsequent time. This concept illustrates the interconnected and interdependent nature of normal pelvic support and suspension anatomy. Recognition of all damaged segments allows for more complete and successful treatment.

A characteristic pattern of fine transverse creases, rugae, is present in the normal vaginal wall. Rugae signify the presence of deep endopelvic connective tissue septa beneath the vaginal epithelium of the anterior and posterior walls. In the presence of prolapse, the septa are disrupted and sheared away from normal proximal and lateral attachment points. Displacement of the detached septa allows the enlargement of the prolapse. A careful search for the presence and absence of rugae reveals much information about the location of displaced normal deep endopelvic connective tissue. As a general rule, connective tissue does not atrophy. Even in cases of advanced prolapse, a careful search for and sculpting of the displaced fascial septa reveals sufficient connective tissue to allow repair of prolapse using native tissue. Use of a pelvic organ prolapse map to record the presumed location of displaced fasciae can assist the clinician in surgical planning (Figs. 3.2 and 3.3).

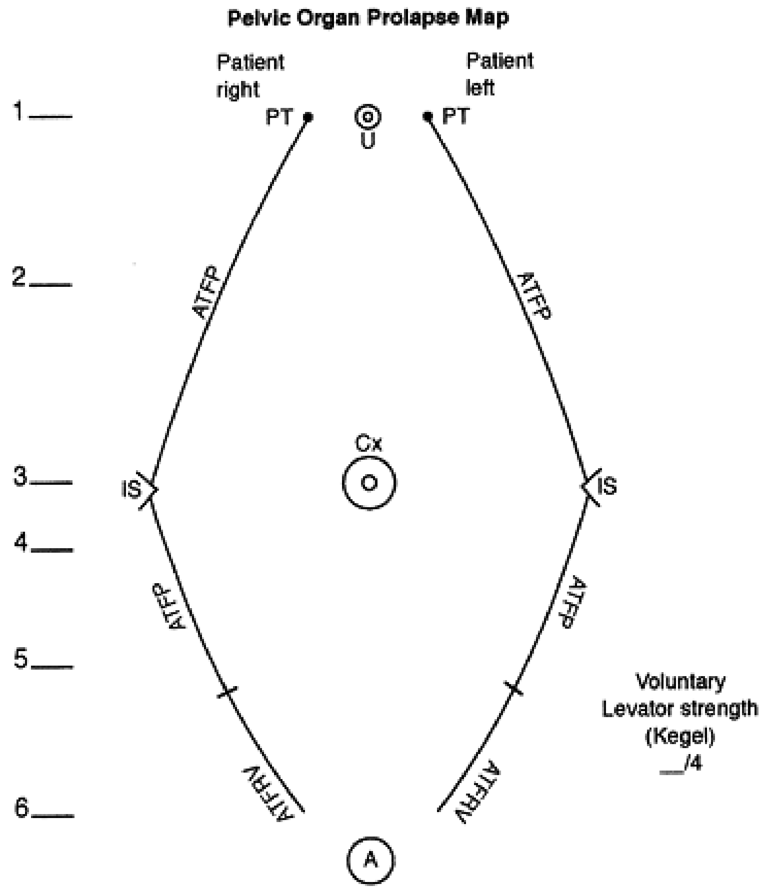


Figure 3.2 Pelvic organ prolapse map. Key elements of pelvic support anatomy. Three dimensions are reduced to two by dividing the vagina at the 3 o'clock and 9 o'clock positions. Baden-Walker vaginal support profile sites: 1, urethral; 2, vesical; 3, uterine; 4, cul-de-sac; 5, rectal; 6, perineal. PT, pubic tubercle; ATFP, arcus tendineus fasciae pelvis; ATFRV, arcus tendineus fasciae rectovaginalis; IS, ischial spines; U, urethra; CX, cervix; A, anus. (From, Zimmerman CW. Pelvic organ prolapse. In: Rock JA, Jones HW, eds. *Te Linde's Operative Gynecology.* 9th ed. Philadelphia: Lippincott Williams & Wilkins, 2003:943
, with permission.)

The interspinous diameter is critically important in evaluation of prolapse. As the narrowest diameter in the female human pelvis, this plane is the location of the highest pressures generated during the process of childbirth. In addition, all named pelvic suspension components of the deep endopelvic connective tissue intersect in the interspinous diameter. This combination of facts leads to a general pattern of disruption within the interspinous diameter and displacement of connective tissue structures toward the vaginal opening. Rugae will be preserved in the areas of the vagina that are closer to the vaginal opening. Smooth areas of distended vaginal epithelium are located adjacent to the interspinous diameter. Paravaginal paravesical defects cause the pubocervical fascia to retract to the opposite of the patient's body. Bilateral paravaginal defects may also occur. A patient right, full-length paravaginal defect is the most common anterior vaginal prolapse pattern encountered clinically. Posteriorly, a transverse full-width detachment of the rectovaginal septum with displacement

toward the perineum is the most common pattern seen (Fig. 3.4).

A rectal examination is necessary to rule out palpable abnormalities of the rectal wall. Anterior displacement of the examining digit frequently allows the examiner to palpate the detached edge of the rectovaginal septum and to evaluate the presence of rectocele, enterocele, and perineal descent.

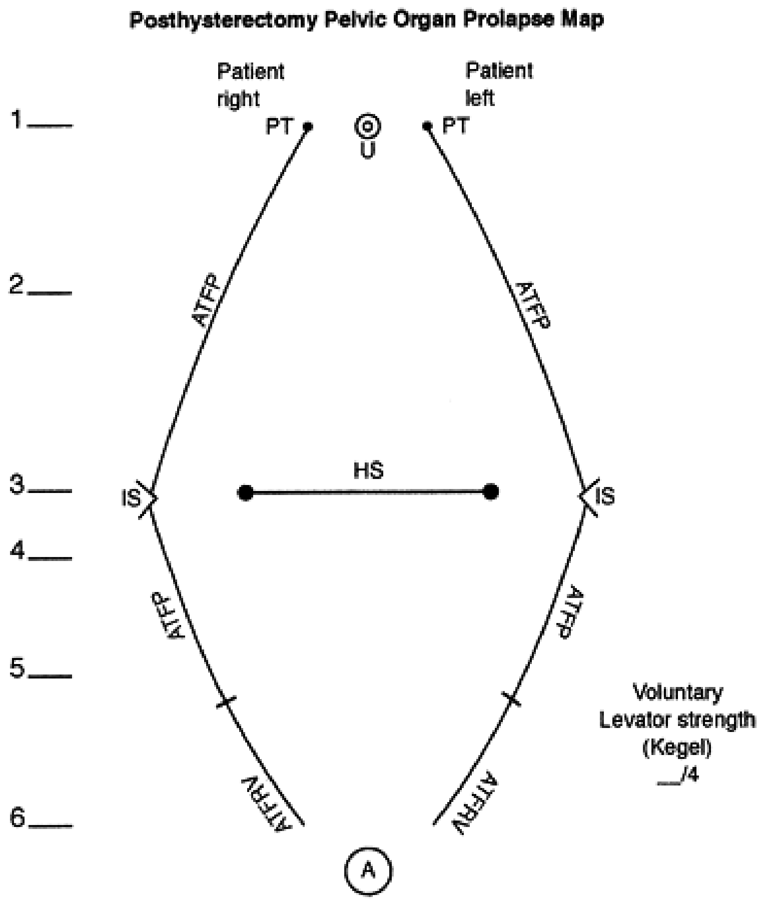


Figure 3.3 Posthysterectomy pelvic organ prolapse map. Key elements of posthysterectomy pelvic support anatomy. Three dimensions are reduced to two by dividing the vagina at the 3 o'clock and 9 o'clock positions. Baden-Walker vaginal support profile sites: 1, urethral; 2, vesical; 3, hysterectomy scar; 4, cul-de-sac; 5, rectal; 6, perineal. PT, pubic tubercle; ATFP, arcus tendineus fasciae pelvis; ATFRV, arcus tendineus fasciae rectovaginalis; IS, ischial spines; U, urethra; CX, cervix; A, anus. (From, Zimmerman CW. Pelvic organ prolapse. In: Rock JA, Jones HW, eds. *Te Linde's Operative Gynecology.* 9th ed. Philadelphia: Lippincott Williams & Wilkins, 2003:943
, with permission.)

Gently swiping a finger across the skin adjacent to the anus normally elicits an anal wink. The presence of this reflex demonstrates an intact autonomic innervation of the rectum. The muscles of the pelvic floor form the pelvic diaphragm, are normally under voluntary control, and may be contracted by the patient. This voluntary exercise is termed a Kegel contraction. The puborectalis muscle is the strongest of these muscles. When contracted, the levator ani muscles partially occlude the urogenital hiatus and form the primary supportive mechanism of the uterovaginal complex. Assessing the strength of these muscles provides important information in the presence of prolapse. A subjective ordinal scale can be used to assign strength of 0 to 4/4. Partial or complete weakening of the ability to contract the puborectalis indicates a loss of muscle mass or a pudendal neuropathy. A weak or neuropathic pelvic floor increases the risk of failure in the surgical and nonsurgical treatment of pelvic organ prolapse.

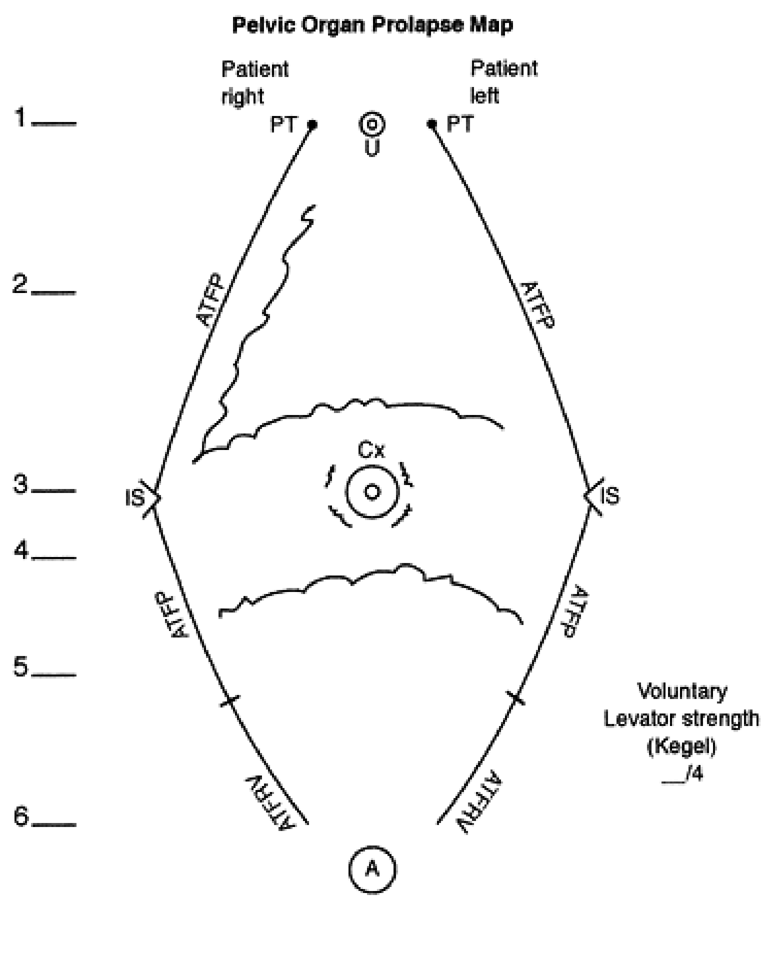


Figure 3.4 Pelvic organ prolapse map: Typical pattern of fascial damage. The most frequently encountered pattern of fascial damage in pelvic organ

prolapse: (i) full-length right paravaginal paravesical defect; (ii) transverse apical detachment of the pubocervical septum; and (iii) transverse apical detachment of the rectovaginal septum. This pattern of damage is consistent with the mechanics of a left occipitoanterior delivery. Baden-Walker vaginal support profile sites: 1, urethral; 2, vesical; 3, uterine; 4, cul-de-sac; 5, rectal; 6, perineal. PT, pubic tubercle; ATFP, arcus tendineus fasciae pelvis; ATFRV, arcus tendineus fasciae rectovaginalis; IS, ischial spines; U, urethra; CX, cervix; A, anus. (From,
Zimmerman CW. Pelvic organ prolapse. In: Rock JA, Jones HW, eds. *Te Linde's Operative Gynecology.* 9th ed. Philadelphia: Lippincott Williams & Wilkins, 2003:944
, with permission.)

Various methods exist that allow for more objective recording of the presence and severity of pelvic organ prolapse. Traditionally, a subjective classification of mild, moderate, and severe was used for specific sites. Poor interobserver reproducibility led to the development of the two systems in use today. The Baden-Walker Halfway System is useful primarily in clinical circumstances (21). The assignment of a score to each of six specific midline sites encodes a large amount of information in a small amount of time and space. When descriptive notes and a pelvic organ prolapse map are added, a more complete description of the prolapse can be created. Although descriptive, some shortcomings exist in the Baden-Walker system. For instance, a strategically placed 1-cm increase in prolapse results in an increase in the assigned stage. In addition, interobserver agreement is not perfect with the Baden-Walker system (see text box on following page).

Baden-Walker Halfway System

The extent of prolapse is recorded using a number (0 to 4) at each of six sites in the vagina. Two sites are located on the anterior, superior, and posterior walls of the vagina, respectively. Table 3.1 lists the anatomic sites and the associated symptoms. The six numbers are recorded as a measure of descent. For all sites except the perineum, the hymen is used as a fixed anatomic reference point. Zero indicates normal anatomic position for a site, whereas 4 represents maximum prolapse. Between these extremes, the intervening numbers grade descent using a halfway system as illustrated in Figure 3.5. The examination is performed with the patient straining so that maximum descent is attained. The patient may wish to stand to demonstrate maximum descent.

The perineum is graded using the familiar perineal laceration system used in obstetrics (Fig. 3.5). The patient is asked to hold or Kegel to evaluate the amount of muscular and fascial compensatory support. Comments may include site of dominant prolapse, location of scars, palpable plications, and the type of efforts necessary to demonstrate maximum prolapse. Strength of the levator contraction may be recorded as 0 to 4.

Example: Baden-Walker pelvic support profile 12/44/32. A dominant complete proximal prolapse is noted with enterocele, significant cystocele, and rectocele, and perineal attenuation to the level of the external anal sphincter. 2/4 levator strength is present.

Although this type of notation encodes much information in a small space, no specific location of fascial defects is indicated (21).

Table 3.1 Primary and Secondary Symptoms at Each Site

	Symptom(s)	
Anatomic Site	Primary	Secondary
1 Urethral	Urinary incontinence	Falling out
2 Vesical	Voiding difficulties	Falling out
3 Uterine	Falling out	Heaviness, and so forth
4 Cul-de-sac	Pelvic pressure (standing)	Falling out
5 Rectal	True bowel pocket	Falling out
6 Perineal	Anal incontinence (gas/feces)	Too loose

Baden-Walker Halfway System: Primary and Secondary Symptoms at Each Site (From, Baden WF, Walker T. *Surgical Repair of Vaginal Defects.* Philadelphia: Lippincott, 1992:12, with permission.)

In an effort to create an encoding tool useful to both the clinician and researcher, the Standardization Subcommittee of the International Continence Society created the Pelvic Organ Prolapse Quantification System or POP-Q system in 2002 (34,35,40,41). This system relies on specific measurements of defined points in the midline of the vaginal wall. The fixed reference point used for measurement is the hymenal ring. In this system, small increases in prolapse are recorded as small increases in measurement. Because specific measurements at nine sites are recorded in a tic-tac-toe grid, interobserver agreement is improved. Researchers favor the use of the POP-Q system for this reason. Unfortunately, the detail involved in making and recording nine measurements has been an impediment to more widespread clinical adoption of this system. The routine use of the POP-Q system decreases significantly the amount of time needed to collect the desired data (see text box below).

Pelvic Organ Prolapse Quantification (POP-Q) System

This system was developed as an effort to introduce more objectivity into the quantification of pelvic organ prolapse. For example, measurements in centimeters are used instead of grades. Nine specific measurements are recorded as indicated in Figure 3.6. Point Aa is defined as being 3 cm proximal to the external urethral meatus on the anterior vaginal wall. Point Ap is defined as being 3 cm proximal to the hymen on the posterior vaginal wall. Points Ba and Bp are defined as points of maximum prolapse excursion on the anterior and posterior vaginal walls, respectively. Measurements are recorded as negative numbers when proximal to the hymen and positive numbers when distal to the hymen. POP-Q sites C and D are identical in location to Baden-Walker sites three and four in the proximal vagina. In addition, measurements of the total vaginal length, genital hiatus, and perineal body are taken. All measurements are recorded on a tic-tac-toe style grid (Fig. 3.7). When combined with sagittal line drawings, a fairly complete picture of prolapse is attained (Fig. 3.8). Ordinal stages of pelvic organ prolapse are then assigned from stage 0 (no prolapse) to stage V (complete prolapse) so that the outcomes of cases of like magnitude may be compared. This system is a physical examination tool and does not assign the specific location of fascial defects (35).

Both the POP-Q and Baden-Walker systems may be supplemented by the use of a pelvic organ prolapse map. When combined with a brief notation of the dominant prolapse, location of scar contractions, strength of the levator ani contraction, and other anatomic findings, this map can significantly supplement the amount of detail that can be rapidly recorded. An effort should be made to assess each of the important sites of pelvic organ prolapse and accurately record the findings, regardless of the system used.

A complete history and physical examination with emphasis on details that specifically impact the pelvic floor is necessary for proper planning in the management of pelvic organ prolapse.

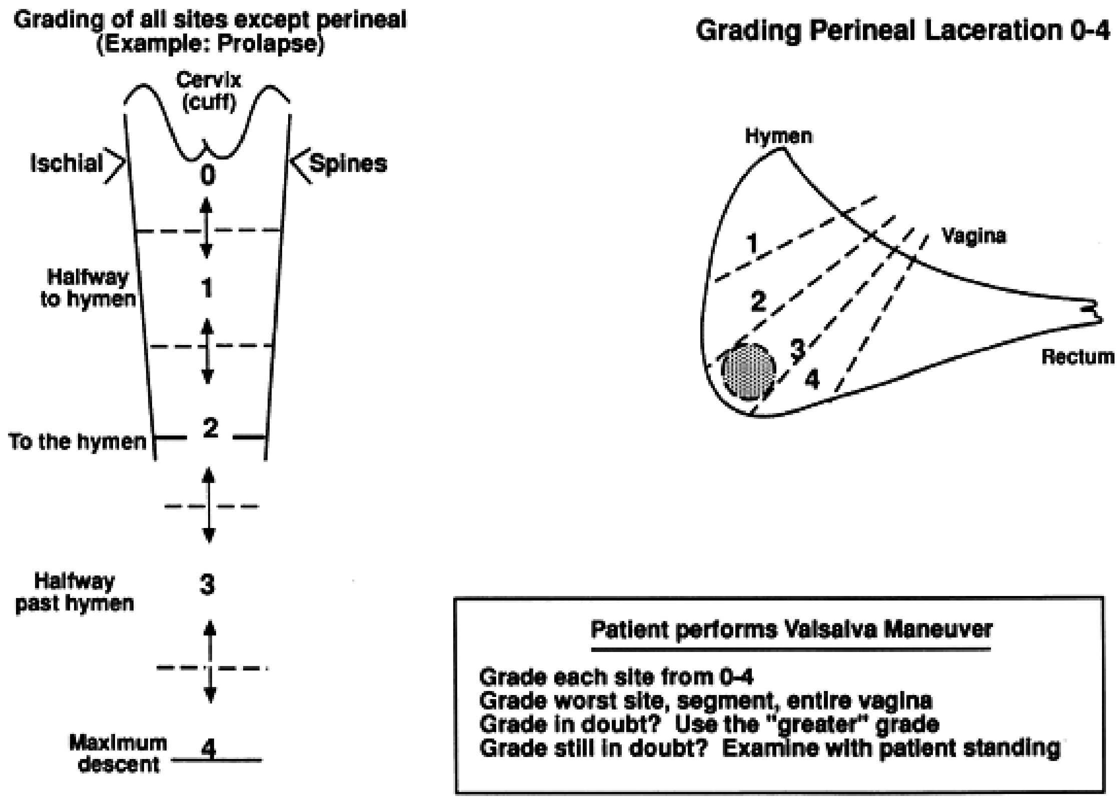


Figure 3.5 Baden-Walker Halfway System. Guidelines on how to assign ordinal grades in the Baden-Walker Halfway System. (From,
Baden WF, Walker T. *Surgical Repair of Vaginal Defects*. Philadelphia: Lippincott, 1992:236
, with permission.)

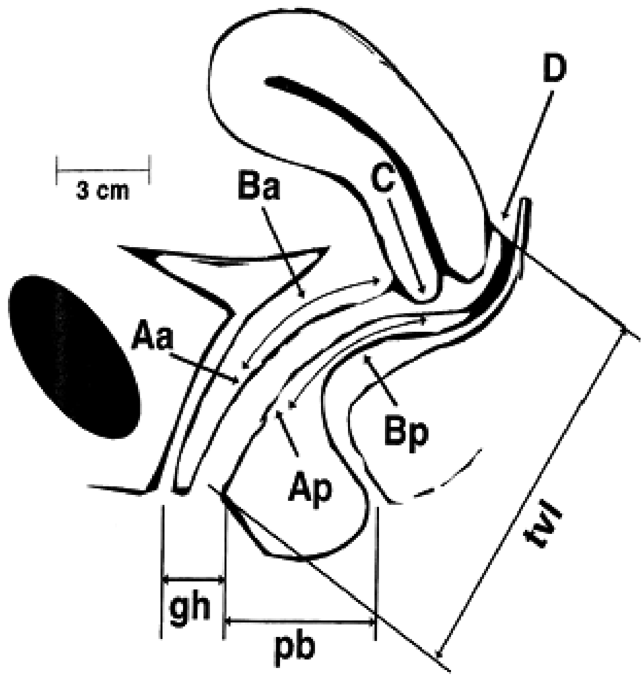


Figure 3.6 Pelvic organ prolapse quantification (POP-Q) system. The nine specific sites of measurement used in the POP-Q system are indicated by the letters in this figure. gh, genital hiatus; pb, perineal body; tvl, total vaginal length (see Fig. 3.7). (From,
Bump RC, Mattiasson A, Bo K, et al. The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction. *Am J Obstet Gynecol.* 1996;175:12
, with permission.)

Management

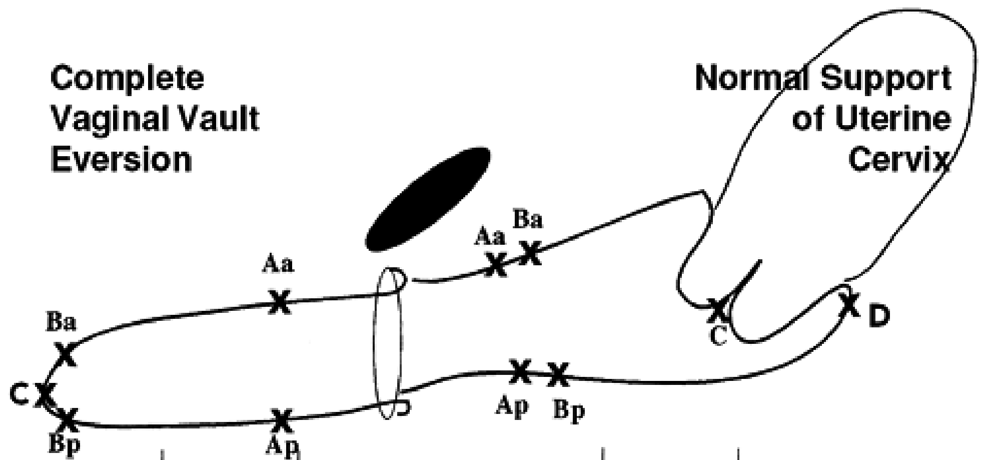
Pelvic organ prolapse is generally a quality-of-life issue. Serious medical consequences are uncommon in this condition. No patient should be persuaded or encouraged to undergo an operation for prolapse. The patient's perception of how the prolapse impacts her day-to-day life is the key element in the management of her individual prolapse. As in other quality-of-life medical conditions, conservative measures should be used primarily. A given patient may tolerate a significant degree of prolapse and not complain. When conservative measures are ineffective then surgery may be considered.

anterior wall **Aa**	anterior wall **Ba**	cervix or cuff **C**
genital hiatus **gh**	perineal body **pb**	total vaginal length **tvl**
posterior wall **Ap**	posterior wall **Bp**	posterior fornix **D**

Figure 3.7 Pelvic organ prolapse quantification (POP-Q) system. The tic-tac-toe grid used to record measurements in the POP-Q system. (From, Bump RC, Mattiasson A, Bo K, et al. The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction. *Am J Obstet Gynecol.* 1996;175:13
, with permission.)

Certain things should be suggested to everyone with prolapse or at risk for developing prolapse. Specific measures can help strengthen specific muscle groups, protect the pelvic floor, and increase efficient emptying of the bladder and bowel (11). These same techniques are useful in both prevention and postoperative management of the prolapse patient.

Shoulder, upper extremity, and low back strengthening will help an individual to accomplish daily tasks without placing undue strain on the pelvic floor. Low resistance exercise to increase muscle tone is encouraged for all patients, especially those who either have or have had prolapse. Exercise weights in the 1 to 5 pound range will help accomplish this goal. Greater upper body strength allows a greater work load to be performed without resorting to the compensatory use of the Valsalva maneuver.



+3 Aa	+8 Ba	+8 C
4.5 gh	1.5 pb	8 tvl
+3 Ap	+8 Bp	--

-3 Aa	-3 Ba	-8 C
2 gh	3 pb	10 tvl
-3 Ap	-3 Bp	-10 D

Figure 3.8 Pelvic organ prolapse quantification (POP-Q) system. Two examples that use the POP-Q system. Measurements in the left grid correspond to a complete external prolapse. Measurements in the right grid correspond to normal anatomic position without any prolapse. (From,
Bump RC, Mattiasson A, Bo K, et al. The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction. *Am J Obstet Gynecol.* 1996;175:4
, with permission.)

Lower body strength is helpful to lifting. Proper technique of lifting primarily strengthens the quadriceps of the lower extremity and, to a lesser extent, the erector spinae muscles. Walking on an incline and range of motion low back exercises are helpful for all patients with prolapse.

A comprehensive, well-organized, and well-taught program of physiotherapy is a necessary and universally recommended component of the care of a patient with prolapse (29,30,32,42). Pelvic floor strengthening and specific voiding and defecating techniques were described earlier in this chapter. Consultation with a physiotherapist or other individual who has the time and knowledge to successfully teach the patient all of these concepts can help improve the chances for a good surgical or conservative management strategy. Patients should understand that all of these techniques are lifelong recommendations. Postpartum patients are frequently told to perform Kegel exercises for a short time immediately after delivery. Perhaps a more comprehensive instruction at that time would be helpful. No one knows if good physiotherapy would help prevent the development of prolapse if initiated postpartum and continued through life. Common sense would certainly suggest that none of these activities would be harmful.

Postmenopausal hypoestrogenemia is believed to be a major risk factor for the development of pelvic organ prolapse (13). Administration of hormone replacement therapy is controversial because of the complex risk and benefit analysis associated with postmenopausal estrogen (43).

Pessary management is only slightly more invasive than physiotherapy (13,15,42,44,45). Because no surgical intervention is required, this option should be presented to most prolapse patients. Pessaries act as bolsters that hold the apical portion of the prolapse above the pelvic diaphragm. If properly fitted and maintained, they may significantly improve a patient's quality of life. A large variety of pessaries exist. Each has a specific set of strengths and limitations. A full discussion of the application of these devices is beyond the space and scope of this text. Traditionally, pessaries have been most useful to elderly, debilitated patients and those patients with multirecurrent failure. Younger and more active patients may also benefit from pessaries. A patient who engages in specific activities, such as work, jogging, or tennis, may wish to wear a device at those times and not routinely.

Surgery is the only known way to reverse the structural damage that has allowed prolapse to develop (13,21,36,37,46,47,48,49,50). Once prolapse is present, spontaneous regression will not occur. If sufficient deterioration of lifestyle is present, surgery should be included in the potential management strategies offered to the patient.

During the last half of the twentieth century, significant advances were developed in the way that prolapse was approached. A shift from anatomically distorting plication procedures to anatomically restoring site-specific techniques occurred. Biomechanical principles of suspension, lateral attachment, fusion, and bolstering have been included in these new techniques. Now prolapse surgery uses principles of hernia repair. For that reason, permanent suture has replaced absorbable suture for connective tissue reattachment and bolster placement. Inherent conceptual problems will forever exist with prolapse surgery. The urogenital hiatus is large enough to accommodate the birth of a full-term infant. This hiatus is not closed in anatomically

restoring site-specific repairs. Restoration of the suspensory axis simply places the prolapse above the pelvic diaphragm and posterior to the urogenital hiatus over the levator plate. For these complex anatomic reasons, the propensity for failure will always be present in prolapse; however, it may be successfully and permanently repaired. Surgical procedures that account for all of the biomechanical principles listed previously and that restore normal anatomic relationships will have the greatest success and longevity.

Patients who experience recurrent or very large prolapse may require obstruction of the urogenital hiatus. Occlusion of the vagina by colpocleisis is an intentionally anatomically distorting surgery of last resort (Chapter 21).

A complete and current review of specific surgical techniques, described by experts in the field of pelvic reconstructive surgery, is included in the following chapters of this text. Comprehensive care of the prolapse patient is not limited to surgery. Metabolic control, weight control, physiotherapy, lifestyle management, and surgery are all integral and necessary requirements for complete management of these complex problems

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4

How Do You Teach Vaginal Surgery?

Thomas Julian

Carl W. Zimmerman

Editor's note: The future of vaginal surgery is dependent on the way young and future surgeons perform these techniques. Our legacy is dependent on the physicians who come after us so it is important that we teach them well. Unfortunately, there are as many ways to teach vaginal surgery as there are vaginal surgeons. For that reason, I have asked Drs Julian and Zimmerman to take the question â€œHow do you teach vaginal surgeryâ€• and write about it, in their own way. Their approaches are different so we are able to provide you with a unique perspective on this important topic. Enjoy!

--S. Robert Kovac, MD

Dr. Thomas Julian

Obstetrics and Gynecology residency training programs in the United States are required to certify that their residents are competent to perform surgery. Certification requires attestation by the program director as to the competence of the individual resident. At the time of this writing, no educational or governing body provides prestated types or numbers of procedures to assist in certification, nor do they state the required level of involvement needed by the resident. Not all gynecology residents are well trained in surgery, and our experience indicates the least training may be in vaginal surgery. Practicing gynecologists not trained in vaginal surgery during residency rely on short courses, books, video demonstrations, and â€œon the job trainingâ€• through self-instruction or under the supervision of a colleague or perhaps after the urging of an industrial representative to add to or improve surgical skills.

As teachers of surgical gynecology, the onus is on us to do the best possible job teaching residents and practitioners. We need to teach in a manner that ensures skills acquisition and that will stimulate the surgical learner to continue life-long learning. To carry out this mission, we should ask our selves: â€œWhich are the most effective methods to teach surgical skills?â€• This discussion examines three components of this larger question:

- Is there a best way to teach gynecologic surgery?
- How do we ensure the mastery of material before the independent performance of a procedure so that the patient is both safe and well served?
- Can these skills be taught or practiced without direct supervision?

Is There a Best Way to Teach Surgery?

Learning any complex skill is an acquisition of both cognitive knowledge (preparation for performance) and demonstration of skill acquisition (performance behaviors). The question then becomes, are there ways to teach that will best ensure learning? Many famous educators have made their careers on trying to answer this question in theory, and many have concluded that the teaching-learning process may be so complex that we cannot really teach how to teach. The advantage of a learning theory model of teaching is that it does not let theory obstruct the teaching of necessary skills and lays out what are perhaps the most effective methods to teach behavior that requires preparation and performance. Learning in that model is a deliberately arranged set of events that are external to the learner and that are designed to support the internal learning process.

Basic learning principles apply to all types of instructional experience and fit especially well when applied to surgical teaching. The successful teaching surgeon may do these things without ever having *been taught how to teach*, but most of us would benefit from understanding how better to do it.

Teaching begins with the instructor understanding the goals for instruction, consideration of the resources available, and the constraints placed upon the system. The *goals serve as the basis for your curriculum planning*; the resources define how you can teach the desired skills; and constraints are those problems you must recognize and either compensate or overcome to ensure teaching occurs.

The *planning of curriculum* within a learning theory model begins with defining first the complex behavior (for example, learning to do vaginal hysterectomy) into the many simpler behaviors that make up the whole. Each behavior is then taught or learned, practiced, and positively reinforced or tested to mastery (rewarded) as closer and closer approximations of the desired end behavior are performed. The process of having the learner make closer and closer approximations is what we would call practice and is called *shaping* by behavioral learning theorists. Each simple component behavior is then chained (linking together of component simpler behaviors into a complex behavior) together into the more complex skill. If the learner cannot satisfactorily perform any of the component behaviors, the teacher can coach the learning, break down the behavior to an even simpler step, demonstrate the step or have the learner repeat the step until mastered. The learner performs all the steps until successful and thus the skill is attained (the new behavior learned). And that is all there is to it! Seemingly simple, but hard to do.

First, however, we must decide what it is we want to teach. It has been shown that when instructors identify goals and describe plans to accomplish these goals; teaching, as measured by learner performance, is more effective. Just as any trip begins with a map, so should the learning experience. When written down by a classroom teacher, these are called lesson plans. Whether there are called lesson plans, learning objectives, performance objects, or outcomes, the surgical teacher should know and be able to describe the observable and measurable skills (behaviors) to be learned by the surgeon in training.

These learning objectives must be given to the learner prior to the beginning of instruction with the intention that the learner will know when during the curricular experience they are going to be expected to know or be tested on their content or to perform the skill if it is a behavioral objective. These objectives make both the learner and teacher accountable at known times within the learning experience. To break down a complex behavior like performing vaginal hysterectomy to write learning objectives, we must analyze the component cognitive and performance behaviors.

At this point those of you who are teacher-surgeons are wondering how you would ever have the time to do this. Fortunately, the objectives have already been written for us and there are a number of gynecologic surgical texts that allow the learner to acquire the cognitive knowledge to prepare to perform surgery. At the very beginning of the residency, all learners can be given rotational objectives. The cognitive or learning objectives should be accompanied by predetermined reading assignments. It is up to the rotational supervisor to determine how the objectives are measured, but cognitive objectives can be tested with pencil and paper to any degree the supervisor wishes.

Cognitive Knowledge

The beginning point for teaching a resident surgery should be an understanding of the general principles of surgeryâ€”how to determine indications for surgery, how to prepare the patient mentally and physically before performing the surgery, and to prepare all conditions and personnel in whom the patient must entrust their well being. The learner must understand basic principles for all surgeries, how to select the patient, and steps in preparing the patient/surgeon/and operating room. The surgeon in training must anticipate what should happen to carry out the procedure indicated. These learning objectives would include:

- Pathophysiology of the patient's problem
- The indication for a surgical procedure
    - selection criteria based on the history and examination findings

  - selection criteria based on the general gynecologic indications
- The feasibility of the procedure in the patient being treated
  - risks and benefits
  - patient disability short and long term
  - â€œcure,â€• improvement, versus palliation
- Risk assessment for the individual patient for surgery
  - risks based on past medical history
  - risks based on physical examination
  - special preparation for surgery
  - patient education about the surgical experience
- Anesthesia
  - types
  - risks
  - complications
- Technical preparation
  - rules, regulations, and administrative criteria
  - letting the operating room know what you will need
  - very common possibility must be planned
  - reviewing the procedure in a text
- Patient needs the morning of surgery
- Checking on what you need the morning of the procedure
- In the operating room

    - type of anesthetic/anesthesia used
    - positioning
        - patient safety
        - surgeon comfort
        - assistant
    - positioning surgeon, assistants, and equipment
    - lighting

    - instrumentation
        - retraction
        - cutting
        - hemostasis
        - irrigation
- Complications in surgery
    - organ injury
    - excessive blood loss
    - when a procedure does not work as planned
    - recognize the need for intraoperative help
- Postoperative complications
    - postanesthesia recovery area
        - hemodynamic instability

        - respiratory distress
        - cognitive distress
    - in hospital
    - outpatient convalescence
- The operation that does not work

These learning objectives can be accomplished or prepared for before ever seeing a patient. There seems to be a significant difference between the training of general surgeons and gynecologists for many of the previously noted cognitive behaviors. It seems to me that most gynecologic residents come unprepared even with the basic understanding of why we do what we do. Residents come on the service feeling the end goal is to perform an operation rather than knowing the steps leading to, the procedures in carrying out, and following up surgery.

It is not the fault of the resident that they do not know these things. We have to let them know that doing surgery is made up of all these things. All surgical training should start with a set of objectives and a textbook.

The Link Between Cognitive and Performance Objectives

Performance objectives are cognitive objectives acted out. Measuring them in a meaningful way is the greatest challenge in teaching surgery. The limiting factor in measuring performance objectives in teaching gynecologic surgery will always be the teacher, not the learner. The two relevant questions regarding the successful implementation of this teaching task will be:

- Does the teacher know what and how to measure skills?
- How committed is the teacher to the educational measurement?

There is a good chance that each of us remembers a teacher who made certain we knew what we were doing by asking us direct questions in class, giving us homework and handing it back graded the next morning, and testing each and every learning unit to mastery. This is what teaching is aboutâ€”assignments, prompting, measurement, and feedback. It is best accomplished as an organized process.

A first step in learning should be a series of tests of cognitive knowledge examinations that would be administered to residents in surgical training programs. In general surgery the in-service training examination measures these things and is used for promotion and remediation. The problem with a sampling examination like this is that the test randomly samples a given number of areas, assuming that the knowledge demonstrated on the examination generalizes to the entire body of knowledge on the topic.

To do more than sample knowledge, there needs to be testing based on the basic concepts covered in the learning objectives. In other words, every aspect deemed important should be included in a testing format. To do this one needs to develop a test blue print. A test blueprint is a list of objectives that ensures each area has a question. To do this residents would be given the list of learning objectives before appropriate rotation and the teachers on that rotation would be given the same list. The resident would know that they would have to answer these questions at a 90% correct level at the end of the rotation. This would allow them to focus their learning on those concepts teachers felt to be most important. These tests should follow appropriate curricula: The resident curriculum. These tests could be developed in place of laundry lists of learning objectives that now exist.

Performance Skills

Most gynecologic surgeons agree that the ability to do vaginal surgery is the most distinguishing characteristic of our specialty; still we hear members of out specialty say we are losing the ability to do vaginal surgery. These observations most commonly come from older, more experienced surgeons; they feel younger surgeons don't know how to do vaginal surgery. It would seem logical at that point to ask the older, more experienced surgeons: Why did you stop teaching it?

The lack of teaching is not related to a lack of surgical material. There are more than one million hysterectomies, vaginal reparative procedures, and stress incontinence operations performed in the United States each year (Gagne RM, Briggs LJ, Wager WW, 1992). There are several reasons we do not do as many vaginal surgeries:

- Today there is a general opinion, correct or incorrect, that lower parity makes vaginal operations less needed and more difficult than they used to be.
- Vaginal hysterectomy is no longer acceptable as a sterilization operation.
- Many teaching programs make strong efforts to train residents in the alternatives to hysterectomy, emphasizing medical management, endometrial ablation, arterial embolization, or myomectomy.
- The most influential surgeons in our teaching programs are gynecologic oncologists and urogynecologists, who have been trained to operate primarily through the abdomen.

- Laparoscopic techniques have been touted as less invasive than traditionally performed vaginal procedures. None of these assumptions are necessarily true.

What Methods Are Likely to Help in Teaching and Learning Vaginal Surgery?

Although expert vaginal surgeons make the argument that all patients are candidates for vaginal surgery, not all women undergoing surgery are good candidates for the inexperienced surgeon performing surgery. The teaching surgeon should make sure that the initial hands-on operative experiences by the inexperienced surgeons are successful. Difficult cases should be reserved for demonstration by the experienced surgeon or for the more advanced learner who is prepared for cases that are not routine. It is important that a learner experiences success, especially early in training. Behavior that produces success is likely to increase in frequencyâ€”that which has an unpleasant outcome will diminish or stop.

This requires teacher and learner to (i) know how to select the patient who is a good candidate for vaginal surgery, (ii) know the steps described to perform a surgery, (iii) understand how to prepare for the operating experience both by knowing what they will need for routine performance of surgery and common problems encountered, and (iv) have the conditions in the operating room and instrumentation to optimize the performance of surgery. For purposes of illustration in this discussion, vaginal hysterectomy will be used to demonstrate the steps in teaching. Other procedures are similar, and the same concepts should generalize to other transvaginal surgery.

History

Most gynecologic surgery textbooks state that a history of prior pelvic inflammatory disease, endometriosis, ruptured appendix, prior pelvic surgery (especially cesarean section), or other known pelvic/abdominal adhesions are contraindications to vaginal hysterectomy. Experienced vaginal surgeons seldom believe that history alone eliminates the possibility of vaginal hysterectomy and that most if not all reparative procedures can be performed vaginally.

Examination

Many operators feel that parity is the rate-limiting step in determining suitability for vaginal hysterectomy, but more importantly the operator needs to assess the size of the uterus, the space available through which to operate, and the mobility of the pelvic organs. Vaginal operations are performed mainly through the lateral and anterior vagina. This is where room will be required to perform surgery; therefore, the pelvis must not only be a certain size but shape is important. Always ask yourself if it is rounded like the opening of a can or triangular like the top of a pyramid. The former will make an easier operation, the latter a difficult one. The pelvis must be a certain size and shape (round or gynecoid) for the operator to see (visualize) and work (physical limitations for operating).

To identify which patients are good candidates for vaginal hysterectomy, the learner performs the same maneuvers to determine whether a fetal head will fit through the pelvis. When assessing a patient for vaginal hysterectomy, the beginning resident should envision the uterus as a baseball, softball, football, or some other common object and the pelvis as a rigid container like a metal can. Then ask, â€œWill the object pass through the rigid container?â€• Most importantly the clinical pelvimetry done for vaginal hysterectomy should take into account the width of the subpubic arch. The wider the arch, the easier the surgical procedure.

A patient with a narrow subpubic arch, a small intraspinous diameter, or short intratuberous diameter will be more difficult to operate upon; visualization and room to work are both less.

Excessive soft tissue makes the vagina long and difficult to work through during the operation. The surgeon must assess the physical characteristics of the uterus and the surrounding soft tissue including bladder, rectum, uterus, adnexa, or vagina. Mobility of the uterus must be assessed. Can it be moved upward and downward with ease? A uterus that is mobile will become progressively easier to remove as vaginal hysterectomy continues. Mobility is more important than degree of prolapse. The uterus that is fixed and immobile should not be removed vaginally.

The teaching physician and resident should do the pelvic examination together to begin each case, and the attending physician should tell the resident what the relevant findings are that affect surgery. The resident should examine the patient first and verbally state what they have learned from the examination. The teaching surgeon should repeat the examination and provide immediate feedback. When the resident does not see the patient before surgery but has their first exposure in the operating room, the examination can still be performed and discussed before surgery, but most of the clinical examination techniques that can be performed on an awake patient are lost. The resident will not be selecting patients for surgery under anesthesia when in practice, and the skills that go with office examination will not be learned.

The Teaching Surgeon's Comfort Level

Every surgeon establishes their own comfort level with teaching surgery based on internalized guidelines that may vary greatly from teacher to teacher and from case to case. As lifelong learners, surgeons should attempt progressively more difficult cases to challenge and thereby increase their own skills. By the same token there is a Latin proverb, *Qui docet diciâ€”He who teaches, learns.* Both teacher and learner should realize there is no growth without challenge or risk. The teacher will see things done by the learner that will increase their own knowledge. The two working together should be better than the one alone. The same concept

should generalize to physicians in practice: The assistance of a partner often gives you the extra hands, skills, or confidence that may be necessary to do the very difficult procedures that could not be accomplished with a less-skilled assistant. Do not hesitate to ask for help. Surgeons who find that they are doing simpler procedures or avoiding difficult but necessary parts of procedures to avoid the problems are not doing their best for patients and need to remember that the purpose of operation is to benefit a patient and not to get through the operation.

Using Teaching Models for Dexterity

Teaching of surgical skills can begin well before the resident surgeon comes to live surgery. Reviews of anatomy can be done from any anatomy book, gynecologic surgical text, or commercially available pelvic models. Many residency programs also have access to cadaver laboratories in medical schools for basic preparation. It should also be remembered that surgical skills are not just innate dexterity but a function of skills acquired through practice. Practice with commonly used tools: (i) a clamp that can be carried in the pocket and opened and released many times per day to learn to use it with the right and left hands with ease, (ii) making simple heavy thread available for knot-tying practice, (iii) an 8-ounce tin can may be used with a needle holder and suture to practice placing and tying knots in a washcloth or pillow at its base, (iv) surgical movies of procedures to be done should be available, any of a number of media can be used. These are cheap, practical, readily available, and obviate the need for expensive trainers, pie-in-the-sky virtual-reality trainers, or unusual set-ups that take time without proven benefit.

Planning the Operation

The learner should be able to identify materials, appropriate consultation, operating room assistance, positioning of the patient, operating room layout, and the instruments or special equipment needed for every operation should be planned and arranged before beginning surgery so that everything is in its place. All special materials or circumstances must be planned so that all things are as secure as possible before ever embarking on an operation.

Operating Needs

The physical configuration of the operating room, the positioning of the patient, and the instruments used during surgery should be a routine consideration when teaching vaginal surgery. You should decide where you want the table positioned. Some surgeons prefer to operate standing and some sitting. The choice of position for the surgeon and assistants will affect the positioning of the patient.

The patient should be positioned with her buttocks just over the edge of the operating table. Some operators use a small shelf placed on the edge of the operating table for several reasons: (i) The operator's legs tucked under the shelf can be draped, helping to maintain a sterile field. The suture, suction tubing, and electrocautery do not end up dangling downward out of the sterile field. (ii) A Heaney clamp, heavy scissors, and tissue forceps can be kept on the shelf, thereby decreasing the amount of passing done at the time of surgeryâ€"saving time, decreasing injuries, and allowing the operator to never turn attention from the operative field.

Table 4.1 Basic Components of Pelvic Anatomy Required to Perform Vaginal Surgery

Relationships of the central pelvic organs including the reproductive, gastrointestinal, and urinary tracts

Name and course of blood vessels including common variations

Name and course of major pelvic nerves

Name, origin, and insertion of the pelvic muscles

Named divisions of the deep endopelvic connective tissue and interrelationships

Named avascular spaces of the pelvis

Interrelationships of pelvic anatomy with special emphasis on the nerves, blood vessels, and ureter

Vulnerable vascular and neurologic points in the pelvis and lower extremities

Positioning the Patient

Patient positioning should be taught before every surgery. The position needs to be safe for the patient, but also a comfortable one for operator and assistants, maximizing visualization for all. To facilitate patient comfort and safety, some vaginal surgeons position the patient while awake, most do not. Elderly patients with hip problems, hip replacement, arthritis, and those long immobilized are best positioned awake. All patients need to be positioned such that excessive abduction of the thighs is avoided. The operating tables we use have a small central cut out area under the buttocks. The patient is positioned on the table so that the buttocks are just over this cut out area to enable a weighted speculum to hang in this spot with the lateral buttocks well supported with soft padding over the femoral nerve areas.

There are two common nerve injuries during vaginal surgery, those to the (i) peroneal nerve, as it passes on the lateral side of the knee, and the (ii) femoral nerve as it exits the pelvis and continues down the leg as the sciatic nerve. Nerve injuries to the peroneal nerve are usually pressure injuries from compression of the nerve laterally at the knee. To avoid peroneal nerve injury, the most common nerve injury at the time of vaginal surgery, the patient's legs should be placed in the high lithotomy position to give the assistant(s) room to stand without a foot in their faces or in such a position that the assistant is not leaning or pushing the patient's leg laterally into the stirrup.

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Well-padded leg holders with sufficient soft support for the entire leg provide protection. To avoid femoral nerve injury from positioning, the leg is raised sufficiently high to avoid hyperflexion of the hip, which stretches the femoral nerve. This position also prevents excessive rotation of the hip in the dorsal lithotomy position.

Damage to the peroneal nerve results in foot drop. Damage to the femoral nerve causes paresthesia of the anterior and medial surfaces of the thigh, extending downward to the foot. Severe damage to the femoral nerve can affect the motor function of the leg in extension, resulting in an inability to walk. Excess lateral rotation of the hip can dislocate the hip.

Lighting

To illuminate the operative field, most surgeons rely on the overhead lighting coming over the operator's shoulders and free of assistants' shadows, usually with one large and one smaller bank of lights. Placing the patient in about 20 degrees of, Trendelenburg position helps directs both lights down the vagina into the center of the operative field.

Some surgeons wear a head lamp; others find it uncomfortable or distracting. To an assistant, the headlight may be distracting because every time the operator looks away from the field, the assistant cannot see as well. Headlamps also generate a small amount of heat, and pressure on the forehead, and the cord hanging down the operator's back may be annoying and a source for contaminating the surgical field. A head lamp may also force operators to hold their head in a fixed or awkward position, leading to discomfort to see well.

A snake-light with sterile cover can be used but occupies room in the field. A lighted, suction-irrigation instrument can be used. Lighting devices that attach to vaginal retractors are also available.

Surgical Assistants and Assistance

Vaginal surgery is most comfortably done when the surgeon has two assistants, but this is dependent on assistant availability. If possible, the more senior residents should be made to operate with a single assistant and be made to direct the flow of the operation. Often the verbal direction of the operation, knowing what to ask for and when to ask for it, is done by the attending physician. When the learner is expected to do this as an independent practitioner, directing the flow of the surgery may be the most difficult part of the operation to master.

To be most effective surgical assistants must be correctly positioned and involved in the operation. Especially during teaching cases, the assistant(s) (often the attending physician) must be able to see the field and be comfortable to provide the patience and emotional well-being necessary to do much of the teaching involved in vaginal surgery. Although either standing or sitting is acceptable, sitting relieves much of the tedium of extended vaginal reparative cases, both for the surgeon and the assistants, with many of our cases requiring 3 hours or more.

When the seats of the assistants are 4 to 6 inches higher than the operator's seat, the assistants' arms are comfortable and out of the operator's line of sight. This position also facilitates standing by the assistants when this becomes necessary. The operator is always seated centrally, and the first assistant, if right-handed, should be on the operator's left (the right side of the patient). This allows the right-handed, first assistant to use the dominant hand to the best advantage on either side of the field when needed and allows the left hand to be stationary on a retractor if necessary. The suction should be placed on the side of the first assistant to use to clear the field for the operator, as a pointer, and as a blunt dissection device. A good portion of any operation can be initiated with the suction device and still allow a resident to accomplish most of the surgery.

Surgical Exposure

Self-retaining retractors may be very helpful. In our practice we use several types of self-retaining retractors to (i) reduce the often tedious job of retraction, (ii) free the hands of surgical assistants to help with surgery, (iii) allow assistants greater mobility in assisting and viewing the surgery, (iv) provide counter traction for dissection, and (v) provide retraction that never tires, moves, and is always available.

When the pelvis is large, the Magrina-Bookwalter retractor (Codman, Randolph, MA) is excellent for vaginal hysterectomy. When the vagina or pelvis is small or there is minimal uterine descent, the Martin arm retractor (similar to Elmed Retract-Robot, Elmed Inc., Addison, IL) attached to small Deaver retractors (Zinnanti Surgical Instruments, Chatsworth, CA) as an anterior retractor, first for the vaginal wall and later to retract the bladder, frees the hand of one assistant.

For vaginal reparative surgery, the Lone Star Retractor (Lone Star Medical Products, Houston, TX) and accompanying surgical stays make it possible to work easily in difficult to see spots and allows the operator to open surgical planes by ensuring adequate visualization in nearly any situation. The retractor is a variation of the Scott and White retractor and is invaluable in facilitating visualization and dissection, and provides excellent countertraction for dissection. It obviates the need for a dozen clattering, impossible-to-hold Allis, Pratt, or Kocher clamps dangling from two huge, floppy pieces of vaginal epithelium, freeing the assistant's hands to help with the operation rather than passively retract. We use this retractor in all vaginal reparative surgery, Bartholin gland surgery, simple vulvectomy, vestibulectomy and sometimes cone biopsy. This retractor is also especially good at keeping the labia retracted.

Some operators dislike this retractor because to use it optimally, dissection must be done sharply in anatomic

planes. Finger dissection or blunt tearing against a sponge does not work as well with this retractor. To me, this limitation is a great asset, because it forces the surgeon to operate visually, recognizing tissue planes, and dissecting anatomically. Self-retaining retractors are advantageous also because they allow vaginal operations to be done without two assistants. One can operate with one assistant who needs to do very little in most cases.

Weighted self-retraining speculum retractors are commonly used. We use several types of weighted specula. We have Auvard weighted specula of two sizesâ€"a short one with a blade 2Â¾â€³ Ã— 1Â½â€³ Ã— 2Â½ pounds and a long blade 4â€³ Ã— 1Â¾â€³ Ã— 2Â½ pounds. The Steiner speculum (Zinnanti Surgical Instruments Inc.) is an ideal instrument for gynecologic surgery, with a 5Â½â€³ long, 1Â¼â€³ narrow blade for insertion into the posterior cul-de-sac and a pelvic curve that fits nicely into the hollow of the sacrum. The narrow blade makes this speculum easy to insert and the extra length and pelvic curve prevent it from slipping out during surgery. The Nichols Vaginal Retractor (Zinnanti Surgical Instruments Inc.) is an especially designed weighted speculum with attached suction and openings to sew the speculum into place. We will often start with a short speculum and change as the procedure progresses. When the patient has protuberant buttocks, preventing the weighted retractor from staying in place, we place a heavy gauge, figure-of-eight suture into the buttocks over the top of the retractor to keep the weighted speculum from falling out.

For anterior retraction we use a Deaver retractor attached to a Martin arm, which attaches to a side rail on the operating table. For lateral retraction on routine cases, we use small Deaver retractors with flat grips. For work deep in the vagina, we use the Breisky-Navratil retractors (Zinnanti Surgical Instruments Inc.). We have on hand about 12 of these retractors with blades ranging in length from 10 to 17 cm and width from 18 to 38 mm.

Injecting the Cervix or Vagina with a Vasoconstrictor

Today, especially with the fear patients have of transfusion, every drop of the patient's blood should be conserved. Many experienced operators conserve blood by working rapidly and surely. In teaching settings, this cannot always be accomplished. One of our techniques to minimize blood loss is to use a vasoconstrictor; our choice is vasopressin (Pitressin, Parke-Davis, Morris Plains, NJ), 10 units in 30 to 50 mL of normal saline or 0.25% bupivacaine injected directly into the cervical stroma or vaginal epithelium. By doing this we decrease blood loss by about one third and keep a clearer operative field to facilitate surgery.

This technique probably has secondary benefit in that it allows residents to continue operating when they in some cases would be assisting because of excessive blood. We have used vasopressin during hundreds of vaginal, abdominal, and laparoscopic cases. It provides a blood-free field in most cases for 75 minutes, and we have had no problem with intraoperative cardiovascular instability, delayed bleeding, or postoperative healing.

Bladder Management

Before beginning most vaginal surgical procedures, the bladder may be drained or not drained. Those who favor drainage, feel that the thicker bladder wall and decreased intravesical volume make the bladder a smaller target. Others feel leaving a small amount of urine in the bladder allows the surgeon to more easily either recognize the bladder margin or identify a fluid leak. In our practice we favor drainage.

When there is an increased risk of bladder injury, we give 5 mL of indigo carmine dye to the patient intravenously. It allows the operator the following advantages: (i) If you enter the bladder, there is never any doubt as there is immediate recognition of the blue dye; (ii) the indigo carmine dye facilitates recognition of the ureteral orifices as they spurt the blue dye into the urine. Patients younger than age 50 will spurt dye in less than 10 minutes; patients in their 80s can take three times that long to pass the dye. In elderly patients or those with renal impairment, dye passage can be hastened by the intravenous administration of furosemide (10 to 20 mg).

Surgical Clamps

In selecting surgical clamps, we emphasize that learners use the clamp that best fits the task to be accomplished. The Heaney clamp (referred to in our institution as the hysterectomy clamp) (Zinnanti Surgical Instruments Inc.) is satisfactory in most cases, but sometimes it is too big or the curve is not optimal. We encourage the learners to use Ballantine, Pean, Kocher, right angle, tonsil, or long Allis (25 cm) clamps, always emphasizing that we have many choices so that we can use what works best. We keep at least two extra-long clamps in the operating room, such as those used for thoracic surgery, ready to use in difficult situations. They are separately wrapped but readily available. Our goal is to make the operation and the instruments fit the patient, not other way around.

Suturing and Knot Tying

We try to use several principles in teaching suture use: (i) work behind clamps; (ii) sew perpendicular to the blade of the clamp to avoid wandering laterally with the needle point; (iii) sew from small or difficult to reach places toward larger spaces to allow more accurate placement and simpler retrieval; (iv) sewing away from the bladder or rectum is not safer when it causes the operator to be clumsy or inaccurate with suture placement; (v) never turn, twist, or use as

a retractor a clamp that has been placed for suture ligation of a vascular pedicle; (vi) release clamps slowly on a predetermined command from the surgeon who is tying the suture. (vii) during the release of a clamp hold the clamp so that the pedicle remains in the anatomic position that it was before the pedicle was cut (this decreases the chance of tissue slippage, or avulsion); (viii) tie with the pedicle being ligated between the tying surgeon's hands; (ix) knots are pushed downward, pulling the tissue upward with no more tension than is necessary to keep the knot tight; (x) only square knots are tied and pushed downward with the surgeon's index finger: The suture is not used as a fulcrum when tying.

Control of Bleeding

Do not allow oozing of blood that can easily be controlled. It can add up, especially during vaginal repairs: (i) Pack and exert pressure on an area that may be oozing, as you work in a different area; (ii) persistent oozing can be stopped many times by using a vasopressin injection or a packing soaked in vasopressin; (iii) we use Gelfoam (Upjohn, Kalamazoo, MI) soaked in liquid thrombin (Thrombostat, Parke-Davis) as a hemostatic pressure packing.

For bleeding sites that are hard to reach, use a long Allis clamp to secure these areas and bring them toward you. The Allis clamp can be placed directly over a bleeding site, unlike many other clamps. To suture small bleeding sites we use a fine gauge suture (000 polyglycolic suture) on a fine needle (SH-1) on each side of the Allis clamp. It works better than cautery in many cases. When the area is very difficult to reach, we often use silk suture rather than absorbable suture because of its handling properties. Never hesitate to leave a t-tube drain in a nonhemostatic operation. This can then be connected to a grenade suction device, providing continuous, closed suction to prevent hematoma formation and infection, and to allow the patient to self-coagulate an oozing space.

Summary

It has been estimated by the National Center for Health Statistics that there are more than 300,000 operations performed for female pelvic organ prolapse each year. With the general aging of the population, it is likely that there will be even more reparative surgery in the future. Efforts need to be made to enhance our surgical technique for vaginal reconstruction. Choosing the correct patient by indications for surgery and individual patient characteristics is the first step in successful vaginal surgery. To become a successful surgeon, you must challenge your own abilities and optimize operating instrumentation and techniques. Theses simple recommendations should help almost anyone wanting to do more vaginal surgery.

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Dr. Carl Zimmerman

Teaching vaginal surgery is a complex, time-consuming, and occasionally vexing activity that involves both hard work and significant rewards. Patience and cooperation are required on the part of the teacher and pupil in approximately equal proportions. The instruction of surgical skills is very similar to the system of apprenticeships used in historical times. An apprentice began with simple tasks, progressed to the position of an assistant, and gradually accrued enough experience to perform independently the given skill to be labeled a journeyman. At some subsequent point in time, the craftsman could become a master, engage an apprentice, and start the cycle again. The gradual transition from apprentice to master craftsman required knowledge of the proper tools, the various processes involved in the profession, and the experience to manage contingencies that created unique challenges. The obvious parallels are not difficult to see. The natural history of surgical skill development generally begins with the simple tasks of retraction, suctioning, cutting sutures, and observation. As time passes, the tasks assigned to the assistant become more and more complex. Eventually, the assistant performs specific portions of a surgery. As skill acquisition progresses, the teacher becomes more and more an assistant and the trainee becomes more and more a surgeon. With the passage of time, a trainee learns to become a surgeon; however, the process is not so simple. Surgical cases present in an amazing degree of complexity and detail. Even the well-seasoned surgeon must retain the capacity to become a pupil at any time. In the face of a sufficiently challenging case, the best among us is wise and prudent to ask for help.

After assisting in surgery, a young obstetrician-gynecologist learns to operate. The slope of the learning curve should be guided by the teacher. As operative skills are acquired, the surgeon becomes a better assistant. The converse concept is also true. The learning process never stops. Surgery is not a static field, and new ideas and techniques further complicate this process. One of the most valuable lessons that a young doctor may witness in the operating room is the acquisition of a new skill by an experienced surgeon. Demonstration of the proper way to progress through a learning curve helps the student. The willingness to be proctored, to gain experience, and eventually to share the desired skill are valuable lessons. I continually emphasize my desire to be a life-long learner.

I encourage open communication and stress that the only bad question is one that is left unasked. Everyone in the operating room should feel comfortable raising a point of concern or confusion at any time. If a question is asked, it should be treated with the same degree of respect, regardless of the source. Conversely, everyone should feel comfortable enough to put forth an answer without fear of ridicule or intimidation. Depending on the ingenuity of the teacher, every inquiry can serve as a point of reference for teaching. Permitting open communication allows everyone in the room to alert the surgeon to points that need to be explained. Likewise, the student should be receptive to teaching points from any source. All of us remember the guidance of nurses, surgical technicians, and patients who were more experienced in a given environment than we were at an early stage in our careers.

A teacher must be confident in the subject matter to be taught. True confidence is gained through experience and should be differentiated from bravado. Experience is one of the primary requirements to be a successful teacher of the subtleties and nuances of an operative procedure. During surgery, the teacher anticipates problems, analyzes technique, and demonstrates methods for improvement. The teacher's approach to a complication is very important. Within the confines of patient safety, I allow the student to analyze and plan a method of approach to an untoward event. If necessary or desirable, I may manage a specific complication. I always review my thought process during management of a complication and again after the procedure.

A significant premium is placed on the volume of operative experience in today's training environment because a need exists to shorten the learning curve and, in the process, to perform a sufficient number of cases. Expansion of curriculum content, restriction of work hours, and declining surgical volume are examples of contributing causes to this phenomenon. Of course, some aspects of this residency environment are good, but some are bad. No one believes that students learn more efficiently when fatigued. The wonderfully instructive processes of informal conversational teaching and story telling in the surgical lounge before and after cases have all but disappeared. Teaching time is now largely restricted to group didactics and the high intensity setting of the operating room. I make an active attempt during any surgery to expand on one or more aspects of a case and to teach by second-hand experience. Cases similar to the one being performed, perhaps with a unique aspect, are wonderful sources of probing questions and teaching points. I also see a significant value in having a surgeon-in-training see me operate. I selectively perform particularly difficult cases or portions of cases in an attempt to teach operative efficiency and economy of motion.

Knowledge of anatomy is absolutely essential to ensure the safety and efficiency of surgery. A solid grasp of anatomy should be required of all participants in a surgery. Anatomy is first learned in the cadaver lab and books. Once a substrate of regional anatomy is in place, the surgical case can be used to expand the depth and breadth of understanding. Teaching anatomy in a live patient during surgery accomplishes several objectives. A running anatomic commentary reduces the likelihood that any individual's attention will drift. Every surgery should follow an anatomic plan with specific goals and objectives. Of course, the plan may change as the case progresses; however, all changes should be based on anatomy. The resident should be able to demonstrate complete understanding by adequately describing the anatomy to me. I begin with basic questions and progress in difficulty until a point of uncertainty is reached. The resident/student is asked to review the question and subsequently return with the answer.

Surgical instruments, sutures, and equipment are the tools of the trade. The attending surgeon has the responsibility to familiarize the resident with the names, proper use, and limitations of these tools. This information is best transmitted by experience and is very difficult to gain from reading. Certainly practice on various types of simulators is desirable. Proper knot tying, use of needle holders, technique of release for clamps, and any number of other skills may be learned when the student is properly motivated. Inherent in this process is the implication that one skill must be sufficiently mastered in order to progress to more complex skill acquisition.

Positioning of patients is particularly important in vaginal surgery. The proper use of stirrups to safely gain exposure is a skill that I always personally teach. The surgeon is responsible for assuring the proper placement of the patient and for transferring this artful skill to the student.

Vaginal surgery is unique in many ways. Laparoscopic and abdominal surgeons can easily share cases. Many of these cases lend themselves to side sharing, that is, you do your side, and I will do mine. In this way, the transition to mastering at least half of the case is gradual, and the pace of learning is dictated by the speed that skills are acquired. Teaching of abdominal and laparoscopic skills is begun early in training and continued to the completion of residency. With the exception of episiotomy repair, basic and advanced vaginal surgery is usually taught in the last 2 years of residency after abdominal and laparoscopic skill acquisition is well underway. Abdominal anatomic concepts must be expanded and learned from an obverse perspective. In vaginal surgery, the surgeon sits or stands in the central position and is the only person operating. For this reason, the learning curve is much steeper and more intimidating. The teacher of vaginal surgery must have the skill and confidence to guide the student through the surgery from the assistant's position. Hysterectomy is generally the first major procedure that is taught vaginally. Salpingo-oophorectomy and pelvic reconstructive surgery follow as skills are acquired. Early in the learning curve, I micromanage each move of the student and describe the steps in the same anatomic language that I use in my standard operative note. Before allowing the case to proceed, I frequently take the scissors, clamp, or needle holder in my hand and demonstrate exact angulation and placement. The value of an active and interested assistant can be made very apparent during a vaginal hysterectomy, salpingo-oophorectomy, or pelvic reconstructive surgery. Surgical confidence is gained through experience. Then the emphasis shifts to efficiency, economy of motion, and increasing complexity.

Learning can generally be divided into three categories: cognitive, visual, and repetitive. Obviously, all three of these modes of instruction are required for the assimilation of vaginal surgical technique. If any of these types of learning are not actively pursued, the practitioner is likely to lose the desired skill. An obstetrician-gynecologist who enters general practice will likely have a predominantly young patient population. Vaginal cases will probably not be numerous. The skills that are cultivated will be related to laparoscopy, abdominal surgery, and obstetrics. The natural tendency is to be less and less aggressive with the application of vaginal surgery, even if the doctor was well-trained in residency. Physicians who desire to learn or review specific procedures should have the opportunity to attend and even participate in the desired surgery. The lack of these opportunities is a major contributing problem to the suboptimal application of vaginal surgery techniques today.

Properly performed vaginal surgery is as complex and rewarding as any skill within the field of pelvic surgery. A full knowledge of deep pelvic anatomy, avascular pelvic-space dissection, keen visual differentiation of subtle tissue variations, and reconstructive surgical techniques applied within very confined spaces are all required. In many training programs these skills are taught only to fellows. I frequently receive requests to teach these techniques to seasoned and highly experienced practitioners. Many educators believe that these operations are too difficult and technical to teach residents. I do not share this belief. I find that the residents of today are as eager and capable to learn as surgeons from any other generation. The missing ingredient or catalyst is the availability of skilled vaginal surgeons who are willing to teach. In many communities, the most capable vaginal surgeons are not full-time faculty members. A nonacademic physician with a vast amount of experience may be the best person available to teach basic and complicated vaginal procedures. In that circumstance, academic or training institutions should create opportunities to ensure exposure of today's residents to the best surgeons available. The responsibility of a skilled vaginal surgeon is to pass these minimally invasive techniques to the next generation. Many advantages are afforded by vaginal surgery, and patients deserve to have access to this natural orifice approach.

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5

Antibiotic Prophylaxis and Vaginal Surgery

Sebastian Faro

Prior to the introduction of antibiotics for surgical prophylaxis, the development of pelvic infections following surgery was a frequent occurrence. In addition, development of a pelvic abscess or a tuboovarian abscess was not an uncommon event prior to the routine use of prophylactically administered antibiotic at the time of the operative procedure. The development of a postoperative infection is associated with significant morbidity and mortality and higher costs. The difficulty in understanding postoperative infection is distinguishing between febrile morbidity and fever caused by infection. Fever has been reported in 32% to 52% of patients having major gynecologic surgery (1,2,3,4). The rate of postoperative pelvic infection following the administration of antibiotic prophylaxis is â‰¤10%.

Risk Factors

Common complications associated with surgery are infection, bleeding, and damage to adjacent organs. Several factors contribute to the patient's risk of developing a postoperative pelvic infection after pelvic surgery. Risk factors can be divided into exogenous and endogenous factors. The use of meticulous surgical technique is critical in the prevention of postoperative infection, and, therefore, surgical technique must be considered an important factor in the development of postoperative infections.

The surgeon must make an effort to maintain sterile technique from the beginning to the end of the operation. Tissue must be handled with care and not traumatized. This is especially important during hysterectomy when the vagina is either directly or indirectly involved in the operation. During vaginal hysterectomy the entire operative procedure is conducted through the vagina; therefore, there is constant movement of vaginal fluid and instruments through the vagina. There is constant abrading of the vaginal epithelium and pelvic peritoneum throughout the operation while endogenous vaginal bacteria are driven into the abraded tissue and carried into the sterile pelvis. Although this same trauma is not associated with abdominal hysterectomy, the microflora of the vagina is still the focus as the potential initiator of infection. In both the vaginal and abdominal hysterectomy, the suture placed through and perforating the vaginal apex allows a conduit for bacteria to colonize. The collection of blood and serum along the retroperitoneal vaginal apex also provides an excellent medium for the growth of bacteria. It is not uncommon for a hematoma to develop at the vaginal apex, which can easily become infected. Necrotic tissue or devascularized tissue remains in the tissue pedicles that are created, which in turn provides significant nutrients for bacterial growth. Therefore, the vaginal apex and the retroperitoneal space created by the operative procedure in essence become an incubator that houses the nutrients needed for bacteria to grow. Many of the bacteria that are endogenous to the vagina are pathogenic. Patients with an abnormal or a non-*Lactobacillus*-dominant vaginal microflora, even though they have received prophylactic antibiotic, are at risk for developing a postoperative infection. This risk is dependent upon alteration in the endogenous vaginal microflora and the numbers of bacteria present.

Microbiology

The majority of postoperative pelvic infections are most commonly caused by a significant alteration in the patient's endogenous vaginal microflora. Patients with a healthy vaginal microflora or a *Lactobacillus*-dominant flora are less likely to develop a postoperative pelvic infection (5). The

microbiology of the vagina is complex and maintained, in part, by *Lactobacillus* through the bacteria's production of organic acids, especially lactic acid, hydrogen peroxide, and bacteriocin or lactocin (6,7). *Lactobacillus* produces a copious amount of lactic acid that maintains the pH between 3.8 and 4.5; *Lactobacillus* have adapted to grow at this low pH, whereas the other bacteria, Gram-positive and Gram-negative facultative and obligate anaerobic bacteria, do not grow well at a pH of <5 (Table 5.1). The concentration of *Lactobacillus* in vaginal fluid is â‰¥10^6/mL. The other bacteria are present in vaginal fluid in a concentration of â‰¤10^3/mL. Many of the constituents that make up the vaginal ecosystem are known, such as proteins, carbohydrates, immunoglobulins, hormones, nucleic acids, but many are unknown. The balance or equilibrium of the vaginal ecosystem is delicate and can easily be disrupted by many different substances that are introduced from within the environment. It appears that one main factor is a change in pH, which if elevated can stimulate growth of the non-*Lactobacillus* organisms. The direction of change in the microflora depends upon which bacterium becomes dominant. If *Gardnerella vaginalis* becomes dominant, then as it grows the pH rises and the oxygen concentration decreases. When the pH is >4.5 the growth of *Lactobacillus* becomes significantly inhibited. The obligate anaerobic bacteria begin to grow when the pH is >5. Eventually the obligate anaerobic bacteria become dominant and the concentration of each bacterium in vaginal fluid is >10^6/mL. During this shift in growth, the facultative anaerobic bacteria switch from aerobic to anaerobic metabolism and achieve a concentration in vaginal fluid of >10^3 but probably â‰¤10^6/mL. A concentration of facultative anaerobic bacteria â‰¤10^6/mL is sufficient to colonize both the vaginal apex and pelvic peritoneum as well as to initiate infection. Combinations of bacteria such as *Escherichia coli* + *Bacteroides*, *E. coli* + *Prevotella*, and *Enterococcus* + *Prevotella* are abscessogenic (8).

Table 5.1 Microbiology of Lower Genital Tract

Facultative Anaerobic Bacteria	
Gram-positive	Gram-negative
Lactobacillus crispatus	*Escherichia coli*
Staphylococcus epidermidis	*Enterobacter aerogenes*
Nondescriptive streptococci	*Enterobacter agglomerans*
Diphtheroids	*Enterobacter cloacae*
Corynebacterium	*Morganella morgagnii*
Enterococcus faecalis	*Proteus mirabilis* *Gardnerella vaginalis*
Obligate Anaerobic Bacteria	
Gram-positive	Gram-negative
Peptococcus species	*Fusobacterium species*
Peptostreptococcus species	*Mobiluncus species* *Prevotella species*

Patients likely to develop a postoperative pelvic infection after receiving preoperative antibiotics for surgical prophylaxis are those whose vaginal microflora are altered. Patients who have bacterial vaginosis or an endogenous vaginal flora dominated by a Gram-negative facultative anaerobic bacterium are at risk for developing a postoperative pelvic infection. Patients with a *Lactobacillus*-dominated vaginal microflora are unlikely to develop a postoperative pelvic infection (5). The bacterial make-up of an altered vaginal flora includes Gram-negative facultative anaerobic bacteria in vaginal fluid in a concentration of â‰¥10^6/mL. In the context of bacterial vaginosis, the Gram-negative facultative anaerobic bacteria are present in a concentration >10^3 to â‰¤10^6/mL. The Gram-negative facultative anaerobic bacteria reproduce every 20 to 30 minutes and are very virulent. It is likely that these bacteria initiate the infection and develop conditions that support growth of the obligate anaerobic bacteria.

Microbial Pathophysiology

The environmental conditions present prior to the development of bacterial growth and subsequent infection are devascularized tissue pedicles, suture, dead space, and seepage of blood and serum at the surgical site. These conditions are extremely favorable to the growth of bacteria. The devascularized tissue is hypoxic, and the polymorphonuclear cells and macrophages do not phagocytize bacteria in hypoxic conditions, which results in a decrease in the host's defense mechanisms that combat the bacteria. Tissue hypoxia results in apoptosis of host cells and the release of nutrients from these disrupted cells, thereby providing nutrition for the bacteria. The presence of suture acts as a foreign body and results in a lower inoculum required to initiate a pelvic infection. In the absence of a foreign body (suture) the inoculum required to initiate infection is a bacterial concentration of 10^6/mL, whereas in the presence of a foreign body the inoculum required is lowered to 10^3/mL.

Bacteria gain entrance to the sterile pelvis and tissue pedicles throughout the entire operative procedure as the vaginal hysterectomy proceeds. In addition to the trauma of the pelvic peritoneum resulting in microabrasions that allow bacteria to gain entrance to the deeper tissues, the vaginal fluid containing numerous virulent bacteria is allowed to drain into the pelvis. Once the pelvis becomes colonized, these bacteria can gain entrance to the abdominal cavity. The tissue pedicles can be coated with vaginal discharge that contains bacteria. This vaginal discharge is driven into the tissues as they are crushed by the surgical clamps. Patients with a *Lactobacillus*-dominant microflora, have a very low number of pathogenic bacteria (â‰¤10^3/mL of vaginal fluid). Therefore, administration of antibiotic prophylaxis and the patient's host defenses are sufficient to eliminate this bacterial challenge. Although this is

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hypothetical, it does appear to be a logical explanation of why patients do not develop postoperative infections.

Antibiotic Selection for Prophylaxis

Antibiotic for surgical prophylaxis should be administered to those patients undergoing a surgical procedure associated with a significant risk for infection. The patient who is to undergo the surgical procedure should not have acute, chronic, or subacute infection. Chronic gingivitis should be considered an active infection that may pose significant risk for postoperative infection. Patients with bacterial vaginitis or vaginosis who are scheduled for pelvic surgery should be considered to have an infection and are not candidates for traditional antibiotic prophylaxis. Patients having surgery with an infection, and not receiving appropriate antibiotics, are more likely to develop postoperative infections.

The antibiotic chosen for prophylaxis should be administered within one hour prior to the initial incision. The antibiotic should have a long half-life so that the tissue and serum levels maintain a level greater than the minimum inhibitory concentration that inhibits 90% of the isolates (MIC$_{90}$, for the bacteria most likely to initiate infection for 24 hours. The antibiotic should have a spectrum of activity that is active against Gram-positive and Gram-negative facultative anaerobic bacteria as well as the obligate anaerobic bacteria commonly found to be endogenous to the vagina.

The antibiotic should be administered in a single dose and not given repeatedly over a number of days. As previously discussed, the antibiotic should be administered within one hour prior to the start of the operation. In those instances where the patient loses â‰¥1,500 mL of blood or the duration of the operation is 3 hours or greater, a second dose of antibiotic should be administered (9,10,11,12).

Many different antibiotics have been used for surgical prophylaxis for patients undergoing gynecologic and obstetric surgery (Table 5.2). Although many different antibiotics have been assessed in clinical studies, the three antibiotics most commonly administered for surgical prophylaxis are cefazolin, cefotetan, and cefoxitin. These cephalosporins and cephamycins are the antibiotics most frequently used for gynecologic surgical prophylaxis because they have proved to be both efficacious and safe, and have been used by gynecologists to treat infections for many years.

The success of these antibiotics is based on both their spectrum of antimicrobial activity and the status of the patient's endogenous vaginal microflora. Examinations of the spectra of antimicrobial activity of cefazolin, cefotetan, and cefoxitin reveal both similarities and differences. All three antibiotics have similar spectra of antibacterial activity against Gram-positive and Gram-negative bacteria. However, the latter two have better antibacterial activity against both Gram-positive and Gram-negative obligate anaerobic bacteria. As previously stated, patients who have a *Lactobacillus*-dominant endogenous vaginal microflora are unlikely to develop a postoperative pelvic infection following surgery. Regardless of which antibiotic is administered for prophylaxis, the patient with an altered vaginal microflora, specifically bacterial vaginosis or a Gram-negative facultative anaerobic-dominated vaginal flora, is very likely to develop a postoperative pelvic infection following surgery.

Table 5.2 Antibiotics Suitable for Surgical Prophylaxis

Cefazolin

Cefotetan

Cefoxitin

Metronidazole

Clindamycin

Levofloxacin

Prevention of Postoperative Pelvic Infections

All patients undergoing surgery where the vagina has been entered should be considered at risk for development of pelvic infection following surgery. Factors common to all surgery that contribute to the risk of developing a pelvic infection are listed in Table 5.3 and are categorized into endogenous and exogenous factors. The key to preventing a postoperative pelvic infection is not allowing pathogenic bacteria from the vagina and/or bowel to colonize sterile tissue. In addition, another important factor is limiting the amount of devascularized tissue that remains at the surgical site. The site that most commonly becomes infected following vaginal, abdominal, or laparoscopic hysterectomy is the vaginal cuff. The initial infection begins as a cellulitis of the vaginal cuff, surgical site infection (wound infection), or a pelvic hematoma that becomes infected or develops into an abscess.

Table 5.3 Risk Factors Contributing to the Development of Postoperative Pelvic Infections

Endogenous Factors	Exogenous Factors
Altered vaginal microflora	Devascularization of tissue
Obesity	Poor hemostasis
Chronic illness	Large necrotic tissue pedicles
Smoking	Undetected damage bowel
Abuse of alcohol	Large amount of dead space

Thus, preoperative screening of the patient's vaginal microflora 1 to 2 weeks prior to the operation can have a significant impact. Determination of the vaginal pH using the litmus strips can reveal the status of the endogenous vaginal microflora. A pH of <4.5 and >3.8 indicates that there is a high likelihood that *Lactobacillus* is the dominant bacterium; therefore, the pathogenic bacteria, for example, Gram-negative facultative anaerobes, are in low concentrations in vaginal fluid ($<10^3$/mL). Thus, the inoculum size of the pathogenic bacteria is too low to overcome the concentration of antibiotic in the tissues and the host defense mechanisms to initiate infection. A pH â‰¥5 indicates that *Lactobacillus* is not dominant, the patient's endogenous vaginal microflora is significantly altered, and the likelihood that the pathogenic bacteria are dominant is significant. Patients who have bacterial vaginosis have significant numbers of Gram-negative facultative bacteria as part of the endogenous vaginal microflora. The Gram-negative and Gram-positive facultative bacteria reproduce approximately every 20 to 30 minutes, whereas the Gram-positive and Gram-negative obligate anaerobic bacteria reproduce every 4 hours. Therefore, knowing the bacterial status of the vagina prior to surgery can reduce the risk of the patient developing a postoperative infection.

Patients who smoke or who abuse alcohol are more likely to have an impairment of their immune system. These individuals should be told to stop smoking at least 2 weeks prior to the operation. Although this will likely not reverse the impairment of the immune system, it may allow for some degree of recovery. Although the changes that can be made in the host are limited, steps can be taken to reduce the effect of the endogenous factors by limiting the effect of the potential exogenous factors.

Tissue pedicles should be small, that is, they should not include a thick amount of tissue. Thick pedicles provide an opportunity for the suture to loosen and, therefore, bleeding is likely to occur. Tissue pedicles that lie close to the vaginal suture line can easily become contaminated with bacteria. Blood and serum oozing from the vaginal apical incision are an excellent culture medium for the bacteria that seep into the vaginal incision and cul-de-sac from the vagina. Once the vaginal apical incision is closed by suture, the openings created by the suture in the epithelium provide a conduit for bacteria to enter the pelvis.

Use of electrocautery should be judicious when this technique is used for hemostasis. A needle-tip cautery should be used when cauterizing small vessels. The vessel to be cauterized should be no larger then the diameter of the needle tip. The application of electric current should be brief, just enough to achieve hemostasis, but not enough to cause destruction of the adjacent tissue. If electric energy is applied for too long a period, destruction of the tissue and the blood supply nourishing the tissue result in death of the adjacent tissue. This provides a nidus for infection.

Steps to be taken in the prevention of postoperative pelvic infection are:

- Ensure that the patient's vaginal flora is dominated by *Lactobacillus*.
- Keep the tissue pedicles small.
- Ensure dead space is kept at a minimum.

- Perform drainage of surgical site if hemostasis is not good.
- Use incentive spirometry, especially in obese patients.
- Ambulate the patient as early as is reasonable.

The antibiotic chosen for prophylaxis should be administered within an hour of the start of the operation. A single dose should be administered and a repeat dose should be given if the operation lasts 3 hours or longer. A repeat dose of antibiotic should also be given if there has been greater than 1,500 mL of blood loss.

Individuals suspected of having altered vaginal microflora that has not been corrected at the time of surgery should be given antibiotic prophylaxis that provides a spectrum of activity that is active against the bacteria suspected of being present; for example, if there is a heavy colonization of Gram-negative bacteria, then cephalosporins or cephamycins are a good choice. If bacterial vaginosis is present then a good choice would be clindamycin or metronidazole. These patients should be considered to have a low-grade or subclinical infection, and the antibiotic prophylaxis should be administered for three doses.

If the patient should develop a fever, therapeutic antibiotics should be administered immediately. Although there are no data to support these recommendations, the data available demonstrate that patients with an altered vaginal microflora are likely to fail antibiotic prophylaxis and develop a postoperative infection.

Indicators of a Postoperative Infection

Patients who have pelvic surgery are at risk for development of pneumonia, urinary tract infection, pelvic infection, surgical-site infection, bacteria, sepsis, septic shock, and death. Postoperative infection can occur rapidly or slowly. The clinical appearance of infection can occur immediately after the operative procedure or within hours or days. The physician should always think infection when a significant abnormality is reported to occur. Early indicators of infection are fever, tachycardia, hypotension, a decreased urinary output, and dull sensorium. The physician must respond to any one or more of these clinical indicators. Remember, a delay in the administration of appropriate antibiotic therapy allows the bacteria to increase in number and establish infection.

Fever has been defined by a variety of authors. Hemsell reviewed the literature in an attempt to find a uniform

definition for postoperative fever and found 32 definitions (10). The definition used most commonly is two temperature elevations greater than or equal to 38Â°C (100.4Â°F), 6 hours apart, excluding the first 24 hours after surgery (13,14). Eliminating postoperative fever as a concern, for example, an oral temperature â‰¥101Â°F occurring within the first 24 hours immediately following surgery, does not take into account infection caused by virulent bacteria such as *E. coli*, *Streptococcus pyogenes*, and *Streptococcus agalactiae*. When present in a high inoculum (â‰¥10^6/mL) the bacteria can initiate infection if they can overcome the host's defensive mechanism within the first 24 hours following surgery. Therefore, any patient developing an elevated body temperature â‰¥101Â°F either within the first 24 hours following the operative procedure or later should be evaluated for the presence of infection. Failure to recognize early infection will result in significant morbidity and mortality. Shackelford et al. published a retrospective study and concluded that â€œFebrile morbidity had limited value as a screening test for postoperative infection, with poor sensitivity and positive predictive value after vaginal surgeryâ€• (15). These investigators failed to define febrile morbidity and did not take into account the fact that patients who develop infection typically have a tachycardia that parallels the temperature course. Disregarding the initial rise in temperature, especially temperatures â‰¥101Â°F, would place a number of patients at risk for the development of serious infection. Initiating a minimal evaluation of the febrile patient to determine if there are signs and symptoms of infection should reveal if further evaluation is necessary, for example, specific laboratory tests (16,17).

Table 5.4 Clinical Indicators of Infection

1. Oral body temperature â‰¥101Â°F occurring any time after the operative procedure, or a temperature of â‰¥100.4Â°F and <101Â°F occurring on two or more occasions, at least 6 hours apart 24 hours after the operative procedure.
2. A pulse rate of >100.
3. Physical findings of infection, for example, respiratory compromise, urinary symptoms, cellulitis, increased pain at the operative site, and evidence of peritonitis.

The time at which a postoperative infection becomes clinically established is dependent upon the specific bacterium or bacteria involved in the infection. Bacteria such as *S. pyogenes* (GAS), *S. agalactiae* (GBS), *E. coli*, and other Gram-negative facultative anaerobic bacteria multiply rapidly; therefore, they can initiate infection early in the postoperative course and progress rapidly. So patients with one or more clinical indicators (Table 5.4) should be evaluated (Table 5.5). The specific tests ordered are dependent upon the patient's status. At minimum the following tests should be obtained: a complete white blood cell (WBC) count with differential, serum electrolytes, blood urea nitrogen (BUN), creatinine, and glucose. A urine analysis and urine gram staining should also be obtained.

Table 5.5 Evaluation of the Patient Having a Suspected Postoperative Infection

1. Monitor vital signs every 15 minutes for the first hour, if stable can be obtained on a routine basis.
2. Physical examination, including a speculum and bimanual pelvic examination.
3. If the vaginal cuff is open, a specimen should be obtained for gram staining, culture, and sensitivity.
4. Complete blood count with a WBC and differential.
5. Serum electrolytes.
6. Blood urea nitrogen.
7. Serum creatinine.
8. Urine for analysis, gram staining, culture, and sensitivity.
9. Venous blood for culture of facultative and obligate anaerobes, especially if the patient has rigors.
10. Imaging studies, pelvic abdominal ultrasonography or computed tomographic (CT) scan, should be obtained, especially in those patients whose abdomen and pelvis cannot be adequately assessed.
11. If the patient is tachypneic a chest x-ray should be obtained, pulse oximeter placed, and if there is an indication of hypoxia arterial blood gases should be obtained.

Obviously all the items listed Table 5.5 do not need to be obtained. The physician's physical examination should allow for the creation of a differential diagnosis and indicate which tests are needed. Delay in responding to the patient's presentation can result in progressive disease, thereby resulting in more serious morbidity.

Table 5.6 Evaluation of the Vaginal Ecosystem

1. Color of the discharge, a healthy vaginal microflora has a discharge that is white to slate-gray any other color indicates an abnormality is present.
2. Determine the pH of the vagina, a pH of >4.5 indicates an abnormality in the vaginal microflora.
3. If the pH is â‰¥5, a portion of the discharge should be mixed with a drop of potassium hydroxide to determine if a fishlike odor is produced.
4. Microscopic examination of the discharge should be performed; if there is a lack of large bacilli or a variety of bacterial morphotypes are present, this indicates that the vaginal microflora is altered and dominated by pathogenic bacteria.
5. The presence of numerous white blood cells in the vaginal discharge indicates the presence of inflammation and may indicate that there is a pathogen present, for example, *Trichomonas vaginalis, Chlamydia trachomatis, or Neisseria gonorrhoeae.*

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Summary

All patients undergoing vaginal hysterectomy should be evaluated for a history of postoperative infection. A review of all medications being taken by the patient as well as use of over-the-counter medications and herbal agents should be conducted. The patient also should have a thorough evaluation of the vaginal microflora (Table 5.6).

Patients with an abnormal vaginal microflora should be treated and the flora restored to dominance by *Lactobacillus* prior to surgery, if possible. The patient with an abnormal vaginal microflora who is to undergo a vaginal hysterectomy is likely to fail single-dose antibiotic prophylaxis.

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6

Instruments for Vaginal Surgery

S. Robert Kovac

Carl W. Zimmerman

Successful vaginal surgery is dependent on the surgeons' technical competence, an adequate knowledge of vaginal anatomy, good surgical judgment, and the design and quality of the instruments used. Historically, surgeons have taught that instruments developed by Heaney are the proper instruments to use in vaginal surgery. Today there are significantly better tools available that enable the surgeon to accomplish vaginal surgery with greater ease and efficiency. This chapter will introduce the surgeon to a variety of newer and specialized instruments that have been developed for vaginal work.

Marina Medical (Hollywood, FL) has designed a special candy cane-type stirrup (Fig. 6.1) that has been used by the senior author for the last 25 years without one case of neuropathy.

Several types of weighted specula should be available on each vaginal surgery tray. The Nichols Vaginal Retractor (Marina Medical) (Fig. 6.2) may be useful at the beginning of each vaginal operation. This instrument has the advantage of a built-in tract for continuous suction and openings to suture the speculum securely in place, if necessary. Weighted specula with various lengths of the vaginal blade are helpful during a vaginal hysterectomy. The shorter vaginal blade is more useful when considerable uterine prolapse exists because longer blades push the posterior vaginal wall and the cervix away from the vaginal opening. When the surgeon pulls the cervix downward, the speculum may be dislodged from the vagina.

Once the posterior peritoneum has been entered, the placement of an Auvard-Steiner long-bladed speculum, 5 1/2 inches in length and 1 1/4 inches in width (Fig. 6.3), is extremely helpful in the performance of a vaginal hysterectomy, especially when the uterus is significantly enlarged. The extra length and the pelvic curve prevent the speculum from slipping out of the vagina during surgery. The posterior colpotomy should be extended laterally to the rectouterine folds. A sufficiently wide colpotomy will allow insertion of the blade of the speculum and significantly improve exposure. The blade of the weighted speculum will compress the posterior vaginal cuff and help reduce blood loss during the remainder of the procedure.

The cervix should be secured with a vulsellum clamp. Traditionally, a single or double-toothed Schroeder tenaculum has been used (Fig. 6.4). These instruments are highly acceptable. If a greater degree of traction is needed, a Lahey or Gordon 3x3 vulsellum clamp may be used (Fig. 6.5). If difficulty applying the vulsellum clamp is encountered, attach an Allis clamp to the cervix at the 3 or 9 o'clock position. Downward traction pulls the cervix closer to the surgeon and helps to better define cervical anatomy. This maneuver will prevent the cervix from rolling away from the tenaculum during application.

The use of 8 1/2-inch tissue forceps with a rat tooth is highly recommended because of the length and the ability of the instrument to hold tissue (Fig. 6.6). These forceps are most helpful during repairs of the vaginal wall. During salpingo-oophorectomy, vaginal appendectomy, and other deep pelvic procedures, long Singley forceps are desirable for handling intra-abdominal tissues with minimal trauma (Fig. 6.7). Intra-abdominal procedures performed vaginally sometimes require longer instruments.

A Kovac-Kristeller right angle retractor (Marina Medical) (Fig. 6.8) is lightweight and easier to hold during a vaginal hysterectomy than a Heaney right-angled retractor. This retractor can be held comfortably during lengthy procedures with fewer tendencies toward slippage or wandering. Prior to entry into the anterior peritoneum, this type of retractor can be placed into the vesicouterine space before it is placed in the peritoneal cavity. The retractor can be held in place by the assistant with one finger, thereby allowing

the assistant to assist with other maneuvers during vaginal hysterectomy.

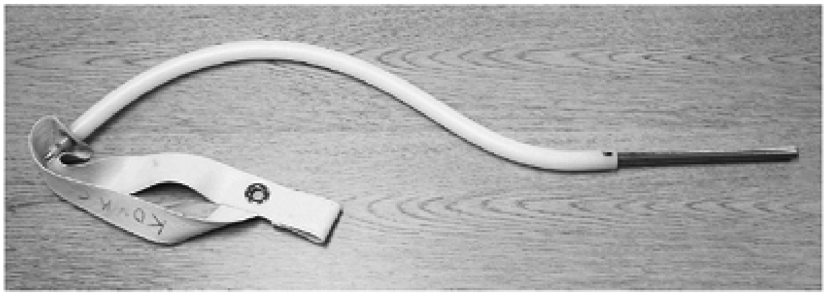

Figure 6.1 Candy cane-type stirrup.

Figure 6.2 Nichols vaginal retractor.

Figure 6.3 Auvard-Steiner long-bladed speculum.

Figure 6.4 Single-tooth Schroeder vulsellum clamp.

Figure 6.5 Triple-toothed Lahey Clamp/triple-toothed tenaculum.

Breisky and Breisky-Navratil retractors (Fig. 6.9) of various width and lengths are ideal for vaginal hysterectomy, oophorectomy, sacrospinous and uterosacral ligament, vaginal vault suspensions, and vaginal paravaginal repairs.

For many years the Heaney clamp with its pelvic curve was considered the appropriate clamp for securing pedicles during vaginal hysterectomy. The pelvic curve of this clamp was actually designed for abdominal hysterectomy. The abdominal surgeon can easily clamp around the cervix with this clamp. It is less helpful to the vaginal surgeon during hysterectomy. *Personal experienceâ€”after many vaginal hysterectomies, I believe the pelvic curve of the Heaney clamp is too acute for clamping the uterosacral and cardinal ligaments, and the uterine artery. The Kovac vaginal hysterectomy clamp (Marina Medical) (*Fig. 6.10*) was developed with less pelvic curve and a rat tooth design at the tip and in the middle of the Zepplin jaws, which are ideal for clamping and holding the ligamentous supports of the uterus. The longer jaws of this clamp are also ideal for simultaneous clamping the uteroovarian and round ligaments and fallopian tube*.

For removal of the ovaries during vaginal hysterectomy the Kovac/MP infundibulopelvic clamp (Marina Medical) (Fig. 6.11)

can be used. Marina Medical has developed a set of four Kovac hysterectomy clamps to give the surgeon more flexibility in choosing the type of pelvic curve desired (Fig. 6.12).

The instruments discussed in this chapter are available from various American and European instrument makers. Marina Medical has designed a special Kovac-Zimmerman vaginal surgery instrument set. This set contains instruments the authors have found helpful in performing all types of vaginal surgery.

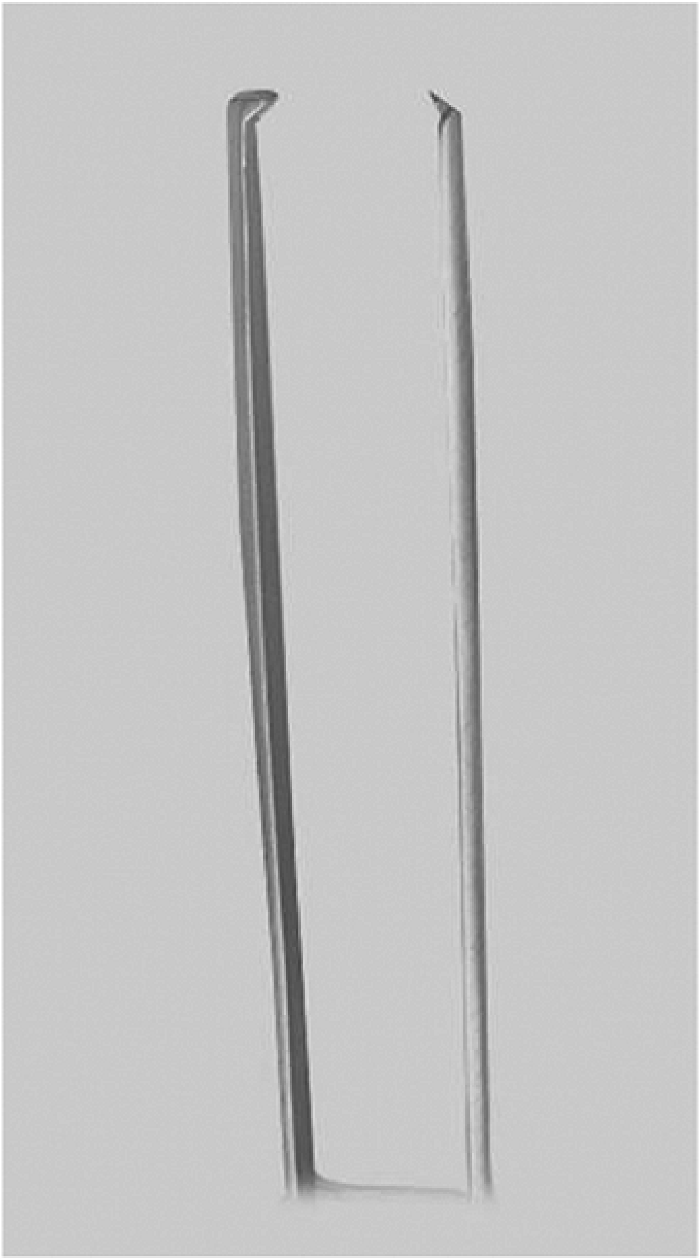

Figure 6.6 8 1/2-inch tissue forceps with rat tooth.

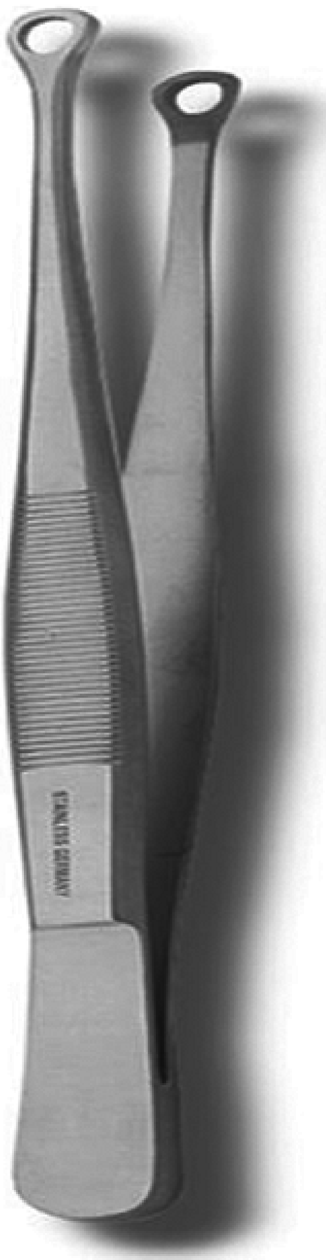

Figure 6.7 Long Singley forceps.

Marina Medical has also created a Zimmerman Myotome Instrument Set specifically designed to assist in removal of the enlarged myomatous or adenomyomatous uterus through the vaginal route. Included in this set of instruments are Martin Cartilage scissors, Lahey and Gordon vulsellum clamps, and Zimmerman myotomes (Figs. 6.13 and 6.14). The myotomes are especially useful in morcellation procedures for enucleating myomas and debulking a large uterus.

In performing reparative vaginal surgery, the use of a Scots retractor (Lone Star Medical Products, Houston, TX) (Fig. 6.15) makes it possible to retract the vaginal epithelium and is invaluable in providing excellent countertraction for dissection and visualization. The retraction is accomplished with tissue hooks and elastic cords attached with variable tension to the frame of the Scots retractor. The frames are available in various sizes and shapes. This alleviates the need for assistants holding numerous Allis type clamps attached to the vaginal epithelium, and frees the assistant's hands to help with the operation rather than passively retract. Dr. Tom Julian, a strong advocate of this retractor, once remarked that this retractor â€œnever falls asleep and never moves during surgery and never gets called to the emergency roomâ€• (*personal communication*). Assistants become more interested in understanding what is being done during surgery when they actively participate in the case.

Yagi-Zimmerman dissection scissors (Marina Medical) (Fig. 6.16) assist the pelvic surgeon in developing the avascular spaces of the pelvis. The tips of these scissors are specifically designed to dissect tissue planes. The Yagi-Zimmerman tips are broader than the Metzenbaum

scissors and narrower than the Mayo scissors. The combination of a precise instrument for incision and a unique push-and-spread dissection tool is useful for the pelvic surgeon. Cottle scissors (Fig. 6.17) are useful for dissection of the vagina during anterior and posterior segment repairs. Sims scissors (Fig. 6.18) aid in cutting the pedicles as their broad points allow for cutting through the various supportive ligaments of the uterus with ease.

Figure 6.8 Kovac-Kristeller retractor.

Figure 6.9 Large Breisky retractors.

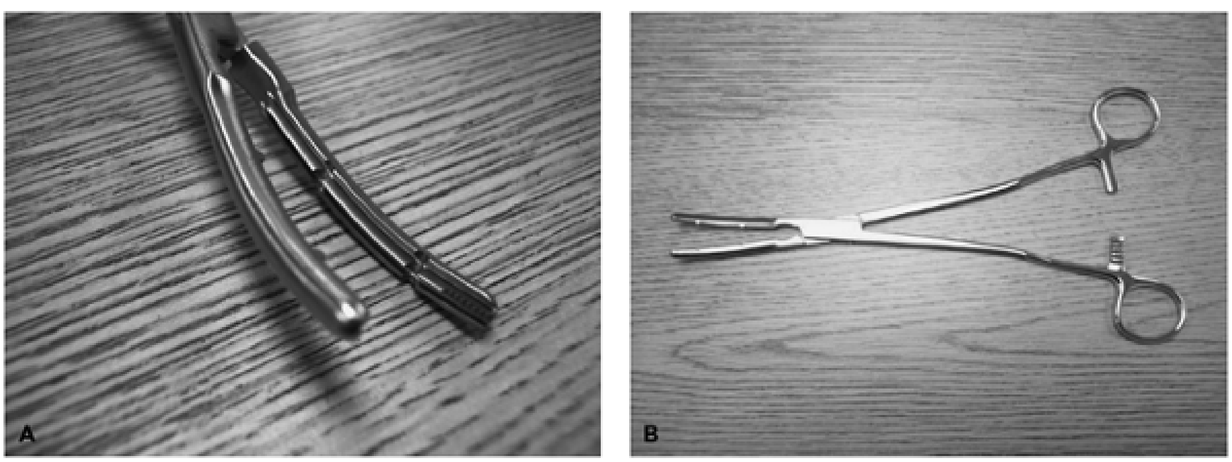

Figure 6.10 Kovac vaginal hysterectomy clamp.

Lighting, irrigation, and suction of the vaginal operative field are constant technical challenges. Especially deep in the pelvis, the vaginal surgeon frequently operates with suboptimal illumination and a limited ability to irrigate. Pooling of blood is also a recurring problem. The ability to easily control these functions speeds the surgery and removes a major impediment to accomplishing the surgery vaginally. For several years, the VitalVue (Tyco Healthcare, Greenwich, CT) has been a useful device. This instrument is a lighted, suction, irrigation tool manufactured in the shape of a Yankauer suction device. The irrigation function allows the surgeon to adequately lavage the vaginal operative field. Irrigation is at least as important in vaginal

surgery as in abdominal or laparoscopic procedures. A newer device is the VersaLight (Lumitex Inc, Strongville, OH) (Fig. 6.19). This instrument also possesses lighting, suction, and irrigation capabilities. The bright cool light is not incandescent and has a superior ability to assist the surgeon with illumination. The light source is extremely bright and the suction/irrigation more efficient. Some vaginal surgeons prefer a head light. These lights tend to be difficult to adjust, uncomfortable to wear, and are not as versatile as a hand-held device.

Figure 6.11 Kovac/MP infundibulopelvic clamp.

Figure 6.12 Kovac clamps.

Figure 6.13 Chisel-tipped Zimmerman myotome.

Figure 6.14 Spoon-tipped Zimmerman myotome.

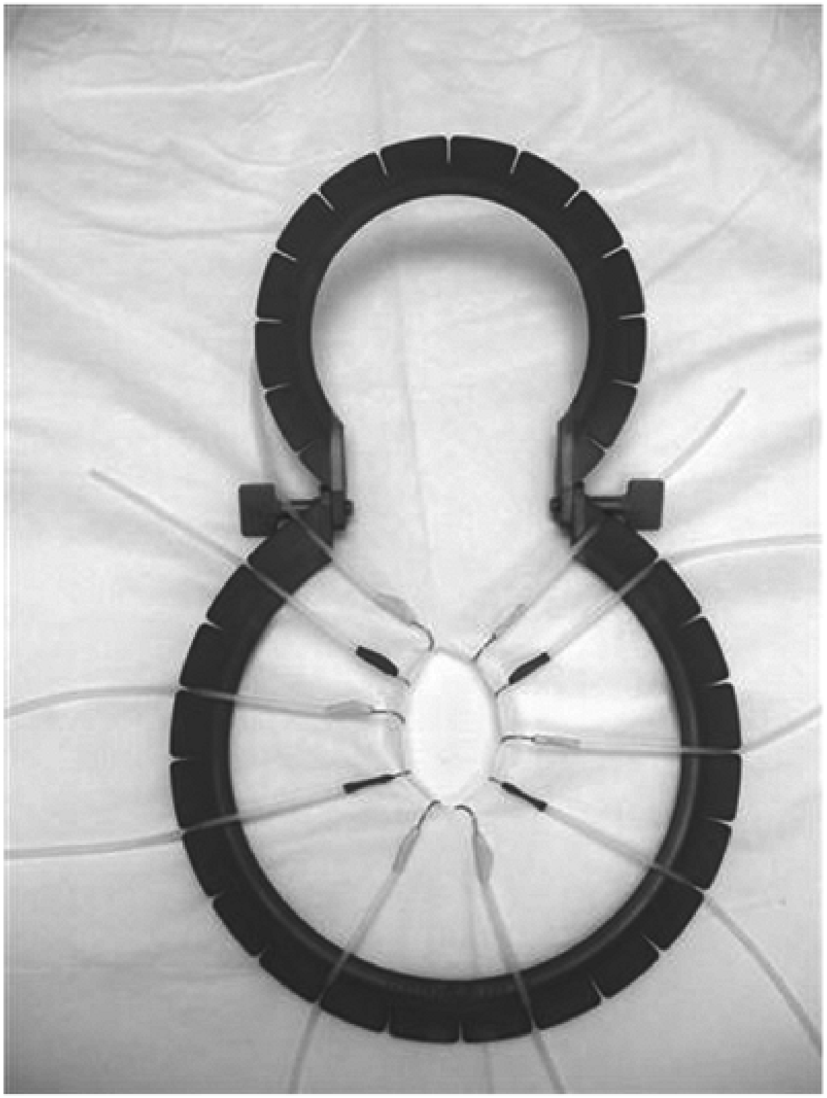

Figure 6.15 Scots retractor.

In the chapter on vaginal hysterectomy, new sutureless technology is discussed. This technology includes the linear Endocutter (Ethicon Endosurgery, Cincinnati, OH) (Fig. 6.20). Energy sources such as the harmonic scalpel (Ethicon Endosurgery) (Fig. 6.21), and the LigaSure endoseal (Valleylab, Denver, CO) (Fig. 6.22) replace the need to suture the cardinal ligament and uterine vessels.

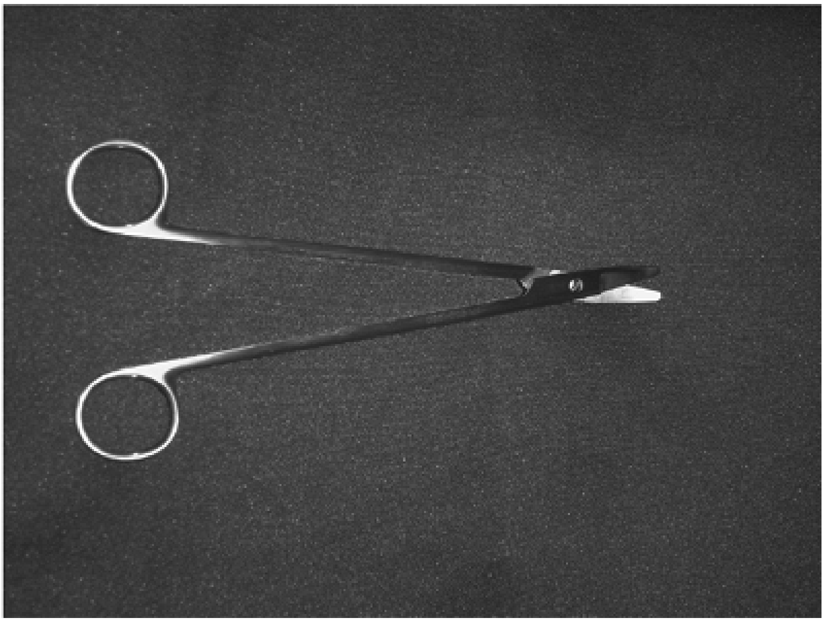

Figure 6.16 Yagi-Zimmerman scissors.

Figure 6.17 Cottle scissors.

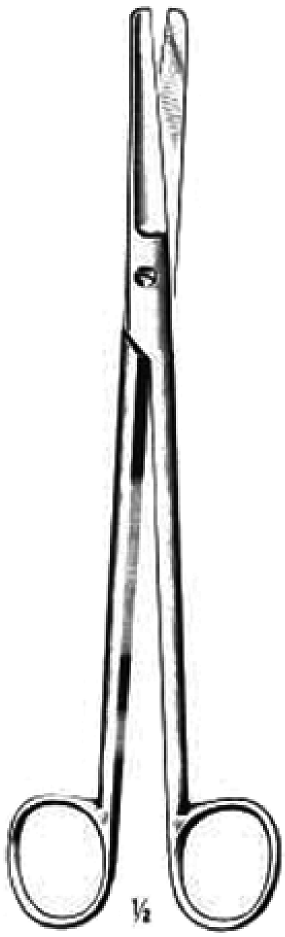

Figure 6.18 Sims scissors.

A vaginal salpingo-oophorectomy using the three-pedicle technique was described by Zimmerman (1). If the surgeon desires, the round ligament and mesovarium can be sealed with the energy sources described previously. The infundibulopelvic ligament may be easily secured with an Endoloop (Ethicon Endosurgery) (Fig. 6.23). Use of the Endoloop allows the surgeon to place a secure tie on this vascular pedicle. Avoiding tension on the infundibulopelvic ligament helps to avoid troublesome bleeding that could lead to a laparotomy.

The Apogee system (American Medical Systems, Monnetonka, MN) (Fig. 6.24) and the IVS Tunneler (Valleylab) (Fig. 6.25) are discussed in Chapters 8 and 17. They are included in this section on instrumentation because of their potential function in prolapse prophylaxis. Both of these technologies place a permanent strip of mesh within the interspinous diameter. This mesh can serve as a neocuff. If the uterosacral ligaments are connected to the mesh, a significant theoretical reduction in the risk for future prolapse occurs. The routine use of these devices to prevent postoperative enterocele and vaginal vault prolapse is currently being studied. Strong consideration should be given to routine insertion of an interspinous bolster when the uterus is removed transvaginally.

Figure 6.19 VersaLight.

Figure 6.20 Linear Endocutter.

Figure 6.21 Harmonic scalpel.

Figure 6.22 LigaSure Atlas.

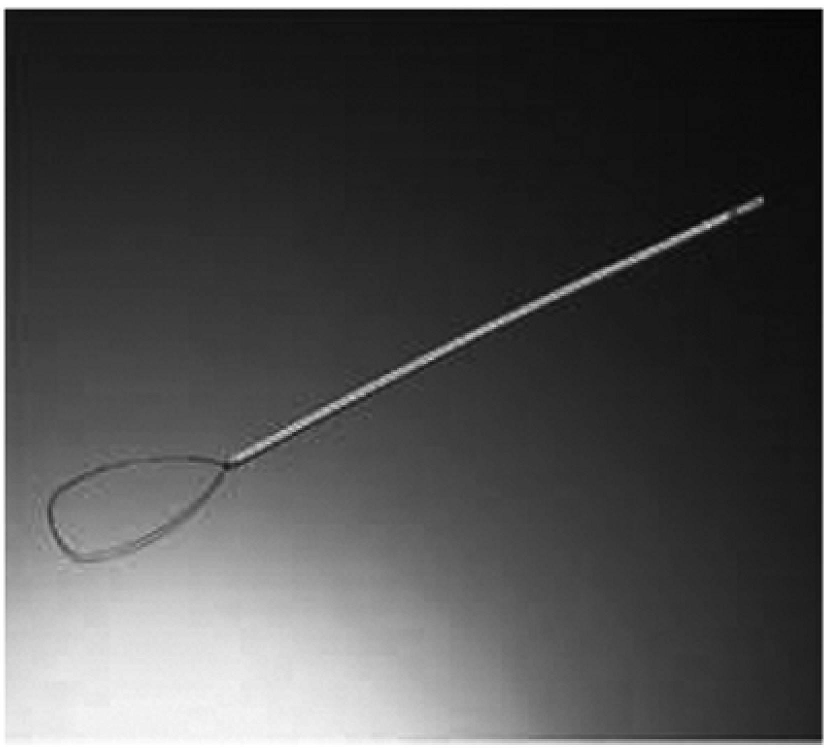

Figure 6.23 Endoloop.

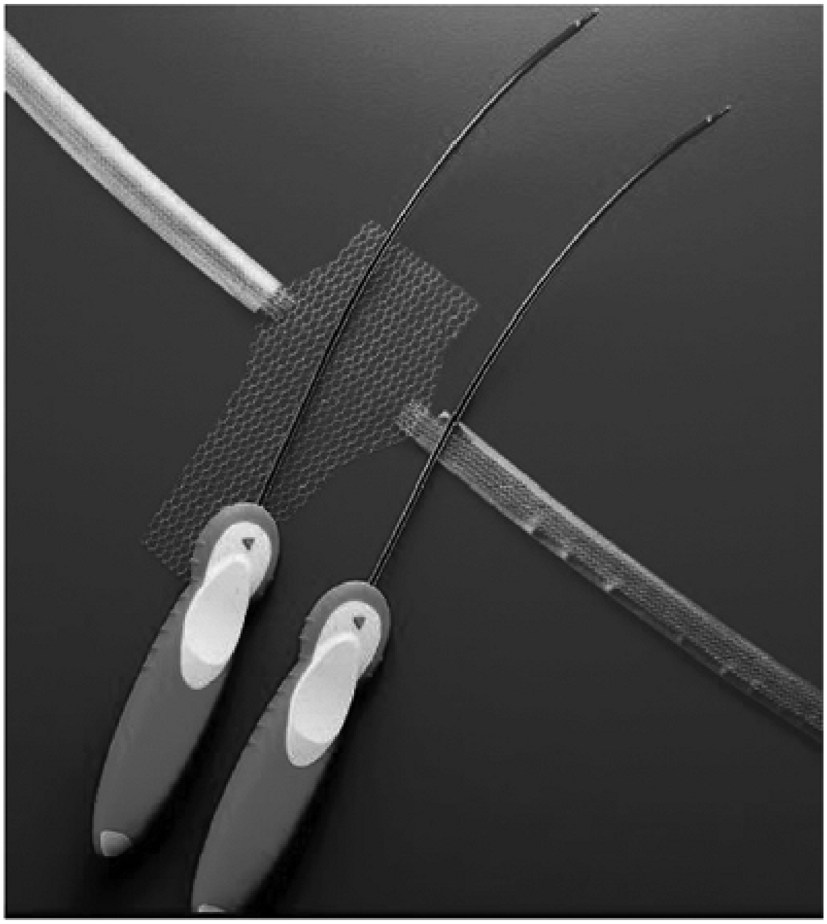

Figure 6.24 The Apogee system.

Figure 6.25 IVS tunneler.

Performing vaginal surgery on obese patients has many advantages but also presents difficulties because of the increased body mass index (BMI). A vaginal Bookwalter retractor (Marina Medical) can overcome some of the problems associated with obesity. This retractor has numerous blades of varying length and width for vaginal retraction (Fig. 6.26).

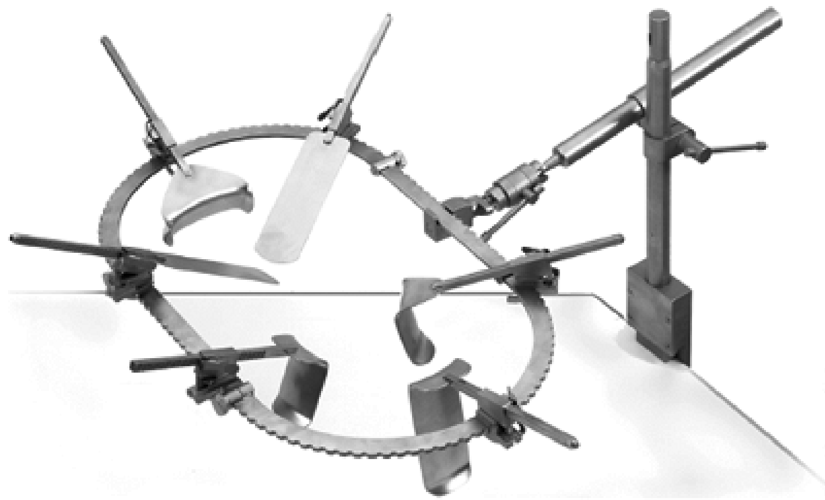

Figure 6.26 Vaginal Bookwalter retractor.

Well-designed instruments will help surgeons elevate their skill level. Operative time can be decreased, complications reduced, and recovery of the patient hastened by quality instrumentation. Every pelvic surgeon should be familiar with the best tools available to help in the performance of vaginal surgery.

Reference

1. Zimmerman CW. Oophorectomy at vaginal hysterectomy. *OBG Management.* 1999;11:50â€“57.

Editors: Kovac, S. Robert; Zimmerman, Carl W.
Title: *Advances in Reconstructive Vaginal Surgery, 1st Edition*

7

The Use of Graft Materials in Gynecologic Surgery

Thomas M. Julian

Graft materials are used in surgery when there is insufficient or inadequate native tissue to repair an anatomic defect. Reports of graft materials in gynecologic reparative surgery date back more than 70 years, with the first reconstructive graft material being autologous fascia lata for suburethral sling surgery (1). The modern age of surgical graft materials began about 40 years ago, when monofilament-knitted polyethylene mesh to lessen tissue tension over a standard hernia repair was described. It is estimated that at present 85% to 95% of hernia repairs in the United States are performed using a synthetic mesh graft (2).

Current graft materials used in gynecologic surgery include autografts, cadaveric allografts, non-human xenografts, and synthetic meshes made from several materials including polypropylene, polyester terephthalate, expanded polytetrafluoroethylene, polyglycolic acid and polyglactin. These materials are used to perform mainly three gynecologic operations-suburethral sling, vaginal vault suspension, and reinforcement of vaginal reparative operations, traditionally performed as simple colporrhaphy. The evidence for success and failure of these graft materials will be discussed.

Properties of an Ideal Graft Material

An ideal graft material should be readily available in multiple sizes and shapes, handle easily, conform to *in situ* structures, incorporate into native tissue, restore the integrity of the grafted structure, resist infection, and provide a permanent repair. No present surgical graft material has been shown to be ideal. It, therefore, becomes a matter of examining existing evidence to determine which, if any, of the existing graft materials is beneficial in pelvic reparative surgery.

Biomechanical Properties of Graft Materials

The relationship of the biomechanical properties of graft material to the success of anti-incontinence surgery is unknown. It would seem logical that graft materials should have a certain basic strength and distensibility. Choe et al. studied graft materials commonly used suburethral sling surgery for stress urinary incontinence to determine whether the materials had significantly different tensile strengths and distensibility, and whether the type of sling (full-length or patch graft) would affect those properties (3).

When comparing autologous tissues (dermis, rectus fascia, and vaginal epithelium), cadaver tissues (decellularized dermis and freeze-dried, gamma-irradiated fascia lata), and syntheti meshes [polypropylene (PPM), polytetrafluoroethylene (PTFE)], the authors found that the tensile strength for full-length grafts was significantly greater than for patch grafts. Full-length cadaveric sling fascia lata tolerated the greatest load to failure (217 N), with cadaveric dermis, PTFE, and PPM, showing load tolerances of 144 to 122 N, respectively. Rectus fascia and vaginal wall epithelium tolerated maximum loads of only 42 N. In rank

P.72

order for the patch grafts, the synthetic materials (PTFE 76 N, PPM 63 N), and dermal tissue (autograft 75 N and allograft 68 N) had the highest tensile strength, followed by cadaveric fascia lata, rectus fascia, and vaginal epithelium (58 N, 38 N, and 21 N, respectively). The authors concluded that autologous rectus fascia and vaginal epithelium were inherently weaker than other materials, and that when a patch graft is constructed from autograft or allograft tissues, the risk of material failure would appear to be even greater.

Dora et al. implanted human cadaveric fascia, porcine dermis, porcine small intestine submucosa, PPM mesh, and autologous rectus fascia in a rabbit model to compare variations in tensile strength, stiffness, shrinkage, and distortion over time (4). After animals were killed, human cadaveric fascia and porcine allografts showed a marked decrease (60% to 89% in tensile strength and stiffness from baseline. PPM and autologous fascia did not differ in tensile strength from baseline; PPM increased in stiffness from baseline. Autologous fascia and small intestinal submucosa demonstrated a 41% and 50% decrease in surface area, respectively. The authors indicated that the data suggested the importance of considering synthetic graft material for anti-incontinence surgery.

The Use of Non-synthetic Graft Materials in Gynecologic Reparative Surgery

Autografts

Autologous tissues are appealing as grafts because they should be 100% biocompatible. The disadvantages of autografts are that they require additional surgery for harvest, thereby increasing operating time and morbidity, mostly as pain from additional incisions and intraoperative and postoperative complications at the donor harvest site.

There is only a single study in the gynecologic literature examining autograft morbidity to any significant degree. In a post-pelvic reconstructive surgery survey evaluating donor site morbidity over a 54-month period, with a mean 25-month follow-up, Walter found in the 71 patients studied that immediate postoperative complications were limited to one hematoma requiring drainage, 2 (3%) seromas, and 5 (7%) cellulitis cases requiring oral antibiotics (5). Of survey responders 22 (40%) reported mild adverse symptoms, 3 (6%) clinically significant symptoms, and 7 (13%) unacceptable symptoms, and 5 (9%) with unacceptable cosmesis. The authors concluded this was acceptable morbidity considering the reparative results. Others might conclude this rate of total morbidity (40%) was unacceptably high. It may also be the case that many gynecologists may not wish to develop the skills or assume the risks associated with autograft harvest.

Comparing Autograft and Cadaveric Allograft for Suburethral Sling Surgery and Modified Colporrhaphy

Flynn and Yap reviewed 134 consecutive women who underwent identical pubovaginal sling procedures (71 autografts and 63 allografts) (6). There was no statistical difference in the overall cure rates but, as expected, using allografts instead of autografts resulted in significantly decreased postoperative pain and disability.

Brown and Govier compared 121 consecutive women who underwent a cadaveric fascia lata suburethral sling (group 1) with 46 consecutive women who had the same procedure using autologous fascia lata (group 2) (7). Unfortunately, mean follow-up was longer in the second group, 44 versus 12 months. One hundred and four of the 121 group 1 patients (86%) responded to the questionnaire; about 85% considered themselves cured of stress incontinence and would recommend the surgery to others. Thirty of the 46 patients (65%) in the autologous fascia lata group responded to the questionnaire; 90% reported overall improvement in urinary control and 73% had no or minimal leakage not requiring pads. Overall 90% of the women were satisfied with the results and 83% would recommend the surgery to others. The authors concluded that cadaveric fascia lata is an effective alternati to autologous fascia.

In a second retrospective case-control study comparing autologous rectus fascia with cadaveric fascia lata in the treatment of urinary stress incontinence with intrinsic sphincter deficiency (ISD) with pubovaginal slings, autologous rectus fascia was used in 33 patients an cadaveric fascia lata was used in 12 patients. Treatment was successful in 78.8% and 33.3% o patients who underwent autologous rectus fascia and cadaveric fascia lata allograft slings. Based on regression analysis, the type of sling material used was strongly associated with th success of the surgical outcome after controlling for all confounding variables ($p < 0.00005$). The authors concluded that fascia lata allografts are a poor choice for pubovaginal slings (8

Dermal Autograft Rectocele Repair

More than 20 years ago, Oster and Astrup described using a dermal autograft in 15 women undergoing rectocele repair (9). The 15 women, ages 48 to 79 years, underwent removal of 15 Ã— 7-cm strip of skin from their thigh, which was implanted under the vaginal epitheliun after standard posterior colporrhaphy. When the patients were examined 1 to 4 years after surgery, the authors state the results were â€œperfectâ€• in 14 patients.

Cadaveric Allografts in Reparative Gynecologic Surgery

To overcome the issues associated with autograft harvest and avoid perceived problems wit synthetic materials, many surgeons use banked cadaveric tissues (allografts) or processed animal tissues (xenografts) as grafts. Allograft and xenograft materials are readily available do not require operative harvesting, and are processed to decrease tissue reactivity. For th performance of suburethral sling surgery with cystocele repair or rectocele repair, several reports with short follow-up show good success rates with allografts and xenografts; others do not. Some suggest the method of preparation is the difference.

Properties/Surgical Outcomes of Cadaveric Allograft Materials Based on Preservation Methods: Freeze-dried versus Solvent-dehydrated and Irradiated versus Non-irradiated Cadaveric Fascial Grafts

Several authors have suggested that the method of tissue processing may weaken the tensil strength of allograft slings. In a laboratory study, Lemer et al. compared the tissue strength and stiffness of autologous rectus fascia to two groups of commercially available cadaveric fascia lata commonly used in pubovaginal sling surgery, one freeze-dried and the other solvent-dehydrated, and commercially available cadaveric dermal grafts (10). There were r differences in strength or stiffness among autologous rectus fascia, solvent-dehydrated fasc lata cadaveric and dermal grafts. But tissue strength and stiffness were less in freeze-dried cadaveric fascia lata.

In a clinical comparison of freeze-dried, non-irradiated cadaveric fascia allografts in suburethral sling surgery for urinary incontinence in 104 women assessed by urogynecologic questionnaire, pad usage, and disease-specific quality-of-life questionnaires, Amundsen et a found 87% of the responders indicated that urinary incontinence was not substantially affecting their daily life (11). The authors concluded that the use of freeze-dried allograft pubovaginal sling provided good results without adverse outcomes.

FitzGerald et al., studying freeze-dried, gamma-irradiated, cadaveric allograft material in sacrocolpopexy and suburethral sling procedures, reported increased late recurrences of vault prolapse and urinary incontinence with the use of irradiated and freeze-dried cadaver fascia lata in 67 abdominal sacrocolpopexy and 35 suburethral sling urethropexies over 2 years (12). Twelve of the surgical failures underwent re-operation. In six, there was no visible remaining cadaveric fascia lata graft, and in the other six the graft showed histologic autolysis, suggesting a graft-versus-host reaction.

Carbone et al. reported 154 consecutive patients who underwent a bone-anchored, cadaver fascia pubovaginal sling procedure by a single surgeon (13). These patients were followed a average of 10.6 months and surveyed by mail and telephone interviews; 58 (37.6%) had recurrent moderate to severe (grades 2 to 3) stress urinary incontinence. Twenty-six patien underwent a second pubovaginal sling procedure, and all cadaveric allograft fascia used in the first procedure was found to be fragmented, attenuated, or absent. The authors reporte abandoning the use of cadaveric fascia allografts in pubovaginal slings. Flynn and Yap in the previously described study found no difference between autograft and freeze-dried cadaver allograft, with good results in each group having identical pubovaginal slings for urinary stre incontinence (Table 7.1)(6).

Flynn and Yap, 2002 (6)
71 autograft

63 allograft

44

19

77 cured

71 cured

Materials are equivalent

Brown and Govier, 2000 (7)

46 autograft

121 cadaveric

12

44

90 cured

85 cured

Materials are equivalent

Soergel et al., 2001 (8)

33 autograft

12 cadaveric

6

79 cured

33 cured

Cadaveric fascia a poor choice for repair

Carbone et al., 2001 (13)

154 cadaveric

10.6

37.6 recurrent mod/severe SUI

Abandoned cadaveric fascia grafts

SUI, stress urinary incontinence.

Author	No. Subjects and Material	Length of Follow-up (mo)	Cured or Improved (%)	Author Conclusions

Table 7.1 Autograft Versus Cadaveric Allograft for Suburethral Sling Repair of Sui

To measure *in vivo* characteristics of donor fascia in a canine model, comparing radiated an non-radiated freeze-dried cadaveric fascia, FitzGerald et al. performed sub-urethral sling and sacrocolpopexy, each operation done on five dogs (14). Dogs were killed at 2, 6, and 12 weeks after graft implantation. Grafts were retrieved and tested with. In a second experiment, non-irradiated fascia was placed as a sacrocolpopexy graft in eight dogs. Half the grafts were placed under tension and half under no tension

and the grafts were later tested with tensilometry. The authors found in the first experimer that 23% of grafts lost all strength, and there appeared to be no relation to radiation. In the second experiment grafts placed under tension tended to be stronger rather than weaker as one would expect.

A total of 18 women (mean age 51.7 years) underwent pubovaginal sling surgery for stress urinary incontinence with solvent-dehydrated gamma-irradiated cadaveric fascia lata. The results were collected with a questionnaire survey and patients were followed for a mean of 9 months. Thirteen patients considered the surgery either successful or to have provided satisfactory improvement. Five patients (27.8%) had significant failure with recurrence of incontinence within 3 to 6 months. The authors conclude solvent-dehydrated gamma-irradiated allograft fascia to be not reliable as a graft in pubovaginal sling surgery (15).

Allografts in Transvaginal Reparative Surgery

Solvent-dehydrated cadaveric dermal allograft was used to augment surgical repairs in 21 consecutive women with severe cystocele. The graft was anchored bilaterally to the arcus tendineus and the cardinal and uterosacral ligaments. Six patients with overt or occult urinary sphincteric incontinence underwent concomitant pubovaginal sling surgery using the same material. The mean follow-up was 20 months.

No postoperative complications related to the material or technique occurred. None of the patients developed a recurrent cystocele. Of the 13 patients having concomitant pubovagin sling procedures for overt sphincteric incontinence, all but two were continent at follow-up The authors found the use of solvent-dehydrated cadaveric fascia lata for cystocele repair and pubovaginal sling surgery to be encouraging (16).

Nineteen patients with combined stress urinary incontinence and grade III cystocele had reparative surgery with a single piece of cadaveric dermal allograft placed in a longitudinal direction beneath the anterior vaginal epithelium. The distal segment of the allograft supported the urethra, and the proximal portion supported the central cystocele defect. On patient developed an acute infection and failure of the graft after presenting with fever, discharge, dysuria, and incontinence. Of the remaining 18 patients, 17 were cured of their urinary incontinence, including 10 who had prior repairs. Sixteen had no recurrence of cystocele and 2 had asymptomatic grade I and II cystoceles (17).

Using cadaveric fascia lata for cystocele repair and pubovaginal sling, Kobashi et al. described 50 patients, ages 37 to 90 years, who underwent a procedure using a single piece of cadaveric fascia anchored to the pubic bone with bone anchors, secured to the medial edge of the levator muscles and pubocervical fascia bilaterally and sewn to the vaginal cuff or cervix with absorbable suture (18). After the procedure, 36 (72%) women had complete urinary continence; none suffered recurrent prolapse. The authors concluded that transvaginal placement of cadaveric fascia for concomitant sling and cystocele repair provides excellent strength for the repair (Table 7.2).

The Use of Xenograft Materials in Gynecologic Reparative Surgery

Acellular collagen xenografts include those derived from porcine small intestinal submucosa porcine dermis, and bovine pericardium. The grafts are specially processed to decrease antigenicity and any chance of trans-species infection.

The intestinal submucosal graft and bovine pericardium graft serve as an extracellular matri material and are biodegradable. These materials in theory serve as a scaffold so that blood vessels and cells grow into the matrix, new tissue is formed, and the matrix graft material gradually disappears. The specially processed glutaraldehyde cross-linked porcine dermis is permanent or semi-permanent graft but also serves as a matrix for cellular in growth.

Cadaveric dermis (Groutz et al., 2002)[a]

21

Suburethral sling, cystocele repair

20

90, 100

Cadaveric dermis (Chung et al., 2002) (7 ,17)

19

Suburethral sling, cystocele repair

Materials (Authors)	No. Patients	Procedure	Length of Follow-up (mo)	Cure (%)
			6	89, 84
Cadaveric fascia lata (Kobashi et al., 2000) (18)	50	Suburethral sling, cystocele repair	6	72, 100
Cadaveric dermis (Kohli et al., 2003)[b]	30	Rectocele repair	12	93

[a] Groutz A, Chaikin DC, Theusen E, et al. Related Articles, Use of cadaveric solvent-dehydrated fascia lata for cystocele repairâ€“preliminary results. Urology. 2001;58:179â€“183.

[b] Kohli N, Walsh PM, Roat TW, et al. Related Articles, Mesh erosion after abdominal sacrocolpopexy. Obstet Gynecol. 1998;92:999â€“1004.

Table 7.2 Cadaveric Allografts in Pelvic Reparative Surgery

Porcine intestinal submucosa has been reported for suburethral sling placement in 300 women with a cure or

improvement rate of up to 93% (19 ,20). In an *in vivo* hernia repair model using large dogs, small intestine submucosa was used to repair bilateral pelvic diaphragm defects created by complete excision of the levator ani muscle. Some dogs had one side repaired using the sma intestine submucosa (SIS) and the other repaired by transposition of the obturator internus muscle. There were two control animals for comparison.

After the animals were killed and biomechanical testing was performed, there were no significant differences in maximum pressure to induce failure, displacement, or stiffness when comparing normal tissue, intestinal submucosa, and obturator transposition groups. Tl intestinal submucosa group had significantly less displacement (p = .004) at 2 weeks than at weeks 12 or 16. For all herniorrhaphy techniques, the failure site was central (n = 22) or at the suture line (n = 2). Histologic examination at 12 and 16 weeks showed no microscopic differences in cell population or tissue characteristics between the two repair groups. This study suggests that SIS can be used as a primary means of repair, as augmentation when the internal obturator muscle is thin and friable, or as a salvage procedure in cases of recurrenc in dogs with perineal hernia. The results do not necessarily generalize to humans (21).

In a second canine study, the response to intestinal submucosa was evaluated in a 2-year study of body wall repair in dogs and rats. The intestinal submucosa was compared to three other commonly used materials-PPM, polyglycolic acid mesh, and bovine pericardium. Measurements were made of tissue consistency, polymorphonuclear cell response, mononuclear cell response, tissue organization, and vascularity at 1 week as well as 1, 3, ar 6 months, and 2 years after implantation.

All materials performed well to repair large ventral abdominal wall defects created in these animals. The intestinal submucosa bioscaffold showed a greater number of polymorphonuclear leukocytes at 1 week after the procedure and a greater degree of graft site tissue organization after 3 months compared to the other three synthetic materials.

There was no evidence of local infection or other detrimental local pathology to any of the graft materials at any time. The authors concluded that like the synthetic materials, the intestinal submucosa was an effective bioscaffold for long-term repair of body-wall defects. Unlike the other scaffold materials, well-organized host tissues replaced the resorbable intestinal submucosa scaffold (22).

Arunkalaivanan and Barrington randomly assigned 142 women with genuine stress incontinence to either pubovaginal sling repair with glutaraldehyde cross-linked porcine dermis (Pelvicol Implant; Bard, UK) (n = 74) or PPM as a tension-free suburethral sling (TVT; Gynecare, Somerville, NJ) (n = 68) (23). These patients were followed for 6 to 24 months ar 109 procedures were carried out in an outpatient surgery unit. Eighty-one percent of PPM ar 77% of the porcine implant patients were able to void urine within 24 hours and had low residual bladder volumes. Postoperative voiding dysfunction was present in 3.4% of the synthetic mesh and 1.4% of porcine implant recipients. Nine percent of the PPM and 6% of tl porcine dermis group developed *de novo* urge incontinence. By questionnaire the subjective PPM cure rate was 85% and 89% in the porcine implant group.

De Ridder described repair of a grade III cystocele using a modified Raz procedure and eithe polyglactin mesh (*n* = 30) or porcine dermal graft (24). At a mean follow up of 9.3 months, there were no recurrences, erosions, or infections in the porcine dermis graft group and three recurrences in the polyglactin mesh group.

Salomon et al. assessed the efficacy of porcine skin collagen (Pelvicol) implant placed by th trans-obturator route in combination with bilateral sacrospinous ligament fixation to treat anterior vaginal wall prolapse in 27 women with stage III or IV prolapse (25). There were no intraoperative or postoperative complications. Median follow-up was 14 months (range 8 to 24 months). No rejection of the porcine grafts occurred. Twenty-two women (81%) had â€œoptimal anatomic results.â€• The remaining five women (19%) had persistent asymptomatic stage I or II anterior vaginal wall prolapse. One implant was removed at one year because of persistent pain. One patient with good results initially had recurrent stage I point Ba prolapse at 18 months. Quality of life scores improved significantly. The authors fe transobturator porcine dermal implant is a safe and effective treatment for anterior vaginal wall prolapse (Table 7.3).

Erosion of Cadaveric Allograft Material in Sacrocolpopexy and Suburethral Sling Surgery

Despite the common perception that cadaveric materials do not erode, Kammerer-Doak reported vaginal erosion of cadaveric fascia lata used for abdominal sacrocolpopexy and suburethral sling urethropexy (26). In 47 cases of abdominal sacrocolpopexy or suburethral sling, 32 utilized cadaveric fascia lata, with 11 for sacrocolpopexy and 22 for suburethral sling. Vaginal erosion of the cadaveric fascia lata graft was noted in 5 (23%) following sling procedures and 3 (27%) following sacrocolpopexy diagnosed a mean of 37 days following surgery.

The women with erosion were treated conservatively with estrogen vaginal cream and both vaginal and oral antibiotics. Four of the 8 (50%) underwent excision of the exposed graft anc reapproximation of the vaginal edges under local anesthesia. The other four responded to medical therapy alone. None of the patients experienced recurrence of vaginal vault prolap or urinary incontinence following graft erosion and treatment. The authors indicated that vaginal erosion of cadaveric fascia lata for abdominal sacrocolpopexy and suburethral sling occurred in 25% of patients and believed this process may have an infectious etiology. Conservative treatment with antibiotics and estrogen was effective for half, but removal of exposed graft was necessary in the remainder.

Table 7.3 Pelvicol Porcine Dermal Graft in Pelvic Reparative Surgery

Author	Procedure	No. of Patients and Length of Follow-up (mo)	Results (%)	Complications (%)
Arunkalaivanan and Barrington, 2003 (23)	Porcine sling vs TVT	72 vs 68, median 12 mo	89% cure vs 85% cure	3.4% vs 9% de novo urge incontinence
Kohli and Miklos, 2003[a]	Reinforce rectocele repair	30, 12.9 mo	93% cure	none
De Ridder, 2002 (24)	Porcine vs polyglactin graft, grade III cystocele	28 vs 30	100% vs 90%	none
Salomon et al., 2004 (25)	Transobturator cystocele repair	27, median 14 mo	81% cure	1 patient, 3.7% persistent pain

[a] Kohli N, Miklos JR. Related Articles, Dermal graft-augmented rectocele repair. *Int Urogynecol J Pelvic Floor Dysfunct.* 2003;14:146â€“149.

Synthetic Graft Materials

All synthetic graft materials are readily available in any size needed and have adequate tensile strength. They differ as to composition, construction, pore size, and elasticity. The oldest materials include Marlex (C. R. Bard, Covington, RI) and Prolene (Ethicon, Somerville NJ), which are woven PPM, monofilament meshes. Mersilene (Ethicon) is a multifilament polyester woven mesh. PTFE (Gore-Tex, W. L. Gore & Associates, Phoenix, AZ) is a nonwove material chemically related to Teflon (DuPont, North America) and is relatively nonporous.

PPM is a strong, nonabsorbable material that is highly elastic and withstands infection. The first monofilament weave of PPM was used in hernia repair in the late 1950s. The original PPM configuration is still in use, but on a largely theoretical basis the weave has been made looser and the material resulting is more flexible, softer, and more distensible. Clinically no difference has been shown in outcomes based upon these material changes. Loose-weave PPM mesh is now the most widely used mesh in gynecologic surgery because of its use in the placement of tension-free suburethral slings.

PPM demonstrates a relatively small inflammatory response with less foreign-body reaction than polyester mesh. The surrounding tissue incorporates PPM within 2 weeks of implantatic with greater fibroblastic reaction than polyester or PTFE. This reaction causes integration o the mesh but increases adhesion formation. Adhesion formation probably becomes a negati attribute only when mesh is exposed directly to bowel or when a graft must be removed secondary to infection, pain, or symptomatic erosion. Differences in pore size and structure of synthetic meshes have no clinical evidence to support the use of one over another with tl exception of PTFE, which has very small pore size and, in several series, unacceptably high erosion or rejection rates.

Polyester mesh, introduced about 30 years ago, is supple, elastic, conforms well to surrounding tissue, and has a grainy texture. It is sufficiently reactive to induce rapid fibroblast response to ensure fixation and seems to have a low complication rate.

PTFE was initially developed as a small-caliber vessel prosthetic. It has greater flexibility than PPM. In 1993, PTFE was changed to a different texture and porosity to try to obtain more investiture of material into native tissue and is commonly referred to as ePTFE becaus of this change. PTFE is also offered in a dual sided (composite) mesh (DualMesh$_{TM}$, Gore-Te with one porous side to encourage tissue incorporation and one side to prevent adhesion formation. PTFE has minimal inflammatory reaction and adhesion formation and is not incorporated into surrounding tissue. It has been used as a barrier to adhesion formation. Efficacy as an adhesion barrier was proven by second-look laparoscopy, but the follow-up period was less than 6 weeks (27).

There are no clinical studies showing that pore size is a critical factor in choosing the type c mesh to be used for grafts. Theoretical disadvantages of multifilament and nonwoven meshe are that intrafiber pores are <10 microns, allowing small bacteria to enter but preventing macrophages and polymorphonuclear leukocytes from passing through. These events are thought to be important, not only for preventing infection, but also for forming fibrous connections to the surrounding tissues (28).

Pourdeyhimi felt that the lack of incorporation of PTFE is caused by its chemical properties and not the pore size (29). It is also difficult to determine the exact size of the pores of most meshes because, depending on the technique for examination, the pore sizes reported in the literature vary from one publication to another. Bobyn et al., in a 1982 study, found that the best tissue infiltration occurs with pore sizes between 50 and 200 microns (30). Th monofilament PPM, therefore, should have the greatest degree of incorporation into tissue and PTFE the least, which clinically seems to be the case. There are no prospective randomized controlled trials

comparing different mesh materials for any gynecologic surgical procedure.

Marlex Mesh in Clinical Use

Marlex mesh has been used for 30 years in performing suburethral sling operations for incontinence. There are several long-term studies reporting subjective cure rates, ranging from 80% to 100% (31 ,32 ,33). Morgan described urethral erosions in 12/284 (4%) patients (32). Ten of these 12 patients had also undergone urethral reconstruction before the suburethral sling placement. The erosion rate for PPM suburethral slings is generally reporte as 3% to 15%. Synthetic mesh erosion is generally unresponsive to conservative local topical measures and requires minor trimming of the mesh or, in a few cases, removal (34).

Marlex Mesh for Sacrocolpopexy

Marlex mesh has been used for abdominal sacrocolpopexy in several series with moderate tc long-term follow-up. Drutz and Cha reported, with an average 28-months follow-up, a 93% cure rate, no erosion, and only one serious complication (35). Iosif, who followed 40 patien from 1 to 10 years, reported a 97% cure with 25 Marlex and 15 PTFE sacrocolpopexy suspensions (36); one draining sinus occurred. Kohli et al. reported 57 sacrocolpopexies usi

Marlex mesh in 47. (37). Five patients (11%) had mesh erosion requiring transvaginal remova at 20 months follow-up. The risk for vaginal erosion was not increased by the performance c an abdominal hysterectomy at the time of sacrocolpopexy in any of these series.

Marlex Mesh for Transvaginal Reparative Surgery

Julian reported the reparative outcome of 24 patients with large, multi-recurrent cystocele (38). Twelve patients received anterior colporrhaphy, transvaginal paravaginal defect repair, and needle urethropexy without mesh, and 12 patients had the same procedure with reinforcement of their anterior vaginal wall with Marlex mesh all done by the transvaginal route. Four patients without mesh had recurrent cystoceles (33%). None of the mesh group had recurrent cystocele. Three (25%) patients had mesh-related complications of erosion presenting as persistent granulation tissue with spotting, or painful intercourse for the partner secondary to fiber perforation. All complications resolved with trimming of the mes

Flood et al. reported 142 patients with Marlex mesh reinforcement of a standard cystocele repair with a mean follow-up of 3 years. There was no recurrent anterior wall prolapse. Three patients (2%) had graft erosions, and the success rate for cure of urinary stress incontinence was 74% (39).

Watson et al. repaired posterior vaginal wall defects with Marlex mesh in nine women with large rectoceles who required preoperative perineal splinting for defecation (40). With mea follow-up of 29 months, eight (89%) achieved successful defecation after surgery, and no erosion of the graft through the vagina or rectum was reported.

Sullivan described an extensive repair technique using Marlex mesh to restore the pelvic flo of women with pelvic organ prolapse (41). The mesh was secured between the perineal boc and the sacrum. Two additional strips, attached to the first, were tunneled to the pubis anc supported the lateral vagina and bladder. Candidates for this transabdominal procedure hac failed previous standard repair or manifested combined pelvic organ prolapse on physical ar cystodefecography examinations.

Two hundred thirty-six women had total pelvic mesh repair, and 205 (87%) were available fc follow-up. Bladder protrusion, vaginal protrusion, or both, were the predominant chief complaint (54%), followed by anorectal protrusion (48%). Physical examination showed degrees of prolapse of rectum (74%) and vagina (57%), perineal descent (63%), enterocele (47%), and rectocele (44%).

Reoperation rate because of complications of the total pelvic mesh repair procedure was 10%. Mesh erosion into the rectum or vagina occurred in 5% of patients and constituted 46% the complications requiring reoperation. Additional surgical procedures at various intervals subsequent to the total pelvic mesh repair were performed in 36% of patients to improve bladder function and in 28% of patients to improve anorectal function.

There was no recurrence of rectal or vaginal prolapse. Reports of overall satisfaction for correction of primary symptoms for patients grouped into early (0.5 to 3 years) middle (>3 t 6 years) and late (>6 years) were 68%, 73%, and 74%, respectively. The authors concluded that total pelvic mesh repair is a safe and effective operation for females with pelvic organ prolapse (41) (Table 7.4).

Polypropylene Mesh in Clinical Use

PPM has become the most popular mesh material used to perform suburethral sling surgery for female stress urinary incontinence (SUI) with the advent of the tension-free vaginal mes procedures. With use of this procedure, the Ulmsten group reported roughly 90% objective cure rates for female stress incontinence in more than 250 patients treated for pure stress, recurrent stress, mixed, and intrinsic sphincter deficiency associated urinary incontinence. this series there was a minimum of 48 months follow-up and there was no reported graft erosion (42 ,43 ,44). More recent studies from other investigators of both mesh erosion and outlet obstruction with the tension-free vaginal

tape procedure have since been reported. Complications seem to be fewer than expected and could well be technique related once the tape is out of the hands of an expert (45 ,46 ,47).

Julian, 1996 (38)
24 (12 per group), 24 mo
Multi-recurrent cystocele
Marlex 100%
No Marlex 67%
25% erosion of Marlex
Watson et al., 1996 (40)
9, 29 mo
Large rectocele

89% successful defecation

None

Flood et al., 1998 (39)

142

Reinforce cystocele

100% without recurrence

3 (2%) graft erosion, 74% cure SUI

Sullivan et al., 2001 (41)

205

Multisite pelvic organ prolapse

No recurrent prolapse, 36% needed bladder surgery, 28% anorectal surgery subsequently

Reoperation 10%, erosion into rectum/vagina 5%

SUI, stress urinary incontinence.

Author	No. of Patients and Length of Follow-up	Type of Repair	Results	Complications

Table 7.4 Marlex (Polypropylene) in Pelvic Reparative Surgery

Polypropylene Mesh for Transvaginal Reparative Surgery

A tension-free PPM was fixed to the urethropelvic ligaments and pubocervical fascia, lateral and posteriorly, to correct large, recurrent, anterior vaginal wall prolapse in 12 women (mean age 65.6 years) with stress urinary incontinence type II and one with type III. Stress urinary incontinence was treated with the tension-free vaginal tape procedure. Examined a 3-month intervals from 15 to 32 months, three patients had asymptomatic recurrent grade 1 cystocele (48).

De Tayrac et al. described dissection of the cystocele from the vesicovaginal space under th inferior pubic ramus into the retropubic space, and placing PPM (GyneMesh, Gynecare, Ethicon, France) without tension into the created space (49). In 48 women with grade 3 to cystoceles followed 8 to 32 months; the success rate was 97.9%. There were four (8.3%) vaginal erosions and there was no postoperative infection.

Mersilene Mesh in Clinical Use

Kersey reported two large series of patients using Mersilene mesh to perform suburethral slings (50 ,51). The initial study reported 105 patients undergoing suburethral sling surgery with an 84% subjective cure rate for stress urinary incontinence, the latter 100 patients wit 78% cure. Two patients had vesicovaginal fistulas and three had vaginal erosions.

Two hundred women with genuine stress urinary incontinence, complicated by recurrence, ISD, or chronically increased intraabdominal pressure, underwent a suburethral mesh sling procedure. Of 176 who were 5 months or more postoperation, 127 (72%) had preoperative and short-term postoperative urodynamic evaluations (mean follow-up 12.6 months). The objective cure rate by stress test was 93% at a mean of 30 months follow-up. Eight patients (4%) had vaginal or inguinal sling erosion and were healed after revision. Delayed healing at the vaginal sling site responded completely to transvaginal estrogen cream in two (1%) patients (52).

Mersilene Mesh for Sacrocolpopexy

In a large series young reported the prevalence of mesh erosion was 3% in the 233 patients undergoing traditional sacrocolpopexy (52). Visco et al. (53) compared sacrocolpopexy anc colpoperineopexy in 273 abdominal sacral vault suspensions performed with the use of permanent synthetic mesh. There were 155 abdominal sacrocolpopexy and 88 abdominal sacral colpoperineopexy. Mesh erosion was observed in 5.5% (15/273) with no difference between the abdominal sacrocolpopexy group (3.2%) and sacral colpoperineopexy group (4.5%) with a mean follow-up of 290 days. The median time to mesh erosion was 15.6 month for abdominal sacrocolpopexy, 12.4 months for abdominal sacral colpoperineopexy, and 4.1 months in the vaginal mesh group (p <.0001). In the 25 patients having an abdominal sacral colpoperineopexy with the graft passed from the abdomen, the erosion rate was 8%. When sutures or mesh were placed transvaginally, the erosion rates were 16% (4/25) and 40% (2/5 respectively. The authors concluded materials placed transvaginally increased the risk of erosion, but their numbers were small for transvaginal operated patients (53).

P.79

Mersilene Mesh for Transvaginal Reparative Surgery

Mage treated 46 patients with pelvic organ prolapse using a vaginal approach with positionir of a polyester mesh sutured at the vaginal angles (54). With a mean follow-up of 26 months no major complication occurred; there was one mesh exposure 4 months after surgery, no recurrent prolapse, and no reported dyspareunia. All patients reported satisfaction with the outcomes.

Migliari and Usai, treating 15 women (mean age 67 years), modified a four-corner bladder suspension procedure using â€œmixed fiber meshâ€• to correct a grade IV cystocele (55). Ten patients also had type II stress urinary incontinence with urethral hypermobility. Patien were examined at 3-month intervals with mean follow-up of 23.4 months. Of the 15 women, 13 (87%) were continent throughout follow-up. There was one recurrent cystocele, and 2 patients (13%) developed enterocele defects 6 months after surgery. Addition of mesh to th classic four-corner bladder base and neck suspension procedure effectively treats incontinence and cystocele in the author's opinion.

Polytetrafluoroethylene Graft in Clinical Use

Subjective cure rates of stress urinary incontinence repaired with PTFE are comparable to repairs with other mesh materials, but the overall complication rates seem to be greater (5). Weinberger and Ostergard reported 22 (35%) sling removals in 62 patients in a 12-month follow-up period using PTFE. Half of the patients remained continent after sling removal (57).

van Lindert et al. reported a series of 61 patients with 15 to 63 months follow-up (58). The group reported one graft erosion at 8 months, and a vaginal fistula requiring mesh removal.

Baessler and Schuessler reported 33 women with pelvic organ prolapse who had abdominal sacrocolpopexy operations with PTFE with pouch of Douglas obliterations and posterior extensions of mesh (59). Concomitant transvaginal colpoperineorrhaphy was done when rectoceles remained on examination following sacrocolpopexy. Thirty-one women returned for follow-up at 12 to 48 months (mean 26 months). There was no recurrence of vaginal vau prolapse, enterocele, or anterior rectal wall prolapse. Among 28 women with preoperative rectoceles, 16 (57%) recurred and one occurred *de novo* . Defecation problems (outlet constipation) were present in 21 (64%) women preoperatively and persisted or were altered in 12 (57%). The authors concluded abdominal sacrocolpopexy with obliteration of the pouc of Douglas and posterior extension of the PTFE mesh was effective for vaginal vault prolaps enterocele, and anterior rectal wall procidentia, but not concomitant rectocele.

Two hundred eighty-seven vaginal operations using synthetic material (Gore-Tex, Dacron, a

Lyodura) were followed. The operations were described as Mouchel procedure (127 cases), small slings (118 cases), large slings (11 cases), Stamey procedure (8 cases), and patch for paravaginal repair (23 cases). Mean follow-up was 49 months.

The graft rejection occurred between 1 and 72 months. The Mouchel procedure had a rejection rate of 28.3% versus 9.3% for the slings. Dacron was better tolerated (rejection 19.3%) than Gore-Tex (rejection 30.2%). The authors suggested that the synthetic graft tolerance is proportional to the area of the material used, exposed surface, and the distanc separating it from the vaginal scar (60).

Polyglactin Mesh to Augment Cystocele Repair

Weber et al. reported 114 women with anterior wall vaginal prolapse randomly assigned to undergo anterior repair by one of three techniques: standard, standard plus polyglactin 910 mesh (Vicryl, Ethicon), or ultralateral anterior colporrhaphy (61). One hundred nine patien underwent operation, and 83 (76%) patients returned for follow-up (median 23 months). Te of 33 (30%) patients who were randomly assigned to the standard anterior colporrhaphy grou experienced satisfactory or â€œoptimal anatomic results,â€• compared with 11 (42%) of 26 patients with standard plus mesh and with 11 (46%) of 24 patients with ultralateral anterior colporrhaphy. The authors concluded the addition of polyglactin 910 mesh did not improve outcomes.

Sand et al., in a prospective, randomized, controlled trial, described patients undergoing repair of cystocele, at or beyond the hymeneal ring, with or without polyglactin 910 mesh reinforcement (62). After 1 year, 30 (43%) of 70 subjects without mesh and 18 (25%) of 73 subjects with mesh had recurrent cystoceles beyond the midvaginal plane (p = .02). Multivariate logistic regression analysis showed concurrent urethral slings to be associated with significantly fewer recurrent cystoceles, and polyglactin 910 mesh reinforcement of th anterior wall repair was found to significantly lessen the chance of recurrent cystocele.

Complications of Synthetic Graft Materials

Synthetic slings have increased rates of erosion or rejection compared to autografts. It appears to depend upon the material used, with PTFE demonstrating the greatest risk for complications requiring graft removal. When performing

transvaginal sling operations, the risk of erosion using any non-PTFE material is low, with rates as low as 1%. It would appear that the more extensive the dissection and the more material used, the more likely erosion will occur.

Erosion into the bladder, urethra, or rectum is rare with any of these materials. The latest (most distant from surgery) erosions to develop reported in the literature occur about 6 yea out from surgery, with most occurring within 3 months. Patients with erosion are often asymptomatic, but common presenting symptoms include discharge, bleeding, dyspareunia, or vaginal pain. On examination, if you see granulation tissue or there is foul-smelling discharge, there is erosion.

Graft erosion with autologous tissue is not reported. Both cadaveric allograft and nonhumar xenograft materials may be associated with erosion, but the lone report in the gynecologic literature indicates that nonsynthetic material erosion may respond, in up to half of cases, treatment with intravaginal estrogen cream with or without antibiotics over a 2 to 4-week period.

Difficulty with synthetic mesh removal depends on the material used. PTFE is removed easil PPM is more difficult to remove in most cases. Small erosions without obvious infection can be trimmed and closed, rather than removed. The role of estrogens and antibiotics is debatable in treatment of synthetic graft erosion (34).

Using Synthetic Graft Materials in Infected Wounds

Many surgeons have raised concerns about the use of synthetic graft material in the bacteri laden space of the vagina. There are several reports of the use of synthetic mesh in infecte surgical cases. Fifty-five patients with incisional hernias-all complicated dirty cases, were treated. Eleven were treated with prosthetic mesh, and the mesh group had no more morbidity but significantly less recurrence of hernias than the comparison group, suggesting that the contaminated wound is not a contraindication for use of prosthetic mesh but perhaps a reason to use prosthetic mesh (63).

McNeely reported the use of synthetic graft placement in the treatment of fascial dehiscen in gynecologic or obstetric wounds with necrosis and infection (64). He used PPM in 11 patients. Although initially doing well, three of the 11 patients (27%) required removal of th graft and revision of the abdominal scar â€œremoteâ€• from the initial dehiscence repair, meaning it worked well without recurrence in 72% of cases.

Conclusions

Traditional pelvic floor reparative surgery has an unacceptably high failure rate in the opinion of many pelvic floor surgeons. The high failure rate seems in great part related to tl poor quality of native tissues available for repair (65 ,66 ,67). The pelvic floor surgeon who wishes to compensate for this inherent tissue weakness may use graft material to repair or augment the repair of the pelvic floor. The choices currently available for use in pelvic floo graft repair include autologous tissue, cadaveric allografts, nonhuman xenografts, and synthetic materials. Existing evidence shows that most materials show some degree of success when compared to no augmentation.

Using autologous tissue from donor sites distant from the operation means extending the tin needed to harvest the materials and the morbidity increase for the patient. Abdominal wall fascia and fascia lata from the thigh both have been shown to produce good results when used to perform suburethral sling procedures for urinary incontinence, but are generally insufficiently reported to judge their use in other reparative procedures. Autografts also produce some morbidity, both short and long term from harvest, and require surgical skills that many gynecologists would need to acquire.

Cadaveric allografts offer the surgeon the advantage of not having to harvest tissue from th patient being operated upon. There is significant evidence to lead one to doubt the quality of cadaveric graft materials and whether they will stand up to produce a permanent result c may be quickly autolyzed by the recipient. The evidence shows these materials produce widely varying results. Although the dermal allografts may offer a reasonable choice, the evidence is not there to recommend any cadaveric graft material without reservation for pelvic floor reparative surgery. Full-length grafts may offer a better choice than patch graft but the results are still not there to ensure the material is a good choice.

An increasing number of xenograft materials are being offered-generally porcine or bovine and including intestine, dermis, and pericardium. Hypothesized to function as a matrix or scaffold material to stimulate the in-growth of native tissue. Glutaraldehyde cross-linking o porcine dermis has made it a more durable and lasting material, but some surgeons find its handling properties and long-term aesthetic results suboptimal compared to those of absorbable xenografts. The longer lasting porcine grafts do have clinical evidence to sugges an increased success rate in pelvic floor repair over non-graft repairs and results comparabl to synthetic, nonabsorbable graft materials. The other xenograft materials remain largely untested at present. They are marketed to surgeons on the basis of their use in other reparative procedures and overall similarity in the opinion of the US Food and Drug Administration (FDA) under what is called a 510(k) ruling.

Synthetic mesh offers the advantages of being strong, readily available, and permanent. Mesh does not undergo materials failure. Synthetic nonpermanent mesh in clinical use seem to offer no clear advantage over primary repair of the native tissues and therefore cannot b recommended.

Synthetic nonabsorbable mesh causes erosion, rejection, and fistulization in a small but significant number of patients, thereby making many pelvic surgeons cautious in its use. As suburethral sling material and for sacrocolpopexy operations, no material has shown better short-term or long-term outcomes than permanent synthetic materials.

For vaginal reparative surgery, a limited but increasing number of studies show graft-enhanced outcomes to be better than traditional reparative surgery. Used transvaginally there may be some increase in erosion rates associated with these materials over the transabdominal route, but these data are not entirely convincing. In transvaginal reparative surgery, the use of nonabsorbable graft material may be best reserved for cases in which there is an increased risk for failure of a standard repair, as in the case of the multi-recurrent, obese, or poor native tissue patient.

Of the available synthetic mesh materials, PPM and polyester mesh seem to have a lower complication rate than PTFE mesh. There are no data to show that either PPM or polyester mesh is the superior of the two, and there are no data to recommend any particular PPM ov another on the basis of its physical characteristics or clinical outcomes at present.

It appears that gynecologic reparative surgery lags behind general surgery in the creative us of materials for reparative surgery. Overall, meshes can provide much-needed support in pelvic reconstructive surgery when autologous tissues are not suitable. The ideal material h yet to be developed, but there are certainly investigators looking for the best material. It may well be that someday fibroblasts will be harvested from a surgical candidate and grown *in vitro* over a nonreactive matrix, but it is at present unrealistic to expect this to happen soon or to be affordable when it does. Trials are underway, however, to attain this goal (68 ,69). Until that time, the gynecologic surgeon must weigh the risks of erosion and rejection with the need for durable, permanent support and long-term surgical success in pelvic orgar prolapse repair.

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8

Guidelines for Hysterectomy

S. Robert Kovac

> *The most highly injurious progress to surgery for hysterectomy is the continued propagation of false facts as they often long endure.*
>
> --S. Robert Kovac, MD, 2004

In order to understand the selection of a particular route of hysterectomy, knowledge of the history of hysterectomy, over the last 100 years, must be understood. Hysterectomy is the signature operation performed by gynecologists worldwide, and the second most common major surgical procedure performed in the United States. There are numerous reports of vaginal hysterectomy performed as early as 2 A.D. by the Greek physician Soranus, but there is some doubt that the entire uterus was removed. In 1815 the German surgeon Langenbeck performed the first planned and successful removal of the uterus via the vaginal route. As Langenbeck had no precedent to follow, he had to devise his own plan for removal of the uterus. The following is a review of the accounts described by Kennedy (1).

> The patient was placed with the pelvis upon the edge of the bed with the thighs separated and the feet resting on two stools. The uterus had gradually descended toward the vaginal outlet, so Langenbeck seated between the patient's thighs began the operation by separating the cervix from the vagina. The

> dissection was continued until the peritoneal envelope of the uterus was reached. By directing with the edge of the scalpel against the uterus and separating the tissues as far as he could with the handle of the scalpel, he avoided entering the peritoneal cavity. To reach the fundus of the uterus, the broad and round ligaments and the fallopian tubes had to be divided. The last portion of the operation consisted in the subperitoneal enucleation of the fundus of the uterus. With severe hemorrhage and approaching collapse of the patient, and no one to assist him, with the left hand he grasped and compressed the bleeding part, and with the right hand he passed a needle armed with a ligature through the tissues and behind the bleeding point. Having only one hand at his disposal, the ligature was tied by grasping one end of the suture between his teeth, and the other with his right hand. He then pushed the vagina upward by placing his entire hand into the vagina where he recognized that above the vagina was a deep pocket, the walls of which were composed of the peritoneal investment of the uterus. The vagina and peritoneal pouch were continuous with each other and no opening into the peritoneal cavity could be detected. Through the peritoneum he could feel the intestinal coils. To prevent the inversion of this peritoneal bag, by pressure against it from the intestines, a sponge was inserted.

This is the first identification of a potential enterocele following hysterectomy. It was also the first complete extirpation of the carcinomatous uterus without an anesthetic, without hemostatic clamps, and without assistance. Thus, Langenbeck must be credited with the well-merited and hard-won honor of having established an important surgical procedure.

Death of the patient would have brought Langenbeck undeserved censure, but her recovery excited the envy of his colleagues, which followed him to his grave. In his description of the events that followed, Kennedy remarked that, â€œthe originator of every marked improvement in medicine and surgery has, during his lifetime, received but little recognition for his labors on the part of his colleagues. Professional jealousy has always selected for its target the men conspicuous by their honest and unselfish workâ€• (1). The patient died 26 years after the operation. Dr. Neuber conducted a postmortem examination in the presence of three other prominent surgeons. No adhesions were found in the abdominal cavity and there were no signs of recurrence in any part of the body. The upper part of the vagina and the empty peritoneal pouch formed by the enucleation of the uterus were found inverted and formed a swelling in the vagina, which reached as far as the labia majora. This is

the first description of an enterocele and vaginal prolapse following removal of the uterus.

In the United States that same year, Dr. Shecut of Charleston, South Carolina reported on a case that he presented to Dr. Samuel Bard, President of the College of Physicians and Surgeons of the University of New York. On September 15, 1815, a surgeon, Joseph Glover, performed a vaginal hysterectomy and removed a solid tumor mass weighing 5 pounds and measuring 11 inches from the fundus in a direct line to the point of section, and from 15 to 18 inches circumference at its greatest diameter. This patient had never been pregnant (1). This was the first report of a vaginal hysterectomy in a nulliparous woman. In 9 days the patient was free from any symptom of disease. These reports are in contrast to the beliefs of today, as the most common reasons offered by gynecologic surgeons why vaginal hysterectomy cannot be performed is that either the uterus is â€œtoo bigâ€• or the patient is nulliparous.

Many have wrongly quoted that John Collins Warren performed the first vaginal hysterectomy in 1829 at Harvard University. The records show that it was Langenbeck in Europe and Glover in the United States that deserve the honor for performing the first planned and successful vaginal hysterectomies.

By the late nineteenth century, vaginal hysterectomy had become a safe operation and was favored over the abdominal route because of the risks of laparotomy. A series of cases appeared in the 1860s and 1870s, and in 1881 Hailden reported 52 cases with a mortality of 32% (2). By 1879, Czerny progressed to the point of standardizing his own technique, and from then on the risks dropped rapidly to 5% to 6% in a series reported in the 1890s (3). This procedure gained popularity among the French gynecologists, and in 1895 Garceau reported more than 400 vaginal hysterectomies with morcellation with a 1.7% mortality rate (3). Pean reported 60 cases of vaginal hysterectomy in 1886, and all patients survived the operation. This was in contrast to a study Pean published in 1881 of 51 women with fibroids, treated by abdominal hysterectomy, in which 18 died, for a mortality rate of 35% (4). Vaginal hysterectomy was adopted because abdominal hysterectomy could not be done safely. In nineteenth century France, vaginal hysterectomy was performed for cervical cancer, enlarged leiomyomatous uteri up to 20 weeks' gestational size, and pelvic inflammatory disease, with tubo-ovarian abscesses, with low mortality rates (5).

Historical Development of Vaginal Hysterectomy

The surgical approach to pelvic disease through the vaginal canal is not only one of the oldest but also one of the safest and most satisfactory procedures in gynecology. Surgeons working in other surgical fields that may be reached through a natural passage have generally appreciated this increased factor of safety. Major pathologic growths were removed regularly through the mouth and throat, the aural and nasal passages, and the urethra and rectum.

The pioneer surgeons in gynecology, especially in the days before aseptic techniques were developed, found that they could remove major growths through the vagina with greater safety than they could through the abdominal wall. In the earliest days of gynecology, death regularly followed laparotomy. Recovery from vaginal self-removal of the uterus had been observed, so several of the early, braver gynecologists began their attempts to relieve those suffering women by planned vaginal hysterectomy. There was intense opposition to their efforts, but they persisted despite it. Soon almost all types of serious pelvic disease, ranging from acute and chronic adnexal inflammation to large uterine and ovarian tumors, were being approached surgically through the vagina. In 1899 DÃ¼hrssen reported on his phenomenal results obtained by vaginal surgery. He reported on 1,600 vaginal hysterectomies with an uncorrected mortality rate of 2% (6).

The evolution and perfection of the abdominal hysterectomy technique is distinctly American. The American operation was almost unknown in France in the late nineteenth century until Second published the details of this operation after visiting the United States (7). Some U.S. surgeons abandoned vaginal hysterectomy. It was thought easier to surgically manage certain conditions believed to require a total view of the abdominal cavity or thought to be too difficult or even impossible to perform by the vaginal route by surgeons who were no longer trained in the procedure.

As stated, the first vaginal hysterectomies were performed in the United States in the early 1800s; however, because of the higher mortality rate for this procedure associated with cervical cancer in the United States, it was almost abandoned by the early twentieth century. By that time, abdominal hysterectomy enjoyed widespread acceptance as improvements in anesthesia and aseptic techniques made laparotomy comparable to vaginal hysterectomy in terms of safety-mortality. Although some surgeons continued to favor the vaginal route because of the more advantageous postoperative course and recovery, by the early twentieth century vaginal hysterectomy was performed exclusively for prolapse. Because many of the uteri involved were small or atrophic, they were readily removed by clamps in 5 minutes, as advocated by Joseph Price of Philadelphia, who popularized vaginal hysterectomy more than anyone in the Western Hemisphere (8). Heaney and earlier gynecologists Emmett, Skene, and Henrotin almost always removed the uterus by the vaginal route, except under exceptional circumstances, since in their time laparotomy carried a much higher risk (8,9,10,11 Vaginal hysterectomy with ligatures was popularized in Vienna, Austria and reintroduced into the United States by Dr. John Porges (12).

Although many leading U.S. surgeons continued to perform vaginal hysterectomy, it was not until the 1930s that the widespread use of this procedure actually began.

Between 1900 and 1930 articles began to appear in the medical literature that promoted the increased use of the vaginal route for expanding indications, whereas those opposed to the operation discussed the contraindications to the vaginal approach. In the United States, surgeons divided into two camps: those who operated through the vagina and those who performed and recommended only the abdominal route.

In the early twentieth century, morbidity became a surgical outcome of interest. In the early 1930s, Babcock, Heaney, Danforth, and others began to rethink the benefits of the vaginal approach (8,13,14). Danforth, who admitted his earlier prejudice against the vaginal method, wrote in 1938 â€œthat vaginal hysterectomy is a procedure of great value and is worthy of more extended use than it receives.â€• Danforth thought that this was a procedure for the trained gynecologic surgeon and should not be performed by general surgeons (14). This was a considerable concern for many gynecologists, who feared the loss of hysterectomy surgery to general surgeons, which resulted in the formation of a new specialty, gynecology, in 1930. In 1932, Babcock maintained that vaginal hysterectomy was the operation of choice for removal of the uterus using morcellation when necessary. He also remarked â€œalthough easily borne by the patient, vaginal hysterectomy may be much more trying for the surgeon than the abdominal approach for the same condition. However, who would sacrifice the comfort of the operation against the safety of the patient?â€• (13). Still in the United States, the abdominal route became the most popular procedure for removal of the uterus. Factors responsible for its adoption were: (i) it was easier to teach abdominal hysterectomy; (ii) it was simpler to perform; (iii) many conditions thought to require hysterectomy were believed to contraindicate the vaginal route, which further shunned surgeons from this route; and (iv) a decline in the number of surgeons trained in vaginal surgery was believed to contribute to the shift toward the abdominal approach.

Many contraindications to the vaginal route were accepted as absolute by U.S. surgeons who were taught only the abdominal route. Competition between the two types of hysterectomies emerged and it was suggested that the operations should not be competitive because they were performed for different indications. This belief that abdominal and vaginal hysterectomy were performed for different indications was never substantiated. In later years, that is, the 1990s, it was confirmed that abdominal and vaginal hysterectomy were performed for similar indications (15).

In the early twentieth century it was generally accepted that vaginal hysterectomy was suitable for conditions such as uterine prolapse, but it was taught that all other conditions should be performed by abdominal hysterectomy. Doyen, a respected French surgeon, said â€œthat no one could call himself a gynecologist until he could perform a vaginal hysterectomy. It is time he said that one sees the start of vaginal hysterectomy for conditions other than vaginal prolapseâ€• (16). However, abdominal hysterectomy became the predominant method of uterine removal with the ratio of abdominal hysterectomy to vaginal hysterectomy of about 3:1 in the United States as abdominal surgeons pressed for center stage.

Some surgeons were simply not comfortable with the vaginal method, which they believed to be more difficult to perform than the abdominal one, and chose not to learn it for that reason. Some abdominal surgeons suggested that the abdominal method was selected simply because it was more appropriate. Large fibroids, suspected adhesions from previous abdominal surgery, and the need to have access to other organs by the abdominal method were now stated as contraindications to the vaginal route in the United States. However, the problem with being trained in only the abdominal method is that one sees only the removal of the uterus through the abdomen and views all other methods as either impossible or incorrect.

Initially vaginal hysterectomy in the United States was met with great enthusiasm, but when the mortality rate increased because of the surgical management of cervical cancer, interest in the vaginal approach waned. The American surgeon did not appear to have interest in the remarkable work by French vaginal surgeons of the time who did not consider large fibroids and other contraindications to the vaginal approach as absolute as the American surgeons. Interested gynecologic surgeons are encouraged to read the significant work of French surgeons prior to the aseptic era, â€œVaginal hysterectomy as done in France,â€• published in the American Journal of Obstetrics, Volume 31, March 1895, to understand the significant benefits of the vaginal method in the early years of surgery. This article clearly demonstrates that the contraindications to the vaginal route were mostly developed in the United States by surgeons who were unfamiliar with this route.

The end of the nineteenth century brought the end of an era. Enthusiasm for the vaginal approach in the United States lost its popularity. In his textbook on gynecologic surgery, Howard Kelly stated â€œvaginal hysterectomy at one time in great vogue for both cancer and fibroids, is exceptionally resorted to in these later years. This change is the outcome of better training and greater familiarity of our operators with the more extensive abdominal panhysterectomy, with its thorough going control of the entire operative field at all times under ocular inspection, and above all with its associated protection of the uretersâ€¦â€• (1). This has been found to be incorrect.

In the 1940s interest in surgical morbidity was further emphasized and interest in vaginal hysterectomy once again grew because of the advantages of this approach. Both Counsellor and Hunt and Pratt and Symmonds from the Mayo clinic as well as others suggested that more indications for hysterectomy were possible for transvaginal removal and could be safely and successfully managed by this route (1,2,6,8,14,17,18,19,20,21). The personal experience of these skilled surgeons was considered by most others as

just that, and many surgeons believed this method was too difficult for the average gynecologist. Therefore, the abdominal approach continued to be the predominant method of hysterectomy taught and performed for the next 50 years. It was not until 1982 when the CREST study conducted by the then Centers for Disease Control reported an overall complication rate of 24.5 per 100 women undergoing vaginal hysterectomy compared with 42.8 per 100 women undergoing abdominal hysterectomy for similar indications that other investigators were stimulated to scrutinize the predominant use of abdominal hysterectomy (22).

In the last 25 years of the twentieth century many studies confirmed that vaginal hysterectomy was associated with decreased complications, less pain, shorter hospital stays and convalescence, reduced hospital charges, and better quality-of-life outcomes, including mortality (15,23,24,25,26,27,28). Symmonds from the Mayo clinic stated, â€œThe unique, distinguishing characteristic of the gynecologic surgeon is the ability to accomplish much of the indicated pelvic surgery by the vaginal route. Yester-year resident training in gynecologic surgery emphasized the vaginal approach, largely, as the result of alterations in the medico-economic pictureâ€¦. Treatment of gynecologic conditions is preferably managed when the operation can be done just as adequately and safely and when exploration of the abdomen is not indicatedâ€¦. Most of the contraindications to vaginal hysterectomy disappear as the skill of the operator increasesâ€¦â€• (29).

Personal Experience

In a personal conversation with Dick Symmonds following the First International Conference on Vaginal Surgery, Symmonds asked me why I was promoting vaginal hysterectomy, since he had tried to do so for 40 years without success. I responded that I had planned to provide the evidence of outcomes, a new concept of the times, to support its implementation.

My interest in guideline development for hysterectomy began during my years as a resident in Obstetrics and Gynecology at Barnes Hospital in St. Louis, Missouri. I assisted on many cases scheduled for abdominal hysterectomy where the attending surgeon used traditional indications and contraindications for certain conditions requiring hysterectomy, which were â€œdevelopedâ€• over many years, but never subjected to scientific investigation (Table 8.1). I became even more puzzled by cases scheduled for abdominal hysterectomy for conditions based upon those indications and contraindications, only to find many occasions when the abdomen was opened by laparotomy that the conditions discovered were insufficient to mandate the abdominal approach. In this chapter I have stated this reoccurring problem over and over, but it is still prevalent today. These hysterectomies were completed abdominally, as the abdomen was already opened, but the surgeon was never required to document in the hospital record whether the presumed preoperative conditions matched the intra-abdominal findings. Unless there is a mechanism to determine and report the actual existence and extent of pelvic pathology, how can the issues of technical feasibility in selecting a particular route of hysterectomy be addressed?

Table 8.1 Traditional Indications for The Route of Hysterectomy

- I. Abdominal hysterectomy for more serious disease
  - A. Uterus â€œtoo bigâ€•
  - B. Vagina â€œtoo narrowâ€•
    1. Pubic arch <90 degrees
    2. Bituberous diameter <8.0 cm
  - C. Uterus â€œtoo high or â€œwill not come downâ€•
  - D. Intraabdominal conditions contraindicate vaginal approach
    1. Adhesions
    2. Endometriosis
    3. Adnexal disease
    4. Previous pelvic surgery
    5. Chronic pelvic pain
    6. Previous cesarean delivery
- II. Vaginal hysterectomy for less serious diseases
  - A. Mainly prolapse

My interest in the vaginal approach was further sharpened because I was impressed with the improved postoperative outcomes over abdominal hysterectomy. I began to study each indication for hysterectomy and questioned whether the indication could be performed by the vaginal route. It was then that I developed the concept of the actual technical concerns (feasibility) for removal of the uterus for each hysterectomy indication via the vagina. It appeared to me that some indications for hysterectomy were confined within the boundaries of the uterus (Table 8.2).

Table 8.2 Conditions Confined to The Uterus

1. Leiomyomata
2. Uterine prolapse
3. Adenomyosis
4. Abnormal uterine bleeding
5. Carcinoma in situ of the cervix

Therefore, I believed the only contraindication to vaginal removal for these indications would involve the actual size of the uterus, provided there were no concerns of other conditions such as pelvic adhesions, endometriosis, or adnexal pathology, or restrictions of the vaginal passageway. In general, most of the time the only concern for these conditions would be uterine size. Thus, I believed it was vitally important to establish a consensus regarding the size of the uterus that could be readily removed transvaginally by most gynecologists. The â€œenlarged uterus,â€• whatever that

meant, was frequently used as a reason to perform abdominal hysterectomy.

Table 8.3 Conditions that Might Extend Beyond the Confines of the Uterus

1. Endometriosis
2. Adnexal pathology
3. Pelvic adhesive disease
4. Chronic pelvic pain
5. Chronic pelvic inflammatory disease

The second concern was extrauterine indications that might extend beyond the confines of the uterus (Table 8.3). In the 1980s, I began using the laparoscope intraoperatively in patients who, by traditional indications, required an abdominal hysterectomy to determine whether the intra-abdominal findings supported the use of abdominal hysterectomy. Subsequently, I collaborated with Drs. Stephen Cruikshank and Helio Retto and published the results of this new technique (30). Laparoscopic evaluation is useful to help confirm whether the characteristics of the pathology preclude the vaginal approach. In the majority of cases of benign uterine disease, it was discovered that vaginal hysterectomy was possible without laparoscopic assistance. The final concern was the adequacy of the vaginal passageway.

Over the years I refined these concepts, but my original thoughts were used as a basis for 10,185 vaginal hysterectomies I successfully performed between 1970 and 2005. Between 1970 and 1980, I performed 173 abdominal hysterectomies, as I practiced what I had learned about hysterectomy during my training years. I began to realize that the contraindications to the vaginal approach I was taught during my early, formative surgical years were not absolute. Therefore, I decided I would attempt to perform all hysterectomies by the vaginal route. Once I became convinced of the value of size-reduction techniques with vaginal hysterectomy, such as intramyometrial coring, I rarely performed an abdominal hysterectomy. I discovered that the feasibility of the vaginal approach for all hysterectomy indications could be evaluated in terms of uterine size, the potential for extrauterine pathology, and the adequacy of the vagina.

Software that recorded the patient's hospital number, patient's age, indications for hysterectomy, pathologic weight of the uterus, type of hysterectomy performed, complications, number of blood transfusions, length of stay, and the hospital cost for each procedure was developed. The data were recorded by the medical records departments of the hospitals where I practiced, as well as by a research assistant in my private office. In 2004 my research assistant at Emory transcribed these data into an Access database for evaluation. The results obtained are listed in Table 8.4. The first listed diagnosis was considered the main indication for hysterectomy.

The data recorded 10,185 vaginal hysterectomies performed between 1970 and 2005. Between 1980 and 2005, only 24 abdominal hysterectomies were performed and between 1990 and 2005, 129 laparoscopically assisted vaginal hysterectomies (LAVHs) were recorded. Of the 129 LAVHs, 10 of these required an abdominal hysterectomy, whereas the remaining 119 were performed vaginally. Operative repairs of the vagina, that is, cystocele, rectocele, or incontinence procedures performed at the time of hysterectomy, occurred in 5,276 patients. Of the 10,185 patients who underwent vaginal hysterectomy, 93 (0.9%) required blood transfusions. Five of these patients had additional postoperative interventions, either by hypogastric artery ligation or embolization. The operative cystotomy rate for vaginal hysterectomy was 1.2%. No ureteral injuries were recorded for the vaginal hysterectomy group, as each patient underwent intraoperative cystoscopy after the completion of every vaginal hysterectomy. There were no operative injuries to the bowel recorded. Interestingly, a conversion from the vaginal to the abdominal approach occurred in eight cases. From 1970 to 1986, the postoperative infection rate was 9%.

After 1986, I began to test the pH of the vagina and treat patients with alkaline pHs, suggestive of bacterial vaginosis, with therapeutic antibiotics. From 1986 to 2005, only two patients had postoperative infections following vaginal hysterectomy (see Chapter 9).

An analysis of these data clearly indicates that the indications for hysterectomies were not dissimilar to the general population of hysterectomies by most gynecologists (Table 8.5). Most uteri were not enlarged as only 524 exceeded 280 g. Because the most common hysterectomy performed in the United States is abdominal and the most common indication is leiomyomata, the question that needs to be answered is â€œWhy is abdominal hysterectomy selected more frequently for leiomyomata?â€• In my series, only 20% of leiomyomata exceeded 280 g. This is consistent with the belief that only 80% of all uteri removed in the United States exceed 280 g. Does the term leiomyomata really mean an enlarged uterus that demands the abdominal approach? Furthermore, this suggests that many uteri removed abdominally for leiomyomata may not be sufficiently large to demand the abdominal approach. Therefore, the abdominal approach may be overutilized for this indication. My own series of hysterectomies performed for leiomyomata demonstrates clearly that 80% of the vaginal hysterectomies I performed for leiomyomata were <280 g and certainly did not mandate an abdominal hysterectomy. Gynecologic surgeons can no longer propagate the false belief that leiomyomata always require an abdominal hysterectomy. An incorrect clinical pathway has been developed and followed that suggests: leiomyomata â†’ enlarged uterus â†’ abdominal hysterectomy. Evidenced-based medicine demands objective

evidence that requires the actual size of the uterus be determined before selecting the abdominal route. Thus, a consensus regarding the actual size of the uterus must be determined before a surgeon decides an abdominal hysterectomy is mandated. This demands a new paradigm be developed to accurately measure the size of the uterus before the abdominal route is selected. For many years surgeons suggested that a hysterectomy could be performed vaginally if the uterus did not exceed 280 g, so an abdominal hysterectomy should not be mandated if the uterus is <280g.

Table 8.4 Indications for Hysterectomy 1970â€“2005

Indication	Numbers (%)
Leiomyomata	2,593 (25.4%)
Prolapse	4,433 (43.5%)

Abnormal uterine bleeding	1,427 (14.0%)
Adenomyosis	896 (8.7%)
Carcinoma in situ cervix	308 (3.0%)
Pelvic inflammatory disease (HX of)	195 (1.9%)
Chronic pelvic pain	528 (5.1%)
(HX of) Endometrosis	333 (3.2%)
(HX of) Pelvic inflammatory disease	195 (1.9%)

Indication	Uterine Weight/Mean (Range)	LOS (Range)	Uterine Weight (>280 g)
Leiomyomata	255.8	2.77	502
No. 2,593	(90â€“2,928)	(2â€“6)	
Prolapse	149.6	3.06	0
No. 4,433	(16â€“165)	(2â€“10)	

AUB	145.9	2.31	0
No. 1,427	(53â€“235)	(1â€“5)	
Adenomyosis	153.2	2.14	11
No. 896	(60â€“425)	(1â€“4)	
Carcinoma in situ	100.4	2.03	0
(cervix) No. 308	(47â€“237)	(1â€“5)	
Chronic pelvic pain No. 528			
Endometriosis	128.6	2.6	0
(HX of) No. 333	(40â€“208)	(2.7)	
Pelvic inflammatory disease (HX of)	114.1	2.43	
No. 195	(42â€“194)	(2â€“4)	0

HX, history.

Most indications in my series of vaginal hysterectomy for leiomyomata did not raise concerns about extrauterine conditions that would traditionally demand abdominal hysterectomy. Thus, the use of these early guidelines established a feasibility rate for successful vaginal hysterectomy of 97%.

Review of the database recorded hospital cost for only 15 years and cost changed year after year so an analysis of this parameter could not be evaluated for the entire 10,185 vaginal hysterectomy procedures. However, many have published data on the cost savings of the vaginal approach as compared to abdominal and laparoscopic hysterectomy, which is considerable (15,26,31,32,33).

Table 8.5 Comparisons of Indications: National Center Health Statistics/SRK

	NCHS	SRK
Fibroids	27%	25%
Prolapse	21%	43%
Abnormal Bleeding	21%	14%
Endometriosis	15%	12%

Guidelines to determine the route of hysterectomy were published in *Obstetrics & Gynecology* in 1995. This study prospectively assigned 617 patients to abdominal, vaginal, or laparoscopic hysterectomy on the basis of uterine size, potential extrauterine pathology, and accessibility to the vaginal passage. Vaginal hysterectomy alone (*N* = 548) or in conjunction with laparoscopy (*N* = 63) was successful in 99.5% of women assigned to these groups (24). Patients in whom the vaginal approach was unsuccessful included 94% of those with uterine weight exceeding 280g

and 97% of those with high-risk factors often cited as reasons for selecting abdominal hysterectomy.

There is little doubt that as the skill in vaginal surgery increases more indications can be performed by the vaginal route. The most important message from this study was that the vaginal approach was feasible in 99% of cases when each indication was assessed in terms of actual uterine size, the potential for extrauterine pathology, and the accessibility of the vaginal passage.

The use of these early informal guidelines for determining the route of hysterectomy were endorsed subsequently in a health technology assessment report published by Emergency Care Research Institute (ECRI) in 1995 (31). These guidelines were then reviewed by the Board of the Society of Pelvic Reconstructive Surgeons (SPRS) and after vigorous review were further developed and are the by-product of evidence-based medicine and applied medical decision analysis (34). The guidelines have been adopted by the National Guideline Clearinghouse, which is supported by the American Medical Association, the American Association of Health Plans, and the U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality (35). These guidelines were developed to assist physicians with their surgical practice to make surgical decisions based on objective evidence rather than personal preferences or the acceptance of invalid contraindications to the vaginal approach in order to provide the best possible decision making for surgeons and their patients.

Surgical and economic outcomes along with the introduction of LAVH in 1990 caused a resurgence of interest in vaginal hysterectomy. The original concept of LAVH was to accurately determine, by diagnostic laparoscopy, whether traditionally accepted indications for the abdominal approach and contraindications to the vaginal approach were valid (30) (see Chapter 11). At the time I believed the most important way of increasing the use of vaginal hysterectomy was to question the validity of the traditional indications for abdominal hysterectomy and the contraindications to the vaginal route. When considering questionable contraindications to the vaginal approach, I suggested that an exact diagnosis was preferred before an unnecessary abdominal hysterectomy was performed. This is what I considered the role of laparoscopy with hysterectomy. Subsequently, it was shown that the vaginal approach was possible after diagnostic laparoscopy, which did not confirm many of the conditions that were thought to mandate abdominal hysterectomy. When many surgeons discovered that after the pelvic contents had been evaluated and the findings did not contraindicate the vaginal route, they turned to the vaginal route to complete the hysterectomy vaginally.

For years gynecologists have debated and promoted the relative benefits of abdominal and vaginal hysterectomy. The issues had to do with training, indications, visibility, and experience of the surgeon. Despite the issue of inadequate training in vaginal surgery, the number of hysterectomies performed each year remains more than 200,000 in the United States. This attests to the feasibility of this approach for many women with benign conditions.

By the end of the twentieth century hysterectomy was performed by three different methods: abdominal, vaginal, and laparoscopic, and surgeons promoted the method they preferred. Justifications for the abdominal and laparoscopic methods were still based on traditional contraindications to the vaginal method established at the end of the nineteenth century. In the United States the most frequent of these previous contraindications was that an â€œenlarged uterusâ€• could be performed only by the abdominal route. In addition, â€œsuspicion of adhesive disease from prior pelvic surgery, history of endometriosis or pelvic inflammatory disease, previous C-section, or suspicion of adnexal diseaseâ€• were also thought to require a laparotomy. However, it was subsequently reported by many researchers that these traditional contraindications to the vaginal method were not considered absolute contraindications to the vaginal approach. Many surgeons began to recognize when the abdomen was opened for suspected disease that these suspicions did not confirm nor justify the need for the abdominal approach.

When vaginal surgeons began to prove that traditional contraindications to the vaginal approach were not absolute, questions arose as to the actual indications for abdominal and laparoscopic hysterectomy as well as the actual indications and contraindications (feasibility) to the vaginal approach.

Decision Making

Thus, the predominant use of abdominal hysterectomy invites scrutiny of how gynecologic surgeons select a particular type of hysterectomy. In discussions over the years with many abdominal hysterectomists, they stated that a laparotomy was necessary for the enlarged uterus. When asked to define what â€œenlargedâ€• meant, none could agree upon a specific size. When abdominal hysterectomists stated that a laparotomy was required when certain extrauterine conditions such as adhesive disease from prior pelvic surgery, endometriosis, and pelvic inflammatory disease were suspected, they were asked whether these suspicions always mandated an abdominal hysterectomy. Some answered, not always, but what were they to do since the abdomen was already opened? To some surgeons this was an ethical dilemma, since physicians are taught to make a correct diagnosis before they intervene. To others uninterested in confirming that their preoperative suspicions mandating the abdominal route were present intraoperatively, they continued using the same invalid contraindications and for a time no one would be the wiser. However, if the preoperative suspicions of intraabdominal disease that contraindicate the vaginal approach cannot be verified, then should the abdominal approach be considered unnecessary and is the hysterectomy even indicated?

The immediate problem is what to do since the abdomen had already been opened. Some abdominal surgeons search for conditions within the abdominal cavity that could be stated in broad terms, such as adhesions, in the hospital record as potential justifications for the selection of the abdominal approach. Other surgeons turn to the use of the laparoscope to confirm the intraabdominal conditions before selecting a particular route of hysterectomy.

Laparoscopic surgeons, who could readily diagnose these conditions prior to the surgery, were also asked if conditions discovered during the laparoscopic assessment of the pelvic anatomy are considered before determining abdominal or laparoscopic hysterectomy. Their answers were nonspecific and variable. In the early years of laparoscopy with hysterectomy it was necessary to determine the indications for laparoscopic hysterectomy. It was generally accepted that the role of laparoscopic hysterectomy was as a replacement for conditions that required an abdominal hysterectomy. Many studies were published to develop the indications for this new laparoscopic hysterectomy, but few documented actual intra-abdominal pelvic pathology as to the presence and, more importantly, the extent of involvement believed to require these more invasive methods. For example, adhesions were long believed to mandate an abdominal or laparoscopic hysterectomy and contraindicate a vaginal hysterectomy, yet the extent of adhesions was infrequently, if ever, documented in most studies. This further questioned the necessity for laparotomy, laparoscopy, or hysterectomy.

Some laparoscopic surgeons wanted to use the laparoscope as a mode of access to all hysterectomies and began to promote the use of total laparoscopic hysterectomy. The reason for this soon became apparent. If laparoscopic surgeons had to document the intraabdominal pelvic findings they believed mandated an abdominal hysterectomy, and thus a laparoscopic hysterectomy, but these conditions were not confirmed, they would have no reason to continue with the laparoscopic dissection for removal of the uterus. Interestingly, surgeons not bound to the laparoscope began to recognize that after laparoscopic inspection of the pelvic contents, many of the previously accepted contraindications to the vaginal approach were not found. Therefore, many proceeded to the vaginal approach for removal of the uterus. For many surgeons it was more appropriate to perform a vaginal hysterectomy than a prolonged operation using a laparoscope.

Quality Care

Published outcomes studies continue to reveal that the vaginal approach was associated with less pain, less complications, shorter hospitalization, faster recuperation, and less in-patient costs for similar conditions (15,26,32,33,36). There is also worldwide interest in reducing the number of abdominal hysterectomies performed, yet this approach still remains the most common hysterectomy method in the United States. Factors responsible for the predominance of abdominal hysterectomy include resident training; personal experience; surgical capability; traditional teaching for treatment decision making; interpretation of results; and misconceptions about the versatility, costs, and suitability of the transvaginal approach for uterine removal for different patient conditions. The most important of these is the continued teaching of treatment decision making, which may be incorrect. It is a proven fact that surgeons perform hysterectomies for the same indications. Therefore, surgeons may often select abdominal, laparoscopic, and vaginal hysterectomy for similar conditions without determining the evidence supporting one procedure over the other.

As surgeons began to measure important quality characteristics and outcomes of hysterectomy, marked variations in clinical practice were also discovered, which verified significant differences in the quality and the cost of hysterectomy care. What role do clinicians play in this variation, especially when hysterectomies are performed for similar indications? What should be done to reduce unwarranted variation caused by physician practice-style?

Variations of Hysterectomy Surgery

Wide variations in the application of medical technology have been recognized for decades but have just recently become the object of intense scrutiny and debate. Such variations have important implications for the cost and quality of medical care. These variations also raise specific questions about the process of clinical decision making for patients, physicians, and those charged with the responsibility to gather and disseminate information on which to base clinical decisions. The focus on the decision-making process has been sharpened by the professional uncertainty hypothesis, which holds that variation can largely be explained by the differences in physicians' beliefs about the value of procedures and practices for meeting patient needs.

Many patients have not accepted the fact that medicine is an imprecise science, sometimes more gamble and guesswork than certainty. Hence, policy makers have urged researchers to gather information to better define health care outcomes associated with variations in clinical practice, and to develop consensus practice standards. Exploring the reasons for geographic variation in the use of medical and surgical procedures may assist surgeons in defining the appropriate care for conditions such as hysterectomy. For years the ratio of abdominal-to-vaginal hysterectomy in the Northeastern part of the United States was 6:1 compared with the remainder of the United States, which was 3:1 (37). What other than abdominal hysterectomy is an available option to this region of the United States? Are there that many differences in physician beliefs in the Northeastern part of the country about the value of abdominal hysterectomy compared to the rest of the country? These questions

demand careful scrutiny of clinical decision making, both for the need of hysterectomy and the type of hysterectomy performed.

The quality of hysterectomy procedures is judged by the quality of both the decision that determines what actions are taken and how those actions are executed-what to do and how it is done. When marked variation in clinical practice occurs, clinical practice guidelines can be used effectively to mitigate uncertainty and improve quality. The concepts and methods of decision analysis are valuable discipline tools for indicator development in determining the route of hysterectomy. These tools can improve indicator development because they help determine which decisions are most likely to be appropriate, thereby making indicators based on these decisions more likely to be valid and useful for the provider, patient, and payer.

If the goal of gynecologic surgeons is to select the optimal route of hysterectomy based on the best medical outcomes, then they need to identify the clinical factors that are valid indicators of the route. If abdominal or laparoscopic hysterectomy is selected because of the belief that a severe pathologic condition that would contraindicate the vaginal route exists, then good surgical practice dictates that the severity of the pathology be confirmed before selecting the route of hysterectomy. However, the selection of abdominal or laparoscopic hysterectomy for more serious disease has been a *de facto* guideline that has largely gone unchallenged. Studies have shown that gynecologists do not always select abdominal or laparoscopic hysterectomy based on the severity of the patient's clinical condition (15). Rather, just the mere suspicion of more serious extrauterine pathologic conditions frequently dictates the approach that is used, because surgical comfort and preference seem to be more important than documentation of whether more serious extrauterine pathology exists.

What is the clinically appropriate route and method of hysterectomy in a given patient? As wide variation in practice patterns and outcomes continue, there is a gap between what is known and the care delivered. The challenge of arriving at a consensus regarding the optimal hysterectomy procedure is to define the patient's characteristics that indicate whether laparotomy or laparoscopy should be used; in addition to how much of the hysterectomy procedure should be completed laparoscopically. Relying on traditional indications for abdominal hysterectomy may be ineffective because intraoperative inspection of the abdomen often provides insufficient evidence to support clinical suspicions or a medical history that contradicts a vaginal hysterectomy.

Technology Assessments

What is really known about the relative advantages of abdominal, vaginal, and laparoscopic hysterectomy? In 1995 two prominent organizations conducted separate â€œlevel of evidenceâ€• reports of laparoscopic-assisted vaginal hysterectomy. One was produced by a private nonprofit agency and the other was an internal report from a national association of health maintenance organizations (31,32). These studies reviewed the literature to compare abdominal, vaginal, and laparoscopic hysterectomy in terms of indications, operating and anesthesia times, estimated blood loss, complications, duration of stay, and hospital charges to better identify the relative advantages of the different hysterectomy types and to clarify whether the large number of abdominal hysterectomies was justified. In 2004, the Cochrane Collaboration, an international organization that evaluates medical research and draws evidence-based conclusions about medical practice, published their report (33). All three organizations recognized the many advantages of the vaginal approach over abdominal and laparoscopic methods. The Cochrane Group's assessment of the evidence recommended vaginal hysterectomy to reduce complications and to speed up hospital discharge and the patient's return to normal activities. It suggested that vaginal hysterectomy should be performed â€œwhenever technically feasibleâ€• (33). The Emergency Care Research Institute (ECRI) and Terminix (the HMO group) made similar statements. Following the Cochrane Report, The American College of Obstetricians and Gynecologists (ACOG) responded with a Committee Opinion on the appropriate use of laparoscopically assisted vaginal hysterectomy. This report stated that most patients requiring hysterectomy should be offered the vaginal approach when technically feasible and medically appropriate (38).

In the United States, the Cochrane study was met by remarks from experienced surgeons that because the approach to hysterectomy was so tightly tied with experience and comfort level, the predominance of the abdominal approach was unlikely to change. It is also easier to articulate a reform agenda than to implement the changes it demands. The reasons that important and worthwhile changes to the route of hysterectomy are so difficult to implement in health care organizations and systems must be considered. Walshe and Shortell suggest that health care organizations and systems are controlled by powerful, producer-led vested interest (39). The dominant position of health care professionals and corporations enables them to block changes, even those backed by evidence. However rational the case for change, it is likely to be fiercely opposed by producer interests.

Technical Feasibility

The abdominal approach may be the predominant approach for hysterectomy, but it exposes a woman to greater risks of complications, longer recuperation, and poorer postoperative quality-of-life outcomes. Gynecologists trained as abdominal surgeons vigorously defend this approach as necessary on most occasions. They may agree with the Cochrane Group that the vaginal approach should be performed, but only â€œwhenever technically feasible.â€•

Therefore, technical feasibility must be accurately defined. The issue of technical feasibility must be addressed-are the traditional indications and contraindications for abdominal and vaginal hysterectomy established over 100 years ago valid or invalid? One must remember that the contraindications to the vaginal route were developed by U.S. abdominal surgeons of the late nineteenth and early twentieth centuries who were unfamiliar with the vaginal route. Furthermore, although hysterectomy is performed for certain indications, it is not necessarily the indication that demands a particular route for uterine removal.

Technical feasibility may also mean that the surgeon is technically unable or unwilling to perform the vaginal approach because of his/her comfort, preference, training, capability, or experience with abdominal or laparoscopic methods. Clinical medicine is being forced to adopt more rigid evidence-based practice guidelines that are defined by outcomes rather than physician values of preference, comfort, or experience. Outcomes measure quality and cost-effectiveness. Guidelines help determine appropriateness of care and can resolve quality-of-care issues as well as avoid the legal and financial implications of inappropriate care.

More indications exist for hysterectomy than for any other surgical procedure. However, indications for hysterectomy do not define the indications for operative technique. ACOG tentatively addressed guidelines for the route of hysterectomy by issuing a statement developed by committee opinion that the choice of hysterectomy should be based on certain indicators (Table 8.6) (40).

Table 8.6 American College of Obstetricians and Gynecologists (ACOG) Guidelines for Hysterectomy Approach[41] 1989

1. Surgical indication
2. Patient anatomic condition
3. Data that support the chosen approach
4. Informed patient preference
5. Surgeon's expertise and training

ACOG indicators do not address the technical feasibility of the various hysterectomy types. Therefore, a consensus regarding the technical issues for removal of the uterus by the various methods must be reached in order to respond to the evidence of the Cochrane study and other reports, and to determine whether a particular indication for hysterectomy is technically feasible or not.

Technical Concerns

Abdominal hysterectomy has few, if any, technical concerns or limitations for removal of the uterus. The vaginal technique has three technical concerns for each indication requiring hysterectomy. These concerns focus on removal of a certain size and shape of uterus through a vaginal passageway of various sizes and shape. In addition, potential attachments to the uterus from certain pathologic conditions requiring hysterectomy might prohibit vaginal removal. Thus, the three basic technical issues from the indication point of view are: (i) the size of the uterus (e.g., leiomyomata); (ii) potential pathologic attachments to the uterus, tubes, and ovaries (e.g., endometriosis, adhesions, and adnexal pathology); and (iii) the adequacy of the vaginal passageway (e.g., a narrow vagina of less than two fingerbreadths especially at the apex of the vagina, or restrictive orthopedic conditions). These technical concerns are then matched to each hysterectomy indication. The entire decision analysis pathway is presented in Figure 8.1.

Decision Analysis

The concepts and methods of decision analysis are valuable objective tools for indicator development in determining the appropriate selection of a particular route of hysterectomy. Guideline development and adoption have been shown to make medical and surgical care more consistent for patients. Because the surgical care for hysterectomy has been shown to be inconsistent with the various methods chosen for uterine removal, it is time, in the best interest of the patients, to be more consistent in adopting operations based on the best surgical decisions to provide the best surgical outcomes.

In an attempt to study medical decision making, Wennberg et al. supplied a conceptual approach that predicates physician decision-making on the presence of well-defined scientific norms (i.e., a professional consensus) (41). When consensus is lacking or ambiguous, as is the case with the method of hysterectomy selection, physician decision-making is driven by subjective factors referred to as â€œpractice style,â€• which incorporates physician values, attitudes, tastes, and habits. Dorsey showed that decision making for hysterectomy at his institution was not based on technical feasibility but upon physician comfort and preference to perform abdominal or laparoscopic hysterectomy (26). This study suggested that many hysterectomies could have been performed vaginally. Therefore, technical feasibility from different indications was not a concern in decision making among surgeons at this institution and for the predominant use of abdominal or laparoscopic methods.

Eddy described two main steps in medical decision-making: (i) the outcomes of alternative practices must be estimated, and (ii) then the desirability of the individual options must be compared (42). Decision analysis is a systematic approach to making decisions under conditions of uncertainty and developing guidelines as to what is safe and effective for such decisions.

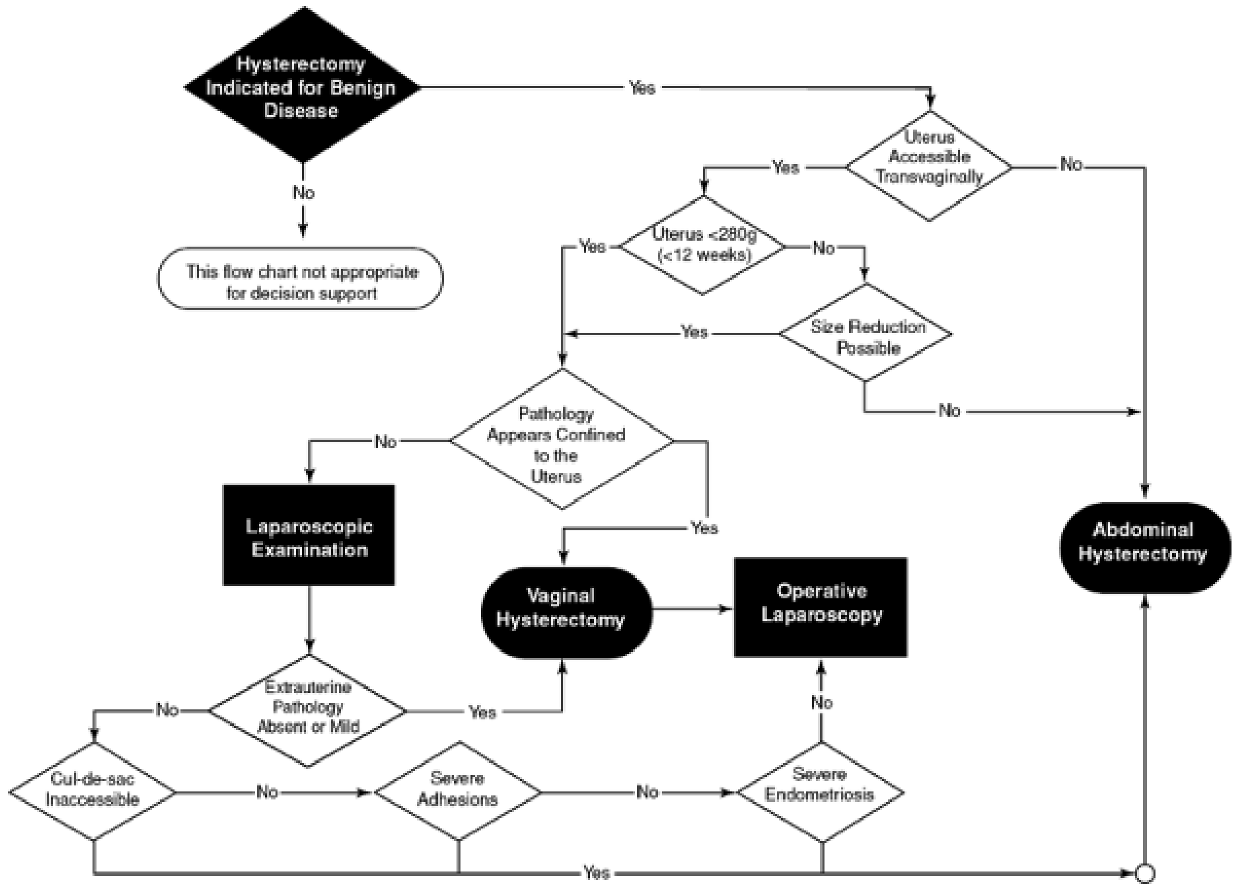

Figure 8.1 Determining the route of hysterectomy.

It is also important to consider the patients' preferences because they are the ones who are affected most by outcomes data. Because patients might not be consulted or be knowledgeable about alternative therapy, or physicians might project their own preferences on patients, misperceptions of a patient's preferences can occur.

Not all hysterectomies demand a specific operative approach, that is, some hysterectomies can be performed vaginally or abdominally for similar conditions. Therefore, the goal of physician decision making under these conditions would be to select the operative approach that patients find desirable by comparing the outcomes of these alternative surgical approaches for hysterectomy and informing them of these data. For benign conditions requiring hysterectomy, surgeons are thought to choose the approach depending on the feasibility of the procedure and the difficulties expected during surgery. These decisions would broadly comprise the indications and contraindications for abdominal or vaginal hysterectomy.

Because the majority of hysterectomies are safe and successful operations and most patients recover well over time, surgical decision making is often only questioned when a complication occurs. Does this suggest that successful completion of a hysterectomy alone is an acceptable measure of appropriate care, since there are measurable differences in the medical and economic outcomes for abdominal, laparoscopic, and vaginal hysterectomy?

Studies on the outcomes of hysterectomies for similar indications strongly support the vaginal approach. One study confirmed the marked variation in health care for hysterectomies performed for similar indications by different routes when there are no guidelines to follow (15). This study documented that length of stay was longer after abdominal hysterectomies than LAVH or vaginal hysterectomies (3.99 + 1.16 days, and 2.45 + 1.58 days, and 2.76 + 0.94 days, respectively; p <.001). There was a higher risk of one or more complications after abdominal hysterectomies (9.3%) than after LAVH (3.6%; p <.001) or vaginal hysterectomies (5.3%; p <.001). The median hospital charges for LAVH and abdominal hysterectomies were 71% and 35% higher than for vaginal hysterectomies. The incidence of postoperative infection or fever was higher after abdominal than vaginal hysterectomies (4.0% versus 0.8%; p = .029).

During residency training residents are taught how to operate, but it is with experience in the practice of medicine

and surgery that surgeons become better at what they do. Learning how to make better decisions for patients is how they become better physicians. Physicians learn this through experience, postgraduate education, and continued personal education. Either new decisions routed in clinical evidence to improve patient care will be adopted or surgeons will continue to practice as they were taught and make decisions based upon traditional concepts that have become obsolete. The former may make them better physicians, whereas the latter may not.

Guideline Development

Although the availability of different routes and methods of hysterectomy has aided the practice of gynecology, it is imperative that guidelines be established to clearly define the most appropriate route for each clinical situation. Very often, a hysterectomy that should have been done vaginally is done abdominally or laparoscopically, only because it is the preferred practice or more easily performed by the surgeon. Having made the easier choice, the gynecologist then tries to justify the decision by asserting that the vaginal route is indicated only in obvious cases of uterine descent or visible prolapse. Sheth describes this practice as â€œchronic excuses from chronic evaders.â€• In addition Sheth states: â€œan experienced gynecologist will always maintain that some contraindications to VH are relative and never absolute-they only vary with the skill of the surgeonâ€• (43). As Cruikshank stated at the 7th Pelvic Reconstructive and Vaginal Surgery Conference in 1994, the only contraindication to vaginal hysterectomy is a previous hysterectomy (personal communication).

There is broad recognition within medicine that clinical guidelines can improve quality by reducing inappropriate treatments and recognizing geographic consistency in the delivery of care, liability protection, and cost savings. Physicians are exposed to guidelines every day, whether they use guidelines for ordering specific tests or for how to manage common conditions such as diabetes or heart disease. However, some surgeons are opposed to clinical guidelines for hysterectomy because they fear implementation of evidence-based guidelines might cause them to practice in a less comfortable manner and no longer allow them to choose a route of hysterectomy based upon their comfort or preference.

Guidelines are the best method by which to determine the feasibility of the hysterectomy type selected. These guidelines do not demand that all cases be performed vaginally. They simply identify many conditions thought to demand the abdominal approach from traditional teaching that have been proven to be invalid or obsolete. If no guidelines are available for surgeons to follow, the number of abdominal hysterectomies will never be reduced, as no method will exist to determine the feasibility of the less-invasive vaginal approach. Many unnecessary abdominal hysterectomies will continue to be performed because gynecologists may continue to propagate the false facts developed in the late nineteenth and early twentieth century to future generations of gynecologists.

Although several guidelines have been proposed, most have either not been subjected to rigorous scientific analysis or it is impossible to apply them in everyday clinical practice. As previously stated, ACOG guidelines do not detail clear-cut criteria for identifying anatomic or technical concerns that would aid physicians or patients when selecting a particular route of hysterectomy. There is also a resistance to guideline development and acceptance despite new evidence suggested by some researchers (40).

When the SPRS guidelines were field-tested in a resident clinic population, the 3:1 ration of abdominal to vaginal hysterectomy previously documented in this program changed to 1:11 using the SPRS guidelines (44). This study showed that the application of evidence-based guidelines in a residency program enhanced both resident surgeon training and experience in the selection and performance of the most appropriate and least invasive hysterectomy procedure for future clinical practice. The guidelines have also been tested in several countries with similar reductions in abdominal hysterectomy rates. Prospectively assigning patients to a particular route of hysterectomy and studying the outcomes of such an assignment represents high quality evidence, since randomization of assignment may not be ethically correct because of knowledge about the differences with the outcomes of each hysterectomy type.

How to Apply the Guideline Decision-Tree

Vaginal hysterectomy is considered the special province of the gynecologic surgeon and the showcase operation. Vaginal hysterectomy is the gold standard. Vaginal hysterectomy has many advantages over abdominal hysterectomy, yet there are certain indications for the abdominal approach. The question that remains is whether the traditionally taught indications for the abdominal route are sufficiently absolute to result in the 3:1 ratio of abdominal to vaginal hysterectomy in the United States.

Because the outcomes for the abdominal approach have been documented to be the least advantageous for patients, it is logical to assume that surgeons who operate on women would want to perform this approach in as few cases as possible. To do this, the circumstances under which other options are safe and successful (technically feasible) must be identified. If evidence-based guidelines could be adopted, then the route of hysterectomy could be selected on objective criteria. As explained, development of guidelines has been difficult. ACOG offered general guidelines that state that the route of hysterectomy should be dependent on the patient's anatomy and the surgeon's experience (45). These are simply not sufficiently specific to aid in the proper selection process.

The SPRS guidelines were based on the evaluation of the most stated reasons the abdominal route is mandated: (i) the size of the uterus, (ii) potential extrauterine conditions, and (iii) the lack of accessibility of the vaginal passageway. The SPRS Board decided it was possible to create similar groups for each indication requiring hysterectomy in terms of uterine size, potential extrauterine attachments, and accessibility of the vaginal passageway. The Latin expression â€œceteris paribus,â€• that is, â€œall else being equalâ€• came to mind. Guidelines for hysterectomy were developed to help physicians base their practice on evidence by dividing clinical diagnoses into groups that could be considered equal. These guidelines address the most common reasons women are given as to why the vaginal approach is not possible: (i) the uterus is â€œtoo big,â€• (ii) adhesions and scarring â€œmay beâ€• present, (iii) or the vagina is â€œtoo narrowâ€• and the surgeon can not see what he/she is doing.

Using the guidelines, once the indication for hysterectomy has been determined, it must first be determined whether the vagina is accessible for transvaginal removal.

Vaginal Accessibility (Feasibility) of the Uterus

A major factor in determining the route of hysterectomy is vaginal accessibility of the uterus for transvaginal removal. Inadequate accessibility because of a narrow vagina, especially at the vaginal apex, makes vaginal hysterectomy technically challenging and may contraindicate vaginal hysterectomy even for surgeons experienced in this procedure. Two factors technically limit vaginal accessibility: (i) an undescended and immobile uterus and (ii) a vagina narrower than two fingerbreadths, especially at the apex. In one study, to determine why physicians make their decisions regarding abdominal hysterectomy, it was reported that those predisposed to the abdominal route were less likely to take note of uterine mobility or vaginal accessibility in their preoperative examinations, as these factors do not appear to be issues in their decision making (46). A narrow pubic arch is frequently suggested as a contraindication to vaginal hysterectomy but is usually not a deterrent to the vaginal route. Harmanli reported that a narrow pubic arch was a deterrent for performing vaginal hysterectomy (47). In the author's experience a narrow pubic arch has rarely been a deterrent to the vaginal route. To obtain objective evidence that the uterus is undescended or immobile, an evaluation in the operating room when the patient is anesthetized can be performed by placing a tenaculum on the cervix to assess whether the cervix descends beyond the ischial spines under cervical traction. If this does not occur, then an objective examination and report of this finding can be accurately stated, and the surgeon can record the objective finding that the uterus is truly undescended and probably immobile, thereby justifying the actual need to perform the abdominal route.

Nulliparity is not an absolute indication for abdominal hysterectomy. Although access to the vagina may be restricted in some nulliparous women, vaginal accessibility cannot be assumed in all cases. In fact, there is no evidence in the literature to support the widely held belief that nulliparity makes vaginal hysterectomy difficult. Despite the belief that accessibility of the vagina may be frequently offered as a justification to avoid the vaginal approach, one study evaluated this possibility and documented that of 617 women only 1% of patients had an inadequate vaginal passageway that excluded the performance of the vaginal route (24). Figueiredo et al. and Agostini et al. also reported on success of vaginal hysterectomy for the nulliparous patient (48,49).

If the vagina is accessible for transvaginal removal of the uterus, the next question the surgeon needs to ask is â€œDoes the uterus weigh less or greater than 280 g?â€•

Uterine Size (Feasibility)

Gynecologic surgeons in the twentieth century have considered an â€œenlarged uterusâ€• as an â€œindication for abdominal hysterectomy,â€• but the term enlarged has never been clearly defined. It is unclear why leiomyomas are more frequently an indication for abdominal or laparoscopic hysterectomies. A consensus must be reached on the size of the uterus that the average generalist who performs hysterectomy is comfortable in performing, either by the abdominal or vaginal route. A normal uterus weighs approximately 70 to 125 g (Table 8.7).

Table 8.7 Uterine Weight and Gestational Size (ACOG, 1989)[51]

Type of Uterus	Weight (g)
	Normal Uterus
Nulliparous	Multiparous
Enlarged Uterus (gestational size)	
8 weeks	125â€“150
12 weeks	280â€“320
24 weeks	580â€“620
Term	1,000â€“1,100

ACOG and other investigators over the last 100 years assert that a vaginal hysterectomy is appropriately indicated in women with mobile uteri of less than 12 weeks of gestational size (<280 g), thus suggesting that removal of uteri heavier than 280 g is appropriately performed by the abdominal route (15,40). However, uterine size may

be frequently overestimated with pelvic examination and without more objective criteria. Because 80% of uteri removed in the United States for various indications weigh less than 280 g and are removed by the abdominal route, this suggests that the abdominal approach is overutilized in many cases where the size of the uterus is not really a contraindication to the vaginal route. Furthermore, this demands that a more accurate and objective evaluation of the preoperative weight of the uterus be determined before the abdominal route is selected on the basis of a proposed â€œenlarged uterus.â€• Stovall stated, â€œthat the greatest limitation to the surgeon's ability to routinely perform vaginal hysterectomy is uterine sizeâ€• (50). Although this may be true in some cases, the evidence documents the fact that many hysterectomies are being performed abdominally for uteri deemed preoperatively â€œtoo largeâ€• for some surgeons to remove vaginally when the postoperative pathologic weight of the uterus does not support this. Therefore, reporting the postoperative pathologic weight of the uterus for comparison of uterine size is of critical importance in evaluating the accuracy and feasibility of preoperative uterine size estimates that are used in the decision-making process for selecting abdominal hysterectomy.

The size or weight of the uterus *in vivo* often can be objectively measured by preoperative transvaginal ultrasonography. An algebraic formula is used to determine uterine size expressed in measurements and weights. By multiplying the three dimensions of the uterus in centimeters (length x width x anteroposterior diameter at the fundus) by 0.52, a more accurate assessment of preoperative estimate of uterine size can be obtained (51). Preoperative documentation of uterine size *in vivo* can help prevent the selection of an abdominal hysterectomy because the uterus is subjectively deemed â€œtoo bigâ€• for transvaginal removal. Therefore, potentially 80% of hysterectomies are currently performed abdominally for this reason. This demands that a professional consensus be reached on what uterine size can appropriately be performed by the vaginal route. The 280-g guideline suggested by ACOG and others appears to be appropriate.

If evidenced-based randomized studies clearly support the use of vaginal hysterectomy for patients with enlarged uteri weighing more than 280 g, an ethical issue may be raised if a surgeon is unwilling or unable to perform vaginal hysterectomy for the enlarged uterus not because it cannot be done, but because he or she cannot perform it. Should the physician consider referring the patient to a colleague who is properly experienced in the vaginal approach or learn the technique?

When surgeons become more familiar with vaginal hysterectomy, it has been shown that they find more indications to use the vaginal route. Experienced vaginal surgeons have investigated the outcomes of removing uteri weighing more than 280 g transvaginally rather than by the abdominal route with the use of morcellation techniques. The first of these studies to rekindle interest in morcellation techniques was introduced in 1986 and confirmed that vaginal hysterectomy with intramyometrial coring was associated with lower morbidity and significant decrease in length of hospitalization (52,53) (Figs. 8.2, Figs. 8.3 and Figs. 8.4).

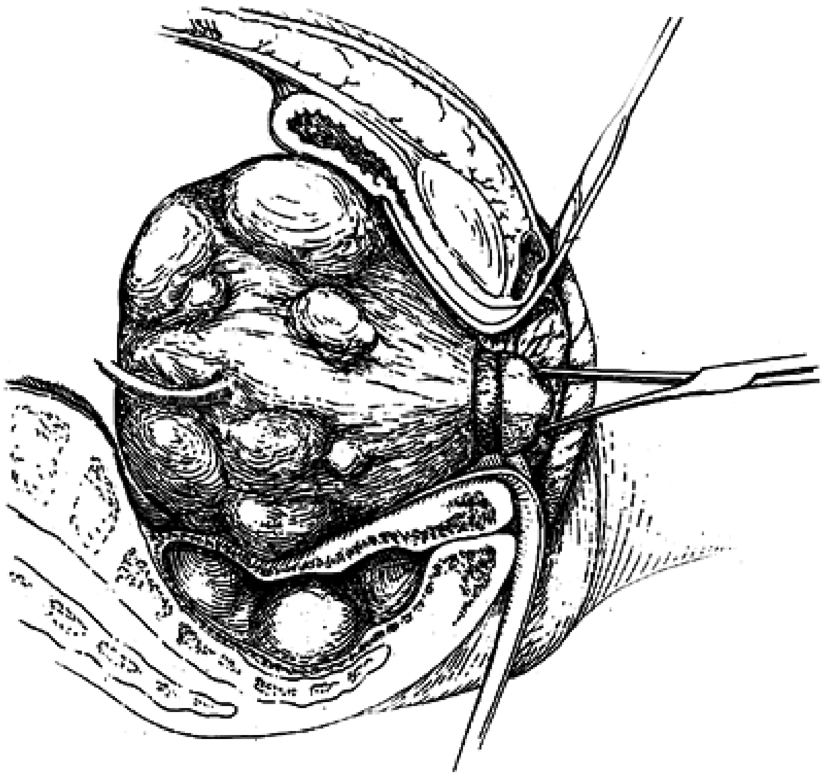

Figure 8.2 Continued coring and traction reduces the size of the uterus by exteriorizing the inside of the uterus with an intact endometrial cavity through the introitus. Intramural myomas are sometimes transected during the coring process. (From, Society of Pelvic Reconstructive Surgeons, www.guidelines.gov.)

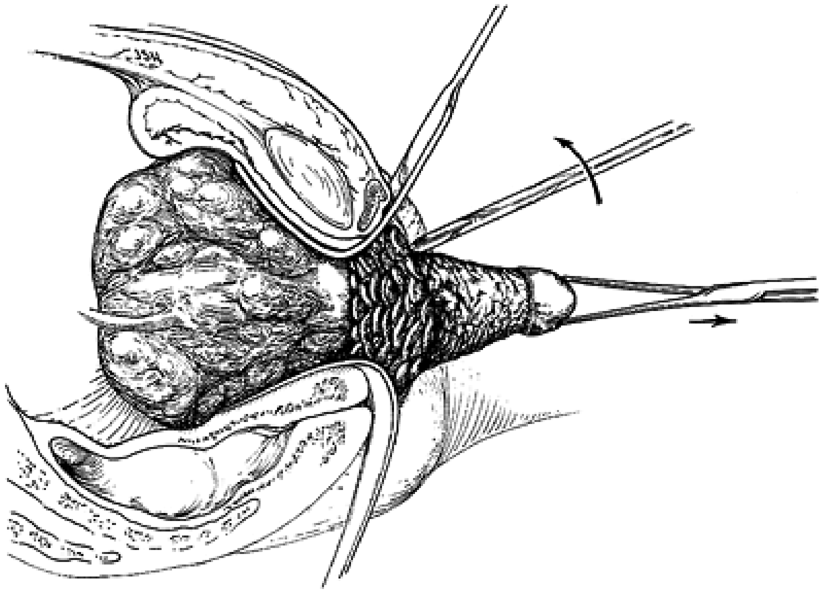

Figure 8.3 The cervix has been circumscribed through the full thickness of the vagina around the cervix, the posterior and anterior peritoneum entered, and the uterosacral and cardinal ligaments secured. (From,
Kovac SR. Intramyometrial coring as an adjunct to vaginal hysterectomy. *shape Obstet Gynecol* 1986;67:131â€“136.
)

Further randomized studies compared the advantages, disadvantages, and outcomes in patients who underwent abdominal or vaginal hysterectomy for enlarged symptomatic uteri ranging from 280 to 1300 g. These studies clearly demonstrate the advantages of the vaginal route in terms of operative times, febrile morbidity, less demand

for narcotics, and reduction in hospital stay (53,54). No differences in intraoperative complications were noted between abdominal and vaginal hysterectomy for enlarged uteri. Several investigators reported use of pharmacologic agents that not only produce a temporary state of amenorrhea permitting a significant rise in depressed preoperative hemoglobin and hematocrit levels, but also reduced the risks of transfusion. These agents also reduced the size of symptomatic uterine leiomyomata by 30% to 50% and decreased uterine volume by one third (a medical debulking), before hysterectomy, perhaps allowing more patients to be candidates for vaginal hysterectomy (55,56).

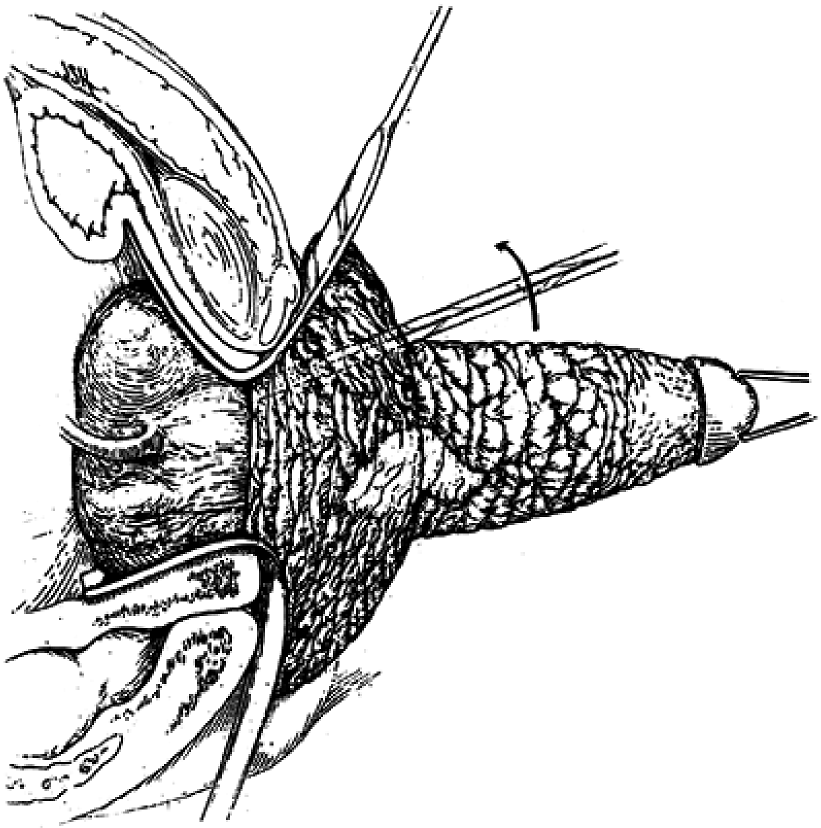

Figure 8.4 After ligation of the uterine arteries, an incision is made in a circumferential fashion parallel to the endometrial cavity and into the outer superficial myometrium in the same plane. Constant traction on the tenaculum while coring assists in developing the proper plane. (From, Kovac SR. Intramyometrial coring as an adjunct to vaginal hysterectomy. *Obstet Gynecol* 1986;67:131â€“136.
)

The next question of the clinical decision tree is if the pathologic condition requiring removal of the uterus extends beyond the confines of the uterus do these concerns require the use of diagnostic laparoscopy?

Extent (Feasibility) of Pathology

Determining whether the pathologic condition for hysterectomy is confined to the uterus or extends beyond its confines is critical to selecting the appropriate route of hysterectomy. There are certain indications for hysterectomy that in and of themselves do not extend beyond the confines of the uterus (Table 8.3). If these conditions are not associated with a previous history of pelvic surgery, pelvic inflammatory disease, endometriosis, or potential adnexal pathology, the technical concern for uterine removal should only be the size of the uterus and the accessibility of the vaginal passageway. When the patient's history or preoperative examination suggests the possibility of pathologic conditions extending beyond the confines of the uterus, further objective evaluation may be necessary. Traditionally, gynecologic surgeons used the information obtained from the patient's history, physical examination, and imaging techniques, such as ultrasound and x-ray studies, to determine whether extrauterine pathologic conditions possibly extended beyond the confines of the uterus. However, investigators have concluded that these techniques are not sufficiently accurate to document the severity of those conditions, especially endometriosis, adnexal pathology, chronic pelvic pain, and pelvic inflammatory disease. Such preoperative examinations are insufficient to accurately allow surgeons to make precise surgical decisions that could potentially result in adverse outcomes (30).

When surgeons base their decision to perform an abdominal hysterectomy on the clinical history and pelvic examination, without further documentation of the severity of the pathologic condition, the surgical findings are often insufficient to support the selection of the abdominal route. This represents a diagnosis/treatment discrepancy, which suggests that the mere suspicion of the severity of the pathologic condition should not dictate the route of hysterectomy selected. Thus, the value of diagnostic laparoscopy has proven to be an important tool to confirm whether or not these presumptive preoperative indications for hysterectomy require the abdominal approach.

As surgeons evaluate the technical concerns for removal of the uterus, it should become clear that it is no longer appropriate to suggest that certain indications require a particular route of hysterectomy, but rather the accurate documentation of uterine size, potential extrauterine conditions, and the accessibility of the vaginal passageway for each indication must be determined. These conditions should be accurately documented and recorded. These are the real issues in determining whether the abdominal route is mandatory or the vaginal route is possible. In fact, these are the same issues suggested by surgeons as to why the abdominal route is required. It would not be unfair to suggest that these conditions be objectively documented before a particular route of hysterectomy is selected. Therefore, three critical determinations should be objectively evaluated before a particular route of hysterectomy is selected for any indication that requires a hysterectomy:

- The adequacy of the vaginal passageway must be objectively evaluated and recorded.
- An objective measurement of uterine size must be documented.
- The presence of extrauterine conditions that might prevent the completion of a vaginal hysterectomy must be objectively identified.

Investigators who have used the SPRS guidelines in several countries have successfully reduced the numbers of abdominal hysterectomies and increased the numbers of vaginal hysterectomies with marked improvement in the surgical outcomes of their patients. One such study in the United States demonstrated that these evidence-based practice guidelines could potentially save 1.2 million dollars for every 1,000 hysterectomies performed, would free up 1,020 patient hospital stays, and would reduce complications by 20% (57). In addition, when these guidelines were followed in a resident training program, the ratio of abdominal to vaginal hysterectomy was reduced from 3:1 to 1:11 (41).

Some surgeons may remain reluctant to change their practice patterns and continue to select the abdominal route. Failure to adopt evidence-based formal practice guidelines may allow surgeons to continue to choose a route of hysterectomy based upon their comfort and preference and not on the clinical evidence that supports the best hysterectomy. Such choices usually follow statements from surgeons that attempt to justify the appropriateness of their choice using certain clinical conditions that have traditionally been suggested to require the abdominal approach (Table 8.1). In many cases the surgical decision is made for similar conditions without the evidence supporting one procedure over the other. From his writing on vaginal hysterectomy, Kennedy stated that â€œthere is nothing more unscientific and dangerous than that which will accrue as a consequence of over enthusiasm for any surgical procedure based on ease of facility of accomplishment â€¦. nor more costly to human life for a surgeon to adopt a procedure which is commensurate with his ability, and yet quite inefficient in mastering the true surgical pathology of the lesionâ€¦.â€• The real value of any surgical procedure must be measured in terms of morbidity and mortality, and not in factors of ease of executionâ€• (1).

The fact that physician attitude fostered in training may dominate clinical considerations is made clear by a number of revealing studies. In one study of hysterectomy practiced over a 5-year period at a district general hospital in the United Kingdom, a mandate by the Royal College of Obstetricians and Gynecologists was issued to carry out as many hysterectomies as possible by the vaginal route (58). In the 5 years after the mandate, the percentage of abdominal and vaginal procedures changed from 68% and 32% to 5% and 95%, respectively, without any increase in morbidity. If gynecologic surgeons in the United Kingdom can successfully achieve such a conversion, it is logical to assume that U.S. surgeons can do likewise.

It is hoped that this chapter can assist with this conversion. In a personal communication with G.S. Han, he reported that during his residency he performed only four vaginal hysterectomies, but now performs more than 90% of his hysterectomies by the vaginal route. He has published his conversion to the vaginal approach (59).

The pendulum for performing minimally invasive surgery appears to be swinging back to vaginal surgery. Physician organizations, hospital associations, resident training programs, third party payers, and, most importantly, the patients that undergo hysterectomy procedures are suggesting the adoption of evidence-based medical practice.

An example of this is that the SPRS Guidelines for determining the Route of Hysterectomy is now included in *Healthcare Standard's: Official Directory*, which is one of the most respected printed indices of health care standards (60). This reference book is used in law universities, medical schools, hospital libraries, and private medical and legal libraries. It is used daily by risk managers and patient safety officers, directors of nursing, clinical engineers, medical malpractice attorneys, legal researchers, device manufacturers, and other health care professionals. Its purpose is to keep professionals on top of the changing landscape of health care standards, guidelines, laws, and regulations.

The effect on gynecologic practice of selecting the route of hysterectomy using the SPRS guidelines has been shown to have a most positive effect on physician performance and patient satisfaction. These guidelines help to accurately determine the technical feasibility and medical appropriateness of performing vaginal hysterectomy.

The next chapter will address how to technically perform a vaginal hysterectomy.

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9

Vaginal Hysterectomy

S. Robert Kovac

Carl W. Zimmerman

Every gynecologic surgeon has an obligation to personally possess or offer by referral a certain set of skills that are required for the basic surgical care of his/her patients. Vaginal hysterectomy is the bedrock skill and the signature operation of the gynecologic profession. Ample evidence exists to show that patients who undergo the vaginal approach experience lower morbidity, less pain, more rapid recovery, more rapid return to normal activities, consumption of fewer health care dollars and resources, and a host of other benefits. The minimum skill required of a gynecologic surgeon is the ability to perform abdominal and vaginal hysterectomies. Few contraindications exist to vaginal hysterectomy (see Chapter 8); therefore, the vaginal approach should be the first option offered to the patient. Failure to offer a vaginal approach violates the ethical principle of *ceteris paribus*. This principle states that when two possible approaches may be used to accomplish a given medical goal, the surgeon acts unethically when using the more painful and more morbid of the two. Each gynecologic surgeon should develop the training and experience required to maximize the use of the vaginal approach for hysterectomy because this use of this natural orifice surgical approach is minimally invasive and maximally beneficial to the patient. If a hysterectomy is begun vaginally, no harm is done if, during the operation, a timely decision is made to insert a laparoscope or convert to laparotomy to safely complete the procedure. An experienced surgeon can generally decide when to convert to another approach in order to avoid complications. A conversion of approach should be infrequent. The additional incisions and/or instrumentation required in a change of approach would have been used if the vaginal approach had not been attempted primarily. No one can ethically defend limiting the most beneficial approach to a given operation on the basis of a surgeon's lack of training or skills. No surgical specialty should tolerate the use of a suboptimal approach to a problem on the basis of the inability of doctors of that specialty to perform a superior operation. Vaginal hysterectomy is and should remain the hallmark of gynecologic extirpative surgery and surgical excellence. Vaginal hysterectomy is the â€œgold standardâ€• for the surgical removal of the uterus.

Adequate surgical instrumentation is necessary for the performance and completion of a vaginal hysterectomy. In the operating room, the surgeon is often presented with a surgical tray that consists of a set of weighted vaginal speculums from a dilation and curettage set added to a laparotomy tray. These instruments are insufficient to perform a simple, much less a complicated, vaginal hysterectomy (see Chapter 6). Because the vagina is a relatively restricted space for surgery, the numbers of instruments employed at any point during the procedure should be kept at a minimum to prevent clutter and restricted vision in the operative field. The numbers of instruments used during any gynecologic operation are inversely proportional to the skill of the surgeon, and the quality of instruments is directly proportional to the skill of the surgeon. These concepts are especially true in vaginal surgery (Fig. 9.1A-C).

When the surgeon has concerns about the potential to unintentionally cause injury to the rectum, it should be cleansed by an electrolyte purgative such as GoLytely, NuLytely, and HalfLytely (Braintree Laboratories, Inc., Braintree, MA), or Colyte (Schwarz Pharma, Inc., Mequon, WI) the evening before surgery. In a routine case, a Fleets enema is adequate if it is given the evening before surgery.

A single dose first-generation cephalosporin should be given one hour before the operation as a prophylactic measure. Prophylactic antibiotics have been documented to reduce the risk of postoperative infections. Gynecologists accept that a Betadine solution will remove potential pathogens in the vagina. For the last 20 years the senior author has checked the patient's vaginal pH before the operative preparation. The normal vaginal pH is 3.8 to 4.2. If the pH is not normal, the vaginal ecosystem is disturbed. If the vaginal pH is 5.0 or higher, the potential for bacterial vaginosis is great. In this circumstance, the facultative bacteria, normally present in the vagina at concentrations of 10^3, have reached concentrations of 10^8. This finding strongly suggests that the vagina was infected prior to the operation. These patients will not be protected by prophylactic antibiotics and will require postoperative therapeutic antibiotics, usually 500 mg of metronidazole orally twice daily from the postoperative days 2 to 7. This practice has reduced the senior author's postoperative infection rate from 9% from 1970 to 1986 to less than 1% from 1987 to the present.

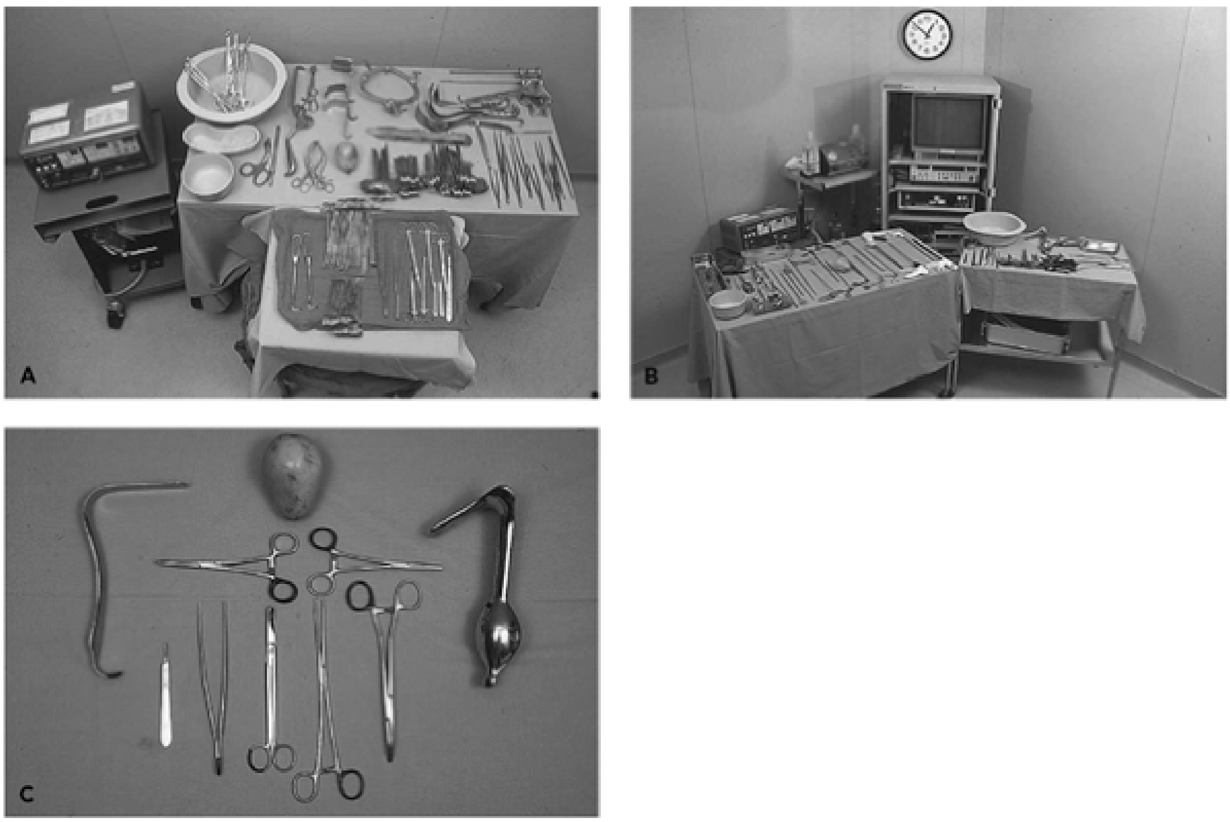


Figure 9-1 Numbers of instruments and equipment required for a simple hysterectomy for a uterus of similar size and shape, depicted by the same pear placed on each instrument tray: (A) abdominal, (B) laparoscopic, and (C) vaginal.

The senior author also prefers to prepare all patients with ethanol, even in the vagina, and to use a surgical drape (Ioban, 3M, Minneapolis, MN), which covers the rectum and keeps pubic hair and the labia from interfering with the operative field. Shaving of the pubic hair is clinically unnecessary. Shaven patients are more uncomfortable postoperatively. The authors are adverse to suturing the labia to the inner thighs.

Copious lavage of the vaginal vault before, during, and after completing vaginal hysterectomy will help to prevent postoperative febrile morbidity. Lavage is commonplace in laparoscopic and abdominal surgeries; however, it is not as frequently used in the vaginal approach. Lavage with a VitalVue (U.S. Surgical/Tyco Healthcare, Norwalk, CT) or a bulb syringe can be used to accomplish this goal. There is also a new light/suction/irrigation apparatus called VersaLight. (Lumitex, Inc., Strongsville, OH) (see Chapter 6).

Although some surgeons stand during vaginal hysterectomy, others prefer to sit. However, in order to make the assistants comfortable during the operation, the surgeon's chair is raised to a height that allows the assistants to stand straight during the entire procedure. The authors prefer to operate with the tray of necessary instruments on their laps. Because the scrub nurse frequently stands behind the surgeon, the passage of instruments is inefficient and increases operative time. Footstools are helpful in keeping the instrument tray level and stable on the surgeon's lap.

The type of stirrups used for the lithotomy position is solely at the discretion of the surgeon. Whatever type is used, careful attention is required to protect vulnerable vascular, bony, and neurologic points in the lower extremities. The patient is then positioned with the buttocks at the end of the surgical table or just beyond. The table is placed at a zero horizontal position without Trendelenburg. In this manner, the surgeon can see directly into the vagina without looking over the weighted speculum. Final positioning should protect the patient and allow the surgeon to operate comfortably. The assistants need to stand inside the patient's legs so they can observe the operative field, assist in an appropriate manner, and learn the operation. Adequate room is necessary for surgical assistants to be effective. Pneumatic stockings are also recommended to help prevent thromboembolic disease.

Catheterization of the bladder is optional at the initiation of vaginal hysterectomy. Sometimes unintentional cystotomy is easier to identify when the bladder contains some urine rather than when it is empty. Conversely, if the bladder is distended, catheterization may improve the visibility within the restricted operative space. Some surgeons prefer to instill a dilute solution of indigo carmine or methylene blue to ensure recognition of an unanticipated operative injury to the bladder. Bladder injuries may occur during the course of any gynecologic procedure. Sterile milk or formula obtained from the newborn nursery is a valuable tool for identifying bladder injuries during a vaginal hysterectomy. When instilled into the bladder, any leakage will be visible in the operative field, and the site of injury can readily be localized. If an unintentional operative cystotomy occurs, complete the vaginal hysterectomy before repairing the bladder. The bladder must be mobilized adequately around the operative injury to allow the surgeon to completely evaluate the extent of the cystotomy and to be certain that the repair is completed without excessive tension.

An examination under anesthesia should be performed before initiation of the operation to reaffirm the preoperative findings. Undetected pathology may be appreciated during an anesthetized examination, and a more complete assessment of the subtleties of the patient's anatomy will be attained. Placement of a tenaculum on the cervix to apply traction can document the degree of descensus. If more descensus is desired, traction on the cervix with vigorous massage of the uterosacral ligaments for approximately 30 seconds will result in further descensus of the cervix of approximately 2 to 3 cm.

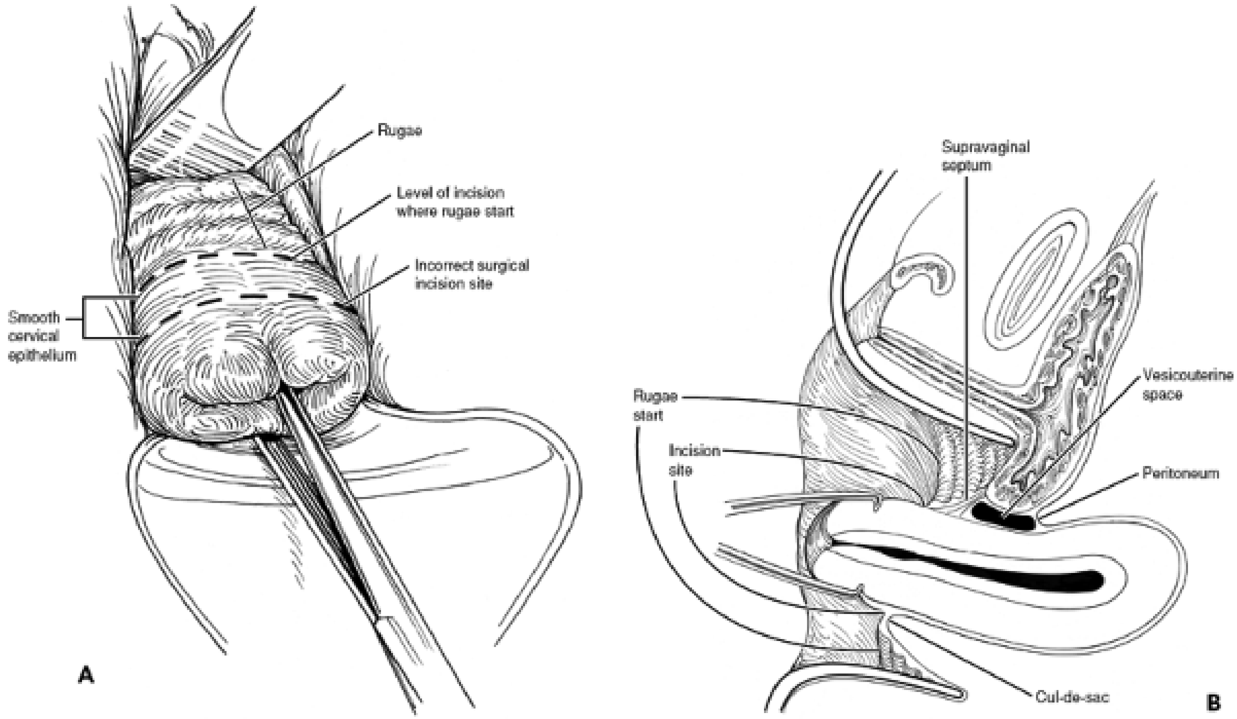


Figure 9-2 A: Initial incision should be a full-thickness incision at the border where the vaginal rugae begin and the smooth cervical epithelium of the cervix ends. B: Relationship between the vaginal rugae and the anterior and posterior peritoneum.

Operative Technique

The most frequently used method for vaginal removal of the uterus has been the Heaney technique. The second in frequency is the DÃ¶derlein hysterectomy. The third is the Mayo vaginal hysterectomy promoted by Joseph Pratt and performed by him in 8,351 cases (personal communication). The authors have performed the Kovac-Zimmerman vaginal hysterectomy technique for 65 years cumulatively.

Regardless of the route of surgical approach, the uterus should be removed without injury to the urinary and gastrointestinal systems. The initial incision of the vagina should be made at the border of the vaginal rugae and smooth cervical epithelium through the full thickness of the vagina (Fig. 9.2A). A circumscribing incision made close to the cervix is frequently taught to preserve vaginal length and avoid unintentional entry into the bladder. This teaching is incorrect because decreased rugae mark the point where the actual vagina begins. In addition, an incision

adjacent to the vaginal rugae is closer to the point of entry into the posterior and anterior peritoneum (Fig. 9.2B). It also reduces blood loss from the dissection of the connective tissues between the vagina and the peritoneum. This dissection would involve transection of several cervical branches of the uterine artery. Thus, bleeding will be less when the incision is made where the rugae begin. Some surgeons have suggested the possibility that this incision location increases the risk of inadvertently opening the bladder or rectum. Surgeons who employ this technique have not found this approach to be a concern.

Many surgeons infiltrate the vaginal wall with a mixture of 1:200,000 epinephrine diluted in normal saline for control of small blood vessel bleeding from the vaginal walls. Julian has reported on the benefit of this technique (1). Rarely does oozing from the vagina result in significant loss of blood when the cervical incision is made at the proper level. If oozing from the vagina becomes a problem, it is easy to control with electrocautery. For many years, it has been taught that the initial cervical incision should be a complete circumscribing incision. However, when the cervix is within the vagina at the start of the operation, the circumscribing incision makes it difficult to hold the scalpel perpendicular to the vaginal incision. This difficulty is not a concern when the cervix protrudes from the vagina. In recent years, the authors have taught that the initial incision should be made on the anterior vaginal wall from approximately the ten to two o'clock positions, and on the posterior vaginal wall between the eight and four o'clock positions. This technique provides adequate space for the subsequent entry into posterior and anterior peritoneum (Fig. 9.3A,B).

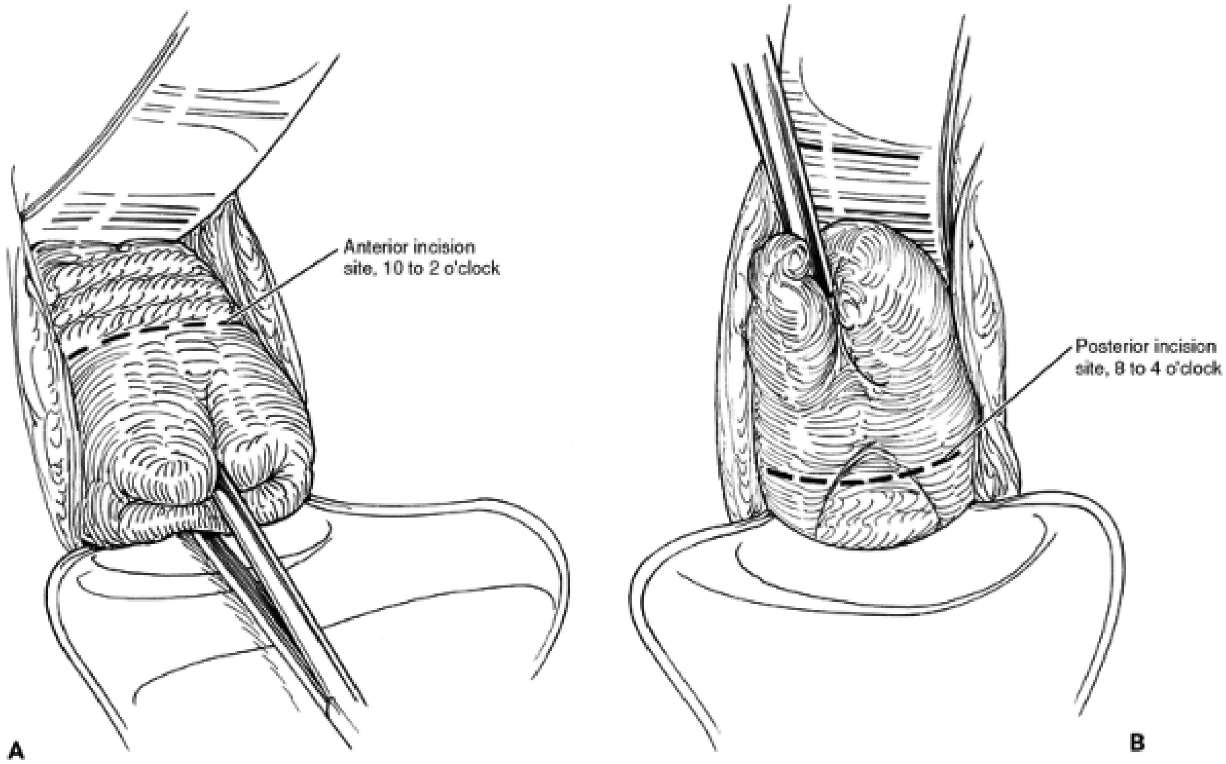


Figure 9-3 A: When cervix remains within the vagina when traction is applied with a tenaculum, the anterior full-thickness vaginal incision need only to be performed between 10 and 2 o'clock. B: Initial full-thickness vaginal incision need only to be performed between the 8 and 4 o'clock position. Note this incision is placed posteriorly where the vaginal rugae begin and where the uterosacral ligaments attach to the cervix.

After these incisions are completed, the cervical tenaculum is replaced onto the posterior lip of the cervix, and taut traction of the cervix is achieved by elevating the tenaculum anteriorly. If the posterior incision in the vagina has been made at the appropriate level where the uterosacral ligaments join the cervix, the posterior cul-de-sac and peritoneum can be identified with tissue forceps. By putting the subvaginal tissue and accompanying peritoneum on stretch, these tissues will bulge outward toward the surgeon (Fig. 9.4A). This concept cannot be stated too strongly. Injury to the rectum is not prevented by incising the peritoneum close to the cervix. This idea represents an incorrect understanding of the pertinent anatomy. Peritoneal entry is best accomplished by incising the vertical crease created by upward traction on the cervix and grasping the fold with tissue forceps (Fig. 9.4B). Unfortunately, an incision placed near the cervix for entry into the peritoneum frequently results in a retroperitoneal dissection. Continued dissection

in this plane ultimately pushes the peritoneum both superiorly and posteriorly and makes the identification of the peritoneum more difficult. If this occurs, the posterior lip of the cervix and vagina can be cut in a vertical direction that exposes the peritoneum at a higher level so it can be recognized and entered directly, a cervical colpotomy (2) (Fig. 9.5A-C). This problem can be avoided if the subvaginal tissue and accompanying peritoneum are incised just above the tissue forceps that grasp the peritoneal fold (Fig. 9.4A,B). Infrequently, the cul-de-sac may be obliterated by adhesions. At this stage of the operation, proceed with an extraperitoneal dissection and sever the uterosacral ligaments and the cardinal ligaments to bring the uterus and peritoneal folds closer to the surgeon. If further adhesions are encountered, a decision must be made to continue with an extraperitoneal hysterectomy or to abandon the vaginal approach.

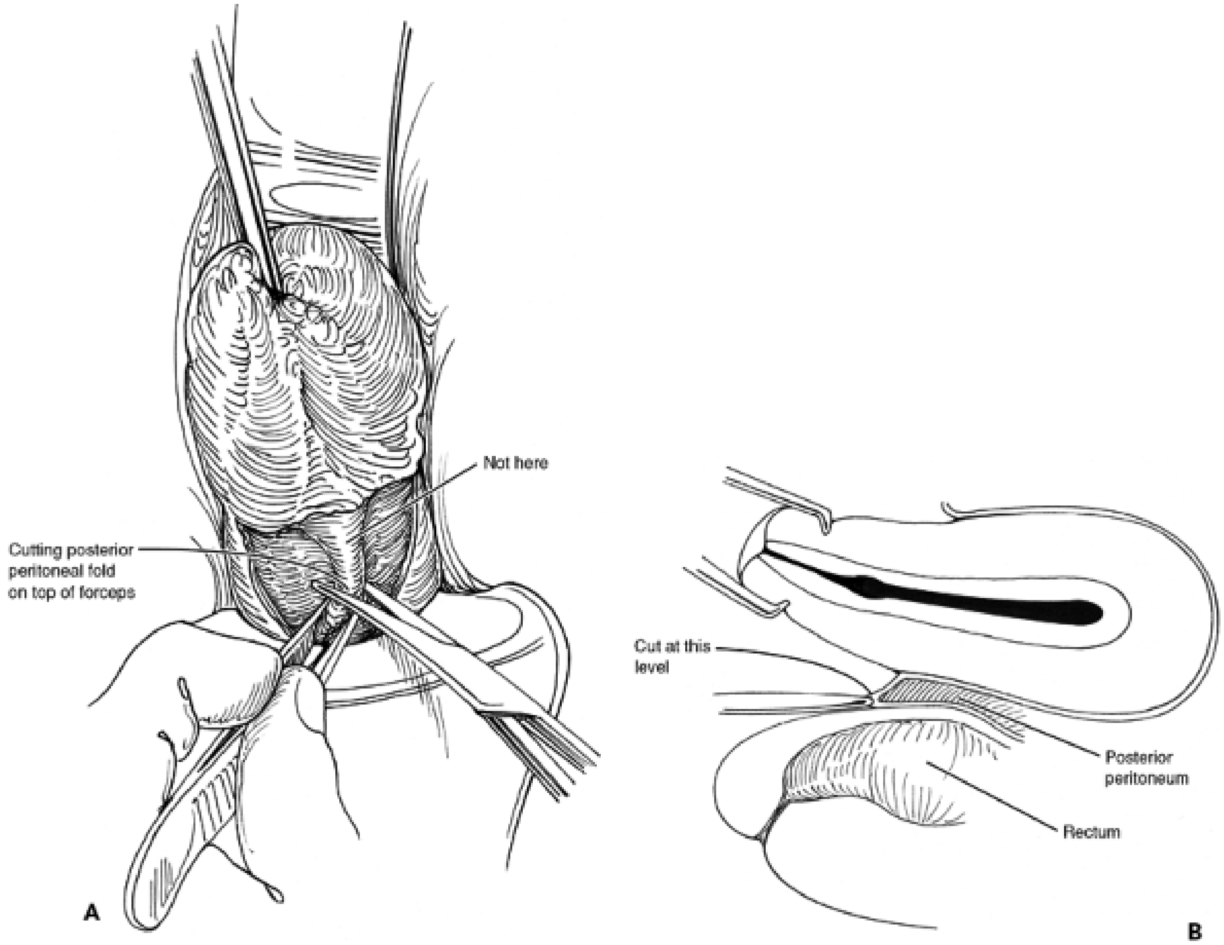


Figure 9-4 A: With traction on the cervix anteriorly, the posterior peritoneal fold is grasped with tissue forceps and the peritoneum is entered by incising with scissors the peritoneal fold directly above the tissue forceps. B: Transverse view of entering the peritoneal cavity.

The posterior peritoneum is opened with curved scissors to admit an examining finger, and subsequently a long-bladed Steiner-Auvard weighted speculum. Examination of the cul-de-sac can detect any additional pathology such as endometriosis, leiomyomata, or adnexal disease that may be encountered later in the operation. Identification of the uterosacral ligaments by palpation can be accomplished during examination of the cul-de-sac through the posterior colpotomy incision. Transection of the uterosacral ligaments is the single most important step in successfully completing a vaginal hysterectomy. No need exists to tag the posterior peritoneum to the vagina with suture because the edges of the peritoneum do not separate far from the edges of the vagina. Oozing of blood from this separation of the vagina and peritoneum may occur, but placement of a weighted speculum into the posterior peritoneal cavity will compress most bleeding points between the cut edges of the vagina and the peritoneum.

The cervix is then retracted downward or inferiorly, and the subvaginal tissue including the supravaginal septum

and the bladder is elevated with tissue forceps in the midline. The supravaginal septum is identified and incised with the tips of curved scissors pointing downward and the handles not elevated above the horizontal axis (Fig. 9.6A). This incision exposes the vesicouterine space, the proper avascular cleavage plane to gain access to the anterior peritoneum. To further develop this space, the blades of the scissors may be spread apart to open the tissue that normally fuses the posterior wall of the bladder to the cervix (Fig. 9.6B). A Kristeller lightweight right angle retractor (Marina Medical, Inc., Hollywood, FL) can be placed into the anterior peritoneal space to elevate the bladder and expose the anterior peritoneal fold. If the patient has had a previous C-section, the scar from this procedure can be readily visualized and

identified separately from the bladder (3). Controlled dissection of a C-section scar is easier and more directly visible vaginally than abdominally. A low transverse C-section incision is made in the cephalic portion of the cervix near the isthmus of the uterus. For that reason, in the nonpregnant state, the scar is very close to the anterior vaginal incision that is used to develop the vesicocervical and vesicouterine avascular spaces in vaginal hysterectomy (Fig. 9.6C). A C-section scar distorts the anatomy by reducing the vesicouterine space between the scar and the urinary bladder. Further dissection above the scar can be performed by identifying the scar, the bladder, and the peritoneum as independent structures. When possible, dissection under the scar keeps the dissection even farther from the urinary bladder (Fig. 9.7). The peritoneum is grasped and then entered above the tissue forceps by a 1-cm incision created by the scissors (Fig. 9.8, Inserts A1,A2). The shiny surface of the peritoneal cavity is recognized, and the opening is stretched

additionally by spreading the scissor blades into this space. A right angle retractor is inserted into the anterior cul-de-sac and kept in this position to elevate the bladder throughout the remainder of the operation. Retracting the bladder superiorly reduces the risk of operative injury to the bladder if the surgeon has properly dissected the vesicouterine space. A Kristeller right angle retractor does not have the heavy handle of the Heaney retractor and is more comfortable for the assistant to hold in place throughout the procedure (Chapter 6). The anterior peritoneal fold should always be opened under direct vision. The best location to enter the peritoneum depends on where the tissue-forceps grasp the fold (Fig. 9.8, Insert A1).

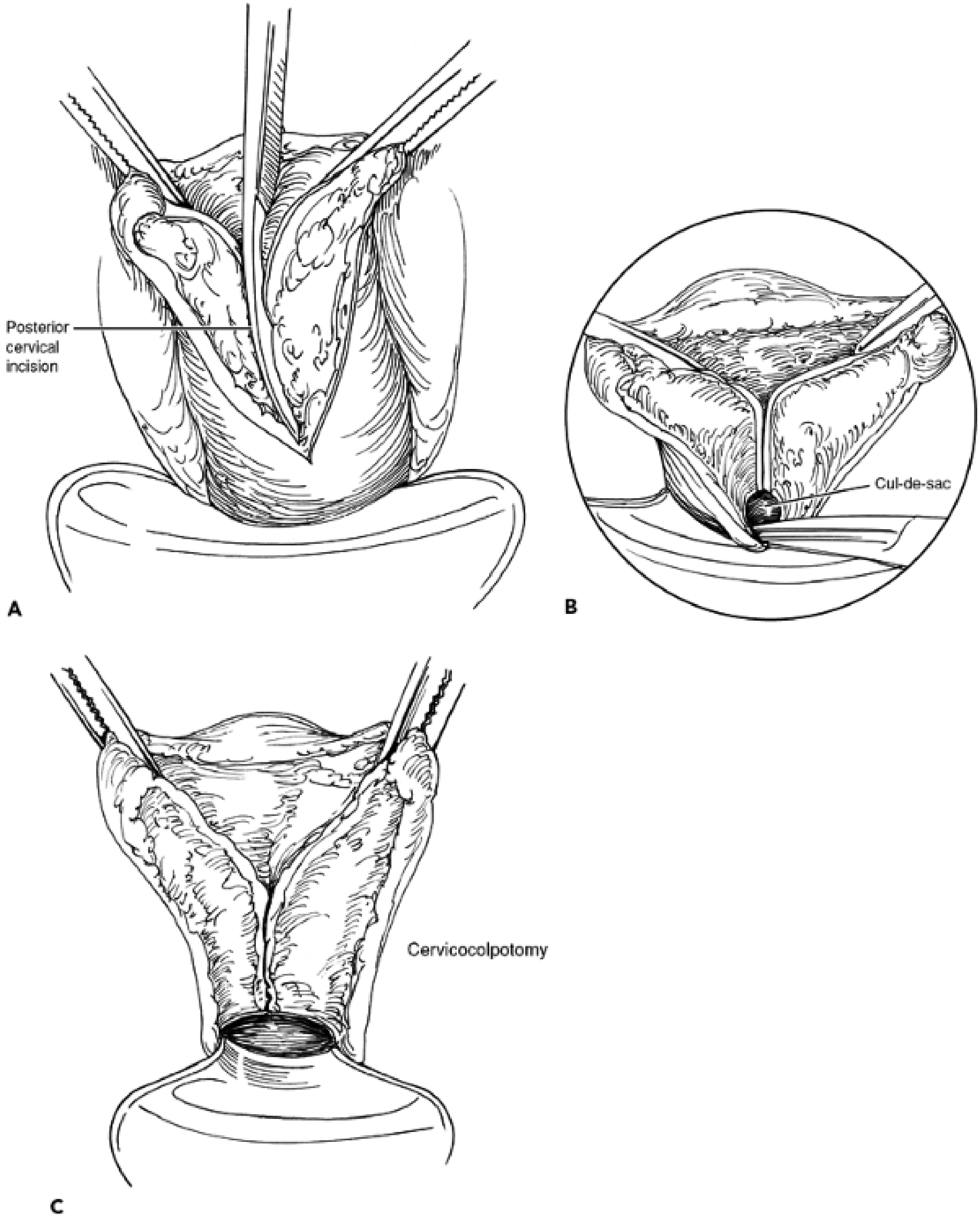


Figure 9-5 A-C: Cervical colpotomy for entry into the posterior peritoneum.

Posterior cervix is grasped with Allis clamps approximally at the four and eight o'clock positions, and the cervix is incised starting at the six o'clock position and incising the cervix and posterior wall of the uterus until the posterior peritoneum is entered. Once the peritoneum is entered a weighted speculum is placed into the posterior peritoneal cavity.

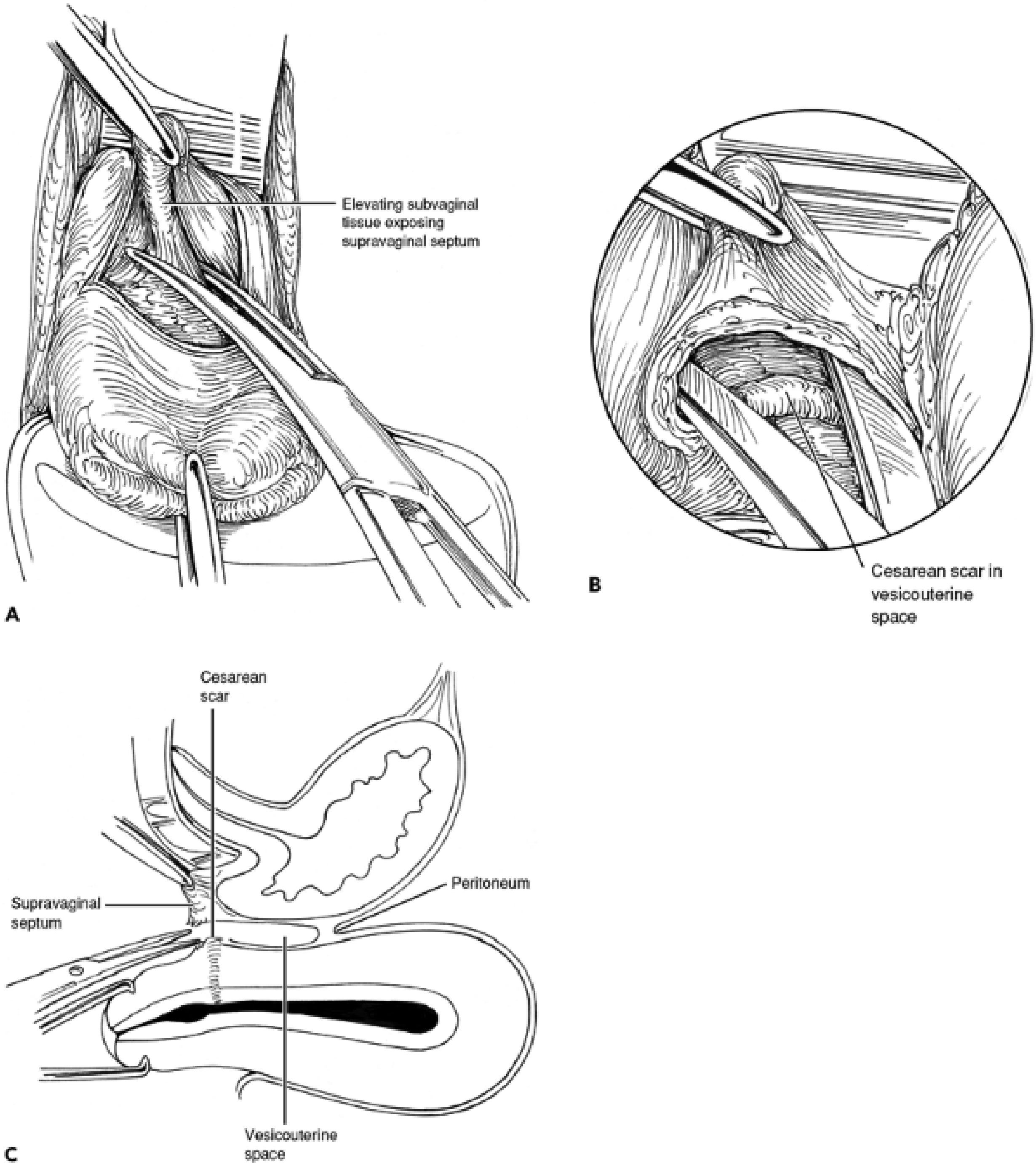


Figure 9-6 A: Entry into the anterior peritoneum involves incising the supravaginal septum to gain entry into the vesicouterine space. B: Once the vesicouterine space has been entered, the space is developed by spreading the dissecting scissors for placement of a retractor to elevate the bladder. C: Relationship between the supravaginal septum, vesicouterine space, C-section

scar, and anterior peritoneal fold.

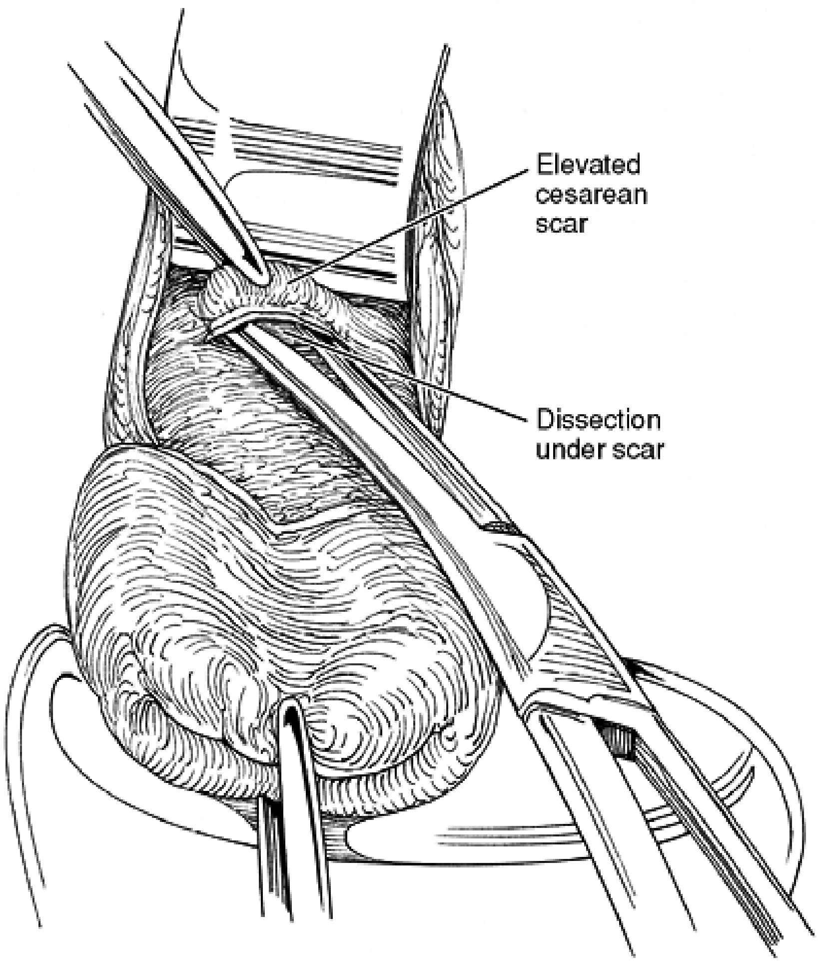


Figure 9-7 Sometimes it is possible to dissect beneath the C-section scar to gain entry into the superior part of the vesicouterine space to identify the anterior peritoneal fold.

A surgeon's desire to dissect as far as possible from the bladder may result in a retroperitoneal dissection caused by an incision into the connective tissue capsule of the cervix. This deviation is more likely when the initial incision into the vagina is made too close to the cervix. Further dissection beneath the peritoneal covering of the anterior uterine segment results in failure to enter the anatomic plane between the bladder and uterus (Fig. 9.8, Insert A2). If a surgeon proceeds without caution and without a correct understanding of the anatomy of this region, the result is further retroperitoneal dissection or unintentional bladder penetration. This failure is one of the most common reasons for accidental cystotomy. If an injury to the bladder results, and the bladder has some urine, a gush of urine will be immediately recognizable. During this stage of vaginal hysterectomy, the injury will occur well above the trigone of the bladder and will not be near the ureteral orifices. This type of injury is simple to repair after the uterus has been removed. Unintentional operative cystotomy is an inherent risk of any vaginal hysterectomy technique. The overall incidence of operative cystotomy with the technique described in this chapter has resulted in an acceptable morbidity rate of 1.2% with vaginal hysterectomies (3).

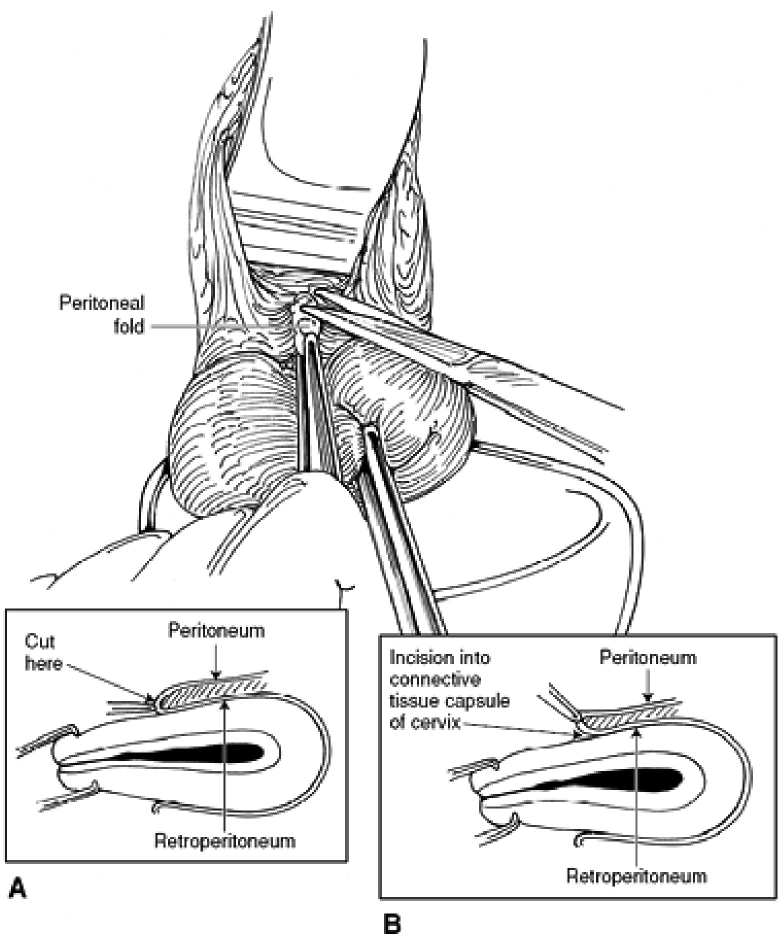


Figure 9-8 Entry into the anterior peritoneum. Peritoneal fold is grasped with tissue forceps and pulled downward. Scissors incise peritoneal fold just above tissue forceps. Insert A: Lateral view demonstrating the method for entering the anterior peritoneum. Insert B: Retroperitoneal dissection with elevation of the peritoneal fold.

The use of a sponge on the surgeon's finger to push the supravaginal septum and the vesicouterine space superiorly in attempts to find the anterior peritoneum is occasionally described by some surgeons. This maneuver is considered an â€œ*accomplir forcÃ©e*â€• (i.e., accomplish with force) technique rather than a surgical dissection (Fig. 9.9). If the patient has had a previous C-section, blunt dissection increases the risk of injury to the bladder. The anterior peritoneum should always be opened under direct vision and never blindly because unintentional entry into the bladder may result.

If there is any doubt that the peritoneal fold is clearly recognized, do not persist in attempts to open the anterior peritoneum. Cutting the uterosacral and cardinal ligaments will bring the uterus and peritoneal fold closer to the operator. The peritoneal fold can be identified and entered at this point of the operation. Prior to opening the peritoneum, a

small superficial artery in the surgical bladder pillar may bleed if the vaginal epithelium is reflected laterally from the cervix. To prevent bleeding from this vessel, separately clamp it and the adjacent surgical bladder pillar on each side of the cervix. The surgical bladder pillar is also known as the pubourethral ligament.

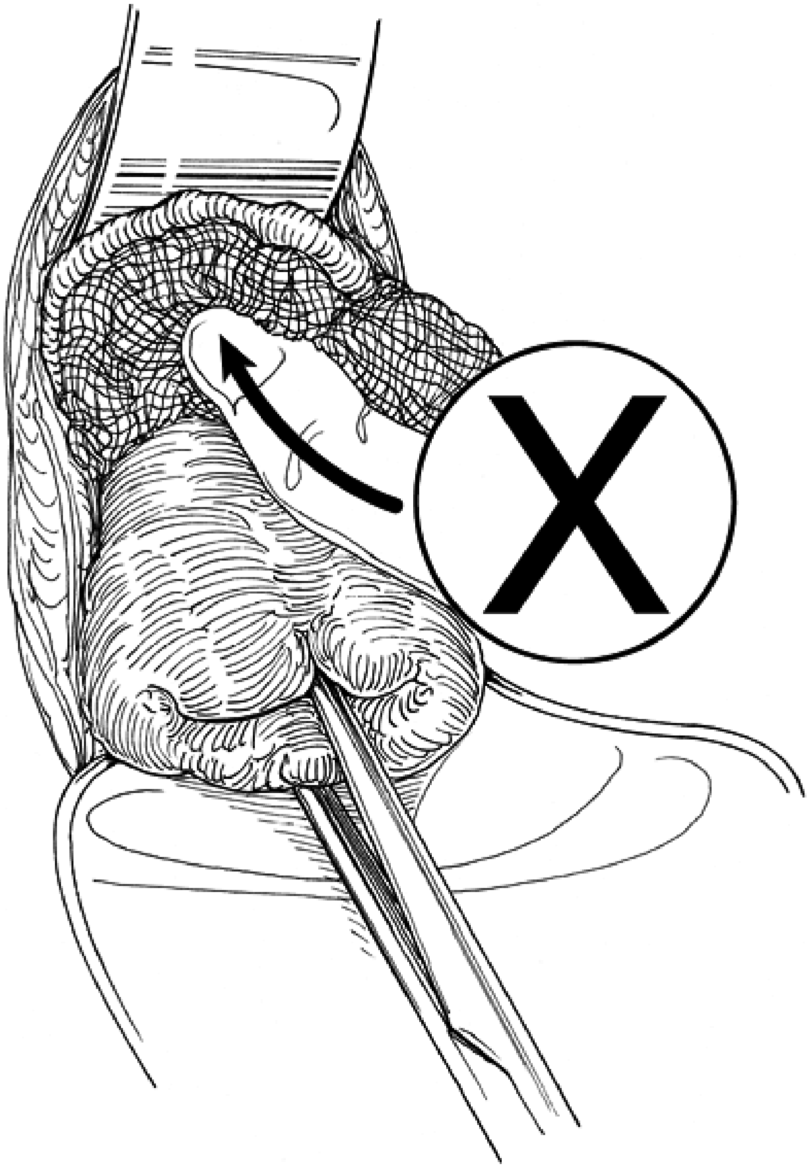


Figure 9-9 Technique of â€œAccomplir forceâ€• potentially increasing the possibility of operative cystotomy.

The anterior peritoneum can be safety opened when the uterus is enlarged. Make a vertical incision in the fashion of an anterior colporrhaphy to allow accurate identification of the bladder from the peritoneal fold at a higher level (Fig. 9.10). After the posterior and anterior peritoneum has been successfully entered, the detachment of the uterus from its supportive ligaments can be accomplished. The uterosacral and cardinal ligaments can be ligated and secured in separate pedicles before any attempt is made to enter the anterior peritoneum. This extraperitoneal approach provides significant additional exposure. Increased visibility results from separating the cervix from the paracolpium and from the resulting descent of the uterus. This exposure is significant and makes the peritoneal identification/entry process less troublesome. Indeed, the uterine artery can also be divided prior to peritoneal entry to allow even greater exposure. Transillumination of the broad ligament with a secondary light source, for example, VitalVue or VersaLight will ensure that the bladder has successfully been retracted superiorly. The bladder will not transilluminate to the same degree that the broad ligament will.

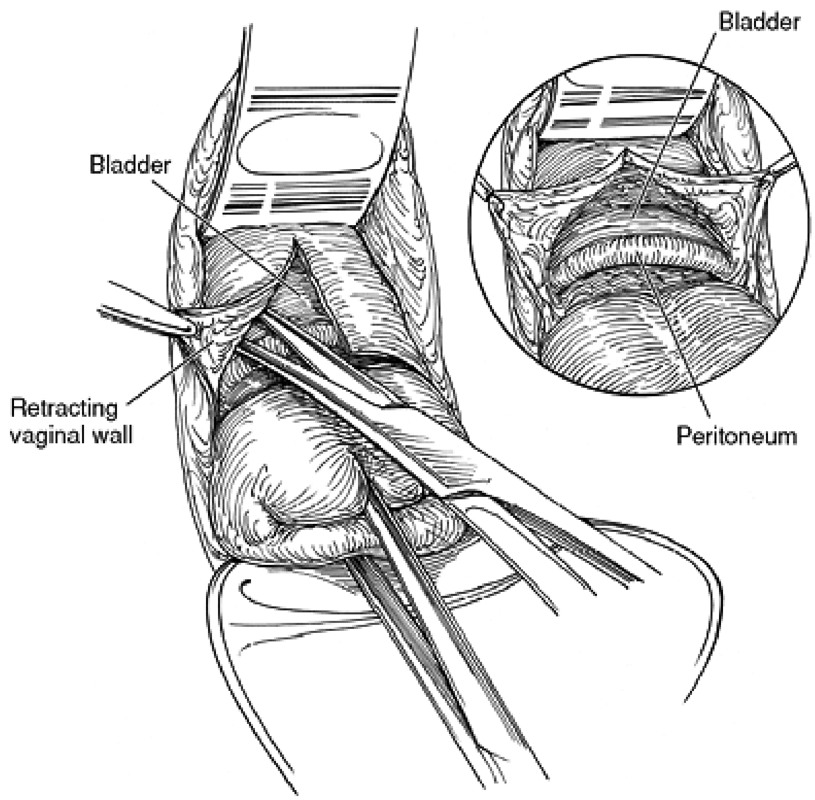


Figure 9-10 Opening the anterior vaginal wall to expose the bladder and anterior peritoneal fold.

The exact location of the ureter during abdominal, laparoscopic, or vaginal hysterectomy has always been a concern. Nichols suggested that the risk of ureteral injury during a vaginal hysterectomy is greater because the ureters may be pulled downward and medially by the uterine artery (Fig. 9.11) (9). By studying the surgical anatomy of the ureter during vaginal hysterectomy, the uterine artery

was found not to be the primary factor in movement of the ureter during vaginal hysterectomy (4,5). Instead traction on the cardinal ligament is the chief factor that affects movement of the ureter. A margin of safety is created by releasing the cardinal ligament during a vaginal hysterectomy. Magnetic resonance imaging (MRI) studies with a brass tenaculum placed on the cervix in a resting state and under traction confirmed this fact. When traction was applied to the cervix, the ureter's position was displaced upward and lateral when compared to the position of the ureter at rest (Fig. 9.12A,B). This movement confirmed radiographically that the ureters were displaced laterally and superiorly away from the cervix and into a position of surgical safety. When bladder retraction was used, this displacement was more pronounced. Observation during vaginal hysterectomy shows that once the uterosacral and cardinal ligament complex was cut, the ureter actually moved out of harm's way. Identification of the ureters was more difficult during vaginal hysterectomy after these ligaments had been severed. This observation shows that the uterosacral and cardinal ligaments, not the uterine artery, play a major role in determining the position of the ureters during vaginal hysterectomy. Once these ligaments are cut, the connective tissue within each ligament returns that ligament to its original position and allows the ureter to retract from the operative field (Fig. 9.13A,B).

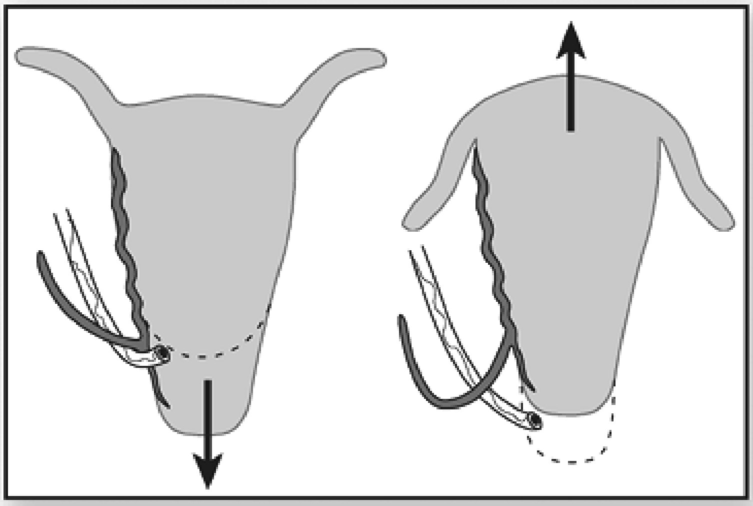
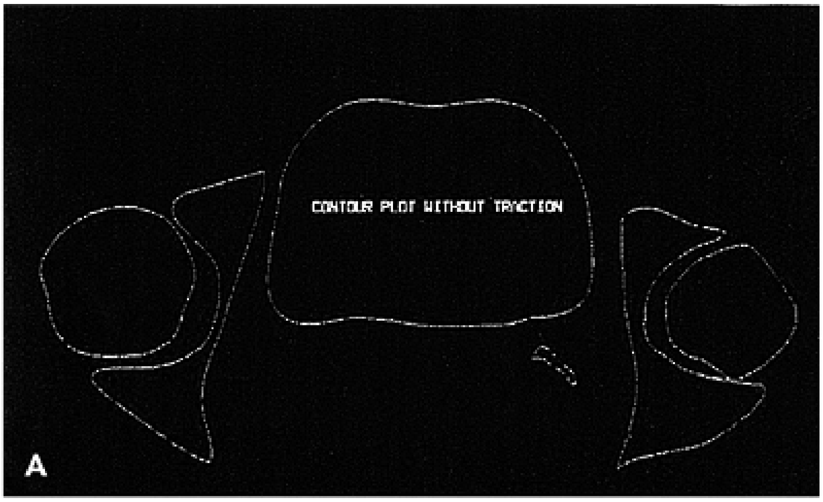


Figure 9-11 Incorrect concept that traction on the uterus with vaginal hysterectomy causes the uterine artery to position the ureter closer to the operative field and potentially in harms way.



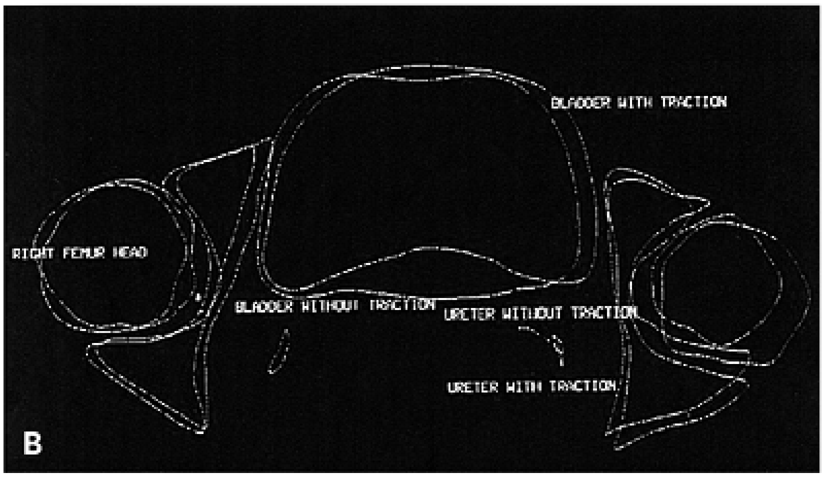
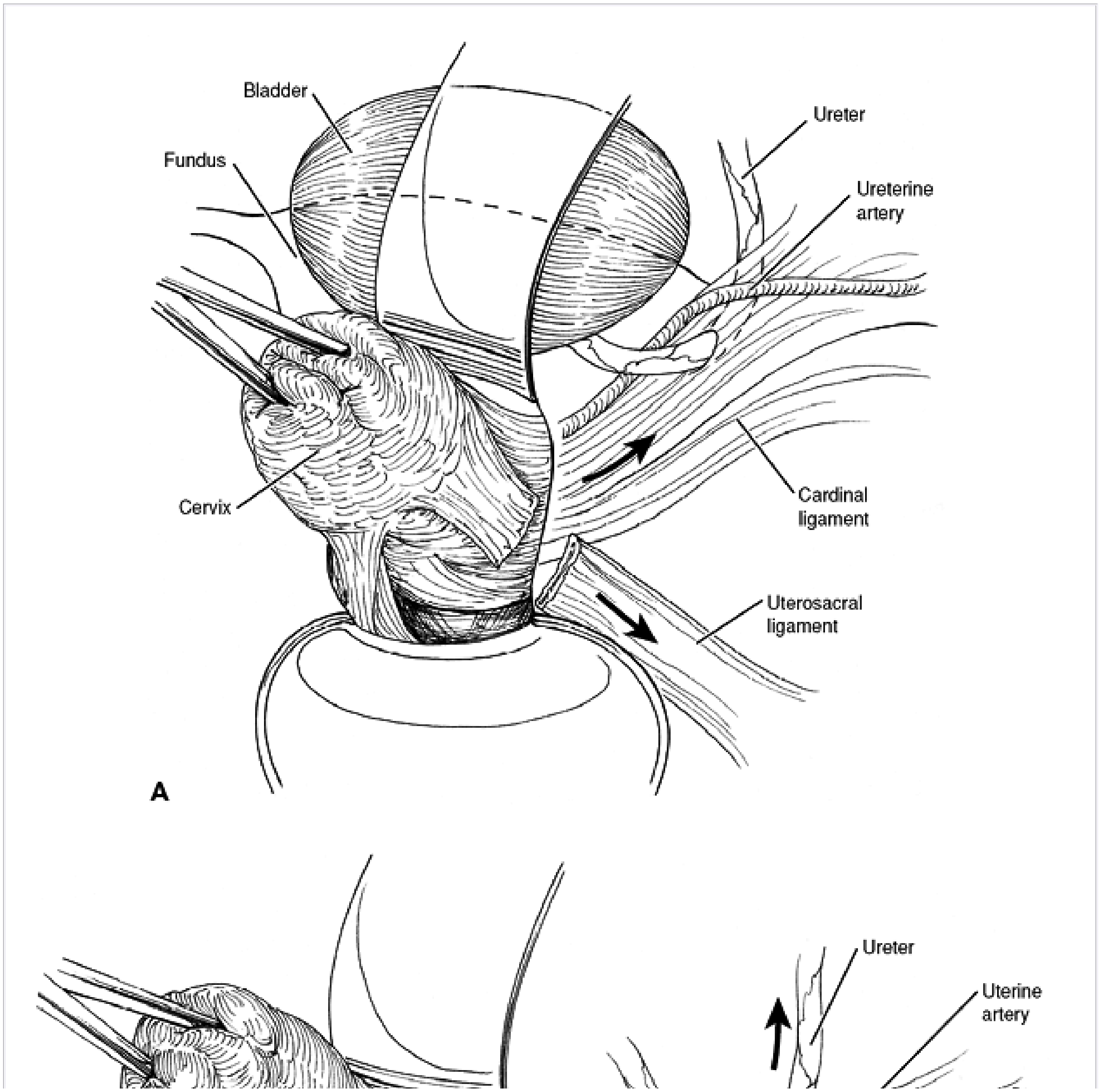


Figure 9-12 A: Magnetic resonance imaging (MRI) studies of ureteral movement when downward traction is placed on the uterus. Ureter position is seen on the right. B: Overlay of MRI films. Traction on the uterus with a brass tenaculum is applied to the cervix. Note indentation to the bladder from the uterus and lateral and upward displacement of the ureter compared to the position of the ureter position without traction to the uterus.

For years, the senior author routinely opened both the posterior and anterior peritoneum before clamping the uterosacral and cardinal ligaments. This study of ureteral movement during the operation demonstrates the surgical benefit of the value of this technique. Placement of a retractor under the bladder elevates the ureter out of the operative field (Fig. 9.14A,B). Therefore, once the retractor is placed under the bladder, it should not be removed during any stage of the vaginal hysterectomy. When forceful traction was applied to the uterus during vaginal hysterectomy with no retraction of the bladder, the ureter was pulled medially and potentially placed in harm's way. Before clamping the supportive structures of the uterus, the lateral vaginal wall must be incised if a complete circumscribing cervical incision has not been made (Fig. 9.15).

The uterosacral and lower portion of the cardinal ligaments are grasped with the tip of the clamp. The tips of the clamp should be placed posteriorly within the peritoneal cavity (Fig. 9.16A,B). The clamp may be rotated around the ligament anteriorly if desired. The Kovac hysterectomy clamp (Marina Medical) is the authors' preferred instrument. The length, curve, and tightly gripping atraumatic jaws create security and comfort for the surgeon. Double clamping of each uterine supportive or vascular structure is not necessary. Each uterosacral ligament is secured by a transfixion suture that includes the posterolateral surface of the vagina. These sutures are located at the four and eight o'clock positions (Fig. 9.16C). Lateral traction on these sutures provides the best exposure to the remaining structures within the broad ligament. Traction on these sutures replaces the need for lateral retractors that expose only the lateral vagina. These retractors occupy vaginal space and do not effectively expose the structures of the broad ligament (Fig. 9.17). Clamping and tagging the uterosacral ligaments separately allow for their later use in cuff repair and, if desired, for performing a McCall culdoplasty at the end of the procedure. Only the uterosacral ligament pedicle needs to be tagged during a vaginal hysterectomy.

Next, the cardinal ligaments are clamped with the assurance that the bottom jaw of the clamp is within the posterior peritoneal cavity. The anterior peritoneum is not pulled into the anterior jaw of the clamp at this point in the operation. Bringing the peritoneal edges together serves to seal off the broad ligament and effectively prevents further bleeding from any laceration of the vascular plexus located within the leaves of the broad ligament. The anterior peritoneum usually begins at the level of the uterine vessels and may not descend sufficiently to bring both the anterior and posterior peritoneal surfaces together at the level of the cardinal ligaments. Avoid any attempt to bring these peritoneal surfaces together when the uterosacral or cardinal ligaments are clamped (Fig. 9.18). The leaves of the broad ligament should be approximated within the uterine artery pedicle. A simple suture ligature is sufficient to secure the cardinal ligament. Transfixion is not necessary. Rotating the handles of the clamp laterally and superiorly facilitates suturing at the tip of the clamp. This technique brings the tip of the clamp into full view and exposes a triangular area beneath the clamp for easier retrieval of the needle (Fig. 9.16B). Needle placement should be 2 to 3 mm lateral from the tip of the clamp in order to leave an adequate space to place the next clamp in the hysterectomy sequence.



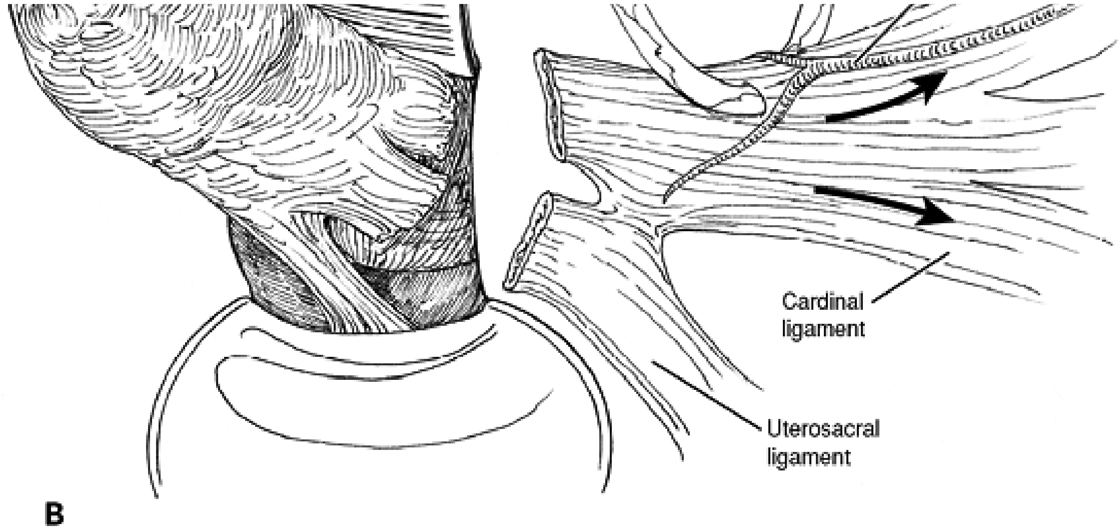


Figure 9-13 A: Transection of the uterosacral ligament returns this structure back to its original position. B: After both uterosacral and cardinal ligaments have been transected ureters are displaced upward and lateral out of harms way.

At this point, the uterine arteries should become visible on each side of the uterus and be clamped. Using a Kovac vaginal hysterectomy clamp (Marina Medical), which has less pelvic curve is helpful. This clamp is placed parallel to the uterus because its tip secures the uterine artery as it bifurcates into the ascending and descending branches (Fig. 9.19). When traction is placed on the uterus and the artery is cut, a definite sensation of uterine descent is appreciated. This descent signifies that the entire uterine artery has been cut, including the ascending and descending branches. If

descent of the uterus is not noted, an additional portion of the uterine artery must be included in another clamp. A single suture is all that is required for the uterine artery pedicle. Transillumination is a valuable technique in identifying the exact location of the vascular bundle associated with the uterine artery. The portion of the broad ligament cephalad to the uterine artery is very thin and transmits light without impediment. Include only the vascular bundle within the clamp to make the pedicle manageable and to make the suture ligature more secure. Many surgeons try to include middle portions of the broad ligament with the uterine artery pedicle because they feel a need to place clamps on the remaining portions of the broad ligament (Fig.

9.20). Clamping the portion of the broad ligament above the uterine artery is unnecessary. This cannot be stated too emphatically.

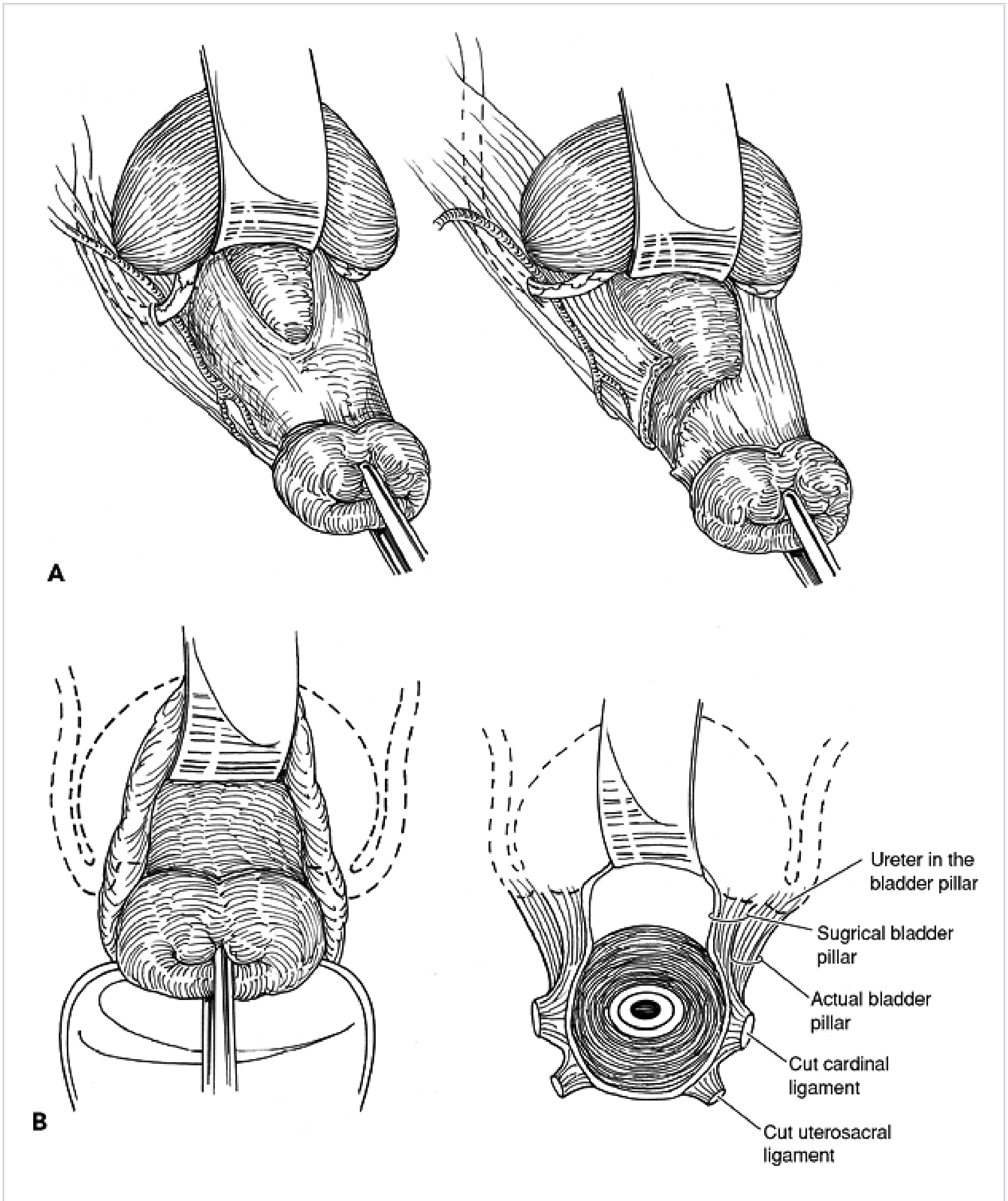


Figure 9.14. A, B: Note elevation of the ureters out of harms way with upward traction on the bladder during vaginal hysterectomy.

Most gynecologic surgeons are comfortable with performing a vaginal hysterectomy to this point. Beyond this point of the operation, most gynecologists have concerns about their ability to successfully remove the uterus. This insecurity began with the Heaney procedure of continued clamping of the broad ligament along the sides of the uterus that is required for successful removal. Surgeons of the 1940s resolved this stumbling block as they figured out how to remove the uterus without clamping above the uterine artery. During most modern abdominal hysterectomy techniques, the upper portions of the broad ligament are sharply dissected rather than clamped. When the surgeon continues to place clamps above the uterine artery, the available space becomes more restrictive, and attempts to place sutures around these clamps become more difficult. Suturing of the broad ligament above the uterine artery is unnecessary because the few blood vessels within the leaves of the broad ligament do not require suturing. This unfortunate and incorrect misconception has been a major stumbling block for transvaginal removal of the

uterus and a source of criticism of the vaginal approach to uterine removal. Elimination of the need to place clamps above the uterine artery is the major difference of the Kovac-Zimmerman hysterectomy technique. No clamping is needed above the uterine artery until the adnexal pedicles are reached.

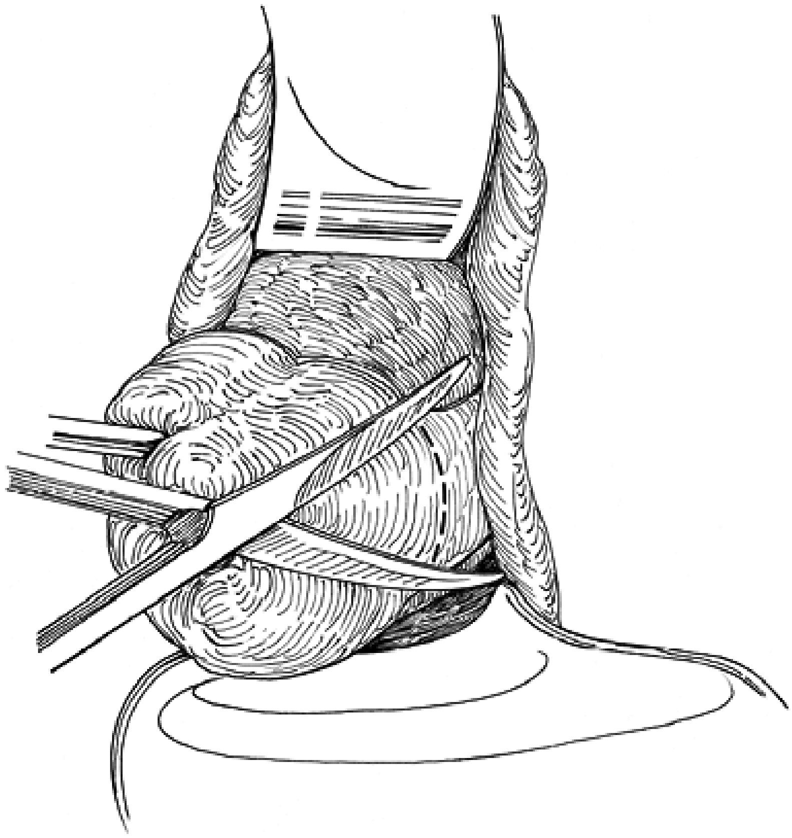


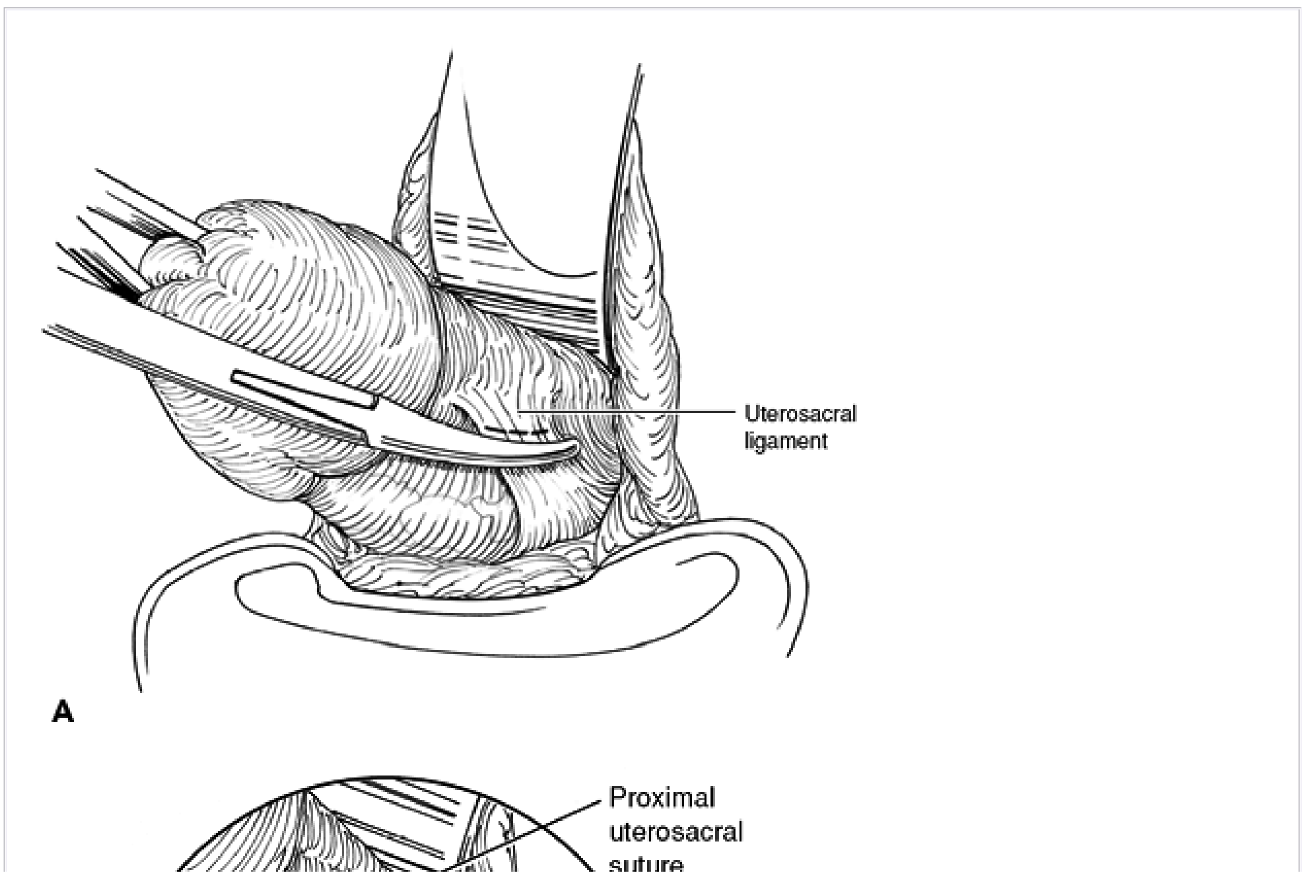
Figure 9-15 Lateral vaginal wall incised between the blades of scissors. This is necessary if a complete circumscribing incision around the cervix has not been performed.

If the uterus is small, the next step in its removal after the uterine artery has been secured is to deliver the fundus through either the anterior or posterior peritoneum. When the uterus is small and mobile, simple traction may result in uterine delivery without rotation. Some surgeons suggest that delivery of the uterus without rotation decreases the potential risk for contamination of the peritoneal surfaces as a result of contact with the cervix. No evidence exists to support this concept.

When downward traction and rotation of any size uterus does not appear to be possible, the technique of choice is intramyometrial coring. This technique was introduced by Lash in 1942 for this particular situation, and reintroduced in 1986 by Kovac for the removal of enlarged uteri (6,7). In this simple technique, the myometrium can be circumferentially incised with a scalpel that is placed within the myometrium parallel to the long axis of the uterus and the serosal covering of the uterus (Fig. 9.21). Coring removes the inside of the uterus without violating the integrity of the endometrial cavity. To facilitate the coring incision, strong traction on the uterus is necessary (Fig. 9.22).

The Lash or coring incision reduces the intraabdominal uterine bulk by decreasing the width and increasing the length of the fundus. This action is similar to the moulding

of a baby's head during childbirth. Coring converts a spherical structure to an elongated rod shape and enhances the ability of the surgeon to facilitate removal of the uterus (7) (Fig. 9.23A-C). It is a surprisingly bloodless maneuver once the uterine arteries have been secured. Strong traction during the coring appears to restrict blood flow from the ovarian pedicles. Coring and other debulking techniques for the enlarged uterus are further described in Chapter 8.



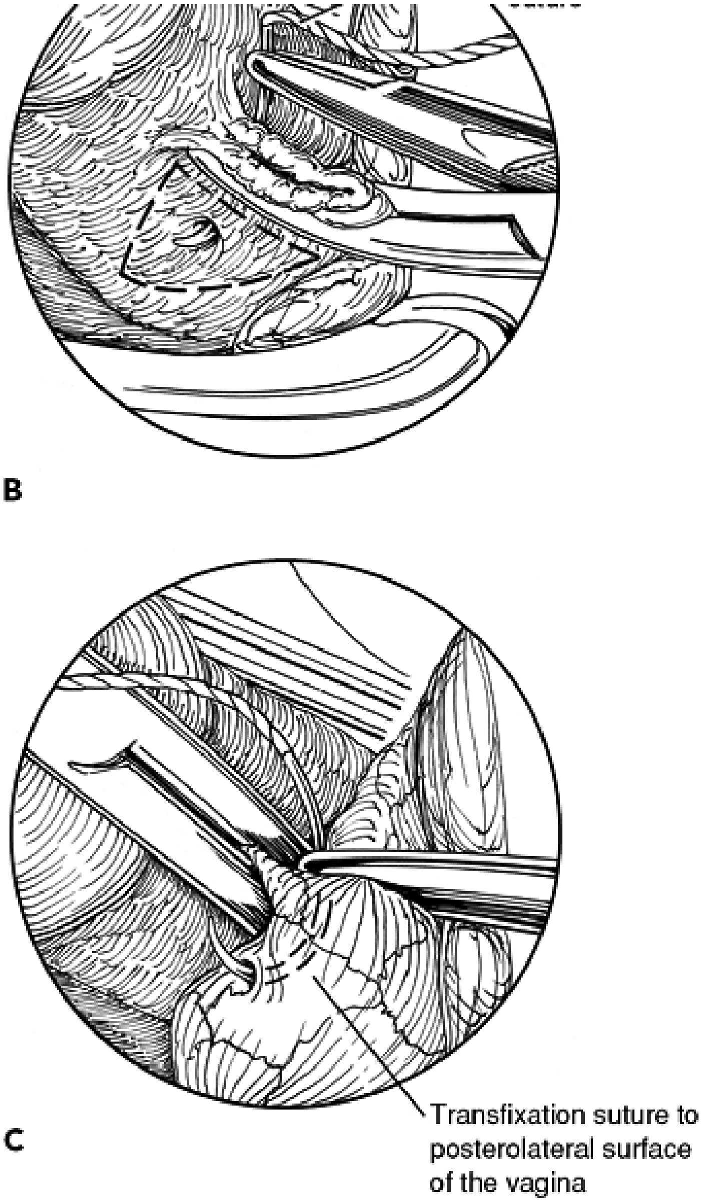


Figure 9-16 A: Clamping of uterosacral ligament. B: Lateral rotation of clamp to expose tip of clamp for passage of suture. C: Transfixation suture placed behind clamp into lateral vagina.

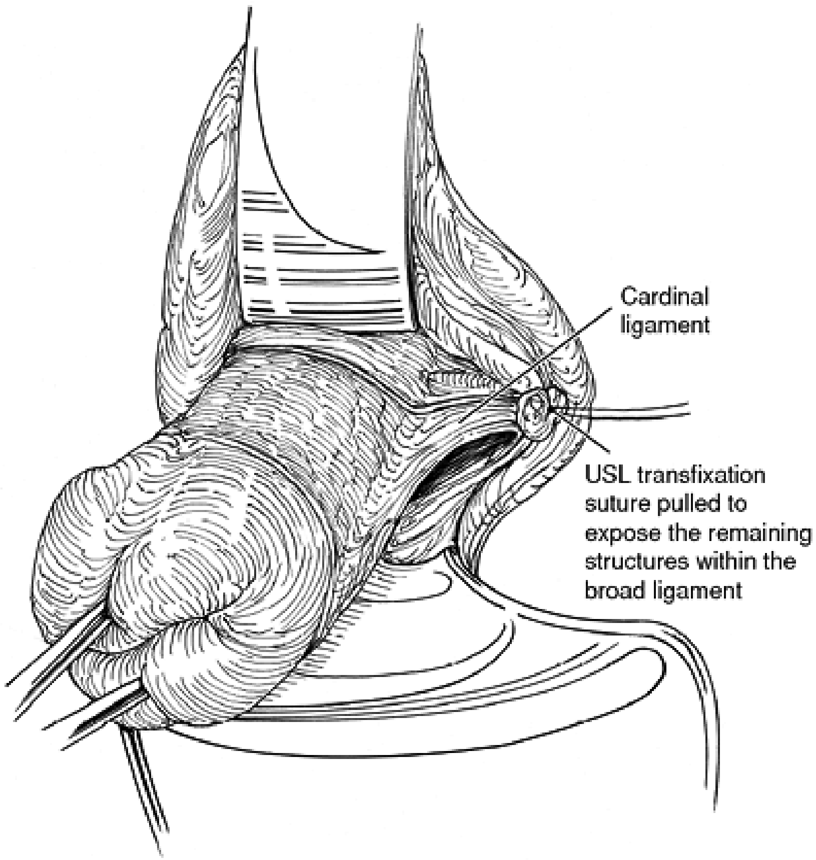


Figure 9-17 Traction on uterosacral suture laterally exposes the broad ligament structure.

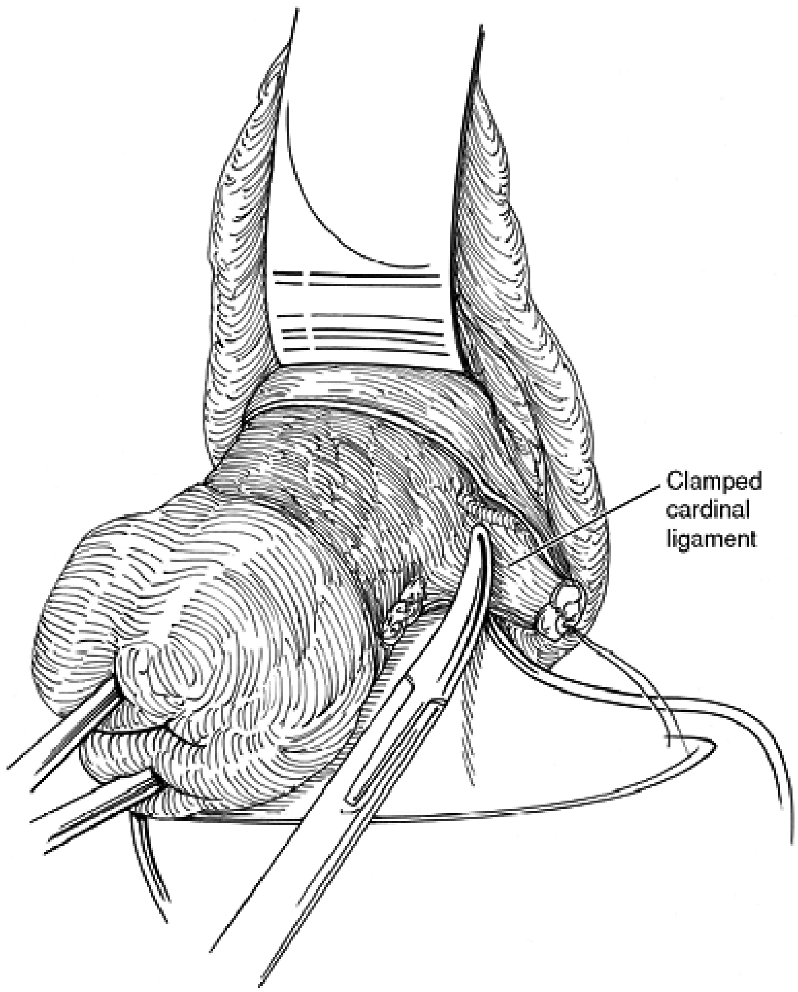


Figure 9-18 Uterine artery clamped with anterior and posterior leaves of the broad ligament included in the clamp.

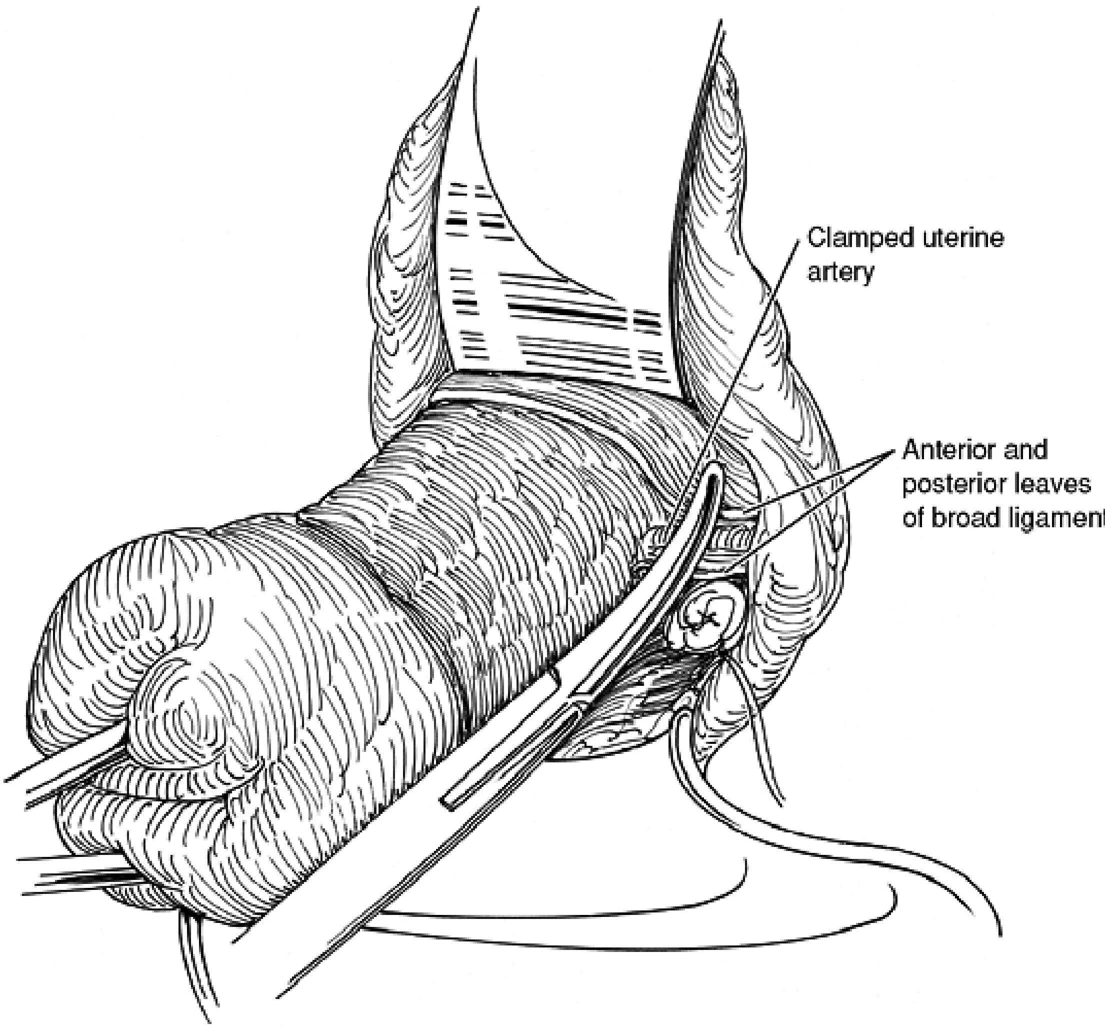


Figure 9-19 Clamping cardinal ligament. Note anterior peritoneum is not included in this clamp.

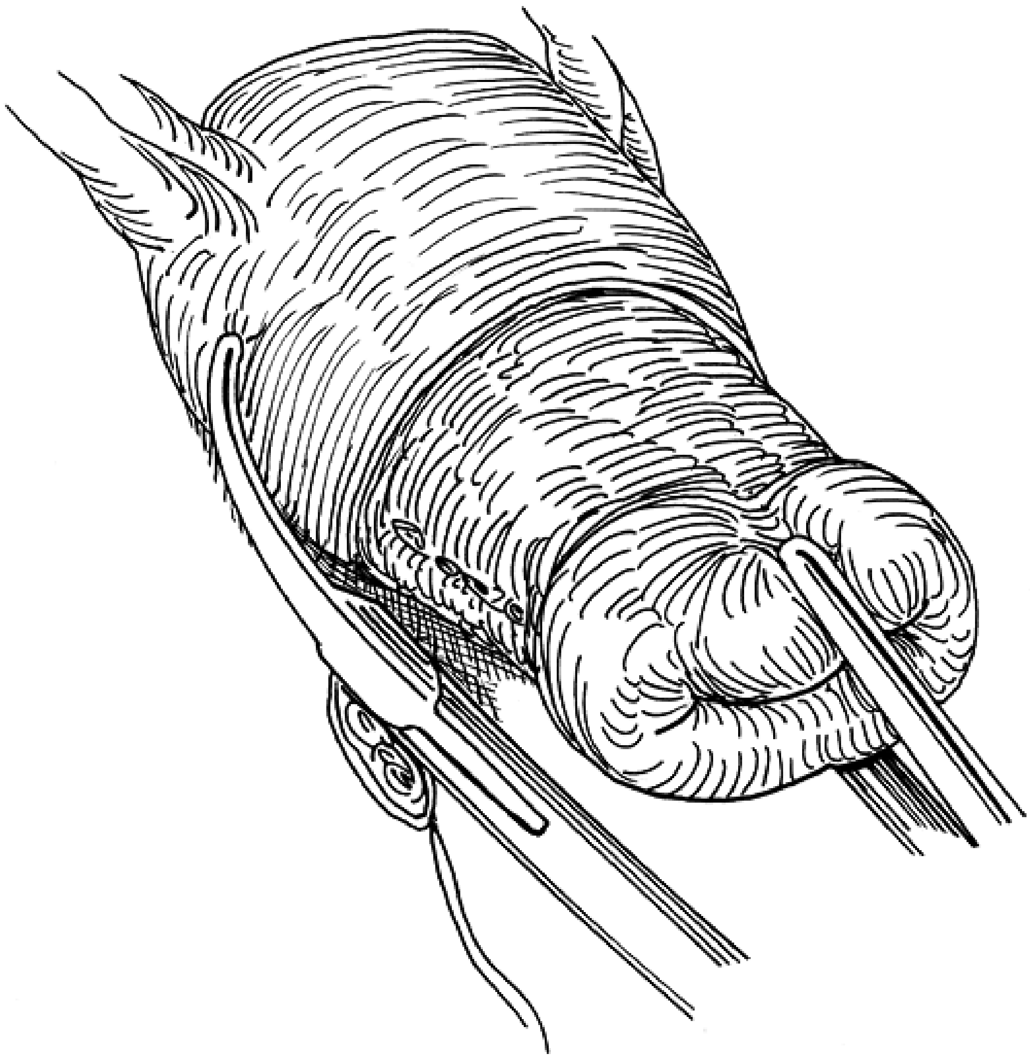


Figure 9-20 Unnecessary technique of clamping, cutting, and suturing of middle broad ligament.

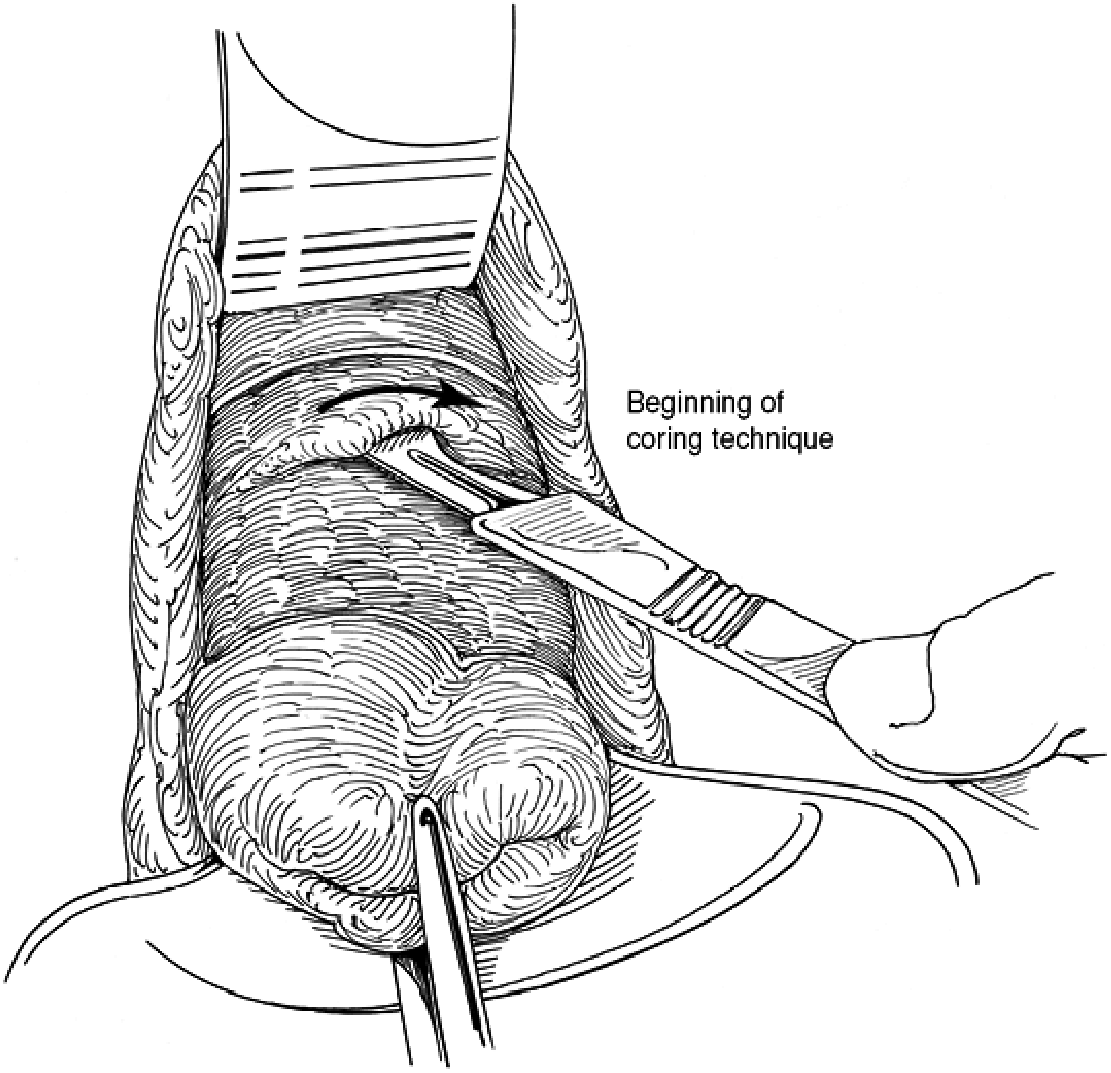


Figure 9-21 Coring incision is started just below the serosal covering of the uterus anteriorly. Coring of a small uterus to facilitate exposure and clamping of the upper pedicle. No sutures were placed above the uterine artery to bring the uterus closer to the surgeon for removal of the uterus.

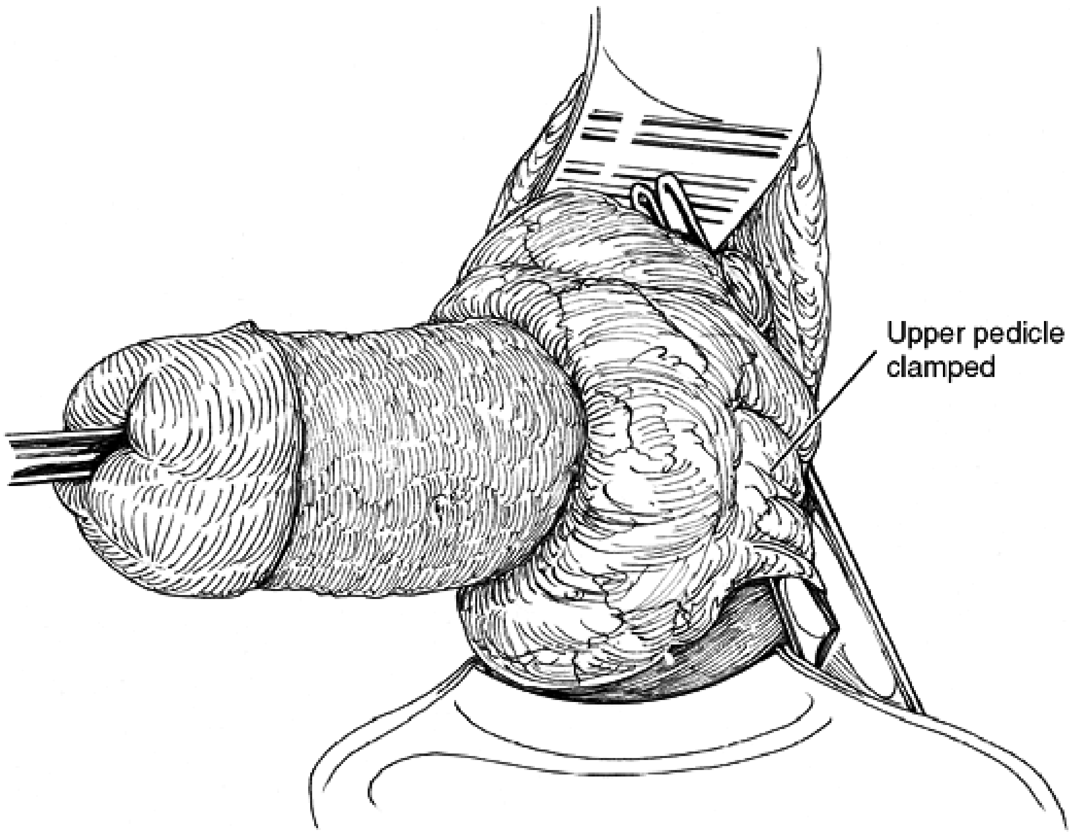


Figure 9-22 Coring of a small uterus to facilitate exposure and clamping of the upper pedicle. No clamps or sutures were placed above the uterine artery in order to bring the uterus closer to the surgeon.

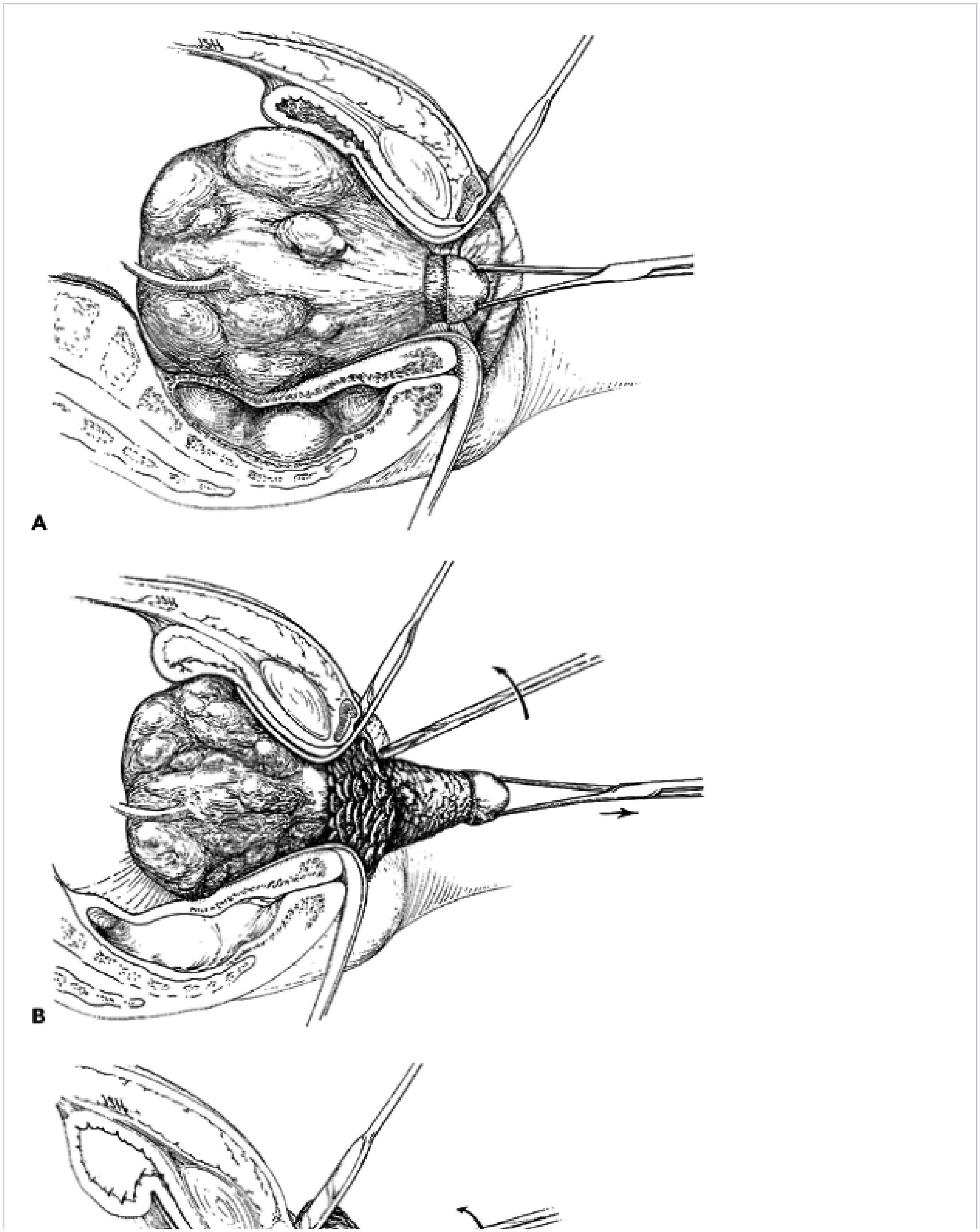
During the coring procedure, the uterus will begin to descend through the vagina, bring the cornual portion of the uterus into view, and expose the uteroovarian ligament, round ligament, and fallopian tube (Fig. 9.22). Once these structures become visible, the surgeon can be assured that the uterus will be removed vaginally. The adnexal attachments can be either clamped individually or together. Depending on the preference or experience of the surgeon, a suture placed around the tip of the clamp may be tied or transfixed as appropriate. This suture is tagged to provide traction on the pedicle and to expose the ovary for evaluation or removal. The ovary should not be removed at this time.

Once the uterus is removed, evaluate each pedicle to determine whether any bleeding persists. If the ovaries are removed before adequate determination that all pedicles are hemostatic, the operator may spend considerable time to find the source of bleeding. Frequently, bleeding appears to be from a higher point; however, it may be from the hysterectomy pedicles. Each pedicle can be evaluated by starting at the twelve o'clock position within the peritoneal cavity and proceeding in a clockwise manner. The use of a 4 Ã— 4 sponge folded longitudinally on ring forceps is very helpful. If brisk bleeding is noted, 90% of the time it can be found by placing traction on the upper pedicle tags and looking between that suture and the suture around the uterine artery. Bleeding from this area is the result of the anastomosis of vessels between the ovarian and uterine artery. Because this site is the most frequent for this type of bleeding, the surgeon should direct his or her search to this area first. Placement of a clamp and encircling suture or a figure-of-eight suture that is passed through the vagina into the peritoneum at the site of bleeding will rapidly resolve the problem (Fig. 9.24).

If no bleeding points are discovered from either side of the pelvis, the posterior vagina will most likely be the remaining source of bleeding. Posterior cuff bleeding may be rather brisk because the vagina and the peritoneal edge separate. Before proceeding with any concurrent procedure, control blood loss from this area with a locking suture that starts from one uterosacral ligament tag and proceeds to the other (Fig. 9.25). Electrocautery may also be used in this area. After bleeding is controlled, examination of the hysterectomy site and peritoneal cavity should reveal complete hemostasis.

If the patient has consented to the removal of the uterus only, support of the apex of the vagina becomes the next important step. If desired, salpingo-oophorectomy should be performed at this time.

The indications for ovarian removal should be similar in abdominal, vaginal, or laparoscopic hysterectomy. Thompson remarked, â€œIf the ovaries are accessible, the same guidelines for prophylactic oophorectomy should apply to the menopausal and post menopausal patient at the time of vaginal hysterectomyâ€• (8). Nichols stated, â€œBecause the ovaries are not technically as accessible during vaginal hysterectomy as during abdominal laparotomy, there is a significant decreased frequency of ovarian removal on a prophylactic basis when hysterectomy is accomplished by the vaginal routeâ€• (9).



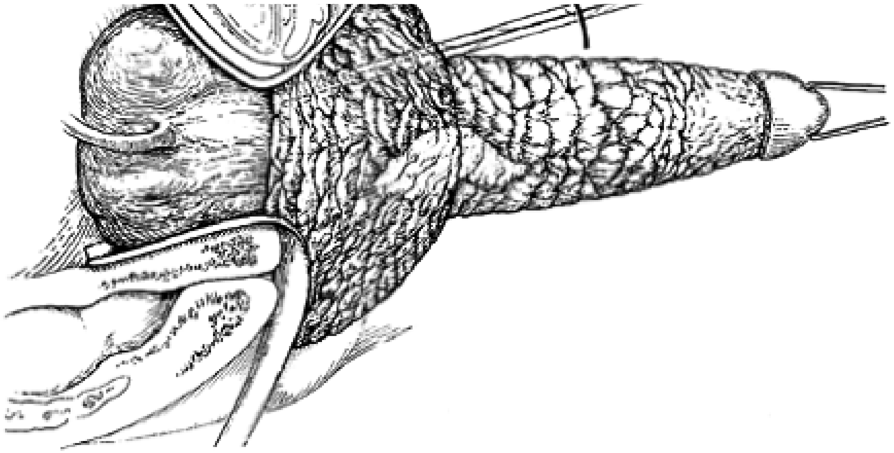


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Figure 9-23 A: The cervix has been circumscribed through the full thickness of the vagina around the cervix, the posterior and anterior peritoneum entered, and the uterosacral and cardinal ligaments secured. (From, Society of Pelvic Reconstructive Surgeons, www.guidelines.gov.) B: After ligation of the uterine arteries, an incision is made in a circumferential fashion parallel to the endometrial cavity and into the outer superficial myometrium in the same plane. Constant traction on the tenaculum while coring assists in developing the proper plane. C: Continued coring and traction reduces the size of the uterus by exteriorizing the inside of the uterus with an intact endometrial cavity through the introitus. Intramural myomas are sometimes transected during the coring process. (From,
Kovac SR. Intramyometrial coring as an adjunct to vaginal hysterectomy. *Obstet Gynecol* 1986;67:131â€“136.
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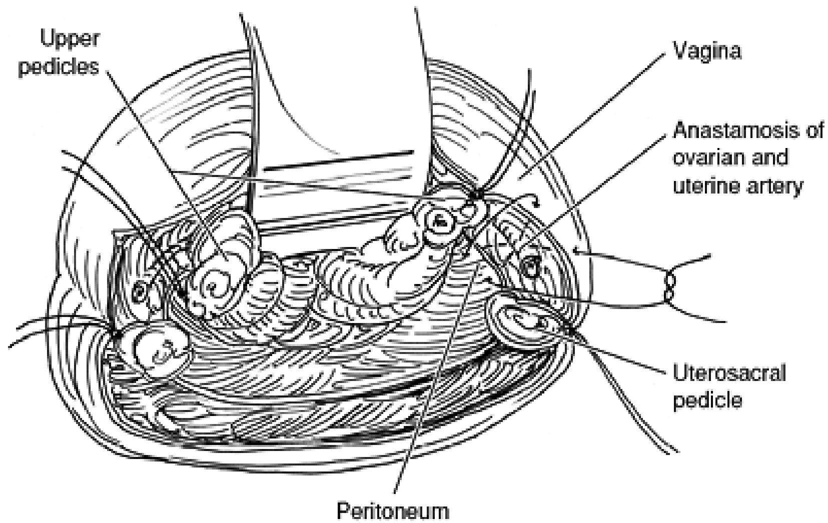

Figure 9-24 Most common source of bleeding after removal of the uterus is the anastomosis between uterine and ovarian arteries. Suture placed through the lateral vagina into the lateral peritoneum in a figure-of-eight fashion and tied resolves most, if not all, bleeding from this area.

Some reluctance exists to combine vaginal hysterectomy with oophorectomy because this procedure is thought to be risky and difficult. Two factors seem to foster this perception: (i) fear of restricted access to the ovaries and (ii) inadequate visibility of the adnexa during conventional vaginal surgery.

In order to obtain objective evidence regarding these perceptions, a study was designed to determine the adequacy of visibility and accessibility for transvaginal oophorectomy in most patients undergoing vaginal hysterectomy (10). After the uterus was removed, the accessibility of the ovaries for transvaginal removal was assessed by stretching the infundibulopelvic ligament by placing traction on the suture tag that was used to ligate the uteroovarian ligament, round ligament, and fallopian tube. The position of the ovaries was graded in relation to the long axis of the vagina. The degree of ovarian descent and visibility was graded by modification of a system previously used to grade pelvic organ prolapse (Baden-Walker Halfway System) (11). The grade corresponded to the minimal degree of descent of either ovary (10) (Fig. 9.26).

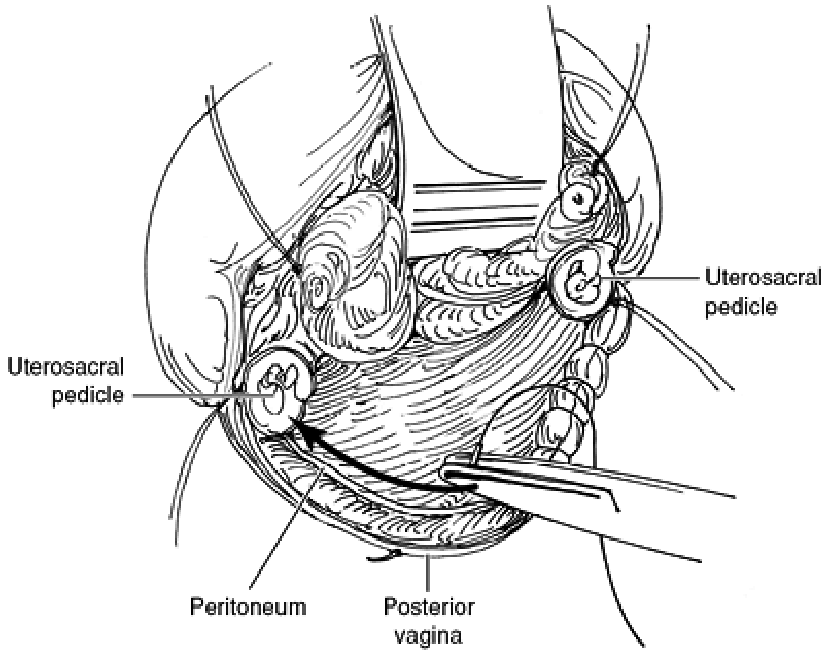

Figure 9-25 Control of bleeding from posterior vagina with a running locked suture from one uterosacral ligament to the other.

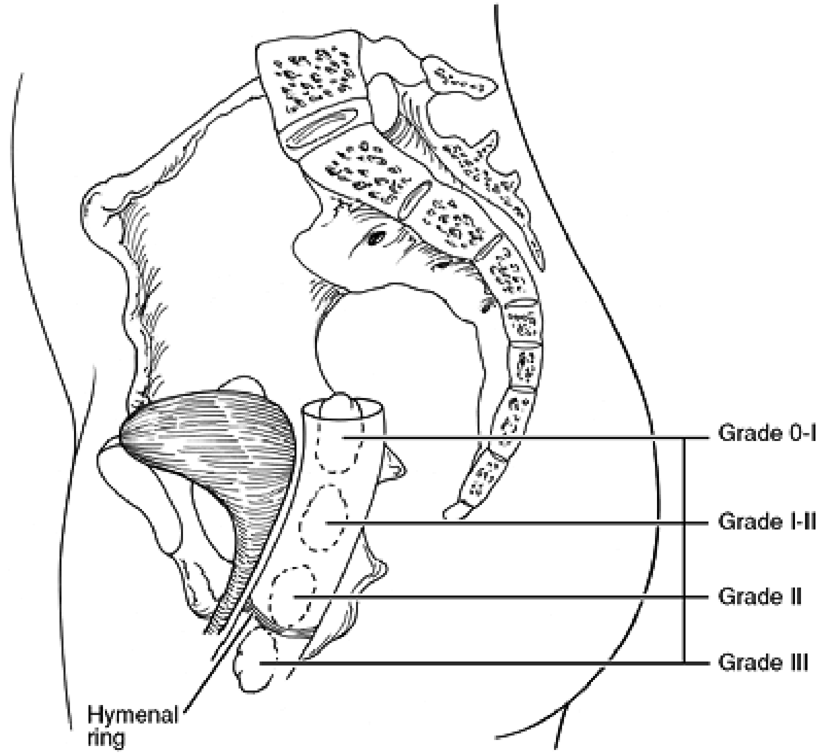

Figure 9-26 Grading ovarian descent after vaginal hysterectomy with Baden-Walker Halfway System. Grade corresponds to the position of the ovary at the ischial spine superiorly and the hymenal ring inferiorly.

Grade 0: No descent was defined as the infundibulopelvic ligament has little or no stretchability and the ovaries are positioned at the lateral pelvic wall at or above the ischial spines and cannot with traction be brought into the long-axis plane of the vagina.

Grade I: Infundibulopelvic ligament stretchability brings the descent of the ovaries into the long-axis of the vagina with traction halfway between the ischial spines and the midvagina.

Grade II: Infundibulopelvic ligament stretchability brings the descent of the ovaries into the long-axis of the vagina with traction between the midportion of the vagina and the hymenal ring (Fig. 9.27).

Grade III: Infundibulopelvic ligament stretchability brings the descent of the ovaries into the longitudinal plane of the vagina with traction past the hymenal ring.

To determine what grade would be considered accessible and visible for transvaginal oophorectomy, the experience of other surgical specialties was considered. The distance from the hymenal ring to the ischial spine is approximately 8 cm. In dentistry, the distance from the front to the last molar is 6 cm, and, in otolaryngology, the distance from the front teeth to the tonsil is 10 cm. These distances

are manageable operatively. Therefore, any ovary grade I or higher should be visible and accessible for transvaginal removal by most gynecologic surgeons. In this study, of the 875 patients with ages ranging between 29 and 69 years, 813 (92.9%) were judged to be grade II, 40 (4.6%) grade III, 21 (2.4%) grade I, and 1(0.1%) grade 0.

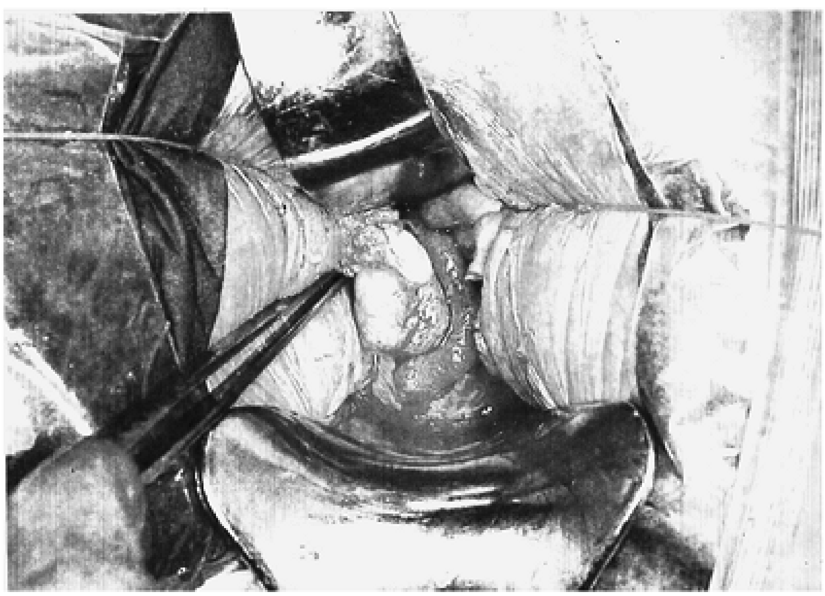

Figure 9-27 Surgical photo of ovary judged as grade II.

This study provided objective evidence that the ovaries may be more visible and accessible for transvaginal removal than heretofore perceived. Adhesive disease, endometriosis, or other significant pathology may cause the ovary to be inaccessible for transvaginal removal. However, the ovary cannot be accurately perceived to be inaccessible at the start of any vaginal hysterectomy. The success of other investigators has demonstrated that planned vaginal salpingo-oophorectomy is successful in 94% to 97% of cases (12). The routine use of the laparoscope to perform an oophorectomy has been heralded as being safe and comfortable. Use of the laparoscope for adnexectomy has become commonplace. â€œTo be sure we can get the ovariesâ€• is a phrase too often heard worldwide to justify the use of abdominal, laparoscopically assisted, or laparoscopic hysterectomy. For too many years, the belief that the ovaries are inaccessible because they are â€œtoo highâ€• for transvaginal removal has erroneously guided the selection of the route of hysterectomy and salpingo-oophorectomy for many gynecologic conditions.

Good surgical practice dictates that objective determination of the visibility and accessibility of the ovaries is the primary criteria for selecting a particular route of oophorectomy. Therefore, if the ovaries are found to be inaccessible after the completion of vaginal hysterectomy then ovarian removal can be performed with the laparoscope or by a simple laparotomy. The correct paradigm substantiated by clinical evidence should be to attempt ovarian removal first transvaginally. If vaginal removal is not possible, then proceed with laparoscopy or laparotomy for removal of the adnexa.

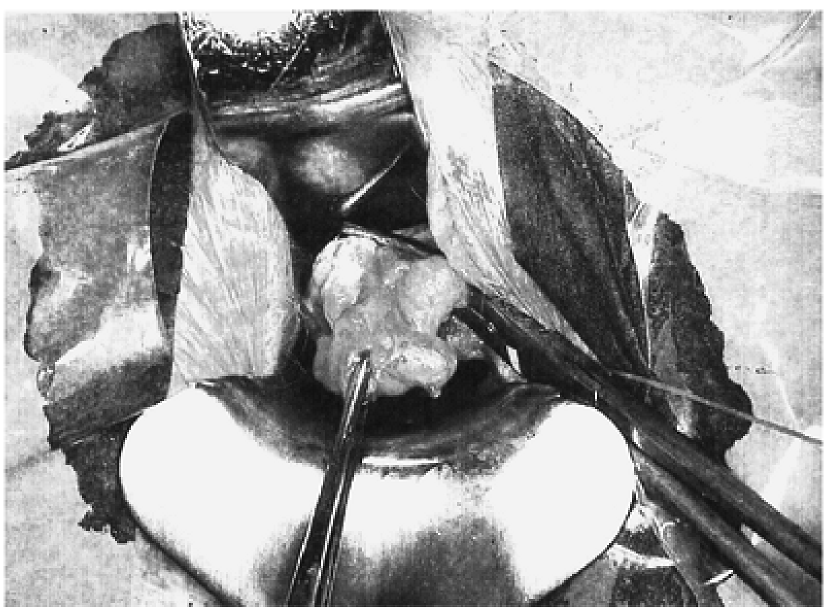

Figure 9-28 Fallopian tube and ovary excised under direct vision after clamping

infundibulopelvic ligament clamped with a MP/Kovac infundibulopelvic ligament clamp.

Vaginal salpingo-oophorectomy may be accomplished in the following manner. Downward traction is applied to the suture that ligates the uteroovarian ligament, round ligament, and fallopian tube. Direct the end of the fallopian tube toward the ovary with tissue forceps, and hemostatically clamp the infundibulopelvic ligament. The Marina Parametrium (MP) infundibulopelvic ligament clamp with the Kovac modification of the jaws (Marina Medical) can be used because of the length and curvature of the clamp and the security of holding the ligament with its specialized jaws. Excise the tube and ovary under direct vision (Fig. 9.28). Place a suture approximately 2 cm from the tip of the clamp and tie around the tip to secure the ovarian artery. A suture is then placed behind the clamp for transfixion and tied firmly with several squared knots (Fig. 9.29). Some surgeons have used an Endoloop (Ethicon Endosurgery, Cincinnati, Ohio) successfully on the infundibulopelvic ligament pedicle.

An alternative method of salpingo-oophorectomy is the three-step technique previously described by Zimmerman (13). This technique mimics the same maneuvers that are used to remove the adnexa abdominally. After removal of the uterus, the uteroovarian pedicle is held with a clamp, and the handle is rotated laterally. This maneuver exposes the round ligament that can be clamped, transected, and ligated. Division of the round ligament gives the surgeon access to the retroperitoneal space between the leaves of the broad ligament. Division of this space makes it possible to isolate, clamp, and ligate the mesovarium. After division of the mesovarium, the only remaining tissue that connects the adnexum is the infundibulopelvic ligament. This ligament can be clamped and ligated with an Endoloop. Division of the adnexectomy into three manageable steps increases surgical control and decreases the likelihood of a complication during suture application. Transection of the round ligament and mesovarium in separate pedicles

significantly increases the descent of the adnexum and results in increased visibility of the infundibulopelvic ligament (Fig. 9.30A-C).

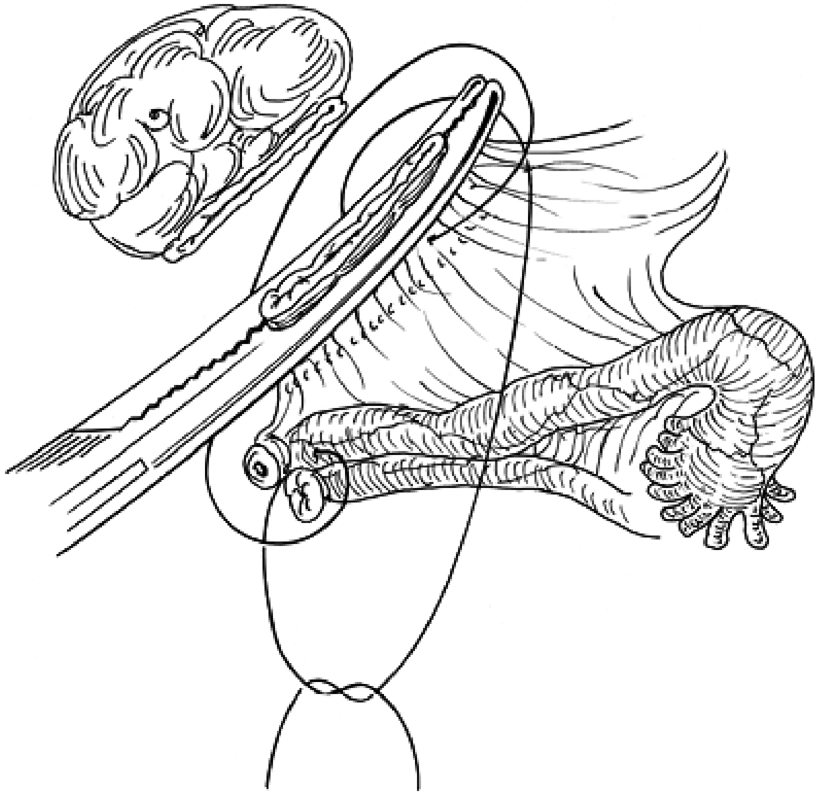

Figure 9-29 The infundibulopelvic ligament has been clamped and the ovary and the tube removed There is a single penetration of the infundibulopelvic ligament and its midpoint and tied around the end of the clamp and tied. This transfixation suture usually occludes the ovarian artery. The suture is then passed around the end of the clamp and transfixed into the tissues behind the heel of the clamp and tied again.

Closure of the peritoneum has been frequently described by many surgeons that perform vaginal hysterectomy. This technique is unnecessary. Closure of the peritoneum is a time-consuming and sometimes dangerous exercise that results in no benefit to the patient. The authors have never regretted leaving the peritoneum open; an open peritoneum should help expose any postoperative bleeding immediately.

The remaining part of a vaginal hysterectomy is to provide support for the vaginal cuff to ensure that an enterocele or vaginal vault prolapse does not occur in later years.

Compensation for the connective tissue defect that is created by the removal of the cervix is best accomplished at the time of hysterectomy. Failure to adequately compensate for the cervical defect will expose the patient to an increased risk for posthysterectomy vaginal vault prolapse in the form of an enterocele or apical anterior vaginal wall prolapse. Enterocele repair and suspension of the prolapsed posthysterectomy vagina are among the most technically demanding of all pelvic surgery procedures. Closure of the cervical defect and reestablishment of the suspensory axis of the vagina by incorporating the uterosacral ligaments into the cuff are effective prophylaxis for future prolapse.

Nichols describes a technique to excise excess peritoneum that is discovered in the cul-de-sac and to prevent the further development of an enterocele (14) (Fig. 9.31). This technique only removes excess peritoneum and does not address the cause of an enterocele after hysterectomy. Correction of the underlying defect is necessary to prevent enterocele formation.

Several methods to repair the posterior vaginal cuff for prolapse prophylaxis have been described. The incidence of enterocele after hysterectomy has been quoted as ranging between 0.1% and 16%. Surgical procedures designed to resolve this problem emphasize the use of the uterosacral ligament in any repair. Inclusion of the uterosacral ligaments in cuff repair is very important because they are the primary suspensory element in the vaginal vault. Connecting the uterosacrals to the cuff reestablishes the suspensory axis of the vagina and should be considered during all hysterectomies. The most commonly employed technique to close the posterior vaginal cuff is the McCall culdoplasty (15). This technique obliterates the cul-de-sac, suspends the posterior superior vagina and its fascial attachments to the uterosacral ligaments, and brings these structures together (Fig. 9.32). Before the innovation of McCall, the surgical closure of the vaginal cuff after removal of the uterus was believed to be a sufficient end to the operation. A high incidence of vaginal vault prolapse and associated enterocele formation resulted.

Recent advancements in pelvic reconstructive techniques and an improved understanding of the cause of enteroceles have resulted in a new method of preventing enteroceles and vault prolapse at the time of hysterectomy. Enteroceles are now recognized to form from a separation of the rectovaginal fascia from the pubocervical fascia (Fig. 9.33).

Vaginal vault prolapse and enterocele formation differ anatomically. The upper vagina can be well supported, although an enterocele exists and vice versa. An enterocele dissects between the vaginal epithelium of the pubocervical fascia of the anterior vaginal segment and the rectovaginal fascia of the posterior vaginal segment. Superior segment vaginal vault prolapse results from the loss of the uterosacral and cardinal ligament support.

The layer of visceral connective tissue surrounding the bladder, vagina, and rectum is the endopelvic fascia. The peritoneum of the cul-de-sac of Douglas extends just caudad to the cervix and is positioned between the posterior vaginal fascia and the anterior rectal fascia. An enterocele develops when a weakness occurs or is created iatrogenically in the apical posterior vaginal fascial sheath, or when the rectovaginal septum is detached from the pericervical ring and pubocervical fascia. Removal of the cervix during hysterectomy creates a connective tissue defect that predisposes to enterocele formation. Enteroceles are pelvic hernias that descend through the posterior vaginal fornix. If the defect is sufficiently large, the anterior wall of the rectum may descend through the same endopelvic fascial defect in the form of a rectocele. Iatrogenic enteroceles can be found in the same location but are caused by a

failed posterior hysterectomy cuff repair that does not compensate for the defect left by the absence of the cervix.

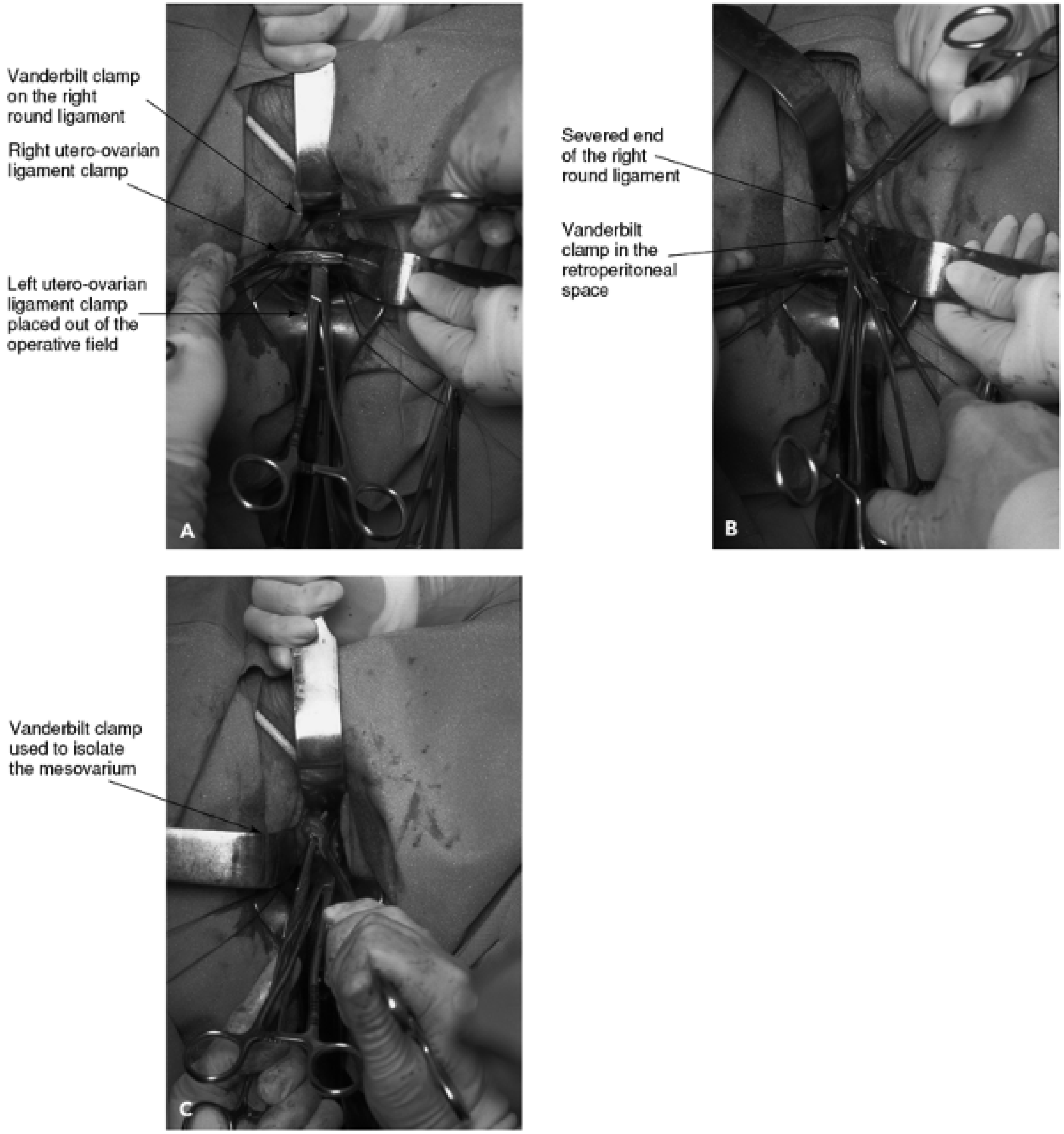

Figure 9-30 When increased mobilization is required, separating the round ligament and tube provides greater descent for transvaginal removal. A: Vanderbilt clamp on the right round ligament, right uteroovarian ligament clamp, and left uteroovarian ligament clamp placed out of the operative field. B: Severed end of the right round ligament and Vanderbilt clamp in the retroperitoneal space. C: A Vanderbilt clamp is used to demonstrate the

mesovarium (all tissue distal to the opening in the right broad ligament created by dividing the right round ligament).

Hysterectomy and the removal of the cervix create a separation of the rectovaginal septum and the fibers of connective tissue that form the pericervical ring. This separation widens the cul-de-sac and allows the peritoneum with its intraabdominal structures to protrude through this weakness with any increase in intraabdominal pressure.

Restoration of normal anatomy following hysterectomy is accomplished by repairing the disrupted connective tissues. Permanent interrupted sutures are placed vertically between the pubocervical vaginal fascia and the rectovaginal fascia to close the space vacated by the absence of the cervix. Because the anterior vaginal wall is shorter than the posterior wall, approximation of these tissues may shorten vaginal length. The fascia on the anterior vaginal wall is easily identified with tissue forceps; however, identification of the rectovaginal fascia requires placement of a finger into the rectum. The use of a pelvic reconstructive surgical drape with a finger cot (American Medical Systems,

Minnetonka, MN) is most useful to avoid contamination. If an enterocele sac has been identified, it does not require high ligation of the sac because the mesothelial lining of the peritoneum has little supportive value. The sac is simply pushed upward as each suture is tied between the pubocervical fascia and the rectovaginal fascia. An Allis clamp is then placed on the suture line of this closure, and traction is applied toward the introitus. If this tissue can be pulled with traction to the midvagina or beyond, the uterosacral ligaments that support the rectovaginal fascia have been disrupted or are not sufficient to support this repair. Additional support is needed to reduce the possibility of further prolapse of the vagina. Several techniques can be employed to resolve this potential problem. The posterior vaginal wall can be opened in the midline to identify the cul-de-sac. The lateral edges of the rectovaginal fascia may be attached to the uterosacral or sacrospinous ligaments. If the sacrospinous ligament is used, two sutures are placed into each sacrospinous ligament. The medial suture is connected to the lateral margins of the pubocervical fascia and the rectovaginal fascia. The lateral sutures are placed into the vaginal wall to support the vaginal epithelium. Placement of an IVS Tunneller (Tyco Healthcare, Norwalk, CT), Apogee (American Medical Systems, Minnetonka, MN), or similar posterior suspensory slings represents another option. These instruments place a band of mesh in the

diameter between the ischial spines. The pubocervical fascia may be attached to the superior edge of the tape, and the rectovaginal fascia to the posterior edge of the tape. The mesh is less likely than sutures to shorten the vagina because of the shorter anterior wall (Fig. 9.34). The mesh is then supported to the uterosacral ligaments bilaterally. The ligaments are grasped retroperitoneally near the sacrum where they fuse with sacral periosteum. A suture is placed through each ligament (Fig. 9.35). After insertion through buttock incisions and the ischioanal fossa, the mesh forms a neocuff or scaffolding for fascial attachment. The authors consider this technique to be a vaginal sacral colpopexy. Increasing tension on the IVS Tunneler tape or Apogee mesh elevates the fascia upward and toward the hollow of the sacrum. This technique may obviate the need for a sacrospinous fixation. Short-term studies of this method seem very promising. The mesh must be suspended to the uterosacral ligaments, or the length of the vagina may be compromised. The senior author has suggested the use of a posterior sling neocuff as a prophylactic measure to prevent future enterocele and prolapse at the time of hysterectomy. Current studies will validate this idea.

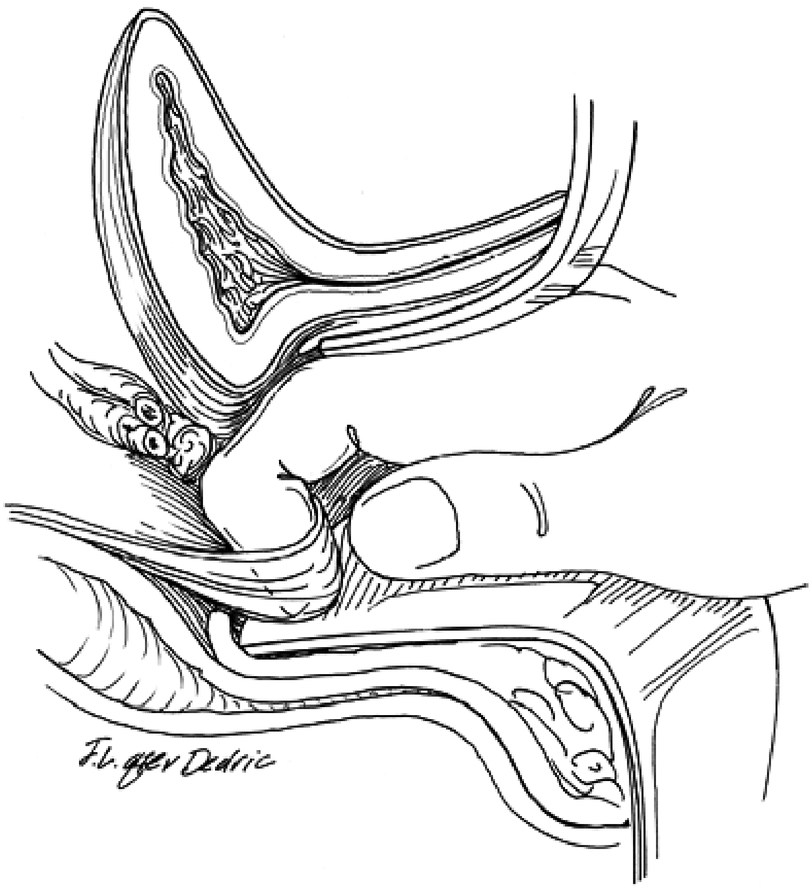

Figure 9-31 Identification of excess peritoneum in cul-de-sac. Excision of excess peritoneum will not prevent future enterocele formation as the cause of the enterocele is not determined.

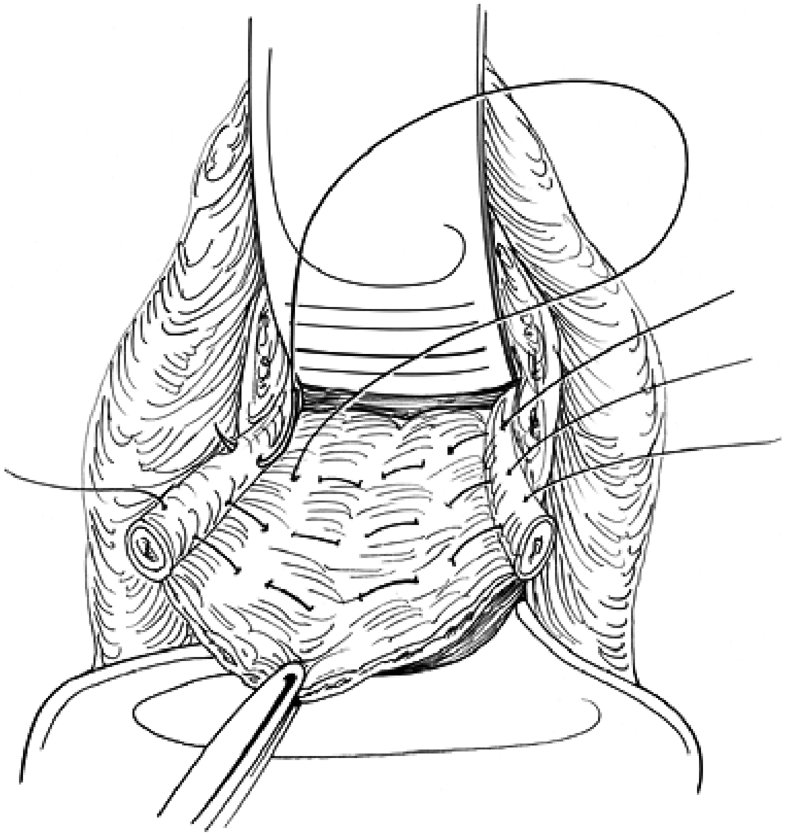

Figure 9-32 McCall internal culdoplasty.

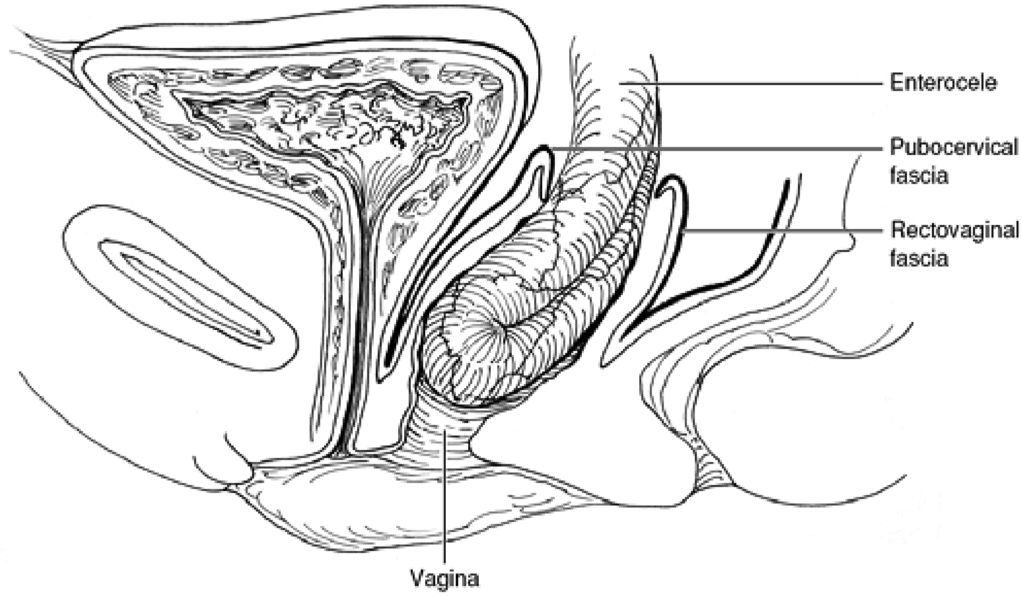

Figure 9-33 Separation of the pubocervical and rectovaginal fascia with enterocele formation.

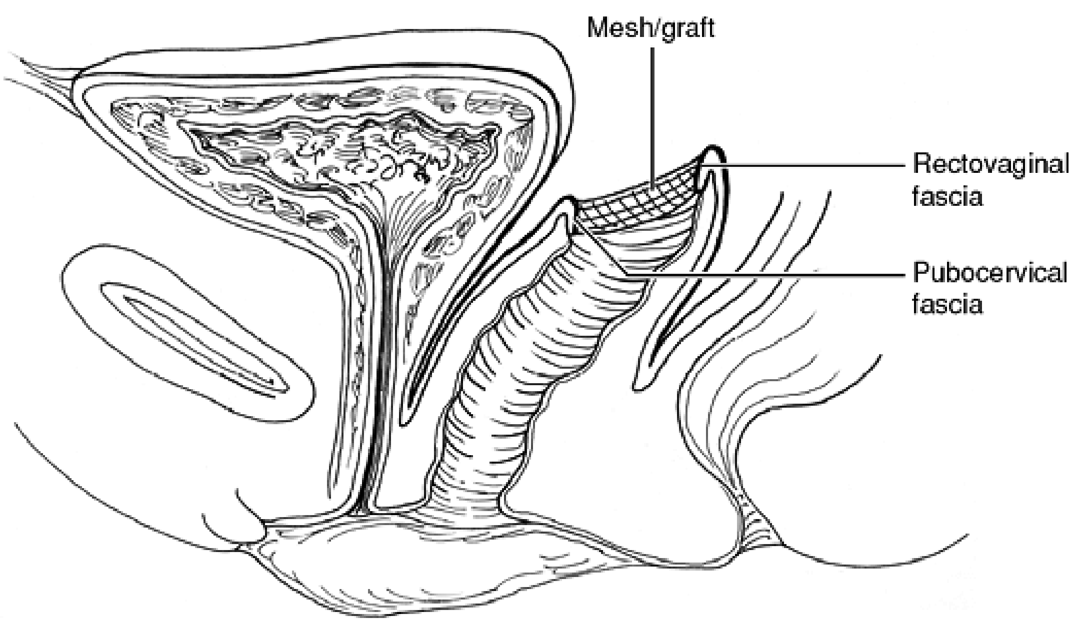

Figure 9-34 Mesh or graft attached to pubocervical fascia anteriorly and

rectovaginal fascia posteriorly to compensate for the absence of the cervix. Graft or mesh is then attached to the uterosacral of sacrospinous ligaments for prevention of vaginal vault prolapse.

The primary objective of vaginal cuff closure is to approximate the cut edges of the vagina in a smooth line with as little irregularity as possible. This technique will assist in preventing postoperative granulation tissue formation at the vaginal incision site. Some surgeons have suggested that the vagina should be closed vertically to preserve vaginal length. Cruikshank has demonstrated that vaginal length depends on the support of the vaginal cuff rather than any specific method of epithelial closure (16). He measured the depth of the vagina following various types of closure of the vaginal epithelium. Vertical closure places the scar at the top of the vagina and on occasion causes hypesthesia during coitus. The scar may require subsequent revision. Closure of the vagina in a transverse direction is preferred. If the cuff has been adequately supported, the transverse closure is positioned on the anterior vaginal wall and leaves more depth to the posterior vaginal wall for coitus.

Numerous investigators have recommended that the vaginal cuff should be left open or a drain placed within the vaginal incision in an attempt to reduce the morbidity of vaginal cuff cellulitis or abscess formation. These efforts have not been routinely successful when compared to complete vault closure. In addition, leaving the cuff open may lead to an increased incidence of enterocele formation and vaginal vault prolapse.

The decision to place a pack into the vagina is subjective. A vaginal pack should not be used after vaginal hysterectomy unless concomitant pelvic reconstructive surgery is performed. Postoperative bleeding rarely occurs from an unsecured intraabdominal pedicle. In the absence of a pack, this bleeding problem will present early in the

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postoperative course. Although the patient may still be hematologically stable, a pelvic arteriogram may be performed. Identification of the bleeding site for arterial occlusion may prevent the need for laparotomy. A vaginal pack will delay the diagnosis of postoperative vaginal bleeding and may delay the diagnosis of intraabdominal bleeding.

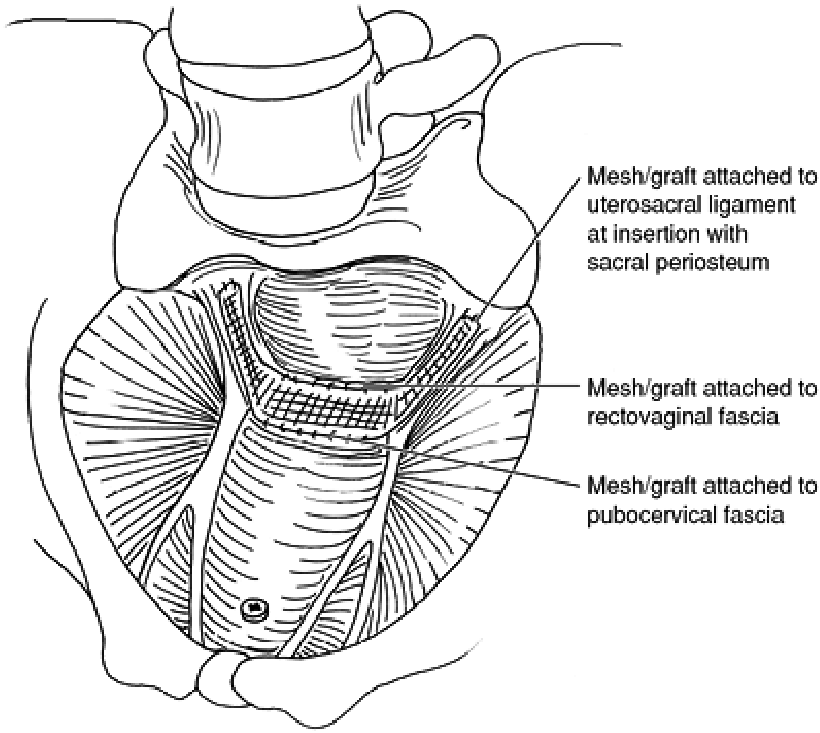

Figure 9-35 Difference between a shorter pubocervical fascia than rectovaginal fascia is resolved with the placement of a graft or mesh to prevent separation of these fascial edges and enterocele formation.

Routine insertion of an indwelling transurethral catheter is not necessary after the removal of a normal-size uterus. Removal of an enlarged uterus may compromise the function of the urethra and bladder. Transient postoperative voiding problems may result. Overnight bladder drainage is recommended after the removal of a large uterus.

The weighted speculum can cause spasm of the rectal sphincter and delay the passage of flatus postoperatively. Joel-Cohen recommends the Lord procedure after vaginal hysterectomy (17). The index fingers of each hand are placed in the rectum at the three and nine o'clock positions and are gently pulled apart laterally for 10 to 20 seconds. Immediate relaxation of the sphincter is noted, and prolonged postoperative ileus is prevented.

Some surgeons recommend routine cystoscopy after vaginal hysterectomy. After the intravenous administration of 5 mL of indigo carmine dye, observe the efflux of blue dye through each ureteral orifice. Although this procedure may not be necessary with each vaginal hysterectomy, it certainly makes the surgeon more comfortable if the patient complains of flank pain the next day. In the absence of efflux from a ureteral orifice, cutting the McCall culdoplasty suture usually reestablishes the flow of urine from a kinked ureter. If the absence of ureteral flow persists, a ureteral stent can be inserted cystoscopically to assess ureteral blockage at a higher level. In this circumstance, ureteral blockage must be addressed before leaving the operating room. Obviously, the surgeon must have the clinical privileges to perform cystoscopy, ureteral stent insertion, and ureteral repairs if necessary. If the surgeon does not have those privileges, consultation with another gynecologic surgeon or colleague with those privileges is required.

New Technology

Current demands on the surgeon require efficiency in the operating room to reduce total hospital cost. Suturing is the most time-consuming part of any vaginal hysterectomy. In recent years, the endoscopic linear cutter (Ethicon Endosurgery) has been employed during vaginal hysterectomy in an attempt to resolve this issue. This method has frequently resulted in the removal of the uterus in less than 10 minutes. Because the average cost of time in the operating room in the United States is approximately $40 per minute and the cost of anesthesia is approximately $8 per minute, reduction in operative time can result in considerable cost benefits. More recently, the use of electrical energy with the LigaSure device (Valleylab, Boulder, CO) has also been employed successfully to reduce operative time. Other instrumentation such as the Harmonic Scalpel (Ethicon Endosurgery) and the Gyrus Seal PK device (Gyrus Medical, Maple Grove, MN) have become available. These instruments have the additional benefit of reducing exposure of the surgeon and operating team to needle injury in patients with HIV, hepatitis, or other infectious conditions.

Electrical or mechanical energy sources may become the norm by enhancing surgeon comfort, reducing complications, expediting the completion of vaginal procedures, and reducing costs. Surgeons must be aware that injuries to the small intestine, large intestine, and bladder are possible with electrocautery devices. These injuries have usually occurred when the surgeon employs these instruments to cauterize the mid and upper portions of the broad ligament and does not recognize the presence of small bowel or another vulnerable structure (Fig. 9.36). These injuries can be prevented if the surgeon performs intramyometrial coring after the uterine vessels have been secured. Clamping of the upper part of the broad ligament is not desirable. The surgeon must always work with the aid of good visibility and sure anatomic knowledge.

Appendectomy With Vaginal Hysterectomy

Removal of the appendix is commonly performed in conjunction with abdominal hysterectomy. In addition to exposing gynecologic surgeons to bowel surgery, the belief existed that this operation would reduce the risk of appendicitis in later years of a woman's life. When the risks of developing appendicitis are studied, the incidence of appendicitis after 35 years of age was so minimal that appendectomy was not considered justified. However, studies have shown that the pelvic appendix, that is, an appendix spontaneously found in the pelvis, increases the risk of appendicitis in any age patient.

Occasionally, during vaginal hysterectomy, the appendix presents itself in the operative field. If the appendix is readily visible, remove it during the vaginal hysterectomy (18,19). In all appendectomies the cecum must be mobilized and secured. This mobilization is surprisingly simple to perform vaginally. The appendix is then removed in the standard fashion with one additional caveat. A surgical clip that is placed at the base of the appendiceal stump is recommended. This documents that the appendix has been removed. This maneuver may be extremely valuable if the patient develops right lower quadrant pain and states that her appendix has been removed. If no abdominal incision is present on her abdomen, her history may be ignored and an unnecessary laparotomy or laparoscopy performed.

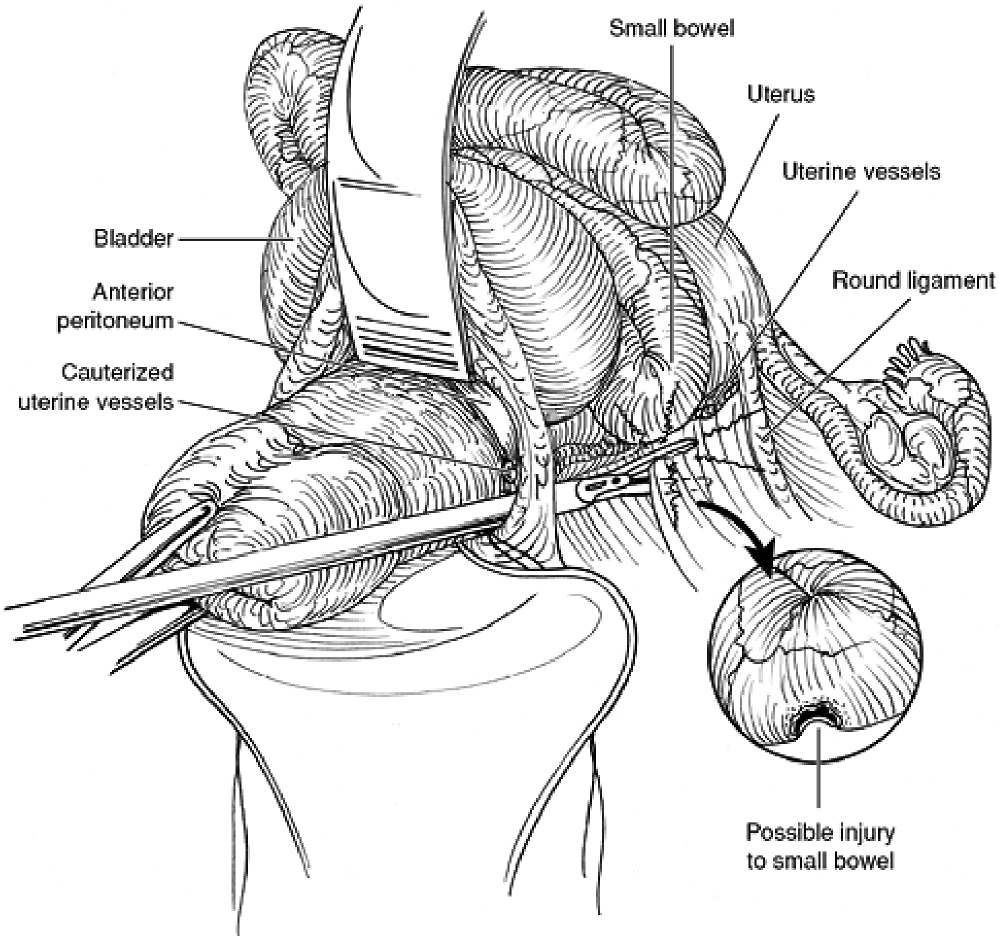

Figure 9-36 Injury to the small intestines with cautery of the mid and upper portions of the broad ligament after the uterine artery has been cauterized. Coring of the uterus after the artery has been managed would prevent this injury as it is unnecessary to cauterize or clamp the broad ligament above the uterine artery.

Conclusion

When a hysterectomy is indicated, the vaginal approach is superior to any other technique in a number of ways. A specific contraindication, identifiable before the operation begins, should be documented if any other approach is offered to the patient. If the Guidelines for Hysterectomy that are documented in Chapter 8 are followed, a large majority of hysterectomies should and can be accomplished vaginally. Emphasis in the Guidelines is placed on identifying small mobile uteri without anatomically distorting, identifiable, or extrauterine pelvic pathology. Indications for removal of the adnexa are the same, regardless of the operative approach. The patient and the health care system benefit in measurable ways when the minimally invasive natural orifice vaginal approach is used for this operation. Each gynecologic surgeon is obligated to provide access to the best operation that is available in a given clinical circumstance. The surgeon should acquire the appropriate skill set to provide optimal care to the patient. In the case of hysterectomy, the vaginal approach is and should remain the primary route of choice.

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10

Vaginal Hysterectomy for the Enlarged Uterus

Octacilio Figueiredo Netto

Octacilio Figueiredo

Vaginal hysterectomy for the enlarged uterus is a concept more than 100 years old. At the turn of the nineteenth century, when laparotomy was dangerous because of a suboptimal knowledge of anesthesia, blood transfusion, and antibiotic therapy, vaginal hysterectomy was particularly relevant. Although at the time transvaginal uterine morcellation was a somewhat heroic procedure, these techniques contributed enormously to the development of vaginal surgery. The scientific literature shows that the morbidity of vaginal hysterectomy, undisputedly lower than that of abdominal hysterectomy, remains even when morcellation techniques are employed (1,2). In addition it has been demonstrated that reduction of large uteri does not increase the morbidity of vaginal hysterectomy (3,4). Moreover, numerous studies have provided evidence that the different methods of morcellation represent a safe and effective means of extirpation of myomatous uteri through the vagina (5,6,7,8,9,10).

Preoperative Considerations

Endometrial Evaluation

Although there is no conclusive evidence that the leiomyomatous uterus presents a higher risk of endometrial cancer, some authors recommend a pathologic evaluation of the endometrium whenever the possibility of uterine morcellation is anticipated (11). Others examined this issue and concluded that routine, preoperative dilatation and curettage (D&C) in patients undergoing hysterectomy is not financially beneficial (12). However, when the patient has risk factors for endometrial adenocarcinoma, such as obesity, hypertension, diabetes, chronic anovulation, tamoxifen use, and unopposed estrogen therapy, it is prudent to perform a preoperative diagnostic hysteroscopy with biopsy.5

Radiologic Evaluation

Imaging studies such as ultrasonography, computed tomographic (CT) scan, and magnetic resonance imaging (MRI) provide valuable information about the number, size, and location of myomas, and help determine the presence of extrauterine pathology. Polymyomatous uteri are easier to remove vaginally than those diffusely enlarged, also known as â€œcannonballâ€• uteri. In these cases, morcellation is more difficult, as the cervix is short and small, and the angle formed between the cervix and corpus is reduced, making it difficult to achieve adequate descent of the organ once the parametria are cut. Consequently, access to the uterine vessels is restricted (Fig. 10.1).

The most favorable radiologic finding is that of multiple intramural fibroids, preferably located at the fundus or posterior uterine wall (13). In some situations MRI may be indicated, particularly in patients with suspicious pelvic tumors or extremely enlarged uteri. In the case of intraligamentary fibroids, a contrasted radiologic evaluation of the course of the ureter is also warranted.

Use of GnRH Agonists

Myomas are very responsive to estrogenic stimulus, a fact confirmed by their rapid growth during pregnancy and their regression after menopause. Therefore, suppression of the endogenous production of this hormone results in size reduction. GnRH agonists induce a state of hypoestrogenism, with consequent reduction of myoma

and uterine size (14,15). The main effects of GnRH agonists are:

- Volume reduction of 50% to 60%, with maximum effect occurring in the first 8 to 12 weeks of treatment
- Myoma regrowth after interruption of treatment in 95% of cases
- Hot flushes are the most common complaints, but the frequency and intensity are lower after a few weeks of treatment.
- Effects of treatment on bone and lipid profile with treatments of short duration are insignificant and reversible.
- Amenorrhea is induced in more than 95% of patients, resulting in the elevation of hematocrit and hemoglobin.
- Approximately 1% of patients present myoma degeneration, with profuse vaginal bleeding requiring surgical intervention.

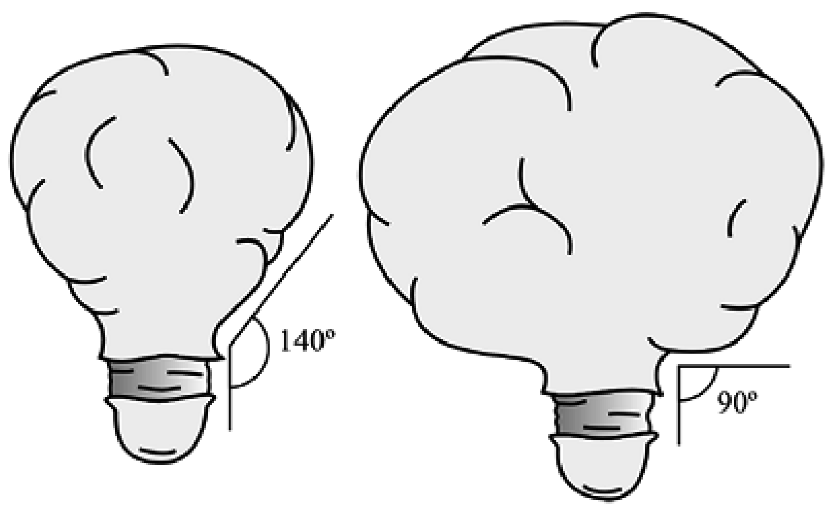

Figure 10.1 Myomatous â€œpear-shapedâ€• uterus favorable for transvaginal morcellation (left), and diffusely enlarged â€œcannonballâ€• uterus (right).

The reasons for using GnRH agonists in patients with uterine myomatosis undergoing hysterectomy are to allow conversion from the abdominal to vaginal approach and correction of preoperative anemia with consequent reduction of the risk of blood transfusion (16). To determine if preoperative use of GnRH agonists would increase the performance of vaginal hysterectomy, Stovall et al. randomized 50 candidates for hysterectomy with symptomatic myomatosis with a uterine volume equivalent to 14- to 18-weeks of gestation in two groups (17). The control group of 25 patients was not treated, whereas the other 25 patients received GnRH agonists during the 2 months preceding surgery. The authors noticed a significant increase in hemoglobin levels (from 10.7 to 12.1 g/dL; $p < 0.05$), and a significant reduction in uterine volume (from 1,086.7 cm^3 to 723.4 cm^3; $p < 0.05$). In addition, a greater percentage of patients underwent vaginal hysterectomy (76% versus 16%); with a significantly shorter hospital stay (5.2 versus 3.8 days; $p < 0.05$). However, these advantages must be analyzed considering the high cost of these drugs (18).

Indications for Transvaginal Uterine Morcellation

Enlarged Uterus

In the case of slightly enlarged mobile uteri, the need for morcellation is dictated by the clinical observation, during surgery, that it is impossible to access the upper pedicle by simple traction upon the cervix and flipping the uterus through the posterior fornix (19). Uteri larger than an adult fist usually need to be morcellated. It is interesting to note that, regardless of the size of the uterus, its main blood supply comes from the uterine vessels, which are invariably located at the level of the cervix and isthmic region, and, therefore, accessible for ligation in the majority of cases. The largest uterus successfully removed through the vagina weighed 2,970 g and was reported by S. Robert Kovac (personal communication).

Absence of Descensus

When the uterus is fixed in the pelvis, as in some cases of endometriosis, pelvic inflammatory disease, or after extensive previous surgeries, division of the paracervical insertions may not provide sufficient descensus. In these situations, the procedure can be expedited by performing a hemisection, and, if necessary, combining wedge resection to allow removal of the organ. This maneuver may also provide access to eventual adhesions at the level of the corpus or fundus.

Cervical Obstruction

Some myomas may obstruct penetration into the anterior and/or posterior cul-de-sac. Morcellation of these tumors as a preliminary step of surgery can be performed without difficulty, allowing initiation of the hysterectomy. Because in these cases the cervical distortion caused by these tumors may prevent the performance of a preoperative endometrial biopsy, evaluation of the cavity must be made intraoperatively once it is reached.

Limited Vaginal Access

Not infrequently a patient with a small uterus may present difficulty for removal of the uterus in toto, either because of limited vaginal exposure or due to resistance of the uterine supporting structures. In these cases, after ligation of the uterine vessels, efforts must concentrate on fragmenting the organ in the midline, instead of insisting on an inefficient and sometimes dangerous lateral approach.

Contraindications for Transvaginal Uterine Morcellation

Suspected Uterine Neoplasia

When uterine neoplasia is suspected, it is necessary to remove the uterus and adnexa *en bloc* for adequate evaluation of disease extension. This information is essential for staging purposes, and is not provided by a morcellated specimen. In cases when there is a preoperative diagnosis of atypical, complex endometrial hyperplasia, the uterus must also be removed intact, since there is a small risk of concomitant endometrial adenocarcinoma. The main concern is the inability to evaluate disease extension precisely and, consequently, the uncertainty regarding the need for any type of adjuvant therapy. It is not yet very clear if mechanical dissemination of malignant uterine cells by the morcellation process might worsen the prognosis.

Absolute Limitation of Vaginal Access

Fibroids that interfere with surgical exposure may be removed, and many vaginal constrictions can be solved with an episiotomy. However, extreme narrowing of the bony pelvis, combined with a very deep vagina, may totally preclude the performance of the maneuvers necessary for division of lower uterine insertions and morcellation. These cases are very uncommon and, in general, if the cervix can be visualized during a routine pelvic examination, the probability of success at vaginal hysterectomy is high.

Combination of Enlarged and Fixed Uterus

Morcellation is only possible through continuous manipulation and realignment of the enlarged uterus. When size-reduction techniques require deeper and deeper incursions into the pelvis, a point is reached when the absence of mobility and the inability to bring the uterus closer to the surgeon render vaginal hysterectomy impossible.

Techniques of Uterine Morcellation

Transvaginal morcellation should be preceded by ligation of the uterine vessels and, regardless of the strategy employed, the surgeon must be well oriented in relation to the bladder and rectum, thereby avoiding excessive traction on the uterus in order to prevent avulsion of the utero-ovarian ligament or laceration of the infundibulum. Sometimes different techniques of uterine fragmentation may need to be combined when one single method fails or in the presence of intraoperative difficulties.

Hemisection

When it is impossible to flip the uterus through the posterior cul-de-sac, one of the morcellation techniques that can be attempted is hemisection, which consists of an anteroposterior division of the uterus in two halves. Hemisection is a very efficient method for removal of uteri containing fundal and/or midline fibroids. The cervix is seized at three and nine o'clock with tenacula, and a longitudinal incision is performed on the anterior and posterior uterine walls with a scalpel. The bladder and rectum must be protected with Breisky and weighted retractors, respectively. Under direct vision, the midline incision continues toward the fundus, always through the uterine cavity in order to keep good anatomic orientation (Fig. 10.2).

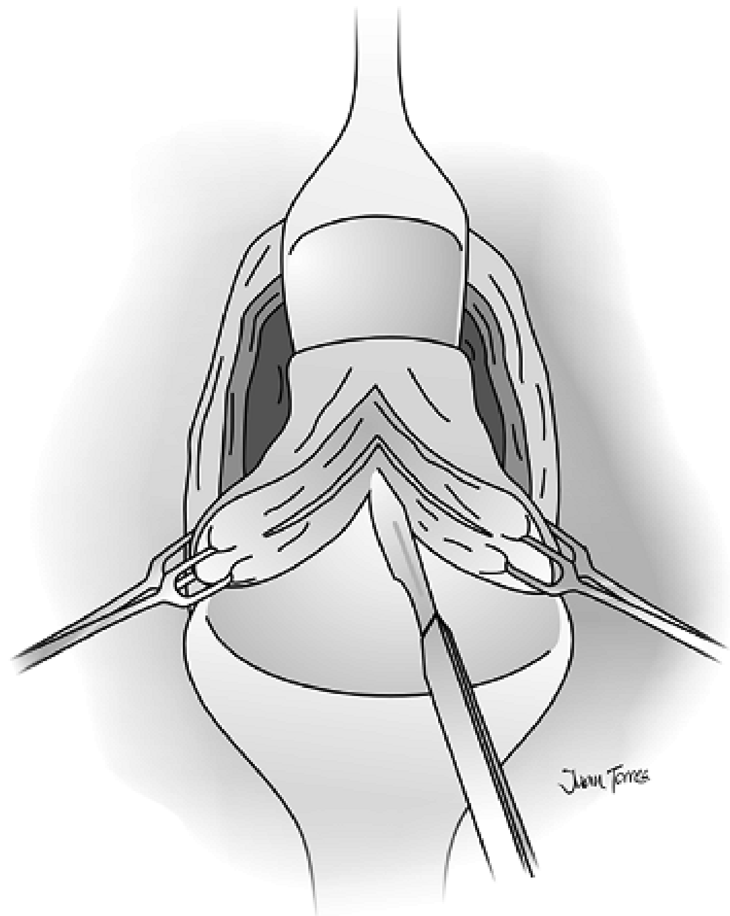

Figure 10.2 Uterine hemisection.

The principle of hemisection is based on simple physics. The force that opposes the extraction of the uterus is the resultant force derived from two divergent forces oriented toward the cornua, where the round ligaments are inserted. When we divide the uterus medially toward the fundus and apply the extraction force at the apex of this incision, the angle formed by the two forces of resistance opens, with consequent reduction of the resultant force. As the incision progresses, eventually this resultant becomes smaller than the extraction force, and the uterus exteriorizes before hemisection is completed (Fig. 10.3).

When the uterine mass precludes progressive descent of the uterus, the apex of the incision is grasped bilaterally, and hemisection is continued on the anterior and posterior

walls until total division of the organ in two halves. By placing one of the halves back inside the pelvic cavity, surgical exposure is improved, allowing clamping and cutting of the contralateral adnexal pedicle. The other half is again exteriorized and then removed. When performed correctly, uterine hemisection results in minimal blood loss because of previous ligation of the uterine vessels and compression of the cut margins of the vaginal wall as traction is applied on the cervix.

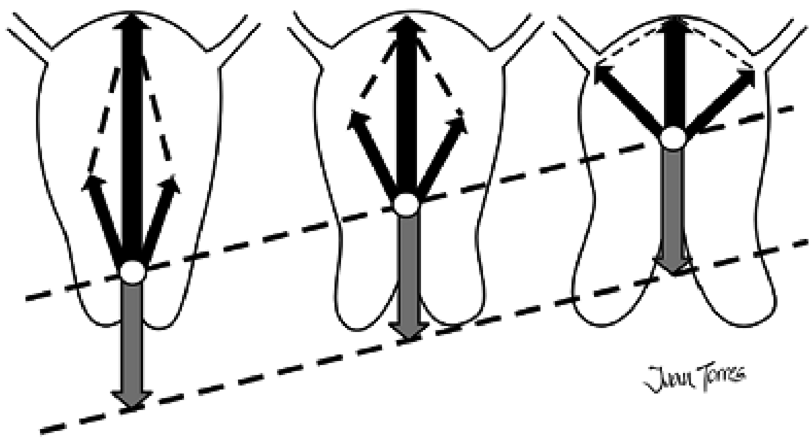

Figure 10.3 Mechanical effect of hemisection.

In case of relatively small uteri, up to 12- to 14-week size, hemisection alone permits removal of the specimen (20). For larger uteri it may be necessary to combine other morcellation techniques. When fibroids are located at the level of the midline incision, they may be divided with the uterus or enucleated and removed separately (Fig. 10.4).

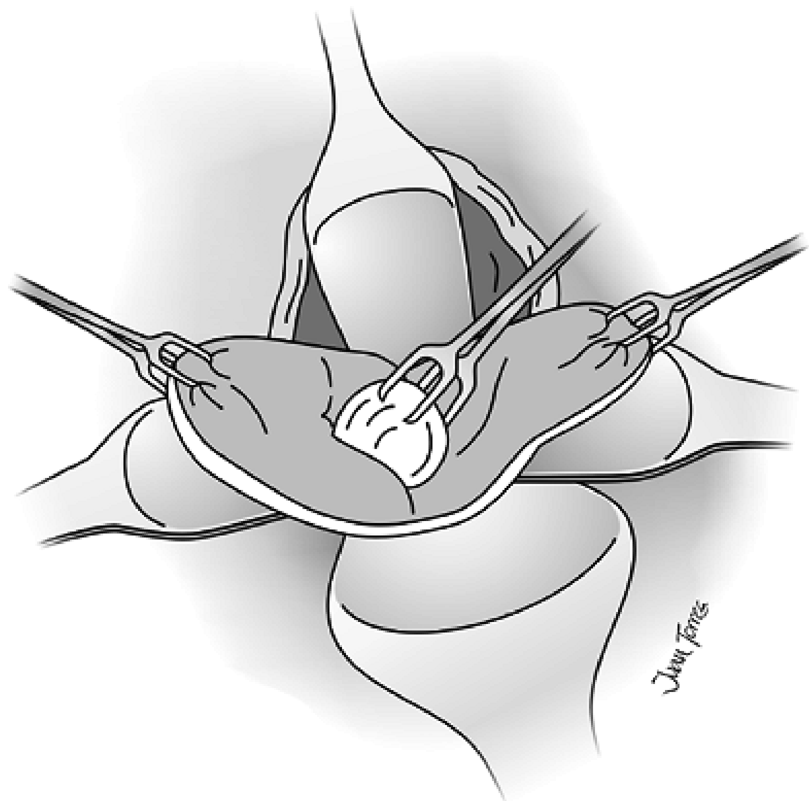

Figure 10.4 Myomectomy during uterine hemisection.

Intramyometrial Coring

Abraham Lash introduced this technique in 1941 as a method of uterine size reduction without penetration of the endometrial cavity, at the time indicated for cases of pyometra and endometrial cancer (21). Later, S. Robert Kovac popularized this procedure in the United States, having also determined its safety in a study that compared three groups (22). Group I (*n* = 554) included patients in whom vaginal hysterectomy with intramyometrial coring was performed. Group II (*n* = 173) comprised patients who underwent vaginal hysterectomy without any type of morcellation, and group III included those submitted to abdominal hysterectomy. All parameters evaluated (duration of surgery, blood loss, hospital stay, etc.) confirmed not only the safety but also the superiority of vaginal hysterectomy, with or without morcellation, relative to the abdominal approach.

Intramyometrial coring is more appropriate for removal of medium-sized, diffusely enlarged uteri. As with hemisection, this technique may also be combined with myomectomy, and it is very useful when the vaginal canal and subpubic arch are narrow. The procedure begins at the level of the isthmus, below the peritoneal reflection. The myometrium is circularly incised with a scalpel, midway between the serosa and uterine cavity. Consequently, the anteroposterior and transverse diameters of the fundus are reduced, and the uterus acquires an elongated cylindrical shape. In order to have satisfactory results with this method, it is important to avoid creation of multiple planes of incision. As the cervix is pulled and the concentric incisions reach the fundus, the uterus is progressively exteriorized through the vagina (Fig. 10.5).

This technique has an advantage in that the uterine cavity is not penetrated, with a lower chance of injury to adjacent organs, since the circular incisions on the myometrium do not reach the serosa of the uterus (23). During intramyometrial coring, a useful maneuver borrowed from obstetrics is applying pressure on the fundus in order to supplement the traction for uterine descent. Coring becomes easier once the corpus comes closer to the vaginal introitus. Suprapubic pressure is more efficient in thin patients with mobile uteri extending to the umbilicus.

Wedge Resection

Wedge resection is the procedure of choice for myomatous uteri of large volume, in which hemisection and intramyometrial coring are unlikely to succeed. It is the most versatile of all techniques, but also the most difficult one to master, since there are many variations for each specific situation. Wedge resection usually begins with a midline incision, and progresses with the removal of small wedges of uterine tissue at the apex of this incision. The central uterine mass is grasped with Lahey clamps and incised bilaterally with a scalpel, removing triangular or oval pieces of tissue. The surgeon must always resect in a symmetrical

midline fashion, avoiding lateral deviation toward the adnexal pedicles. It is important to be patient during morcellation of very large uteri, removing a small piece at a time until the uterine mass becomes small enough to be exteriorized from the pelvic cavity. In the case of very large myomas impossible to enucleate, progressive excision of various wedges of the tumor, always under direct vision, is preferred. Dargent suggests performing two oblique incisions meeting at both extremities for the removal of a wedge of the myoma, analogous to the removal of a piece of an orange (24). After resection of the first piece, the myoma is pulled laterally with a Lahey clamp, exposing another surface of the myoma, from which another piece will be removed. Eventually a point is reached when the whole myoma can be extracted through the vaginal introitus (Fig. 10.6).

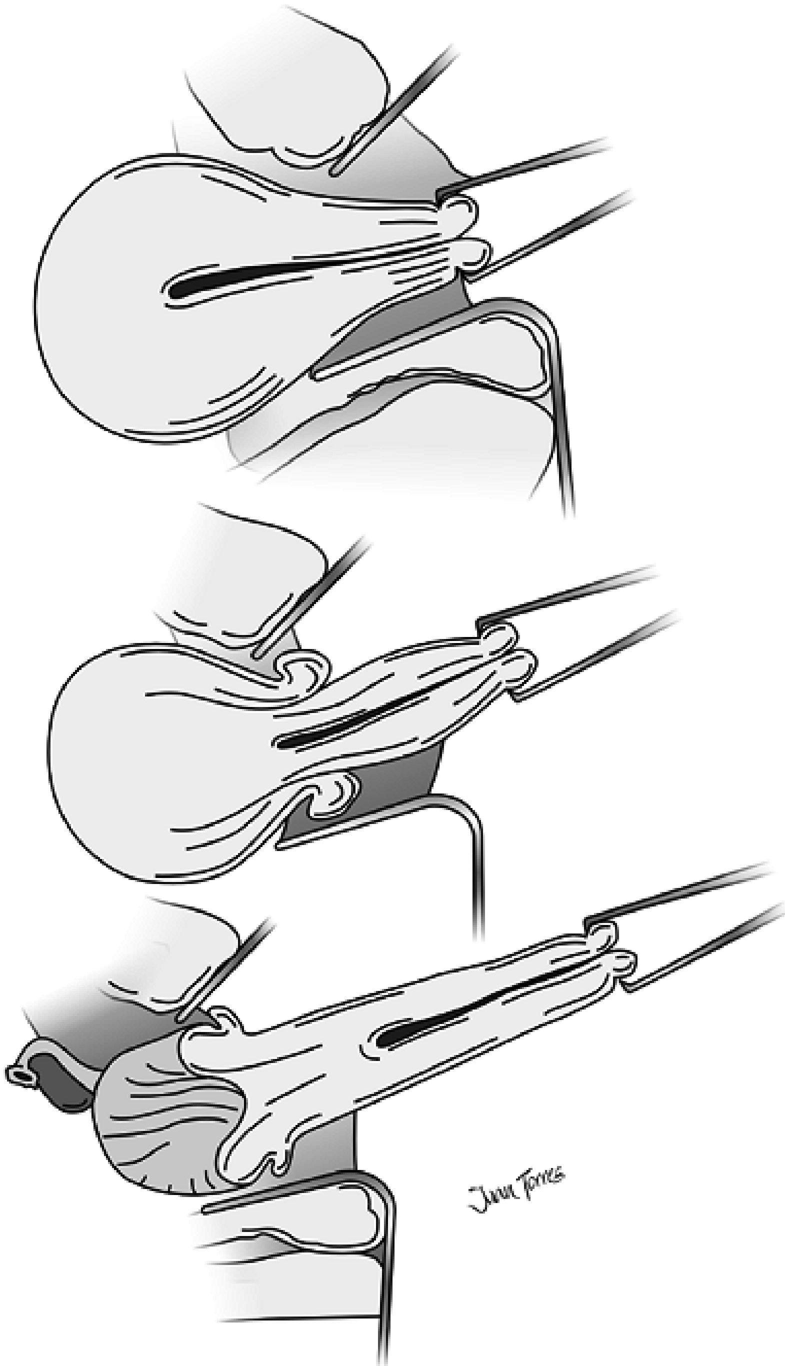

Figure 10.5 Progressive exteriorization of the uterus by means of intramyometrial coring.

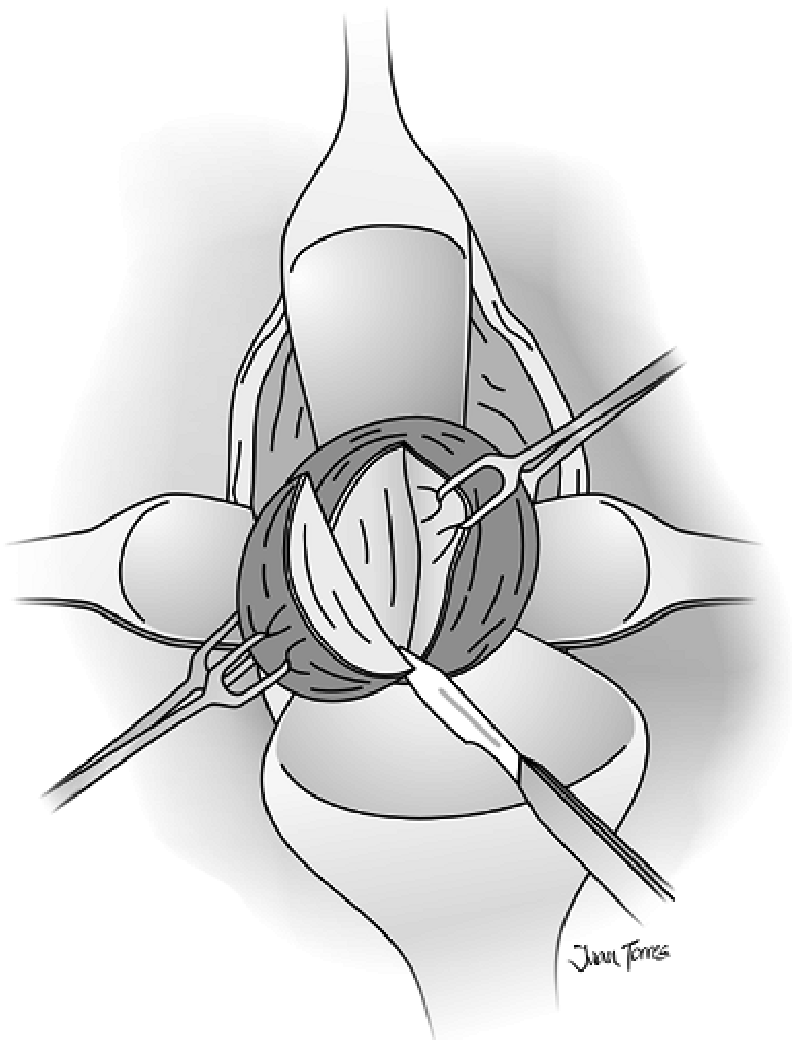

Figure 10.6 Wedge resection of a large fibroid.

Posterior Fundal Morcellation

This approach is focused at the portion of the uterus with the greatest volume, the fundus. After exteriorization of the uterus, sometimes the space available for application of the curved Z-clamps on the superior pedicles is restricted. In these cases, the surgeon can resect a longitudinal wedge of the myometrium at the posterior wall of the fundus and reapproximate the lateral borders of this incision with a Lahey clamp. The reduction in uterine size widens the space for placement of the Z-clamps (Figs. 10.7 and 10.8).

Cervical Amputation and Myomectomy

The cervix may be amputated transversely with a scalpel at the level of the isthmus, in order to facilitate posterior rotation of the uterine fundus. The benefits of cervical amputation must be evaluated carefully, because the cervix often constitutes an important means of traction and orientation during vaginal hysterectomy. When the uterus is flipped posteriorly, the axis of this movement is located at the insertion of the round ligaments. In the normal size uterus, this axis is located right below the geometric center. However, in cases of myomatosis, the difference between the rotation axis and the geometric axis may be significant. With

amputation of the cervix, this asymmetry is corrected, suppressing the â€œbrakingâ€• effect exerted by the organ against the pubis (Fig. 10.9).

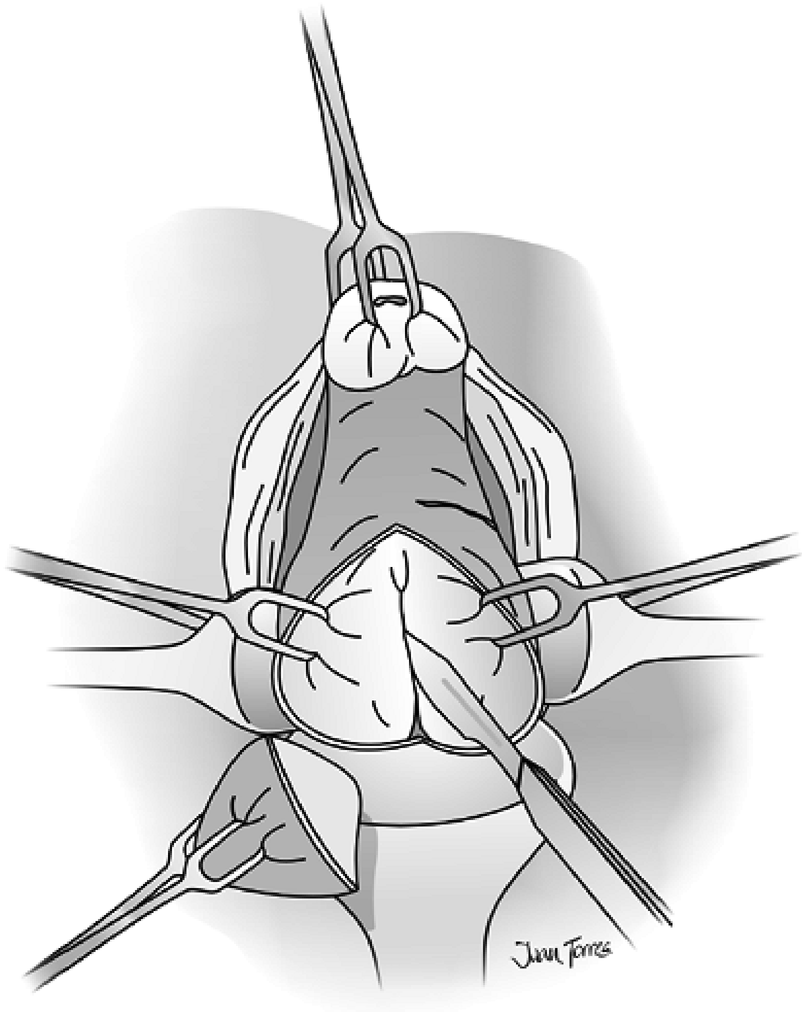

Figure 10.7 Posterior fundal morcellation.

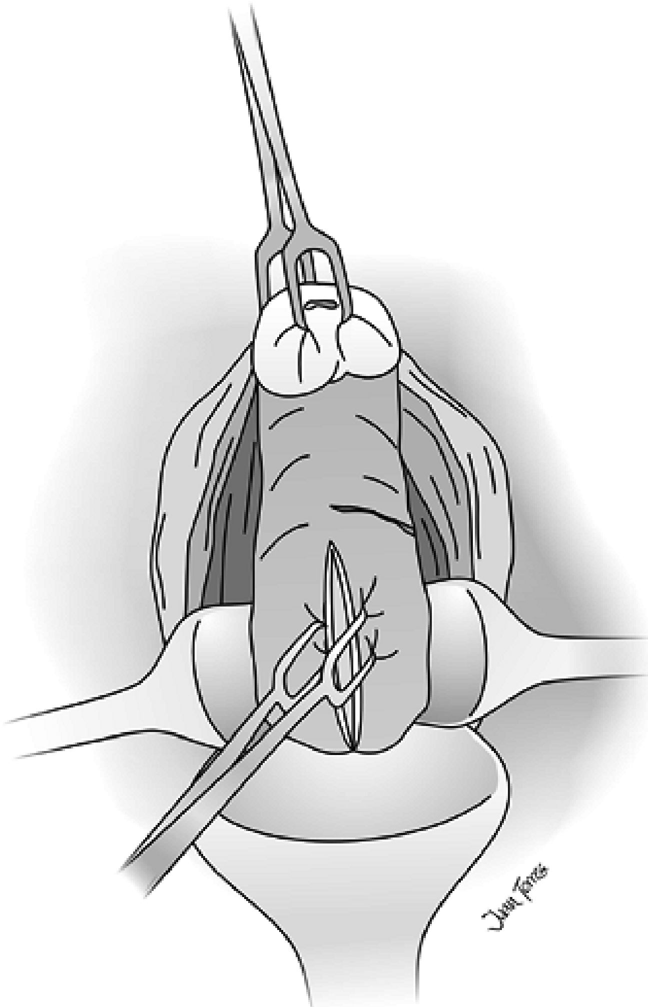

Figure 10.8 Posterior fundal morcellation.

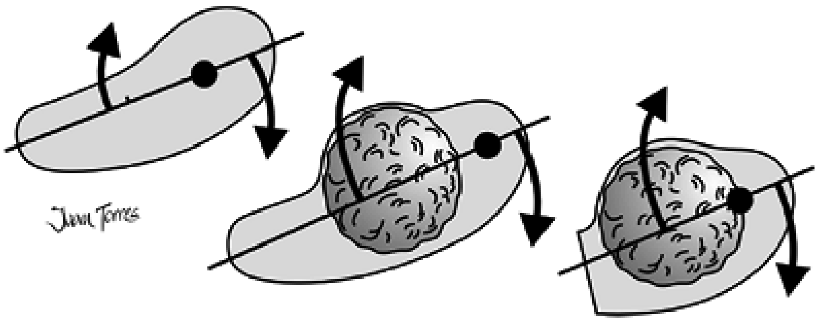

Figure 10.9 Mechanical *effect* of cervical amputation.

Myomas are frequently encountered during the morcellation process, regardless of the technique employed. These tumors can vary in size, location, and consistency. Very large myomas need to be morcellated, whereas those of a small to medium size may be enucleated as they appear in the surgical field, increasing the mobility of the uterus. This maneuver is safer than morcellation of the myometrium, since it is usually possible to identify the cleavage plane between the fibroid and myometrium around it. Eventually, a patient with a prolapsed submucous fibroid has an indication for hysterectomy. Normally this situation does not present major difficulties, as the pedicle of the myoma may be incised at the beginning of the procedure, providing better access to the uterosacral/cardinal ligaments and uterine vessels (25).

Other Morcellation Techniques of Historical Value

Pryor Technique

Contrary to other methods of wedge resection mentioned previously, the technique described by William Rice Pryor in 1899 follows a predetermined pattern, providing excellent access to the adnexal pedicles by flipping the fundus anteriorly. By using this method, the uterus is removed in a fashion similar to the DÃ¶derlein-Kronig technique of vaginal hysterectomy, and it works well in patients with a wide subpubic arch (26). After ligation of the uterine arteries, the bladder is retracted and the anterior uterine wall is incised vertically in the midline. Starting at the cervical level, symmetrical pieces of the myometrium are resected bilaterally from the midline incision (Fig. 10.10).

This incision continues cranially as exposure of the anterior uterine wall increases, allowing the progressive excision of myometrial tissue. Once the cornual regions are visualized, it is useful to excise an extensive wedge at the fundus, exposing the adnexa. At this moment the superior pedicles are clamped, cut, and the specimen is removed.

When morcellation of the anterior wall is insufficient for removal of the uterus, the posterior wall can be fragmented in a similar fashion.

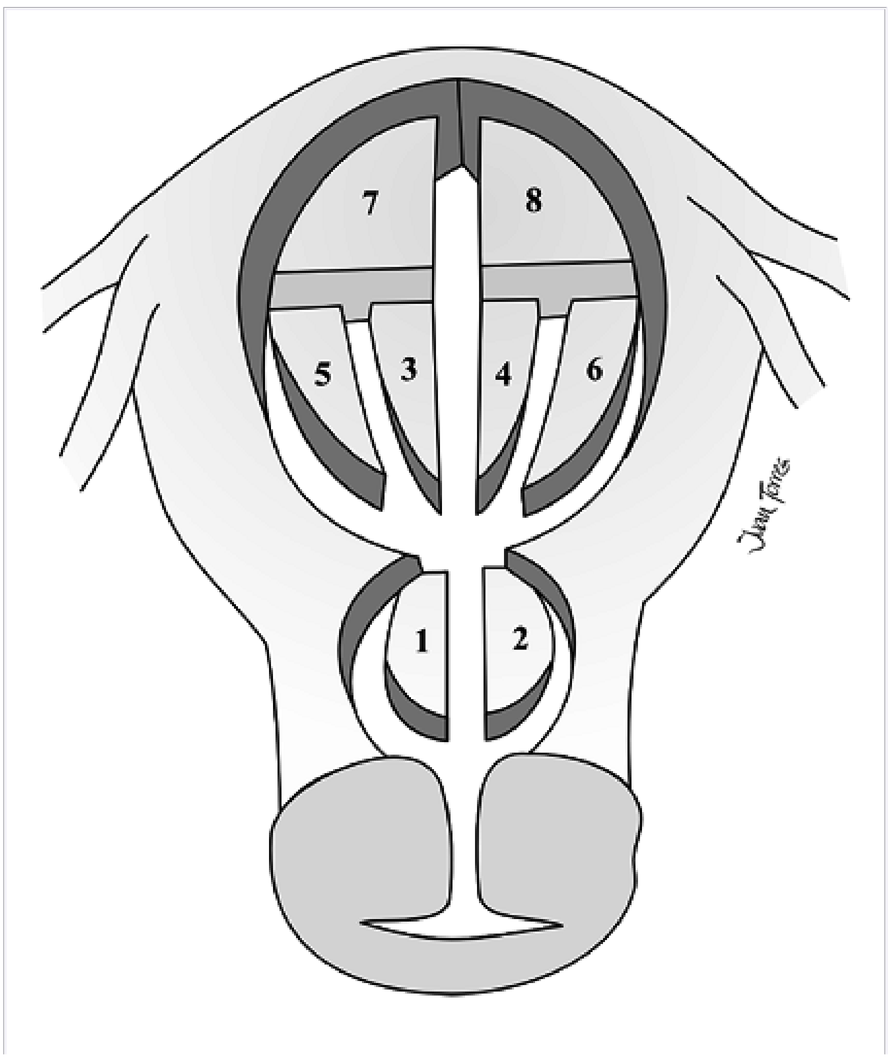

Figure 10.10 Pryor technique of uterine morcellation.

Doyen Method

The method of morcellation described by Doyen in 1920 is the removal of cylindrical columns of tissue from the myometrium and large fibroids, employing metallic tubes with a cutting edge (27). The uterine corpus is first stabilized by suprapubic pressure or, if sufficient exposure exists, by cervical traction. The cutting extremity of the tube is pressed against the central portion of tissue and with rotation movements it is advanced to a depth of 3 to 4 cm. The tube is then removed and the cylindrical-shaped myometrium is excised. Many columns of tissue can be removed in this manner, thereby reducing uterine volume through the creation of an artificial cavity.

Trial of Vaginal Hysterectomy for the Enlarged Uterus

Attempting to remove an enlarged uterus vaginally can be compared with a trial of labor; the patient should receive a detailed explanation of the procedure, including information about the possibility of a laparotomy if intraoperative difficulties or unsuspected pelvic pathology occur (28). Whenever doubt about the feasibility of vaginal hysterectomy exists, the surgeon must have at his disposal all of the necessary preparations for conversion to the abdominal route. When a change of approach is necessary, laparotomy should be done without hesitation. It is then easy to remove the uterus, since the most difficult steps of an abdominal hysterectomy (division of the uterosacral/cardinal ligament complex and opening the vagina) will have already been performed. Failure to convert to laparotomy because of excessive confidence, obstination or pride may create additional problems for the patient.

Vaginal hysterectomy for the enlarged uterus should not be viewed as a surgeon's act of heroism, but rather as a procedure where every effort is made to provide the patient with all the benefits of the absence of an abdominal incision. It is a safe and effective procedure that should be learned and practiced widely. As the overwhelming majority of well-selected cases are successfully performed, the confidence and experience of the surgical team should increase accordingly (29).

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11

Laparoscopically Assisted Vaginal Hysterectomy

S. Robert Kovac

Helio Retto

The use of the laparoscope with hysterectomy was first reported in 1989 by Reich et al. who suggested using the laparoscope as a mode of access for hysterectomy. This followed a single case report in which Reich used the term laparoscopic hysterectomy (LH) (1). Three months later in the same journal, Kovac, Cruikshank, and Retto reported a procedure that combined the use of the laparoscope with vaginal hysterectomy and first suggested the term laparoscopic assisted vaginal hysterectomy (LAVH) (2). The colleagues reported comparative data from 46 patients in whom intraoperative laparoscopy was used to evaluate pelvic disease after an abdominal hysterectomy was advised. Laparoscopic findings revealed that 42 of the 46 (91%) patients could undergo uncomplicated vaginal hysterectomy (which was successfully completed). Reich et al. initially saw laparoscopy as a technique to replace uterine removal by the abdominal route. Kovac et al. regarded LAVH as the first step in an evolutionary process where more accurate diagnoses of the intra-abdominal contents and improved laparoscopic techniques could extend the indications for uncomplicated vaginal hysterectomy to patients whose conditions were previously thought to preclude this approach and require abdominal hysterectomy.

These two reports provided the impetus for others to further the benefits of combining laparoscopy with hysterectomy. Although some authors pointed to the value of using the laparoscope to convert abdominal hysterectomy to a simple vaginal procedure, others viewed the laparoscope as a technique to replace all hysterectomies regardless of the pathologic condition. The terms LH and LAVH were first used interchangeably to describe any method of hysterectomy in which the laparoscope was used.

In early reports of the use of the laparoscope with hysterectomy, the indications for using this method needed to be established. It was suggested that the indications for LH/LAVH were the same as those required for conventional abdominal hysterectomy. Yet, the most common indications listed in reports on LH/LAVH were leiomyomata, bleeding disorders, and chronic pain. Although uterine-size parameters associated with leiomyomas pose potential concerns about transvaginal removal and the need for the abdominal approach, most studies did not record uterine weight measurements. When the actual uterine weight was reported, it would not have been considered a contraindication to vaginal uterine removal by most gynecologists (3,4). (Tables 11.1 and 11.2)

It is unclear why laparoscopic surgeons who adopted this method considered bleeding disorders an indication for laparoscopic hysterectomy, as the uterus for this indication would be of normal size. However, little effort was expended to determine the appropriate use of the different approaches to hysterectomy. This was complicated by several factors:

- In the rush to embrace any form of remote control, minimal access surgery often led to the acceptance of this new technique without scrutiny.
- Heightened market-driven and demand-side patient expectations of pain-free and improved outcomes from the abdominal approach forced the medical community to act prematurely in some cases.
- The dearth of well-conducted published studies, especially randomized controlled trails, comparing LH/LAVH with abdominal and vaginal hysterectomy

were weakened by their small sample sizes and limited statistical analyses.
- Many laparoscopic surgeons who preferred to evaluate this new method to abdominal hysterectomy ignored the vaginal approach.

Table 11.1 Laparoscopically Assisted Vaginal Hysterectomy Reports (n = 66)[3]

Patients (n = 6,143)	Uterine Weight (g)
Mean	181
Median	159
Range	23â€“1,530
25% to 75%	133â€“139

Data from Emergency Care Research Institute. Laparoscopy in hysterectomy for benign conditions. Technology Assessment Custom Report Level 2.

In 2005 the Cochrane Collaboration published a literature review to assess the most appropriate surgical approach to hysterectomy (5). In this report only randomized trials comparing one surgical approach to hysterectomy with another were included. Twenty-seven trials that included 3,643 participants were evaluated.

Table 11.2 Uterine Weight and Gestational Size[4]

Type of Uterus	Weight (g)
Normal Uterus	
Nulliparous	70
Multiparous	75â€“125
Enlarged Uterus	
8 weeks	125â€“150
12 weeks	280â€“320
24 weeks	580â€“620
Term	1,000â€“1,100

The study results showed that the benefits of vaginal hysterectomy versus abdominal hysterectomy were shorter hospital stay, speedier return to normal activities, and fewer unspecified infections or febrile episodes. The benefits of LH versus abdominal hysterectomy were lower intraoperative blood loss, smaller drop in hemoglobin levels, shorter hospital stay, speedier return to normal activities, fewer wound and abdominal wall infections, fewer unspecified and febrile episodes at the cost of longer operating time, and more urinary tract (bladder or ureter) injuries. There was no benefit of LH versus vaginal hysterectomy and the operating time was increased for LH. There was also no benefit of LH versus LAVH, and the operating time was increased for LH. The

Cochrane report concluded that the significantly improved outcomes suggested vaginal hysterectomy should be performed instead of abdominal hysterectomy when possible. When vaginal hysterectomy is not possible, LH may avoid the need for abdominal hysterectomy; however, the length of surgery increases as the extent of the laparoscopic surgery increases. This is particularly true when the uterine arteries are divided laparoscopically and the laparoscopic approach requires greater surgical expertise. One important conclusion of the Cochrane review was the suggestion that vaginal hysterectomy remained a very good option. There were not any significant disadvantages for vaginal hysterectomy versus any other approach and, when possible, vaginal hysterectomy should be performed instead of abdominal hysterectomy. An important benefit of introducing LH/LAVH into gynecologic training has been an increase in surgeon confidence and skill in vaginal surgery, thereby making vaginal hysterectomy a more feasible option for many.

The Cochrane study also concluded that each gynecologist would have his/her own indications for choosing hysterectomy for benign disease. This decision is based largely on the gynecologist's own array of surgical skills and the patient characteristics such as uterine size and descent, extrauterine pelvic pathology, and previous surgery, as well as influenced by other features such as obesity, nulliparity, and the need for oophorectomy. Whether there will be more of a consensus regarding these indications in the future than there has been to date is less certain.

The need to remove the ovaries during hysterectomy prompted some surgeons to suggest using the laparoscope to ensure ovarian removal prior to vaginal hysterectomy. Some laparoscopic surgeons shared this belief with individuals from the surgical equipment companies in an attempt to further promote laparoscopic hysterectomy by leading company representatives to believe that transvaginal removal of the ovaries was difficult or impossible (6). Laparoscopic surgeons and some laparoscopic equipment company associates actively promoted this belief to patients through patient educational pamphlets and encouraged surgeons to perform laparoscopic oophorectomies without evaluating the 22 published, peer-reviewed articles that reported a 94% to 97% success rate for transvaginal oophorectomy (7). Although laparoscopic surgeons propagated the unfounded belief that transvaginal oophorectomy was either difficult or impossible, vaginal surgeons provided evidence that surgeons could remove the adnexal structures during uncomplicated vaginal hysterectomy 94% to 97% of the time without the use of the laparoscope (7). In the

2004 *Journal of Laparoendoscopic Surgery*, Sizzi et al. concluded that the vaginal approach was feasible in more than 90% of cases even when oophorectomy was required (8).

A committee opinion from the American College of Obstetricians and Gynecologists (ACOG) acknowledged that LH/LAVH were a viable alternative to abdominal hysterectomy and that the choice of surgical approach should be

based on the surgical indication, patient's anatomic condition, surgeon's expertise and training, informed patient consent, and the data supporting the chosen approach (9). This opinion even suggested additional procedures, such as ligation of the infundibulopelvic ligaments to facilitate difficult ovary removal, which could be completed laparoscopically to facilitate performance of a vaginal hysterectomy. It appears that the authors of that report were hoodwinked into believing that the laparoscope should be used to perform oophorectomy prior to a vaginal hysterectomy. ACOG did not provide clear-cut criteria for identifying anatomic or technical concerns that would aid physicians in selecting a particular route of hysterectomy. In fact, ACOG did not recommend LH/LAVH as a viable alternative to vaginal hysterectomy. Herein lies the controversy and maze of confusion surrounding the early use of the laparoscope with hysterectomy.

In the conversion of an abdominal hysterectomy to a vaginal hysterectomy, to what extent, if any, is laparoscopic assistance necessary? After 15 years of using the laparoscope with hysterectomy, this is a question that still needs an answer. In the conversion of a vaginal hysterectomy to a LH/LAVH, is the laparoscope necessary or appropriate?

In April 2005, ACOG published a new committee opinion on the Appropriate Use of Laparoscopically Assisted Vaginal Hysterectomy (10). This opinion concluded, â€œThe technique used for hysterectomy should be dictated by the indication for surgery, patient's characteristics, and the patient preference. Most patients requiring hysterectomy should be offered the vaginal approach when technically feasible and medically appropriate because morbidity appears to be lower with the vaginal approach than any other method.â€•

Reich offered the opinion that LH/LAVH should be performed only when it could offer the patient a less invasive and painful method of achieving relief of her symptoms without increased risk of surgical injury (11). This statement must be directed toward abdominal, not vaginal, hysterectomy, as most reports strongly support the recommendation that LH/LAVH should not replace vaginal hysterectomy. In their textbook on laparoscopic hysterectomy, Reich and Garry stated, â€œthe indications for LH and LAVH were not yet definedâ€• (11).

In 1993, Kovac and Reich attempted to define the use of the laparoscope with hysterectomy (12). The following definitions were proposed:

- *Diagnostic laparoscopy followed by vaginal hysterectomy*-the use of intraoperative laparoscopy to determine the patient's feasibility for a vaginal hysterectomy. This procedure is performed only when there are concerns about the presence of extrauterine pathology that might limit the performance of a vaginal hysterectomy.
- *Laparoscopic assisted vaginal hysterectomy (LAVH)*-the laparoscopic assessment has discovered and documented certain conditions that require surgical management such as dissection of adhesions, excision of endometriosis, and, if necessary, removal of the ovaries followed by completion of the procedure via the transvaginal route.
- *Laparoscopic hysterectomy (LH)*-the use of LAVH plus ureteral identification and laparoscopic ligation of the uterine arteries by electrosurgery, sutures, or staples. The uterosacral and cardinal ligaments are divided vaginally.
- *Total laparoscopic hysterectomy (TLH)*-the uterus and adnexal structures are removed through laparoscopic access. In this procedure, the junction of the vagina and the cervix is separated and the vaginal cuff is closed and suspended, laparoscopically. However, this indicates the use of the laparoscope for surgical dissection when the vaginal route is contraindicated due to a lack of uterine descent or adnexal mobility, or inaccessibility from severe adhesive disease, adnexal pathology, or endometrial cancer. This suggested that contraindications to the vaginal route could only be determined after laparoscopic inspection of the intraabdominal contents.

A laparoscopic scoring system to determine the appropriate use of the laparoscope for choosing the proper operative approach was proposed (Table 11.3). Uterine and adnexal mobility are first assessed by pelvic examination and the use of a tenaculum placed on the cervix. Adnexal mobility for potential removal of the ovaries is further assessed laparoscopically by determining the stretched length of the infundibulopelvic ligament by placing a probe (marked in centimeters) at the junction of the ovary's distal pole to the infundibulopelvic ligament.

Uterine and adnexal size and mobility, their attendant characteristics, and the presence and degree of adhesions are evaluated with the cul-de-sac. Each parameter is assigned a point count, including a designated number of points for patients presenting with various stages of endometriosis. The total cumulative points provide the surgeon an objective basis for deciding the operative approach and the need for laparoscopic surgery.

The purpose of this scoring system was to identify the necessity of laparoscopic surgical techniques in the performance of a laparoscopic or abdominal hysterectomy. Published operative studies suggested that total scores of 10 points or less did not require use of the laparoscope except for diagnostic use (2). These scores provided objective evidence of the feasibility of the vaginal approach. Total scores in excess of 10 points and less than 20 points suggested that vaginal hysterectomy may still be considered laparoscopically, if performed by the experienced surgeon, even in the presence of the following relative contraindications: an enlarged uterus in excess of 280 g, severe endometriosis, and extensive adhesions. Total scores of 20 points or more suggested that an experienced laparoscopic surgeon could

perform a total laparoscopic hysterectomy but an abdominal hysterectomy may be the preferred route.

Table 11.3 Laparoscopic Scoring System for Determining the Appropriate Operative Approach[2]

Parameter	Points

Uterine size	
Grade I: 8 weeks or less	1
Grade II: 8â€“12 weeks	3
Grade III: 12â€“16 weeks	5
Grade IV: >16 weeks	8
Mobility of adnexa as judged by stretched length of infundibulopelvic ligament	
Good: <5 cm	1
Moderate: 2.5 cm	3
Poor: >2 cm	5
Adhesions of adnexa (Rock criteria)	
None/mild: no significant paratubal or periovarian adhesions	1
Moderate: periovarian and/or Paratubal adhesions without fixation; Minimal cul-de-sac adhesions	3
Severe: dense pelvic or adnexal	

Adhesions with fixation of ovary and tube to either broad ligament, pelvic wall, omentum, and/or bowel; severe cul-de-sac adhesions	5
Status of cul-de-sac	
Accessible	0
Obliterated	5
Rectal nodule	8
Endometriosis	
(American Fertility Society classification)	
Stage I	1
Stage II	2
Stage III	3
Stage IV	4

Reich and Kovac also described various patient characteristics that needed consideration prior to selection of the appropriate surgical approach. When a vaginal hysterectomy could be performed, Reich and Kovac agreed that there was no advantage to adding the laparoscopic approach. However, laparoscopic evaluation should be considered when the surgeon is concerned about the presence of extrauterine pathology that might limit the performance of a vaginal hysterectomy.

The patients were classified into four types.

- *Type I*-patient characteristics include pathologic conditions confined to the uterus, such as leiomyomata, adenomyosis, abnormal uterine bleeding, carcinoma *in situ* of the cervix, and prolapse. The laparoscope is not required for these conditions, since they are confined to the uterus. Total abdominal hysterectomy and LH/LAVH have all been performed for these conditions, but vaginal hysterectomy has been proven to be the most advantageous for patients with these conditions.
- *Type II*-patient characteristics include those listed for type I as well as potential extrauterine conditions such as:
    - Chronic pelvic pain not responsive to conservative therapy,
    - Endometriosis or a prior history of endometriosis,
    - Pelvic adhesive disease or a prior history of pelvic adhesive disease,
    - Potentially benign adnexal pathology,
    - Potentially problematic leiomyomata uteri, and
    - Poor uterine mobility

The surgeon should laparoscopically assess these potential extrauterine conditions to confirm whether true contraindications to the vaginal approach exist. Diagnostic laparoscopy followed by vaginal hysterectomy for type II patients offers the potential to utilize the vaginal approach in cases that appear to be contraindicated. Furthermore, intraoperative laparoscopic surgery may not be necessary if these conditions are not identified. In these cases, use of the scoring system was recommended to document the actual extent of the pelvic pathology that might require the need for extensive laparoscopic maneuvers. Patients with 10 points or less were viable candidates for the vaginal approach. Total abdominal hysterectomy and LH/LAVH have been performed for these cases, but again the vaginal approach is the proven, preferred route. Types I and II represent the reasons for using the laparoscope with hysterectomy, as the laparoscope is employed to confirm and document conditions that might contraindicate the vaginal route and require an abdominal hysterectomy.

- *Type III*-patients have various degrees of adhesions, endometriosis, and uterine size that are documented by intraoperative laparoscopy. Feasibility of the vaginal approach can be determined by diagnostic laparoscopy, and operative laparoscopy may remove the impediments that might assist with the completion of the hysterectomy by the vaginal approach. Conventional vaginal hysterectomy may be contraindicated because of the extent of adhesions, endometriosis, or ovarian mobility. Total abdominal hysterectomy, LH/LAVH, and vaginal hysterectomy have been performed for these cases, but the choice depends on the laparoscopic and vaginal surgeon's skill and experience. A total abdominal hysterectomy is usually performed for these cases if the extrauterine conditions contraindicate the vaginal route.
- *Type IV*-clinical and laparoscopic findings contraindicate the vagina due to:
    - Obliteration of the cul-de-sac,
    - Lack of uterine or adnexal mobility and accessibility caused by severe adhesive disease, and
    - Undetermined adnexal pathology.

The laparoscopic definitions and patient types presented define how the laparoscope should be used with hysterectomy. These definitions were not universally adopted. As laparoscopic surgeons pressed for center stage, some surgeons began using the laparoscope for all types of hysterectomies. Although some laparoscopic surgeons used the laparoscope to determine the appropriate method of uterine removal, others used the laparoscope for all hysterectomies.

Investigators then began to compare total abdominal hysterectomy, LH/LAVH, and vaginal hysterectomy in terms of medical and economic outcomes. The vaginal approach was associated with the best medical and economic outcomes in several assessment studies (3,13). There was considerable difficulty in evaluating some of the studies because of considerable overlap in the indications selected and performed by abdominal, vaginal, and laparoscopic routes. Subsequently additional definitions developed by laparoscopic surgeons described the use of the laparoscope with hysterectomy (10). Garry and Reich proposed the following:

- *Diagnostic laparoscopy* followed by vaginal hysterectomy indicates the use of intraoperative laparoscopy to determine the suitability of the patient for vaginal hysterectomy. This procedure is performed only in the presence of presumptive pelvic pathology.
- *LAVH* implies the use of the laparoscope for dissection of adhesions, excision of endometriosis, or removal of the ovaries followed by completion of the procedure via the transvaginal route. This requires the surgeon to accurately confirm the suspected presence of adhesions or endometriosis intraoperatively before proceeding to laparoscopic or abdominal hysterectomy.
- *LH* implies laparoscopic ureteral dissection and ligation of the uterine arteries with removal of the uterus after morcellation. This definition suggests the implementation of a new type of hysterectomy regardless of the indication. If these cases could have been performed by the less-invasive, less time-consuming, and less costly vaginal route, then the benefit of laparoscopically ligating the uterine vessels and morcellating the uterus must be questioned. Promotion of this technique, LH/LAVH, benefited the surgeon as he/she requested additional reimbursement for performing more laparoscopic surgery.

Either LH or LAVH can make a quality difference in both the medical and economic outcomes when compared to abdominal hysterectomy. But, like all such valued innovations, the use of the laparoscope with hysterectomy must be rooted in factual, universal, scientific measurable data and disciplined, appropriate management. To date most studies have not illustrated that this was done. Since the great hope and hype of its inception, the use of the laparoscope with hysterectomy has not grown as expected. Experienced laparoscopists continue with this technique, but many gynecologists who adopted the technique in the early 1990s subsequently found that the laparoscope only increased their awareness of the possibility for performing a straightforward vaginal hysterectomy. In addition, practicing gynecologists found use of the laparoscope to be a time-consuming operative technique, which was a major concern. Therefore, many surgeons began to use the laparoscope more as a diagnostic tool to increase their use of vaginal hysterectomy.

Several conclusions can be drawn from the studies comparing abdominal, vaginal, and laparoscopic hysterectomy. Because vaginal hysterectomy is possible in the majority of patients with benign uterine disease, LH appears to be a waste of time and money for most indications (14). Vaginal hysterectomy also appears to have more benefits for both the patient and the gynecologic surgeon. There are no visible scars, complications are not fewer, postoperative stay is similar to LH/LAVH, and recuperation time is shorter.

However, the newer definitions appear to recommend that the laparoscopic technique replace other types of hysterectomy. Earlier indications for using the laparoscope with hysterectomy for conditions that were thought to demand an abdominal hysterectomy are no longer considered by some laparoscopists. Laparoscopic hysterectomy (LH) is now being performed when the uterus is of normal size, and when there is no concern of presumptive extrauterine pathologic conditions. Despite the evidence of the benefits of the vaginal route, it is not considered by advocates of the laparoscopic method.

Therefore, it is the authors' opinion that appropriate indications for abdominal and laparoscopic hysterectomy and appropriate contraindications to vaginal hysterectomy must be established before resorting to LH or TLH. Laparoscopy has a definite role in hysterectomy as a diagnostic tool to determine the need for abdominal hysterectomy, as well as the possibility of the vaginal approach. However, to continue to recommend LH/LAVH for all hysterectomies when the evidence does not support its benefit over the vaginal route is inappropriate. It has become obvious that experienced laparoscopists will continue to support the use of the laparoscope as a method to remove the uterus, but more demands will be placed upon them to confirm the value of this choice by reporting and comparing their results to other methods, especially the vaginal approach. In the early years there was the perception that LH/LAVH was performed for the same conditions that required abdominal hysterectomy. This has simply not been proven. Johns et al. suggested that although LH/LAVH was developed to convert abdominal to vaginal hysterectomies, many cases that could have been performed vaginally were instead done by LH/LAVH (15).

The Cochrane report encouraged surgeons to report their laparoscopic approach according to their defined subcategories. This attempted to minimize the confusion that has prevailed to date.

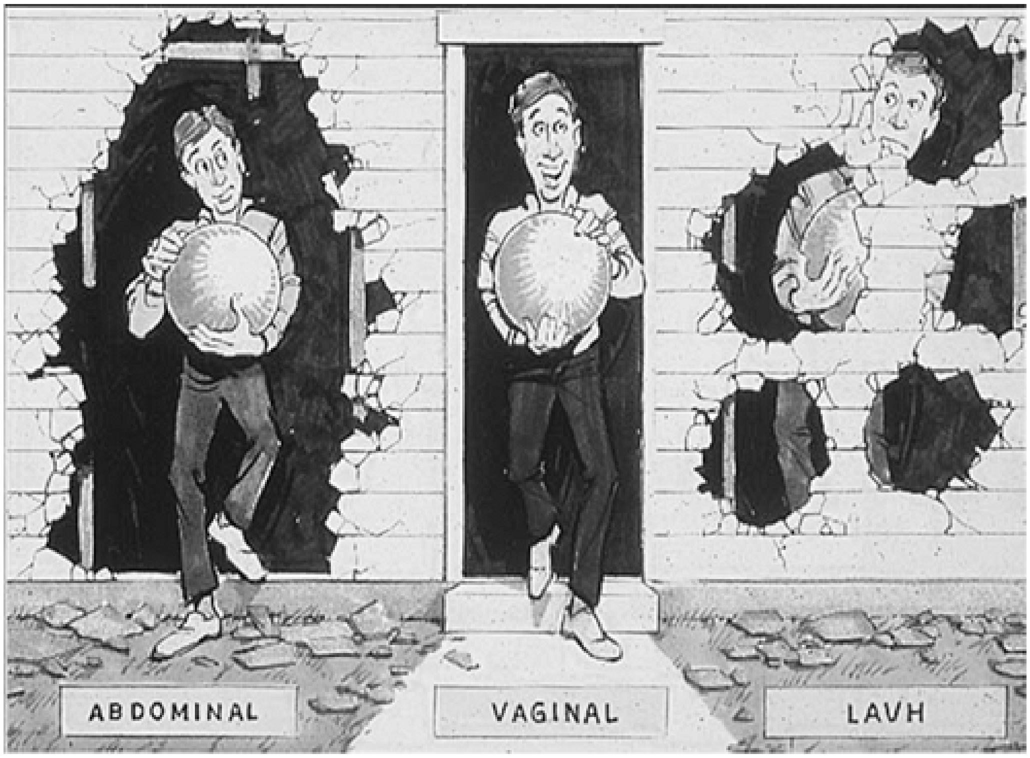

Figure 11.1 Graphic depiction of three methods of hysterectomy when the uterus is removed for similar indications. From left: Abdominal hysterectomy/most invasive hysterectomy. Middle: Vaginal hysterectomy/minimally invasive hysterectomy. Right: Laparoscopic hysterectomy/moderately invasive hysterectomy.

- Laparoscopic assisted vaginal hysterectomy (LAVH)-part of the hysterectomy is performed by laparoscopic surgery and part vaginally, but the laparoscopic component of the operation does not involve division of the uterine vessels.
- Laparoscopic hysterectomy (LH)-the uterine vessels are ligated

laparoscopically, but part of the operation is performed vaginally.

- Total laparoscopic hysterectomy (TLH)-the entire operation (including suturing the vaginal vault) is performed laparoscopically, and there is no vaginal component.

Although these definitions are helpful in determining the type of laparoscopic hysterectomy performed, they do not address the need for a particular type of laparoscopic hysterectomy. As the Cochrane report stated â€œwhat is certain is that gynecologists (as has been the case since abdominal hysterectomy became the alternative to vaginal hysterectomy in 1863) will have their indications to the choice of hysterectomy for benign disease, based largely on their own array of surgical skills and patient characteristics.â€• If hysterectomies are chosen because of the surgeon's skill and preference, what is the need for such studies that do not support the outcomes of abdominal or laparoscopic routes? If surgeons perform hysterectomies based upon their skill and preference and do not respond to the evidence provided by many evidence-based reports, what is the need for studies that report the less advantageous outcomes of abdominal and laparoscopic hysterectomies?

The Cochrane report also suggested future implications for research as the newest approach to hysterectomy, TLH, should be further evaluated compared to abdominal and vaginal hysterectomy. The results of such a study will be welcomed as the current Cochrane report states that there are no significant disadvantages of vaginal hysterectomy compared to any other approach.

The best method to determine the appropriateness of a particular hysterectomy route is to compare hysterectomies performed for similar indications preferably by surgeons of similar abilities. Such a study was published in the journal *Obstetrics and Gynecology* in 2000 (16). In this study, uncomplicated hysterectomies performed on patients whose pathologic indication requiring hysterectomy-such as leiomyomas, abnormal uterine bleeding, adenomyosis, carcinoma *in situ* of the cervix, and uterine prolapse-was confined to the uterus and whose uterus was determined preoperatively to weigh less than 280 g were evaluated (16) (Fig. 11.1). Although this was not a randomized study, it still presents high quality evidence as patients were prospectively assigned to a particular route of hysterectomy by each operating surgeon.

When surgeons chose abdominal and laparoscopic hysterectomies, though the vaginal route was not contraindicated, the surgeons' decisions resulted in an increase in hospital charges of 71% and 35%, respectively, over that for the vaginal route. Complications and length of stay were also higher for laparoscopic than vaginal hysterectomy. These findings again support the need and adoption of specific guidelines for determining the appropriate choice of hysterectomy by every gynecologist. Such guidelines are presented in Figure 11.2 (17).

These guidelines have been field-tested in several countries and have successfully reduced the number of abdominal hysterectomies that require an evidence-based determination for each condition requiring hysterectomy. These guidelines determine the feasibility of the vaginal approach and the necessity of using abdominal or laparoscopic methods. For example, if the patient's history or physical examination suggests that extrauterine pathologic conditions

â€œmay be presentâ€• and might suggest the need for abdominal or laparoscopic hysterectomy, a laparoscopic examination should be performed to determine whether these conditions are actually present. If the conditions are not present, then the need to perform a hysterectomy abdominally or laparoscopically may not be justified. For years gynecologists have suggested the type of hysterectomy performed should be based on the degree of pathologic disease. If so, the feasibility of the gold standard for hysterectomies, vaginal hysterectomy, must be determined. Unfortunately, the evidence discovered at the time of diagnostic laparoscopy is not always used when determining the most appropriate route of hysterectomy. Sometimes minimal extrauterine pathology is not accurately defined and is used as a justification for the selection of a laparoscopic hysterectomy as demonstrated in Figure 11.3.

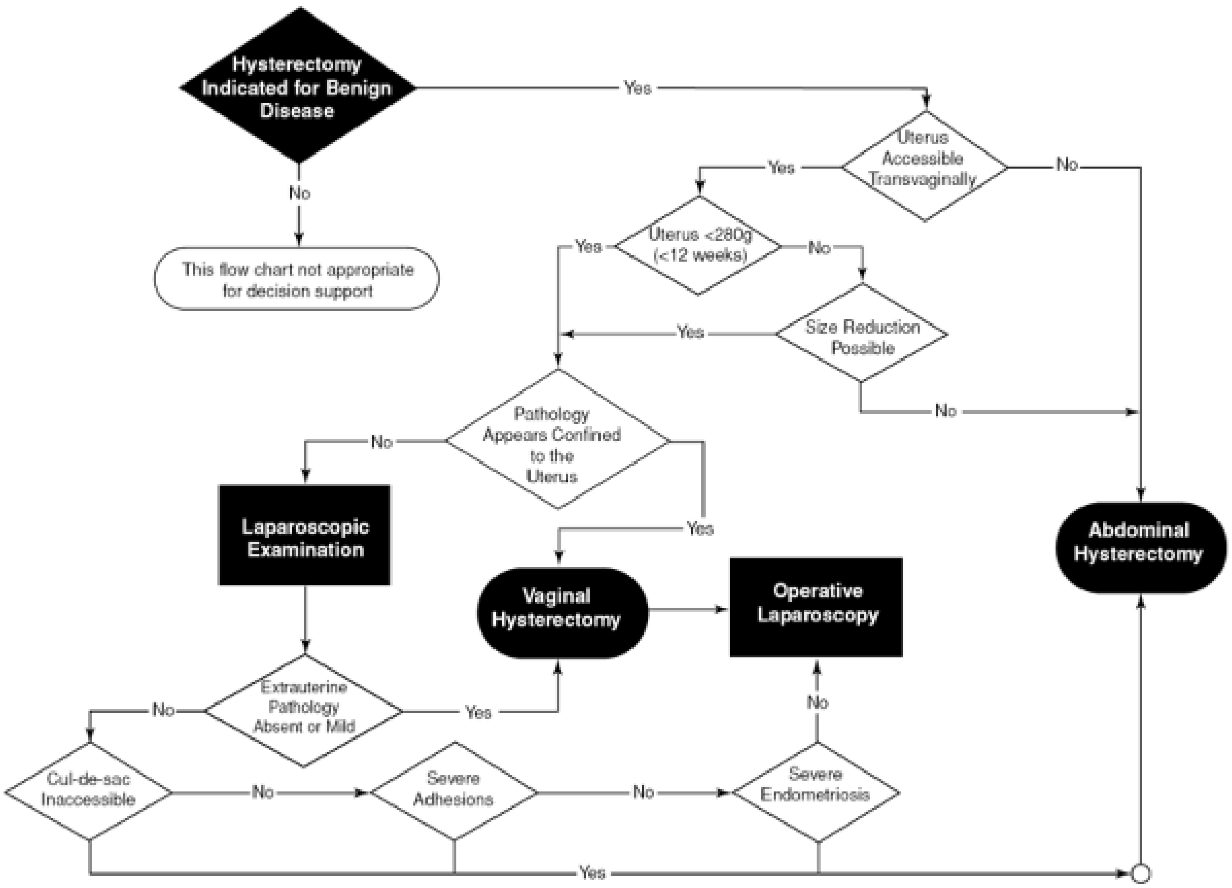

Figure 11.2 Determining the route of hysterectomy.

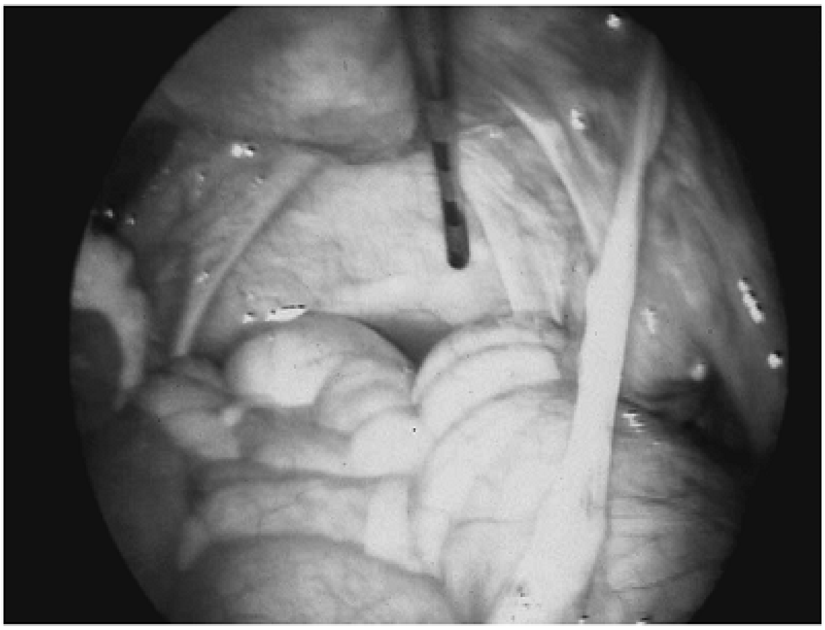

Figure 11.3 Following laparoscopic assessment a laparoscopically assisted vaginal hysterectomy was performed for endometriosis and pelvic adhesions. Note: One implant of endometriosis and one pelvic adhesion.

This type of decision-making suggests both a surgeon's preference to perform a laparoscopic type of hysterectomy and the need to justify this selection on the basis of â€œendometriosis and pelvic adhesions.â€• If surgeons use the laparoscope in this manner, there may be a time when laparoscopic photographs are required to confirm and document justification for laparoscopic types of hysterectomies.

Table 11.4 Total Hospital Charges

Report	Year	LAVH type	LAVH	VH	AH
Kovac[19]	1995	DO	4,690	4,025	7,000
Harris and Olive[20]	1994	?	11,931	5,343	7,031
Nezhat et al.[21]	1994	I?	7,162	4,868	4,926
Boike et al.[22]	1993	IIII	12,814	9,325	10,511
Bronitsky et al.[23]	1993	II	8,533	5,589	10,836
Howard and Sanchez[24]	1993	I	3,926	4,524	
Summit et al.[25]	1992	IIâ€"IV	7,905	4,891	

Data from Emergency Care Research Institute. Laparoscopy for Benign conditions. Technology Assessment Custom Report Level 2.
DO, diagnostic only; LAVH, laparoscopically assisted vaginal hysterectomy; VH, vaginal hysterectomy; AH, abdominal hysterectomy.

The selection of the laparoscope with hysterectomy should be based upon its original purpose, that is, to reduce the number of abdominal hysterectomies by identifying those cases that could be performed vaginally. The use of the laparoscope in this fashion is a proven benefit. However, the primary selection of LH or TLH has not been proven to be of any benefit over vaginal hysterectomy.

Querleu et al. suggested that laparoscopic surgery is an efficient modality for the vaginal surgeon in the presence of adnexal disease, but does not replace the less expensive, quicker, and probably safer vaginal hysterectomy (18).

Surgical instrument companies that once strongly promoted the laparoscopic approach to hysterectomy no longer promote this operation as in the past. These companies have been exposed to and recognize the outcomes of the vaginal approach and are now developing instrumentation for the vaginal route. In addition, the companies now recommend that the route of hysterectomy should be left to the surgeon, where it always should have been, without their influence. Now that the evidence from several major health assessment studies have reported the benefits of the vaginal approach to hysterectomy over total abdominal hysterectomy, LH/LAVH, and TLH, it is hoped that they will use their resources to promote the less advantageous laparoscopic approach to hysterectomy as they have in the past (3,5,13) Residency programs will also need to adapt to the evidence and provide the necessary training in vaginal surgery as they already provide for the laparoscopic methods.

Despite many attempts by researchers to prove the advantages of the laparoscopic route over the vaginal approach, the evidence simply does not support this belief. The future is natural orifice surgery and it is believed that gynecologic surgeons eventually will recognize this trend. There will always be a role for laparoscopy with hysterectomy, but as Magos demonstrated, the use of the laparoscope as a means to perform a hysterectomy may be a waste of time and money (14).

The role of laparoscopic, supracervical hysterectomy (LSH) will not be discussed in detail in this chapter, as the evidence to support this procedure has not been proven. In addition, claims of improved sexual function have not been substantiated. Claims that by preserving the cervix the â€œpelvic floorâ€• is not disrupted have also not been proven. What has been proven is that this is the most expensive of all types of hysterectomies. The early reports of hospital costs comparing LAVH to total vaginal hysterectomy and total abdominal hysterectomy were reviewed to demonstrate the higher costs of LH for similar indications (Table 11.4).

In the statistical bulletin of the Metropolitan Insurance Company, Mushinski reported that claims by group health insurance companies and their dependents averaged $10,500 for a vaginal hysterectomy, $12,440 for an abdominal hysterectomy, and $13,840 for an LH (26). LSH costs have exceeded $14,000. Before gynecologic surgeons decide to perform an LSH, they should consider whether the vaginal route could be used in order to reduce operative times and lessen hospital charges (see Chapter 8).

The real value of the use of the laparoscope with hysterectomy is that it has provided objective evidence that identified that many of the conditions previously thought to demand the abdominal approach were incorrect. This evidence has increased the use of the gold standard for hysterectomy, vaginal hysterectomy.

Surgeons who perform laparoscopic surgery now use the term â€œminimally invasive surgery.â€• In other surgical specialties this term has some meaning when it is compared to laparotomy. However, when this term is applied to hysterectomy, the question â€œminimally invasive to what type of hysterectomyâ€• should be asked. The surgery, named by laparoscopic surgical instrument companies, cannot be judged to be â€œminimally invasiveâ€• when compared to the vaginal approach to hysterectomy, which has been proven to be the most minimally invasive type of hysterectomy.

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12

Subtotal Vaginal Hysterectomy and Myomectomy

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Subtotal vaginal hysterectomy and vaginal myomectomy, taboos for the average gynecologist, are feasible procedures with well-described techniques. Appropriate uterine size, good uterine mobility and vaginal access, lack of additional pathology, adequate surgical experience, and a pair of good assistants are prerequisites. It is not the authors' goal to create a radical change of practice, but in view of the well-proven advantages of vaginal surgery, these techniques are worthy of a wider application.

Vaginal surgery, the â€œspecial province of the gynaecologist,â€• once out of vogue, is increasingly attracting more interest. Guidelines have been published to help clinicians base their practice on evidence rather than personal preferences in order to avoid obsolete decision making (1). Efforts need to be made so that adequate training is provided, and ultimately so that the most suitable procedure is offered to each patient. Subtotal hysterectomy and myomectomy are two challenges for the vaginal surgeon, as both are considered contraindications by many. In this chapter, after historical and literature review, we describe techniques.

Subtotal hysterectomy

Anatomically the uterus consists of two parts: a body and a cervix. Hysterectomy is the surgical removal of the uterus. A total hysterectomy involves the removal of both the uterine body and the cervix; a subtotal hysterectomy involves the removal of only the uterine body, leaving the cervix intact. Subtotal hysterectomy is also referred to as supracervical hysterectomy (SCH).

Hysterectomy is the most common major surgical procedure performed in the United States for nonobstetric reasons. Approximately 600,000 hysterectomies are performed in this country each year; abdominal route is chosen at a 3:1 ratio over the vaginal, despite ample evidence that vaginal hysterectomy offers advantages over abdominal hysterectomy with regard to operative time, complication rates, recovery, return to daily activities, and overall costs of treatment. Evidence also shows that transvaginal hysterectomy is both feasible and optimum for types of patients who have long been considered inappropriate candidates for the vaginal route (absence of prolapse, enlarged uterus, need for oophorectomy) (2).

History and Current Trends

The first reported elective vaginal hysterectomy was performed by Conrad Langenbeck in 1813. The same surgeon attempted abdominal hysterectomy in 1825 for advanced cervical cancer (sadly the patient died several hours later). The first elective subtotal abdominal hysterectomy was performed by Charles Clay of Manchester in 1863 (3). Subtotal abdominal hysterectomy remained the operation of choice until 1929, when E.H. Richardson performed the first total abdominal hysterectomy. Subsequent concerns over the potential for the development of cancer in a conserved cervix, combined with further improvements in operative and anaesthetic techniques, led to a change of practice; total hysterectomy replaced subtotal hysterectomy almost completely.

In Bonney's *Gynaecological Surgery* (1986) it is stated that subtotal hysterectomy â€œâ€¦is only mentioned to say that

there is no indication for its presence in a modern surgical text.â€• Many surgeons feel they have to apologize for performing subtotal hysterectomy, as it is usually perceived as lack of skill. In a survey of current views and practice among British gynecologists with a response rate of 61%, it is clear that subtotal hysterectomy is an unpopular operation in the United Kingdom (4). Although a majority of consultants felt that subtotal hysterectomy was less likely to affect urinary, bowel, and sexual function, this did not seem to affect decision making. Seventy-eight percent of female gynecologists would prefer a total hysterectomy for themselves rather than a subtotal procedure. A questionnaire with 18 questions on physicians' attitudes and practice regarding total versus subtotal hysterectomy that was mailed to 1,647 gynecologists in Washington, Maryland, and Virginia showed that 63% of gynecologists do not counsel women regarding the advantages and disadvantages of both total and subtotal hysterectomy. Only 19% always offered women a choice between the procedures; 61% rarely or never did (5).

Change of practice varies among countries, with Scandinavia moving toward subtotal hysterectomy; yet SCH still accounts for only approximately 2% of the hysterectomies performed in the United States and similar numbers come from the United Kingdom (6). During the last years, debate is increasing regarding benefits, advantages, and indications of the subtotal hysterectomy. Observational and randomized controlled studies have been published, addressing sexual function, urinary and bowel problems, psychological parameters, as well as financial aspects. So far evidence is conflicting. In Cochrane Library there is currently one review taking place and it is expected to be published in the near future.

Total Versus Subtotal Hysterectomy

Traditional indications for subtotal hysterectomy have been complete obliteration of the pouch of Douglas, gross elongation of the cervix and cesarean hysterectomy. In the case of rectovaginal endometriosis, with developments in endometriosis surgery, it is now apparent that leaving the cervix intact is likely to leave significant disease, which could cause future symptoms. This type of endometriosis is now regarded as a positive indication for a total hysterectomy.

Conversely, removal of the cervix as a cancer preventive measure has always been the main argument for total hysterectomy. Nowadays this is not a justifiable reason for this practice routinely, unless there is no reliable screening available (7), provided that posthysterectomy patients will agree to comply. The risk of cervical stump carcinoma in women with a previously normal smear is no more than 0.3% (8), approximately the same risk as that of vaginal carcinoma after hysterectomy for a benign condition (9). For further risk reduction, techniques have been introduced that involve removing the endocervix and transformation zone. For the patients who develop cancer of the remaining cervix, it is true that treatment with surgery or radiotherapy is more difficult, but there is no evidence that prognosis is affected.

Disruption of the close anatomic relation of the bladder and bowel to the uterus and the firm attachment of the cervix to the vagina and the pelvis would explain the effects of hysterectomy on the function of these organs. As neatly summarized by Thakar and Manyonda, the pelvic plexus may be damaged during hysterectomy in four ways (10):

- During the division of the cardinal ligaments
- During blunt dissection of the bladder from the uterus and cervix
- During extensive dissection of the paravaginal tissue
- With the removal of tissues intimately related to the cervical plexus.

Comparison of the two procedures is not easy; subtotal hysterectomy is a less destructive procedure than total hysterectomy, requiring less dissection of surrounding tissue; therefore, it is technically easier and reduces operative time. Hemorrhage is less and vault hematoma unlikely, but chronic cervicitis remains a potential problem; patients may continue to menstruate and estrogen replacement treatment needs to be opposed. Concerns about bladder and bowel function, as well as psychosexual effects are dominating current literature and here is a review.

Bladder

Technically, total hysterectomy is more likely to cause damage to the ureters (11), especially if anatomy is distorted due to adhesions (e.g., endometriosis). Medicolegally, urinary tract injuries remain the commonest cause of litigation after hysterectomy and generally are indefensible.

Regarding various urinary symptoms and the impact of cervical preservation versus removal, there is no consensus in the literature. In 1985, Kilkku reported improvement of incontinence, sensation of residual urine, and pressure sensation one year following both total and subtotal hysterectomy (12). For the two first symptoms, there was statistical highly significant difference between the two methods in favour of the subtotal hysterectomy. However, findings from later studies from the same institute were not consistent (13). Kilkku's studies were retrospective and essentially uncontrolled. In contrast, a recent randomized double-blind trial by Thakar et al. showed similar improvement in bladder capacity and reduction in nocturia and stress incontinence in the two groups (14). Another randomized controlled trial of total compared with subtotal hysterectomy with one-year follow up concluded that a smaller proportion of women had urinary incontinence after total abdominal hysterectomy than after subtotal abdominal hysterectomy one year postoperatively (15).

Bowel

Not many reports have been published regarding the effect of hysterectomy on bowel function, and even fewer compare total with subtotal hysterectomy. Taylor et al. showed that hysterectomized women are more likely to report infrequent defecation and firmer stool consistency (16). Conversely, Prior et al. suggested the opposite (17). Finally, Thakar reported that the frequency of bowel symptoms (as indicated by reported constipation and use of laxatives) did not change significantly in either group after surgery (14).

Sexuality

Reports published in the early 1980s suggesting benefits in preserving the cervix drew the public's attention (18). Subsequent prospective studies once again failed to support those findings. A study comparing the effects of vaginal hysterectomy, subtotal abdominal hysterectomy, and total abdominal hysterectomy on sexual well being over 6 months concluded that sexual pleasure improved similarly after all three techniques (19).

Another recently published multicenter study from Denmark involved 319 women who were randomized to total abdominal hysterectomy or subtotal abdominal hysterectomy (20). No significant differences were observed between the two operations at 1-year follow-up. The authors concluded that a shift toward subtotal hysterectomy seems unwarranted, as both operations significantly reduce dyspareunia without having a negative effect on sexual function. In a randomized study from the United Kingdom, measures of sexual function did not change significantly in either group after surgery (14).

Apart from obvious, operation-related factors (nerve damage, the shortening of vagina, the presence of vault granulation tissue, the persistent discharge or bleeding from the cervical stump) it does seem that hysterectomy is only one of several factors that affects a woman's sexual function. The end result of removing the uterus will depend on social, cultural, and religious taboos, as well as the reasons for surgery, and can range from relief to devastation.

Mental Health and Quality of Life

Kilkku et al. looked at psychological factors up to 3 years postoperatively and suggested a statistically significant difference in favor of subtotal hysterectomy (21). In particular, nervousness, irritability, and depression decreased during the follow-up period significantly in the amputation group but not in the hysterectomy group. In recent prospective studies comparing total versus subtotal abdominal hysterectomy, all women showed an improvement in psychological symptoms following both operations (22).

Vaginal Subtotal Hysterectomy

Apart from isolated cases and very specific indications, there has been virtually no place for subtotal hysterectomy and no role whatsoever for any but the abdominal approach. Things changed in 1991 when Kurt Semm described his laparoscopic technique. This became attractive, as it was designed to avoid the two major pitfalls of laparoscopic hysterectomy, namely, hemorrhage from uterine vessels and ureteric injury. Semm's description inspired many gynecologists to re-examine the role of subtotal hysterectomy.

At first sight, it would seem impossible to carry out a subtotal hysterectomy vaginally. The answer lies in the technique for vaginal hysterectomy described by Doderlein and Kronig in 1906 (23). Their method involved making a semicircular incision anterior to the cervix, opening the uterovesical fold and delivering the uterine body through the anterior colpotomy incision into the vagina. The pedicles are then ligated and divided in a caudal direction, similar in order to that of the abdominal hysterectomy. Subtotal hysterectomy is achieved simply by stopping the dissection at the level of the cervix and amputating the body of the uterus.

This technique has several advantages as well as limitations compared with the procedure described by N.S. Heaney, which remains the standard method for vaginal hysterectomy for most gynecologists (Table 12.1).

Table 12.1 Comparison of Heaney with Doderlein-Kronig Technique

	Heaney	Doderlein-Kronig	Advantage or Disadvantage of D-K
Incision	Circumferential (anterior and posterior colpotomy)	Semicircumferential (anterior colpotomy only)	No oozing from posterior vaginal incision
Direction	Cephalad	Caudal	Better visualisation of pedicles and easier to comprehend and teach
Access	More restricted	Better	Procedure is easier as it is essentially done in the

			lower vagina and introitus
Uterine size	Up to 20+ weeks	Up to 12 to 14 weeks	Not suitable for large uterus
Subtotal hysterectomy	Not feasible	Feasible	More options for the surgeon and the patient

As always, good patient selection is paramount. The cornerstones of successful and safe vaginal hysterectomy are

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(i) good uterine mobility, (ii) adequate vaginal access, and (iii) experienced assistants. The importance of the latter cannot be overemphasized; the senior author was told by his mentor, John Studd, Consultant Gynaecologist in London, that â€œa vaginal hysterectomy is an operation of assistants,â€• a view which is as true today as it was then.

Other considerations for subtotal hysterectomy are that the uterus should not be overly large as it has to be delivered into the vagina through an anterior colpotomy; in realistic terms, this means that the uterus should not be greater than that size of a 12 to 14 week gestation. Although some of the techniques used to debulk a uterus at total hysterectomy can be applied, it is more difficult when the Doderlein-Kronig approach is used. Similarly, laparoscopy can be used to prepare an otherwise unfavorable case for vaginal subtotal hysterectomy (e.g., prior adhesiolysis), but such cases can also be managed as a purely laparoscopic operation.

Technique of Subtotal Vaginal Hysterectomy

Our practice is to carry out hysterectomy under general anesthesia, but regional anesthesia can also be employed. All patients are given adequate thromboprophylaxis (heparin and antiembolic stockings) and prophylactic antibiotics. Positioning the patient is important and ideally should be done by the surgeon. Rather than standard lithotomy, we recommend a position in which the patient's legs are held relatively straight toward the ceiling, out of the way of the two assistants, with good hip flexion and abduction. To achieve this, we use the poles designed by gynecologist KÃ¥re Lakinger from Arendal in Norway. Routine bladder catheterisation is not done provided the bladder is relatively empty; we prefer to catheterize at the end of the procedure to confirm there has not been any bladder injury.

Manipulation of the cervix is achieved with two tenacula positioned at six and twelve o'clock. Infiltration of the anterior vaginal fornix is done with 20 mL of 1% lignocaine containing adrenaline 1:200,000. The cervicovaginal junction is incised between nine and three o'clock, and the bladder is reflected with sharp and blunt dissection. The peritoneal fold, typically identified as a transverse white line, is opened, and a vaginal retractor is placed under the bladder, both to provide access to the anterior uterine wall and to protect the bladder from injury.

The remainder of the procedure, as mentioned previously, is based on the Doderlein-Kronig vaginal hysterectomy (Table 12.2). The uterus needs to be delivered through the anterior colpotomy, and, although clamps can be used, we have recommended the use of a strong nylon or Prolene suture to â€œwalk up the anterior wall of the uterus.â€• At the start, a deep bite is taken into the anterior surface of the uterus as high as feasible. Downward traction of the suture brings the uterus lower, allowing a second bite higher up, at which time the lower bite is pulled through. By continuing with these steps, the fundus is eventually reached and the uterus can be delivered into the vagina (Figs. 12.1 and 12.2).

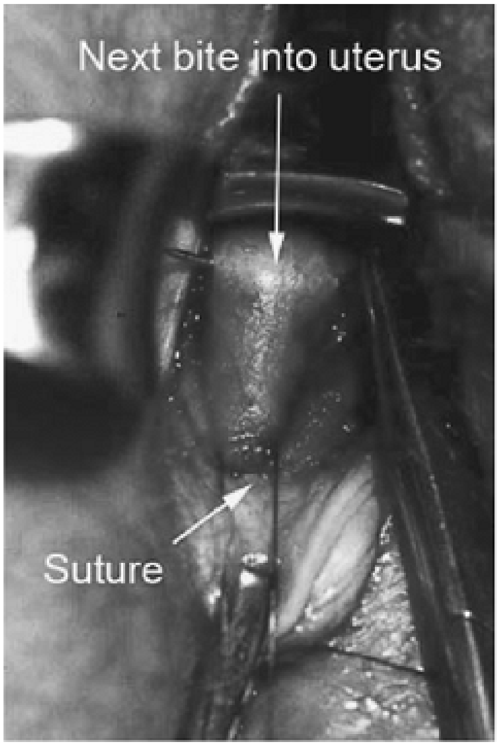

Figure 12.1 Inserting the suture into the anterior uterine wall during delivery of the uterus through an anterior colpotomy.

Table 12.2 Steps of A Subtotal Hysterectomy Based on The Doderlein-Kronig Technique

1. Empty bladder if full
2. Infiltrate cervix with local anaesthetic and vasoconstrictor
3. Make anterior colpotomy
4. Deliver uterus through incision
5. Clamp, ligate, and divide ovarian pedicles
6. Clamp, ligate, and divide uterine pedicles
7. Amputate uterine body
8. Core out the cervical endometrium
9. Suture cervical stump
10. Replace uterus into pelvis
11. Close colpotomy incision

The vascular pedicles are visualized and are clamped, cut, and doubly ligated in the same order as at abdominal hysterectomy. The ovarian vessels are taken either laterally or medially to the ovaries, depending on the need for oophorectomy; if direct clamp application on the infundibulopelvic ligament is not easy, this can be done after the uterus has been removed by applying medial traction to the ovary. The uterine vessels are then taken just above the cervix.

In the case of subtotal hysterectomy, the excision stops here and the body of the uterus is amputated from the cervix utilizing a cone-shaped incision into the cervical stump in order to remove the endometrial tissue from the endocervix; if this is judged to be insufficient, either the

cervical stump incision can be made deeper, or the area can be electrocoagulated to destroy any residual endometrium. Coring out the top of the cervix also facilitates closure of the incision; we use a continuous locking suture for this.

After the cervical stump is returned to its normal position, the peritoneum and anterior colpotomy is closed with interrupted sutures. The bladder is emptied, but we do not routinely insert a vaginal pack. Postoperatively, the patient is encouraged to mobilize early.

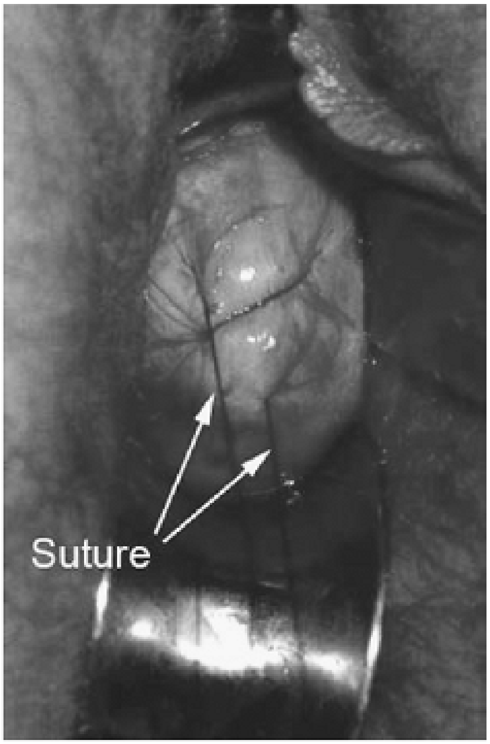

Figure 12.2 Pulling the uterine fundus through the anterior colpotomy incision.

Conclusions

The overwhelming majority of hysterectomies are performed for uterine rather than cervical indications, and some would argue that a healthy organ is unnecessarily removed with a total hysterectomy. Although there may be an advantage in terms of reduced operative risks, there does not seem to be any major long-term benefits to conserving the cervix. Whatever the ultimate truth, there is an increasing interest for the subtotal operation by some women. With regards to the route, abdominal procedures cannot be performed unquestionably any longer. As for laparoscopic surgery, although new and exciting, it is neither time nor cost-effective. Although not suitable for all women, we believe there is a place for the subtotal vaginal hysterectomy and that gynecologists should reconsider this procedure.

Vaginal Myomectomy

As with hysterectomy, myomectomy has traditionally been performed by laparotomy. Over the last 20 to 25 years, laparoscopic and hysteroscopic myomectomy have become accepted procedures for selected cases. With laparotomy there is a high risk of hemorrhage and sepsis with risks of blood transfusion and postoperative adhesion formation, whereas the endoscopic procedures have all the advantages associated with minimal access surgery (e.g., less postoperative pain, faster recovery, and better cosmetic result).

Unfortunately, laparoscopic and hysteroscopic myomectomy have limitations and have to be reserved for patients with only few relatively small fibroids that are positioned favorably for endoscopic surgery (Table 12.3). In addition, these routes of surgery are not risk free.

There is a fourth way. Vaginal myomectomy is an alternative but underused approach, which historically was performed before any of the other methods.

Table 12.3 Routes of Myomectomy and Associated Problems

Abdominal myomectomy	Requires laparotomy
	Haemorrhage
	Sepsis
	Postoperative adhesions
Laparoscopic myomectomy	Technically difficult with intramural fibroids
	Limited to relatively small and few fibroids

	Long operative time
	Haemorrhage
	Weak uterine scar
Hysteroscopic myomectomy	Only suitable for submucosal fibroids
	Limited to relatively small and few fibroids
	Uterine perforation
	Fluid overload

Historical Background

The first successful vaginal myomectomy was performed by Atlee in 1845 on a patient with a pedunculated submucous fibroid (24). Because this type of fibroid is relatively uncommon (Brooks and Stage found pedunculated fibroids in 17 of 1,255 patients due to have hysterectomy over a 10-year period, giving an incidence of 1.3% [25]), there have only been a handful of publications describing outcomes. For instance, in 1942 Rubin described removal of prolapsed small submucous fibroids either by avulsion or pedicle ligation in 11 of 481 cases and used packing of the uterine cavity for hemostasis (26). Davids in 1952, reported 43 of 1,150 women with fibroids managed vaginally, the rest requiring abdominal surgery (27). In 1982, Riley wrote about a series of 41 patients with submucous myomas, of whom 28 were treated by vaginal myomectomy and the remaining 13 by abdominal hysterectomy (28). In 1986 Dicker managed 46 of 142 patients with vaginal myomectomy; 12 patients had abdominal myomectomy and 84 had abdominal hysterectomies (29). In 1988, Ben Baruch et al. published their series of 46 women with pedunculated prolapsed submucous fibroids, of who 43 underwent

successful vaginal myomectomy (the other three patients had a failed vaginal myomectomy requiring abdominal myomectomy) (30).

The indications for vaginal myomectomy have been extended beyond the rare case involving a prolapsed fibroid in the vagina. In 1987, Goldrath performed a series of vaginal myomectomies using laminaria tents to dilate the cervix in women in whom the fibroids were too inaccessible to be avulsed (31,32). Other techniques designed to gain access to intracavitary submucous fibroids included DÃ¼hrssen incision (midline incision into the cervix), and hysterotomy (extension of DÃ¼hrssen incision into the body of the uterus [24]). Finally, the term vaginal myomectomy is now also used to describe the excision of deep intramural and subserous fibroids through a posterior or anterior colpotomy incision, a technique we described in 1994 (33).

Techniques of Vaginal Myomectomy

Basically the term vaginal myomectomy encompasses four different techniques that can be employed depending on the clinical situation as judged by the position, size, and number of fibroids (Table 12.4). For the sake of convenience, we have classified these procedures as types 1, 2a, 2b, and 3. Prolapsed submucous fibroids are ideally removed through the cervix (type 1 procedure). Cervical dilatation or a cervical/uterine incision can be used to access higher fibroids, provided they are mainly in the endometrial cavity (types 2a and 2b, respectively). Deeper fibroids can be approached via an anterior or posterior colpotomy (type 3 procedure).

As with all surgery, there are limitations on these procedures. Size is an obvious limiting factor, and none of these techniques are appropriate if the uterus is larger than 12 to 14 weeks. Adequate vaginal access is essential, whereas good uterine mobility is needed when using a colpotomy technique.

Table 12.4 Techniques of Vaginal Myomectomy

Procedure Type	
1	Avulsion of prolapsed vaginal submucous fibroid
2a	Nonincisional access to intracervical or intracavitary fibroid
2b	Incisional access to intracavitary fibroid (e.g., DÃ¼hrssen incision or hysterotomy)
3	Colpotomy access to intramural and subserous fibroids

Prolapsed Fibroid in the Vagina

For most gynecologists vaginal myomectomy is the method of choice for pedunculated prolapsed submucous fibroids, unless there are other indications requiring hysterectomy. As already mentioned, such fibroids are uncommon, so this type of vaginal myomectomy, however convenient, has limited clinical use.

In such cases, the cervix is invariably dilated and frequently patients present with offensive vaginal discharge and signs of infection. After correcting anemia and treating infection, vaginal myomectomy is performed by twisting the fibroid off its pedicle, or if the pedicle is large it can be clamped and ligated (Fig. 12.3). Brooks and Stage described vaginal myomectomy using a Mayo renal pedicle clamp that was left in place for 24 hours and then removed (25).

In terms of outcome, in Riley's retrospective study mentioned earlier, postoperative pyrexia and hospital stay duration were significantly in favor of the vaginal myomectomy compared with abdominal hysterectomy (28). On Dicker's retrospective study, no significant difference was found in postoperative morbidity or length of hospital stay between these three groups (29). Ben Baruch et al. compared the long-term outcome of 43 women who had previously undergone vaginal myomectomy for pedunculated prolapsed submucous fibroids with a control group of 41 women who underwent abdominal myomectomy. The mean hospital stay and mean hemoglobin level were significantly lower in the study group. Three patients required repeated vaginal myomectomy for recurrent fibroids and only two patients required hysterectomy (30).

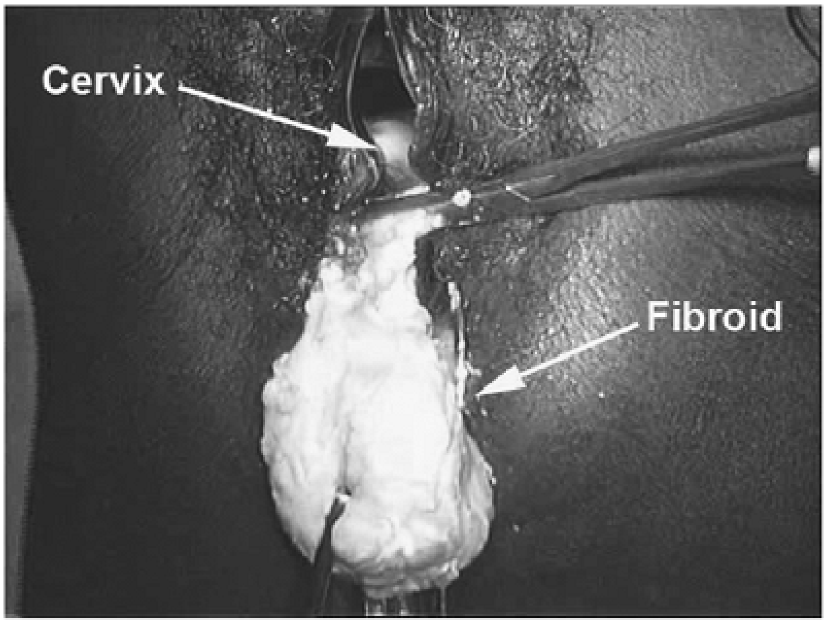

Figure 12.3 Clamp placed at the base of a prolapsed pedunculated submucous fibroid prior to excision.

Nonprolapsed Submucous Fibroids

Access to a fibroid that is in cervix or the uterine cavity and not projecting through the cervix is clearly more difficult.

Nonincisional Techniques

Cervical dilatation with mechanical dilators may be sufficient to gain access to the fibroid. Alternatively, the

hydroscopic properties of *Laminaria japonica* that had been used in obstetrics for many years to dilate the cervix for induction of labor or before abortion, could be employed. Goldrath performed a series of vaginal myomectomies after using laminaria tents to dilate the cervix (31,32). This approach was used for submucous nonprolapsed pedunculated fibroids diagnosed at hysteroscopy. He used a para-cervical block and placed two or three laminaria tents in the cervix. Further tents replaced these after 6 hours, which were left *in situ* overnight. After anaesthetising the patient with a paracervical block and sedation, the laminaria were removed and the fibroid was grasped and avulsed. Sometimes the fibroid was removed intact, but morcellation was occasionally required for larger myomas. If haemorrhage occurred, a Foley catheter was inserted to achieve hemostasis. In his series of 151 patients, this procedure was successful in 139 cases (92%).

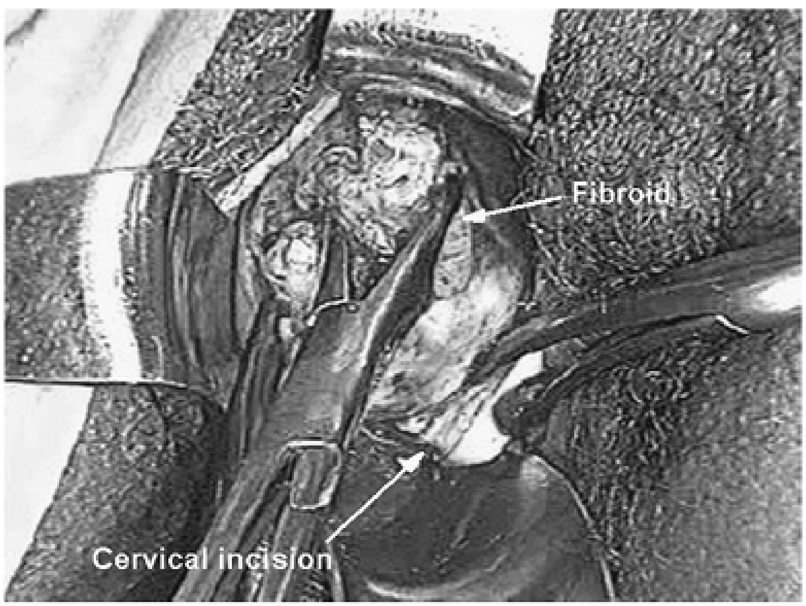

Figure 12.4 Intracavitary fibroid being removed via the cervix using a Duhrssen incision.

Incisional Techniques

An alternative approach to pedunculated intracavitary fibroids is the use of a longitudinal midline cervical incision DÃ¼hrssen incision) (24). With the patient in a lithotomy position, the cervix is infiltrated with local anaesthetic, and the incision is usually made anteriorly until the fibroid can be grasped as discussed previously (Fig. 12.4). Once the myomectomy has been completed, the cervical incision is sutured.

If the submucous fibroid is located higher up in the uterine cavity or is not pedunculated and therefore not suitable for simple avulsion, the incision can be extended into the uterine body into what is in effect a vaginal hysterotomy. If the incision is anterior, the bladder has to be dissected cephalad to avoid injury (as with a cervical suture); in contrast, if the hysterotomy is made posteriorly, as it would tend to be in cases where the fibroid is posterior, the pouch of Douglas may well be entered in the process. Once the fibroid becomes accessible, the pedicle can be clamped, ligated, and divided, or in the case of fibroids that have an intramural extension, the tumor can be enucleated digitally or by using scissors. Morcellation may have to be employed with larger fibroids. Finally, the uterine, cervical, and vaginal incisions are repaired; if the peritoneal cavity has been opened during the hysterotomy, this layer has first to be closed.

There are few data available on the outcomes of subsequent pregnancies. In theory, cervical weakness or stenosis may occur, and, in the case of hysterotomy, there is the potential risk of uterine rupture. The alternative approach in such cases would be hysteroscopic myomectomy, which would not have these potential risks. However, our experience shows that removing a moderately enlarged intracavitary fibroid (>5 cm diameter) vaginally is much quicker than if hysteroscopy were to be used and does not have the problems of fluid overload or incomplete excision.

Intramural and Subserous Fibroids by Colpotomy

The above techniques are not suitable for intramural or subserous fibroids. In this situation, vaginal myomectomy may still be possible using an anterior or posterior colpotomy to access the fibroids. This technique was first described by Magos et al. in 1994, the idea coming from the technique for vaginal hysterectomy described by Doderlein and Kronig (33,34). Some years ago, we were carrying out a vaginal hysterectomy on a patient with a 14-week size fibroid uterus. We had difficulty making the initial posterior colpotomy incision, and, therefore, changed the technique to the Doderlein-Kronig procedure. However, it became apparent that the uterus was too large to be pulled through the anterior colpotomy because of a large anterior fibroid. In an attempt to avoid having to convert the surgery to a laparotomy, we incised the anterior uterus over the fibroid through the anterior colpotomy, and managed to remove the offending myoma. This resulted in sufficient debulking of the uterus for it to be delivered into the vagina and so we could complete the vaginal hysterectomy. After the operation, it occurred to us that in future, we could merely remove the fibroid, repair the incision and replace the uterus back into the pelvis rather than having to complete the hysterectomy. Therefore, vaginal myomectomy via a colpotomy was born (Figs. 12.5 and 12.6).

Since that time we have gained experience in this technique. The steps of this type of vaginal myomectomy are described in Table 12.5. As with vaginal hysterectomy, such an approach is suitable when there is good uterine mobility, adequate vaginal access, and no evidence of adnexal pathology. Uterine size should be less than 12 to 14 weeks. The choice of anterior or posterior colpotomy depends on the site of the main bulk of the fibroids. The posterior approach is preferred whenever possible, as the hollow of the pouch of Douglas provides more space for surgery; there

is the additional benefit that the need for bladder dissection is avoided. Predictably, fundal fibroids are the most awkward to reach by this route.

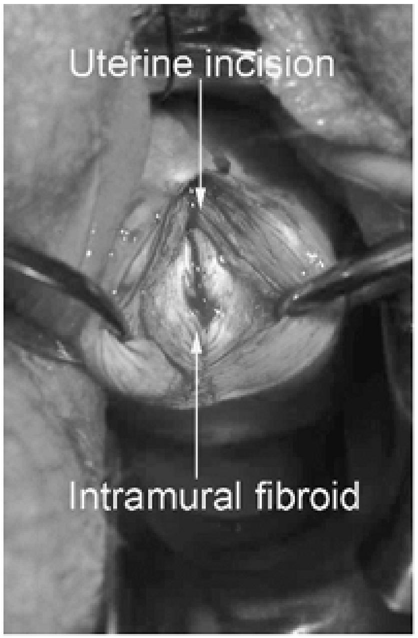

Figure 12.5 Uterine incision over an intramural fibroid prior to excision.

Figure 12.6 The same fibroid being shelled out in the vaginal introitus.

We updated the data on this type of vaginal myomectomy in 1999 (35). the procedure was carried out successfully in 91.4% of cases (Table 12.6). A French group has also published on this technique, tending to reserve it for cases with a single posterior fibroid; certainly, that is the ideal patient for this technique and the one we would recommend as the â€œfirst case.â€• They concluded that posterior vaginal myomectomy is a feasible and reproducible surgical procedure with a success rate greater than 80% (36).

Table 12.5 Steps Involved with Vaginal Myomectomy Via Colpotomy

1. Empty bladder if full
2. Infiltrate cervix with local anaesthetic and vasoconstrictor
3. Make posterior or anterior colpotomy depending on position of dominant fibroid
4. Deliver uterus into or through incision
5. Incise uterus over the fibroid until it is visible
6. Excise fibroid with or without morcellation depending on its size
7. Continue until all fibroids are excised
8. Probe uterus to check integrity of cavity
9. Repair myometrium in layers
10. Close uterine serosa
11. Return uterus to the pelvis
12. Place vaginal drain into pouch of Douglas
13. Close vaginal incision

Although not the main focus of this chapter, laparoscopically assisted vaginal myomectomy (LAVM) has also been described, based on the colpotomy technique (37,38). Certainly, the addition of laparoscopy does provide a better view of the pelvis, better access to fundal fibroids, and allows for additional procedures such as adhesiolysis or the treatment of other pathology. Compared with a purely laparoscopic technique, this type of myomectomy is faster because there is no need for morcellation and the uterus is repaired with conventional instruments.

Table 12.6 Results of 35 Women Undergoing Vaginal Myomectomy (After Davies et al., 1999)

Uterine size (weeks)	9 (6â€“16)
Operating time (min)	77.9 (65.9â€“89.9)
Number of fibroids removed per patient	2.5 (1.7â€“3.4)
Weight of fibroids removed (g)	113.8 (84.2â€“143.4)
Estimated blood loss (mL)	313.6 (206.1â€“421.1)
Number of patients requiring transfusion	4 (11.4%)
Number of patients requiring laparotomy	3 (8.6%)
Postoperative hospital stay (days)	3.9 (3.1â€“4.7)
Number of readmissions to hospital	2 (5.7%)

Conclusions

The excision of uterine fibroids via the vagina is an attractive treatment option, as it avoids the trauma of laparotomy, the inconvenience of laparoscopy, and the limitations of hysteroscopy. Traditionally vaginal myomectomy has been used to avulse prolapsed submucous fibroids, but a range of procedures can now be used to remove myomas from several sites. Vaginal myomectomy should also be considered

in cases of nonprolapsed submucous fibroids and small- to medium-sized intramural and subserous fibroids, provided that there is adequate vaginal access and good uterine mobility. Posterior wall fibroids are generally easier to remove as there is more room for manipulation, and because a posterior hysterotomy or colpotomy is technically easier to perform and does not require bladder dissection.

So far no randomized controlled studies have been performed to compare these techniques. Postoperative adhesion formation should not be a problem when prolapsed submucous fibroids are avulsed, but may be a risk when myomectomy is done through a colpotomy, particularly if the approach is via the posterior fornix. Anecdotally, however, we did not find cul-de-sac adhesions in the few cases that we have laparoscoped some time after vaginal myomectomy. Although the use of DÃ¼hrssen incision or vaginal hysterotomy may compromise the integrity of the cervix and cause cervical weakness or stenosis in a future pregnancy, there is no conclusive evidence that this occurs. Uterine rupture is a potential complication of any hysterotomy, but the uterine repair is likely to be considerably stronger with vaginal than laparoscopic suturing.

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13

The Difficult Vaginal Hysterectomy

Robert F. Porges

The Difficult Vaginal Hysterectomy

Given a choice, most women would elect a vaginal hysterectomy (VH) over an abdominal procedure. This understandable desire occasionally results in the performance of a difficult vaginal hysterectomy, approaching the bounds of good clinical judgment.

To determine the route of surgery one must consider the primary objective of the procedure, the anatomic features, the comparative risks of vaginal versus abdominal hysterectomy, the role (if any) of laparoscopy, and one's skill and experience. One creates thereby a multifactorial intellectual algorithm. There are no absolute contraindications to VH. Only exercises in judgment!

Generally, VH is regarded as a safer operation than is total abdominal hysterectomy (TAH). It has a shorter and more comfortable convalescence. There are few gynecologists well trained in pelvic surgery who do not initially consider a vaginal approach for *every* hysterectomy. Recognition of the factors contributing to an increase in difficulty of VH must appreciate that laparoscopic or TAH also may prove exceedingly difficult under certain circumstances (1,2,3).

To remove an enlarged uterus from below requires a reasonable degree of cervical mobility, which often cannot be judged accurately until after the patient is under anesthesia and in the correct lithotomy position (Fig. 13.1). Two other anatomic issues play a role. A small cervix, with a diameter of less than 3 cm, will restrict access to the intraperitoneal structures, limit inspection, and control of bleeding, and make the adnexa less accessible. A narrow subpubic angle (Fig. 13.2) results in a narrow bituberous diameter, thereby limiting the approach from below (4).

Access to the upper vagina may be restricted by a narrow vaginal introitus. A midline episiotomy will help to overcome outlet stenosis. A mediolateral episiotomy, or Schuchardt incision, is more effective in widening the genital hiatus. Although the Schuchardt incision spares the external anal sphincter, incision into the medial-most portion of the levator ani muscle enlarges the genital hiatus, thereby facilitating uterine removal.

Although size, beyond 14 to 16 weeks of gestation, is often regarded as a contraindication for VH, size alone, less than 20 weeks of gestation, is rarely the deciding feature. Coring and morcellation are two separate techniques that facilitate removal of enlarged uteri. The object of morcellation is piecemeal reduction of uterine size to further its descent into the upper vagina. The scalpel should be applied only to visible and accessible portions of the uterus. Incising the lines of tension produced by downward cervical traction results in further uterine descent and may reveal additional myomas available for excision. At times morcellation and removal of large myomas will lead directly into the endometrial cavity; at other times lateral myomas in the broad ligament may require a deeper incision of the surrounding myoma capsule to effect a cleaner myomectomy and ensure a safer distance from the ureter.

Coring (Fig. 13.3) aims to convert a globular uterus into an elongated sausagelike structure that will move more readily through the vaginal vault (5). Although coring is best done with a scalpel, the incision is bevelled to maintain the continuity of the â€œsausage.â€• Coring is more applicable with a symmetrically enlarged uterus rather than one with subserous or broad ligament myomas.

Both coring and morcellation are facilitated by maintaining strong traction on the cervix, preferably after bilateral ligation of the uterine arteries. If the body

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of the uterus is very wide, then downward traction may result in pressure against the vessels and nerves at the pelvic sidewall and cause numbness of portions of the thighs and some weakness of the quadriceps muscles. It is advisable, at least every 20 minutes or so, to interrupt traction on the cervix to relieve the pressure against these pelvic nerves. The weakness of the quadriceps muscles is usually transient and full recovery is the general rule, with help from physical therapists. Foot drop is a well-know consequence of pressure against the peroneal nerve as it circles lateral to the head of the fibula. Proper positioning of the patient in stirrups will avoid this complication.

Figure 13.1 The â€œcandy-caneâ€• stirrups allow flexion of the hips without

wide abduction. A space, or padding, should always exist laterally between the head of the fibula and the stirrup. (From,
Porges RF. Vaginal hysterectomy at Bellevue Hospital: An experience in teaching residents 1963-67. *Obstet Gynecol.* 1970;35:301
, with permission.)

An enlarged uterus difficult to access from below now may be a candidate for the endoscopic morcellator. Applied to the enlarged corpus of the uterus, the laparoscopic morcellator converts myomas and the uterus into a â€œseaworm-likeâ€• shaped mass, which can be readily retrieved either through laparoscopy or a posterior colpotomy.

Figure 13.2 A narrow subpubic arch restricts access to the upper vagina.

Previous pelvic surgery is considered by some to be a contraindication for VH. Previous low-flap cesarean section often will result in adhesions of the bladder to the anterior lower uterine segment. Although these adhesions need to be separated, it is doubtful that they are more readily dealt with from above. Beginning the dissection while already in contact with the lower uterine segment affords additional protection to the adjacent bladder.

Varying opinions exist regarding the necessity, or value, of combining laparoscopy with a VH. Viewing the abdominal contents through an umbilical port may add information to determine the extent or direction of the surgical procedure. The recognition and lysis of intraperitoneal adhesions may help to facilitate the safe removal of the adnexa by allowing freer access to the infundibulopelvic ligaments. However, the separation of the vesicouterine peritoneal fold, ligation of round ligaments, or even ligation of the uterine arteries, is done with less time and hazard from below.

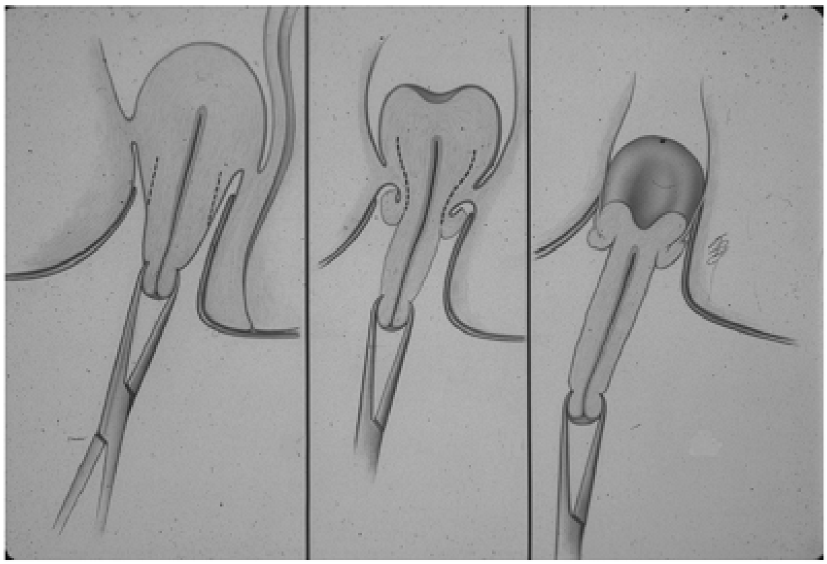

Figure 13.3 Coring of the uterus is intended to convert the globular shape of an enlarged uterus to an elongated, but narrow cylinder (sausage).

An elongated cervix, presenting beyond the vaginal introitus, may pose as a total prolapse of the uterus. Following the initial circumcision at the cervicovaginal junction

one may seek in vain for the insertion of the uterine arteries. To reach these vessels one needs only to push the vaginal cuff off the cervix, without any ligations, up to the anterior peritoneal reflection, where the vessels normally insert (Fig. 13.4).

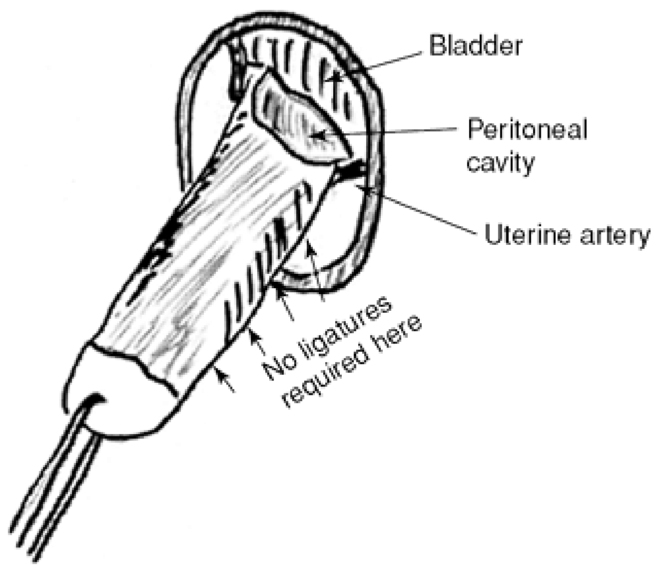

Figure 13.4 Elongation of a prolapsed cervix may lead one to believe the entire uterus is readily accessible from below. Not only may the corpus be enlarged and not available for descent into the upper vagina, but the insertion of the uterine arteries may be at a much higher level, at the anterior peritoneal reflection. Usually in these cases, the vaginal cuff may be separated from the cervical column without any ligations. The insertion of the uterine arteries at the level of the anterior peritoneal reflection is a consistent anatomic finding.

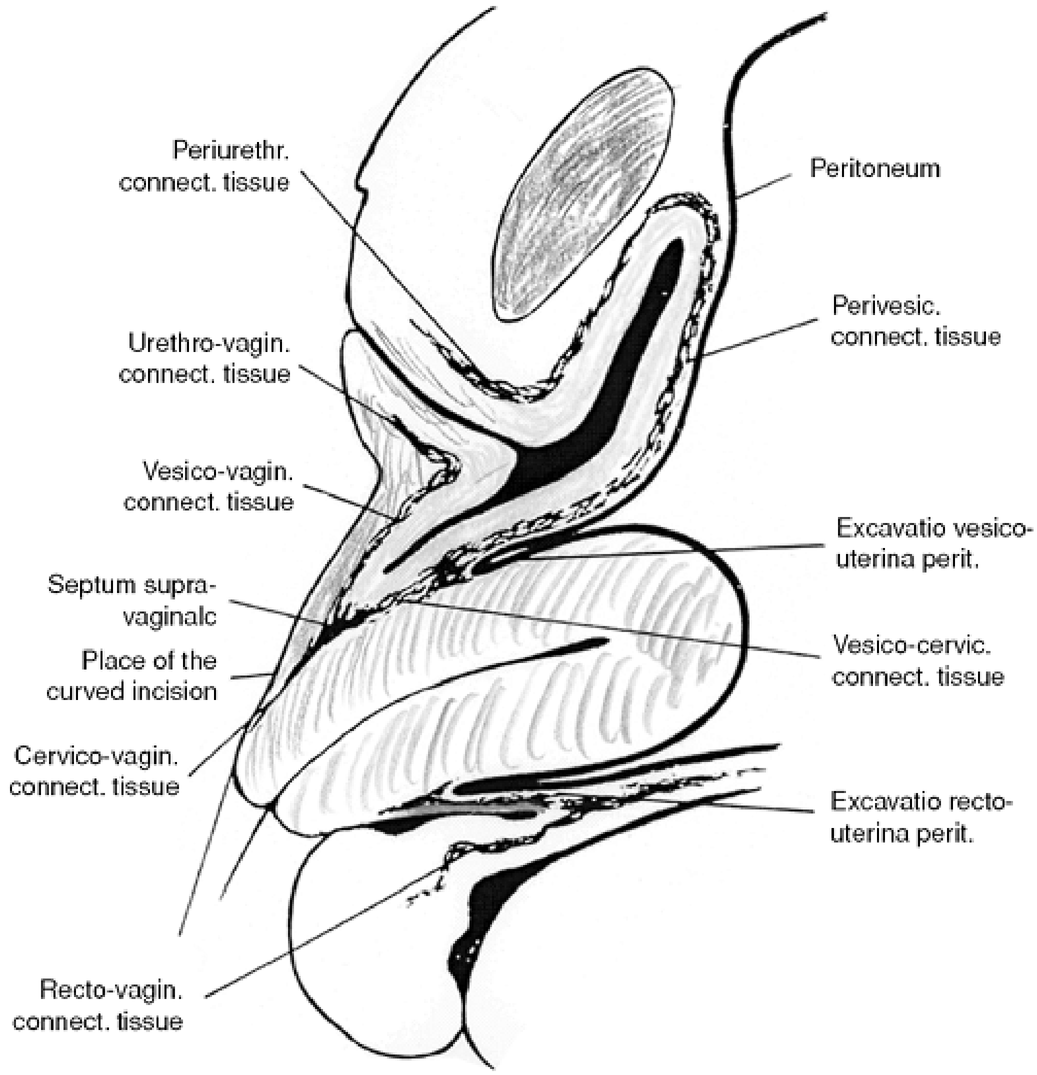

Figure 13.5 Traction, or prolapse, of the uterus creates the above shown distortion in the relationship of the pelvic organs. These anatomic organ relationships must be very clearly understood by the pelvic surgeon. From, Martius HR. *Martius' Gynecological Operations, with Emphasis on Topographic Anatomy*. Boston: Little, Brown, and Company; 1956:173.
Bolten KA, McCall ML, translators.

Injury to Surrounding Structures

Inadvertent entry into the lumen of the bladder is the most common injury to an adjacent structure. Normally the bladder is in direct contiguity below the vesicouterine peritoneal reflection, with the anterior portion of the lower uterine segment and the upper portion of the cervix (Fig. 13.5). Adhesions at this site, following low-flap cesarean sections, or myomectomy, may obliterate the discrete plane between these structures. Following the initial circumcision at the junction of the cervix and vagina, further dissection anteriorly often is carried out bluntly up to the point where the peritoneal reflection becomes visible. Whether digitally, with a sponge stick, or sharply by scissors, there is a distinct risk at this juncture of tearing open the wall of the bladder. The author has found it safer first to open the posterior cul-de-sac. With the anatomic landmarks provided at this site one usually is able, with scissor dissection, to follow the attachment of the paravaginal connective tissues from the posterior, around each side, to the anterior aspect of the cervix. Hugging the cervix with the scissors helps to provide a clear distinction between the bladder and the cervix, serving to reduce the likelihood of bladder injury at this site.

Laceration of the bladder is usually readily apparent, especially if the bladder has not been catheterized in advance of the operation. The injury to the bladder usually lies parallel and posterior to the interureteric ridge and does

not necessarily adjoin the ureteral orifices. Ureteral patency may be assured by stenting the ureter with a double J stent. Opinion is divided whether or not to repair the bladder defect immediately, or proceed on with the operation, leaving repair for a later stage. Recognition of instrumental bladder perforation may facilitate further dissection in the proper plane between the lower uterine segment and bladder. If there is active bleeding from the uterine vessels there is no harm in deferring bladder repair to focus on the expeditious removal of the uterus.

Injury to the rectum is a less frequent but possible injury and may occur above or below the peritoneal reflection. An intraperitoneal injury to the rectum raises the specter of additional trauma to *other portions* of the intestine. In either case, the rectum should be closed in two layers, without tension, the outer layer sewn with nonabsorbable material. After repairing an intraperitoneal defect, the pelvic peritoneum should be copiously lavaged. Although there may be somewhat less concern about a fresh rent in the lower, extraperitoneal portion of the rectum, the type of repair is the same and the area then also should be copiously lavaged. The success of such a repair depends more on an intact closure of the bowel without tension, rather than preoperative bowel preparation.

The combined use of laparoscopy and vaginal hysterectomy has had an interesting history. Initially regarded as an â€œassistâ€• by inexperienced gynecologists (LAVH), the combination of laparoscopy and VH eventually came to be seen more as an â€œextension,â€• as it generally took longer, introduced at least two additional port sites, and was associated not infrequently with injury to bowel, bladder, and ureter, depending upon the extent to which the laparoscope was employed. In the 1980s and 1990s, as more gynecologists became increasingly skilled in VH, the use of the laparoscope tended to diminish. It was recognized that ovaries could be removed vaginally without laparoscopic assistance in at least 90% of cases (6); ultrasonography provided reassurance of adnexal normality, and entry into the vesicouterine space and ligation of the uterine arteries was recognized to be simpler (and safer) from below. The issue regarding the identification of intestinal adhesions to the uterus remained a concern, although it seemed that starting the dissection already on the uterus provided less risk than dissecting first through a mass of adhesions to reach the uterine surface. More recently, with advancing technology, the approach has apparently shifted again to the more common use of the laparoscope in performing either supracervical hysterectomy entirely through the laparoscope, or mechanically morcellating large myomas and removing the cervix and remaining debris through the vagina. Ideally, increasing competence in both vaginal surgery and laparoscopy will lead to continued reduction in the performance of abdominal hysterectomy. The ultimate extinction of abdominal hysterectomy, however, should not be allowed to happen. There continue to be valid indications for an open abdominal approach.

Removal of Adnexa

Vaginal removal of the uterus usually provides a very clear view of the adnexa and a reasonable approach to its excision. Paradoxically, young women with larger, myomatous uteri have more tractable ovaries than elderly women with prolapse, where one would anticipate that the ovaries would also be pulled down into the vagina and targets for easy removal. Instead, the elderly woman generally has a shortened infundibulopelvic ligament and the ovaries often are retracted upward, out of clear view, and against the pelvic sidewall. In either case, separate ligation of the round ligaments assists in isolating the infundibulopelvic ligaments that may be clamped, ligated, burned, or â€œstick tied.â€• There is an important distinction between the uterine and ovarian vessels *when* encountered in pelvic surgery. The uterine vessels, being more tortuous near their insertion into the uterus, will rarely retract out of the operative field, even as one tracts downward on the uterus. Conversely, the ovarian vessels, when torn, *are* very likely to retract upward and deep underneath the posterior peritoneum. Residents are instructed to pull down only gently on the ovaries, to encourage the placement of the ovarian ligature as high up as possible. â€œMake the tie go up to the ovary, rather than insist the ovary come down to join you.â€• Reaching with a clamp for a retracted ovarian vessel is an anxiety-producing step, and may result in injury to a ureter while not preventing the occurrence of a pelvic hematoma at this site. The use of cautery or tripolar instruments at the pelvic brim also is not without risk, considering the proximity of the ureter and large vessels.

Inability to Gain Access to the Peritoneal Cavity

The safe access into the peritoneal cavity is generally ensured by the initial incision at the junction of cervix and vagina, which establishes dissection in a plane along the outer surface of the uterus. If, instead, dissection advances into the cervical stroma or lower uterine segment, or proceeds too superficially into the vaginal tissues, then the peritoneal cavity will prove elusive. Aside from dissection in the wrong plane, obliteration of the peritoneal cavity from dense adhesions resulting from infection, endometriosis, or previous surgery also may frustrate one's efforts to enter the peritoneal cavity.

A History of Previous Pelvic Surgery

Regarded by some as a distinct contraindication, there is no clear evidence that adhesions from prior pelvic surgery will be more safely dealt with from above. When beginning from above and dissecting down through numerous loops of adherent intestine, the risk of injury to the bowel is probably greater than starting the dissection from below, already on the uterine surface. If a plane cannot be clearly discerned, leaving a thin layer of uterine serosa on a loop of intestine is no crime.

Bleeding

Although the initial circular incision with cautery largely eliminates active bleeding, in some cases one may encounter widespread diffuse bleeding from the cuff and parametria. The case against routine hemostatic sutures of the cuff has already been made, but in any given instance, the need for control of active bleeding is a decision to be dealt with on a case-by-case basis. Although cuff bleeding will more often than not, during the progress of the procedure, come under appropriate control, hemorrhage from a branch of the uterine artery will require prompt attention. In the face of profuse hemorrhage from a major pelvic vessel, the *random application of hemostats* may result in inadvertent injury to bladder or ureter. It is critical to recognize the potential for injury and deal with the necessary diagnostic steps during the primary operation, than to play catch-up on postoperative days 1 to 3. Following the intravenous injection of indigo-carmine, 5 mL, cystoscopy should reveal bilateral distinct ureteral jets within 5 to 10 minutes.

Ill-advised Operative Steps that May Create Difficulty

Following initial circumcision at the cervicovaginal junction one's attention should not be diverted by light bleeding from the vaginal cuff. Most of these vessels will stop bleeding as the operation progresses. The aim at this early stage of the operation is merely to reach the peritoneal reflections, control the major vessels, and remove the uterusâ€”and the faster the better! Placing figure-of-eight sutures in the posterior cuff or tagging the vesicoperitoneal fold with a suture is an unnecessary diversion. Lateral clamping of the paravaginal connective tissues actually may obliterate the important distinction between the circular paravaginal connective tissues and the longitudinal parametria, thereby obscuring the course of the uterine artery and preventing displacement of the ureters outside the operative field (Fig. 13.6).

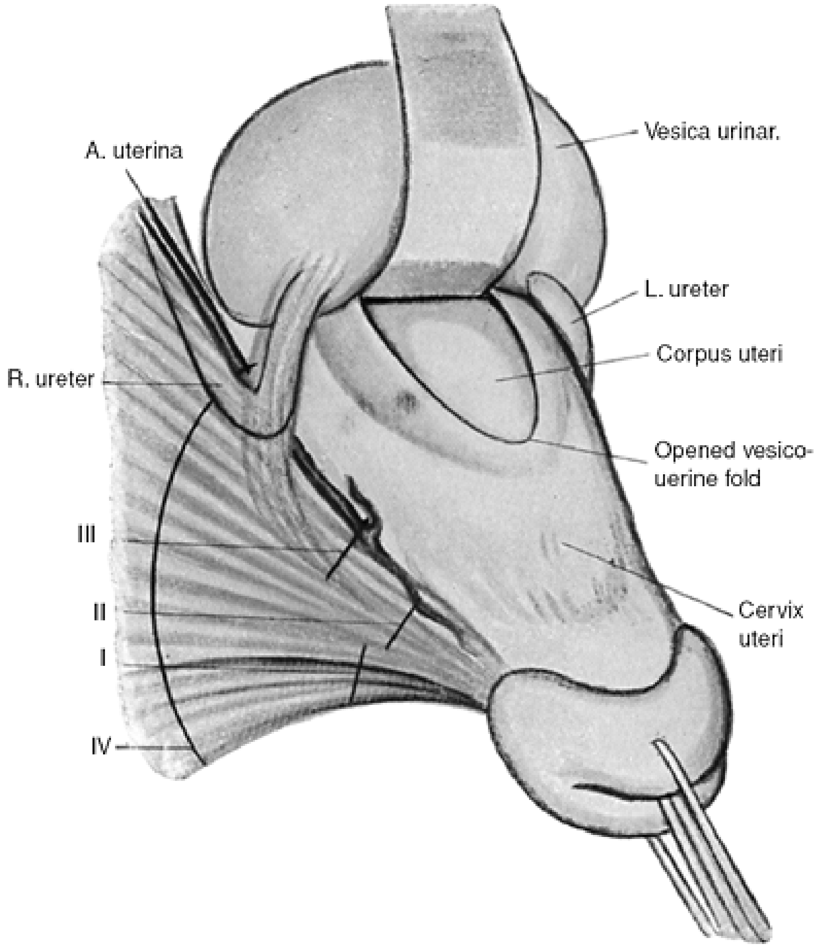

Figure 13.6 Traction on the cervix with a retractor in the anterior vesicouterine peritoneal space displaces the ureters laterally out of the field of dissection. From,

Martius HR. *Martius' Gynecological Operations, with Emphasis on Topographic Anatomy*. Boston: Little, Brown, and Company; 1956:177.

Bolten KA, McCall ML, translaters.figure

Figure 13.7 Traction on the cervix of an atrophic uterus may cause separation at the junction of cervix and corpus, making retrieval of the proper planes more difficult.

Traction on the cervix of an atrophic uterus may cause the cervix to be torn away from the thin lower uterine segment. Although the body of the uterus may be retrieved by Allis clamps, the integrity of the uterine arteries may be disrupted, leading to excessive bleeding (Fig. 13.7).

After removal of the uterus the following steps should always be carried out in a strict sequence.

- Inspect the adnexa and deal with them as needed (retain or remove).
- Consider the degree of overlap between the cul-de-sac and the posterior fornix of the vagina. Portions of the cul-de-sac may need to be excised, or narrowed, and

  the dimensions of the overlap reduced to discourage future formation of an enterocele. Vault descent may be remedied by a McCall procedure.
- As the previous steps themselves may cause new bleeding, control of bleeding is left for last, starting with the upper adnexal pedicles and working down the broad ligament to the parametria and vaginal cuff.

During closure the vascular pedicles should be attached ipsilaterally rather than pulled across the midline. Stretching the connective tissues from one side to the other, may promote a weakness posteriorly leading to an enterocele.

The indications for closure of the pelvic peritoneum and vagina may differ somewhat between abdominal and vaginal hysterectomy. It is acknowledged that by either approach, the peritoneum or vaginal wall, or both, should be closed. There is agreement that one should not leave both open. In an abdominal hysterectomy, in recent years, it has been common to close the vaginal wall and leave the visceral peritoneum open. The concern regarding intestinal adhesions in the pelvis has not materialized.

Conversely, in a vaginal case all of the surgical manipulations proceed through a potentially infected area, presumably creating an increased risk of parametrial infection. The author elects to close the peritoneum, leaving open the vaginal cuff, to allow drainage, and reduce, or prevent, closed-space infections. Postoperative bleeding from the extraperitonealized stumps may be recognized vaginally, and also may be dealt with more readily from below. The open central portion of the vaginal cuff closes within 3 to 4 weeks.

Observance of the VH performance details, outlined in previous chapters, will obviate many difficult situations.

Nonoperative Issues

Improper positioning of the patient on the operating table may add to the complexity of the case. The patient's buttocks should be at the edge of the table and the legs should be elevated without marked abduction of the thighs, but ample flexion of the hips. Flexion of the hips flattens lumbar lordosis and helps to rotate the posterior aspect of the pelvis forward. Lateral pressure of the stirrups against the head of the fibula should be avoided to prevent pressure against the peroneal nerve as it circles around the lateral aspect of the fibula.

The indications for anticoagulation under specific circumstances and in certain medical instances should be arranged in consultation with an internist. In many cases the original strategy adopted preoperatively may need to be revised after surgery, depending upon the sites and degree of bleeding, and the patient's condition.

Vaginal surgery can be conducted both under spinal or general anesthesia. Today, one frequently places an epidural catheter to provide postoperative analgesia for the first 36 hours or so. In any case, the anesthesiologist should be reminded that the vaginal approach does not eliminate the need for relaxation of the skeletal muscles. If the levator muscles are not relaxed, or if intraperitoneal pressure is increased, the surgery may become increasingly more difficult.

It has been the author's practice to use a single intraoperative dose of an appropriate antibiotic to cover approximately 2 hours of operative manipulations. Diabetes or a compromised immune status may require consultation with an internist or infectious diseases specialist.

Informed Consent

A patient's access to the Internet or multiple previous consultations with other specialists does not exempt the operating surgeon from a full disclosure not only of the risks of the operation, but, today, the alternatives to hysterectomy. It is not sufficient to generalize by saying that during hospitalization one may catch cold or die! Nor is it sufficient merely to ease preoperative apprehension by highlighting the general dangers of living on our planet; that is, natural disasters, terrorism, etc. A clear discussion should also focus on what the patient hopes to remedy with the surgery, and whether these goals are realistic.

Among the intraoperative complications, one should address bleeding and the need for possible transfusion, infection and the need for additional antibiotics, possible injury to the surrounding urinary and gastrointestinal structures, and pulmonary emboli. Anesthetic complications may be touched upon, but should today invariably be discussed with the anesthesiologist.

Postoperative complications may be divided into short- and long-term issues. Duration of vaginal bleeding, need for prolonged bladder catheterizations, resumption of sexual activity, and return to work should not be overlooked. There may be unanticipated occurrences. It is the surgeon's responsibility to report such events promptly to the patient, or family member, and enter appropriate documentation into the hospital record.

The indications for a surgical procedure may be weighed more easily in specific quantitative terms when dealing with malignancy. When the risks of surgery, however, are weighed against discomfort, that is, heavy menses, vaginal protrusion, pelvic pain, or incontinence, the conclusions will be more subjective. The benefits of hysterectomy include cessation of heavy bleeding, restoration of normal vaginal anatomy, and a variable reduction or elimination of pelvic pain. The risks have been alluded to elsewhere. Each patient must be led to an individual personal evaluation of the risks and benefits of pelvic surgery

Conversion to Abdominal Hysterectomy

Generally, abandoning the vaginal route implies that at least an initial incision has been made vaginally. Examples

where the vaginal approach is abandoned in favor of the abdominal route include the following:

- The uterus is enlarged, but seemingly mobile, and the cervix protrudes for several centimeters beyond the vaginal introitus. Following cervicovaginal circumcision and entry into both cul-de-sacs it is appreciated that the corpus of the uterus is densely adherent to the anterior abdominal wall. Control of uterine vessels is only marginal. It is estimated that the uterus will not be able to be removed for more than 30 minutes. Following packing of the vagina preparation is made for an abdominal hysterectomy.

- Following removal of the uterus and adnexa, the ovarian artery retracts from a clamp against the pelvic sidewall.
- Unanticipated adnexal pathology.

When a patient gives consent for vaginal, possible abdominal, hysterectomy, is examined under anesthesia, then has her legs lowered following the surgeons' declaration that an abdominal hysterectomy will be carried out, this is *not* an example of â€œconversionâ€•, or â€œabandoningâ€• the vaginal route.

Difficulty in doing a particular case may be anticipated in advance, or may arise as an unpleasant surprise. When anticipated, special precautions may include a coagulation profile beyond a prothrombin time or partial thromboplastin time (PTT). If the nature of the pelvic mass is unclear, sonography may be supplemented with MRI or CT scans. The degree of mobility of the uterus, the presence of a lateral mass, or relaxation of the introitus and genital hiatus may need to be carefully reviewed. Consultation with an experienced pelvic surgeon may prove helpful. In no case should the possibility of an abdominal exploration be fully ruled out. If one encounters an unanticipated, complicated pelvic dissection it may be reassuring to have recourse to an abdominal procedure. Abandoning the vaginal route during the progress of a vaginal hysterectomy should be considered among last resorts, but excessive delay may be catastrophic.

Especially with uncontrolled bleeding, converting to an abdominal procedure necessarily delays control of the offending vessels. Conversion in more than a small handful of cases raises the specter of poor surgical judgment.

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14

Radical Vaginal Hysterectomy and Laparoscopic Lymphadenectomy

Kenneth D. Hatch

Schauta first introduced radical vaginal hysterectomy in 1902 in order to decrease the high mortality rate of the Wertheim abdominal hysterectomy (1). The procedure was not widely accepted because the pelvic lymph nodes could not be removed vaginally. Pelvic lymphadenectomy became an important part of staging and treatment of early cervical cancer in 1951 with the report of Meigs, but it required the use of an abdominal approach (2). With the introduction of laparoscopic lymphadenectomy, the Schauta vaginal hysterectomy was reintroduced.

Laparoscopic pelvic lymphadenectomy with paraaortic lymph node sampling has become an accepted technique in the treatment of cervical cancer (3,4,5). Dargent was the first to suggest that the laparoscopic pelvic node dissection could be followed by a Shauta radical vaginal hysterectomy and reported a 3-year survival on 51 patients at 95.5%. Querleu reported a blood loss of less than 300 mL, a 4.2 hospital day stay, and less pain in a series of eight patients (6). Hatch et al. reported 37 patients with a mean operative time of 225 minutes, a blood loss of 525 mL, and an average hospital stay of 3 days (7). The major advantage over an abdominal operation was an 11% transfusion rate compared with a range of 35% to 95% reported in the literature for radical abdominal hysterectomy.

Schneider reported 33 patients with a transfusion rate of 11% (8). Each of the authors reported some complications from the radical vaginal hysterectomy early in the series, with a decrease in incidence as experience was gained. Comparable long-term survival with radical abdominal hysterectomy has been reported by Hertel et al. in 200 patients with a mean follow up of 40 months (9). The projected 5-year survival is 83%, and for the 100 patients who were stage I and node negative the survival was 98%.

The ability of the laparoscopic pelvic lymph node dissection to adequately identify all positive pelvic lymph nodes had been demonstrated by Querleu, Childers, and Fowler (5,10,11). The ability of the laparoscopic-assisted Shauta to adequately treat the primary tumor is most likely to be dependent upon the surgeon. The large published series of the Shauta operation by Massi et al. and Dargent et al. indicate that the Shauta procedure results in survival outcomes comparable to that achieved by the Wertheim-Meigs operation (12,13). The major obstacle to gaining widespread acceptance of the procedure is the lack of training in performing the Shauta operation, which leads to a high complication rate in the beginning of every series. The issue of blood loss and transfusion also is very important to patients and surgeons, since the identification of the human immunodeficiency virus. Every report on laparoscopic node dissection and radical vaginal hysterectomy has noted a significant decrease in blood loss with transfusion rates of less than 15%. Other societal advantages are the decreased hospital stay and rapid return to normal function, even with the radical surgery.

Technique

The patient preparation begins with a clear liquid diet the day before the surgical procedure. The patient is given a laxative to evacuate the bowel. It is important for the bowel to be collapsed during lymphadenectomy so that the proper exposure can be obtained.

The patient is positioned in the dorsal lithotomy position with the legs in stirrups, which support the legs and decrease the tension on the femoral and peroneal nerves. The arms are tucked at the side, an orogastric tube is in place, and a Foley catheter is in the urethra.

A 10- to 12-mm trocar is inserted into the umbilicus. Additional trocars are placed in the right and left lower quadrants just lateral to the inferior epigastric vessels. A 10- to 12-mm trocar is placed in the suprapubic site so that the lymph nodes can be removed through the port. The patient is placed in the Trendelenburg position to help pack the bowel into the upper abdomen.

The principles of laparoscopic surgery are similar to those of laparotomy. There must be adequate exposure, identification of anatomy, and removal of the appropriate structures. Sponges or minilaparotomy packs can be placed around loops of bowel to aid in exposure and to block small amounts of blood. This decreases the necessity for a suction apparatus in the abdomen and allows the port to be used for graspers or cautery.

The paraaortic node dissection is usually performed first. Both the right and left sides of the aortic nodes are sampled. The peritoneum is incised between the sigmoid mesentery and the small bowel mesentery up to the duodenum. The node chain is isolated and dissection is carried out using electrosurgical techniques. Monopolar surgery, bipolar surgery, harmonic scalpel, and argon beam coagulator have all been used successfully. The landmarks for dissection are the reflection of the duodenum, the inferior mesentery artery superiorly, and the psoas muscles laterally. The ureter must be identified and placed on traction by the assistant to keep it out of the operative field. Common iliac nodes can be exposed through the retroperitoneal incision made from the paraaortic node dissection site. It is possible to resect the upper portion of the common iliac nodes from this approach, and the remainders of the common iliac nodes are dissected from the pelvic node incision sites (Fig. 14.1).

The pelvic node dissection is begun by dividing the round ligaments and finding the lateral pelvic space. The obliterated umbilical artery is retracted medialward, opening up the entire lateral pelvic space. An entire lymphadenectomy is performed including the nodes between the iliac vessels and psoas muscle. The obturator space is dissected in its entirety. The node dissections are best performed by the surgeon on the side opposite of the dissection.

Following the complete pelvic lymphadenectomy, the paravesical and pararectal spaces are open. The uterine artery is identified and isolated at its origin (Fig. 14.2). It is then divided and brought up and over the ureter. The uterine vein is likewise transected and mobilized medially. The cardinal ligament is then detached from the pelvic sidewall with a combination of sharp dissection and harmonic scalpel, clips, or stapler for hemostasis. This ensures that all of the lateral cardinal ligament tissue is removed. The ureter is dissected away from its peritoneal flap and the cardinal ligament tunnel is developed. The peritoneum over the uterosacral ligament is divided at the level of the rectum. The ligament is dissected sharply and with the aid of the harmonic scalpel or electrosurgical cautery to drop the rectum away from the uterosacral ligaments. The bladder flap has been advanced and the vesicouterine ligament is sharply divided using cautery when necessary.

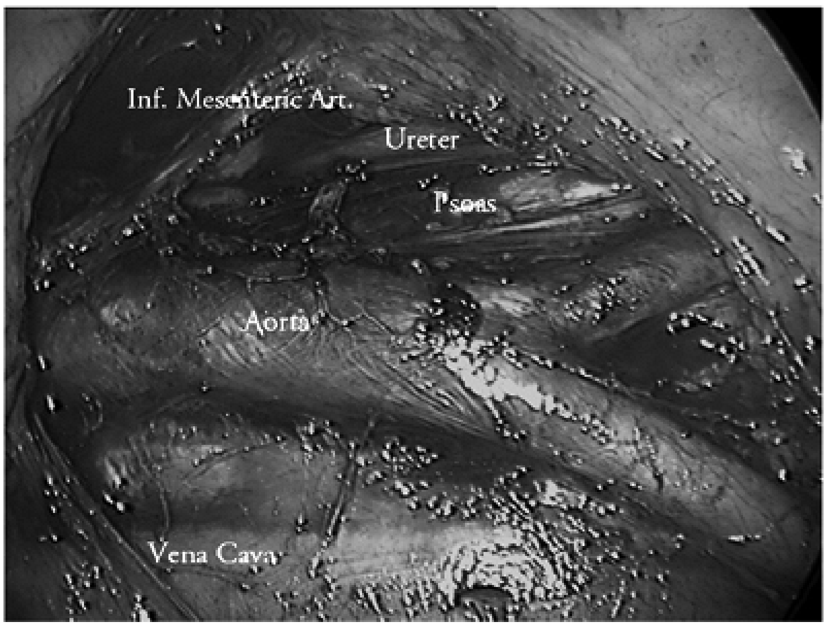

Figure 14-1 Completed paraaortic node dissection with aorta, vena cava, and common iliac nodes removed.

The surgical procedure then moves to the vaginal side. The legs are brought up from the lithotomy position and the

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cervix is exposed. Dilute epinephrine solution (1-100,000) is injected circumferentially under the vaginal mucosa, approximately 3 cm from the cervical vaginal junction. The prevesical space is developed and a curved retractor is placed. The vaginal mucosa in the posterior cul-de-sac incised and the rectum is dropped away.

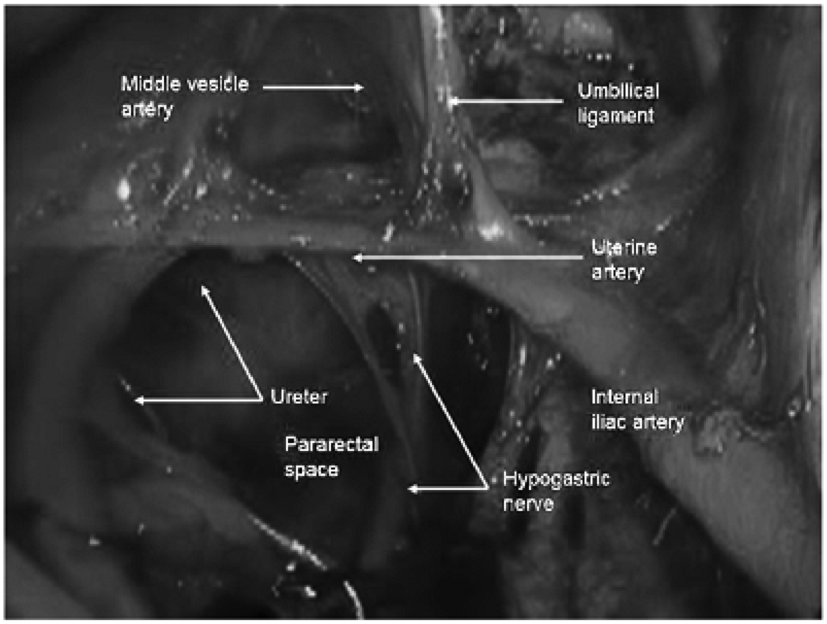

Figure 14-2 Right pelvic sidewall after the node dissection before dividing the uterine artery.

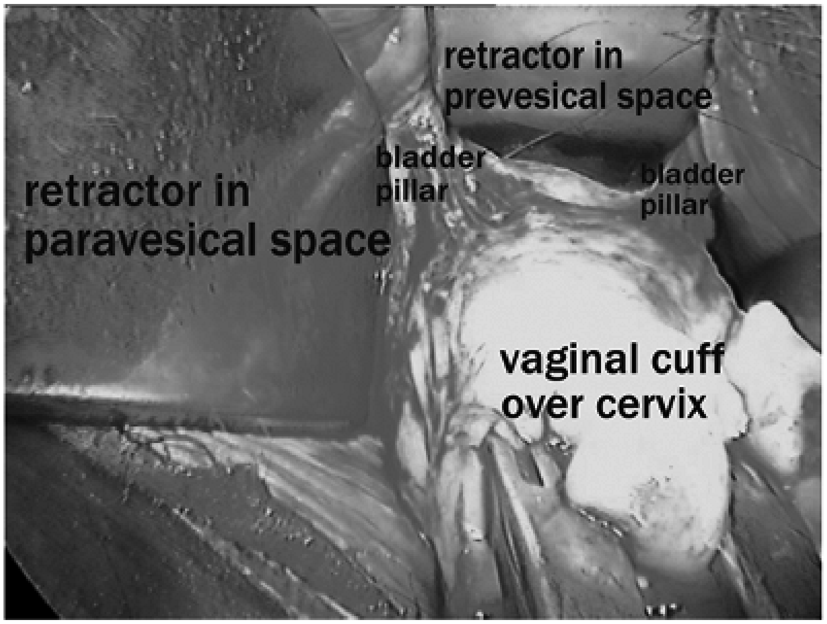

Figure 14-3 Exposure of bladder pillars from vaginal side.

The bladder pillar is developed by grasping the vaginal mucosa at approximately three o'clock; the Metzenbaum scissors are used to dissect submucosally until the paravesical space is entered. This is enlarged so that a Breisky retractor can be placed. This then isolates the bladder pillar from the cardinal ligaments (Fig. 14.3). The cardinal ligament attachments to the vagina are then clamped at the sidewall, divided, and ligated. This allows for greater mobility of the uterus and easier dissection of the ureter in the bladder pillar. The bladder pillar is then dissected sharply until the ureter is found at the midportion of the bladder. The ureter undergoes a sharp bend at this point and as it is dissected out the uterine vessels become visible (Fig. 14.4). The vessels are then brought under the ureter and the ureter is freed from the rest of the attachments and pushed cephalad. Usually there are further peritoneal attachments that need to be divided and the specimen can be removed (Fig. 14.5).

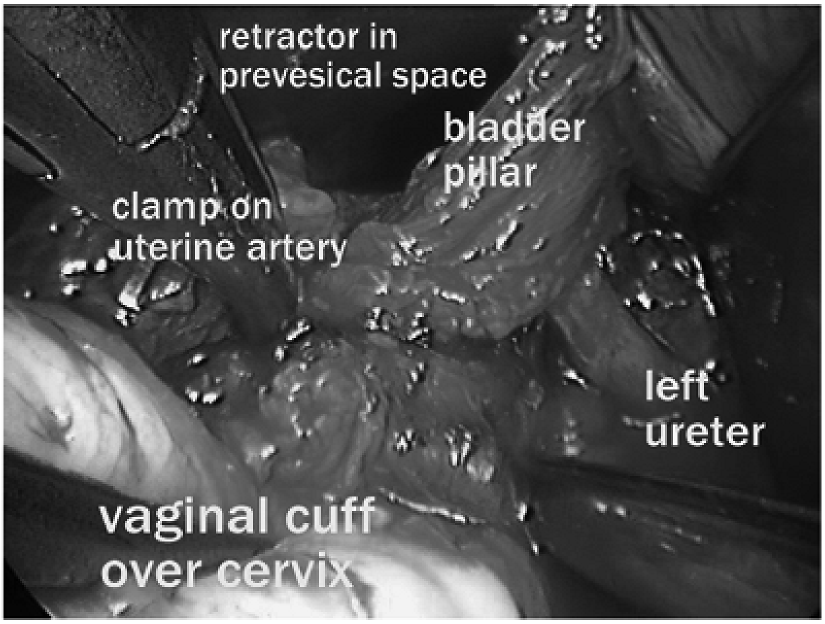

Figure 14-4 Left ureter exposed from its bladder pillar.

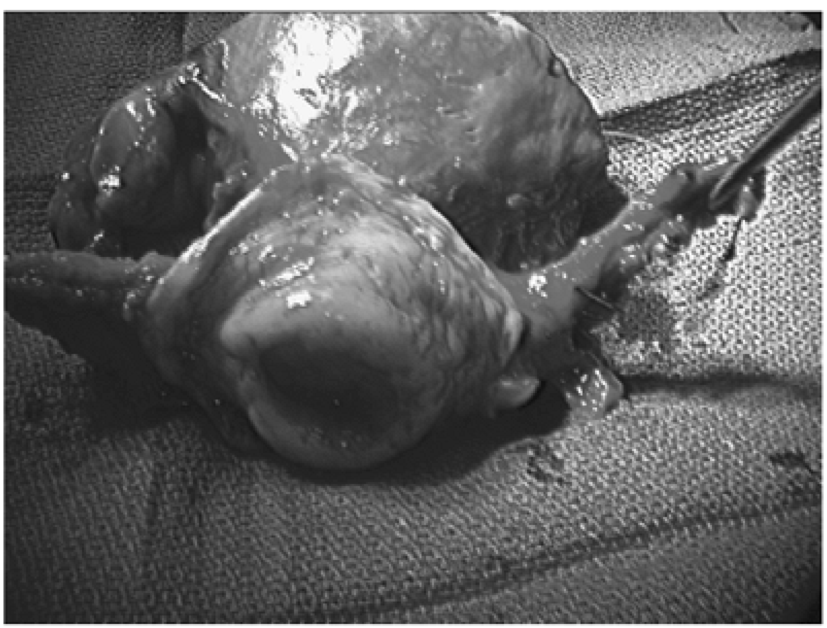

Figure 14-5 Surgical specimen.

After hemostasis is assured, the peritoneum from the bladder is sewn to the anterior edge of the vaginal mucosa. The peritoneum from the cul-de-sac over the rectum is sewn to the posterior vaginal mucosa. This allows for greater length of the vaginal to be established by inward migration of the squamous epithelium.

The carbon dioxide is re-insufflated and the pelvis is inspected for hemostasis and for any unsuspected injuries to the bladder or ureter (Fig. 14.6). The pelvis is irrigated and the 10 to 12 mL trocar sites are closed with absorbable suture. The carbon dioxide is allowed to escape and the skin is closed with 4-0 absorbable suture or skin adhesive.

Marcaine is injected in the skin incision sites to decrease postoperative pain.

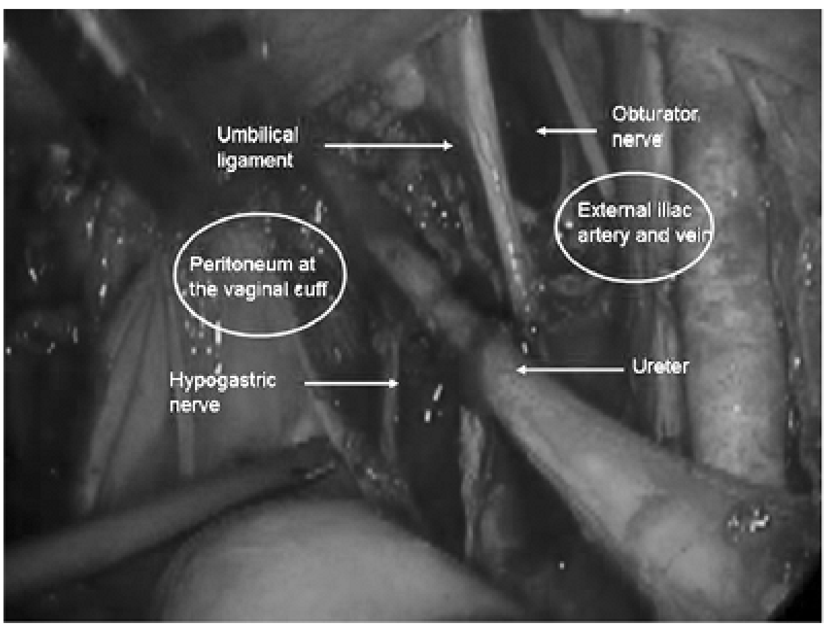

Figure 14-6 View of the pelvis after completion of the surgery.

Patients are given a clear liquid diet the night of the surgery and a regular diet the morning after surgery. They are generally able to be discharged on the second or third postoperative day. Complications of laparoscopy for malignant disease are higher than for benign disease. Postoperative complications of wound infection, ileus, and fever occur but at lower rates than after laparotomy. Adynamic ileus is unusual after laparoscopic surgery, but any abdominal distention, worsening of pain, or vomiting must be taken seriously. Unsuspected bowel injuries manifest themselves by abdominal distention, pain, and free air. The carbon dioxide used for insufflation should be absorbed within hours, so any free air in the abdomen is highly suspicious of perforation. Data on complication rates from laparoscopic lymphadenectomy are inadequate due to small sample sizes, lack of adjustment for a learning curve, and confounding by combinations of and differences in procedures. The author has not observed postoperative lymphocyst formation in more than 140 cases.

Summary

Laparoscopic lymphadenectomy followed by radical vaginal hysterectomy is an excellent option for patients with stage IA or IB cancer of the cervix. Compared with radical abdominal hysterectomy and lymphadenectomy, it has less blood loss, fewer hospital days, and more rapid return to full activity with comparable survival.

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15

Vaginal Salpingo-oophorectomy

Stephen L. Larson

Introduction

â€œSurgery of this type is a living, evolving, and changing method of treatment.â€• Naylor, 1984 (1).

Removal of fallopian tubes and ovaries at hysterectomy is common, depending upon an informed patient's desire and pelvic pathology. They are more frequently removed at abdominal hysterectomy than at vaginal hysterectomy (2,3,4,5,6), despite the latter procedure offering opportunity for adnexectomy. Concern about complications may be an important factor in this disparity of care. Yet Aronson et al. (7) in a retrospective review, state that most reports do not show increased problems with adnexectomy in conjunction with vaginal hysterectomy. Differences of attitudes, training, ability, and habits may also influence the gynecologic surgeon toward the abdominal approach when oophorectomy is planned (8). Understanding techniques, instrumentation, and anatomy as well as a review of other surgeons' experiences should encourage a more dedicated effort to accomplish salpingo-oophorectomy at the time of vaginal hysterectomy.

Background

â€œWhen it is possible to remove the appendages, it is proper to do so.â€• Garceau, 1895 (9). Gray's comprehensive review of the history of vaginal surgery (10) found little emphasis on vaginal oophorectomy. In the late nineteenth century, European surgeons (9,11) did mention removal of â€œthe appendagesâ€• despite the high prevalence at that time of infections and adhesions. Wathen (12) described his own experience with vaginal oophorectomy in Kentucky in 1895. However, there was significant tension between the â€œceliotomistsâ€• (who never did a hysterectomy vaginally) and the â€œhysterectomistsâ€• (who rarely did an abdominal hysterectomy). As a reflection of this controversy, there was no reference to vaginal salpingo-oophorectomy in the 1,104 pages of Howard A. Kelly's *Operative Gynecology* in 1899 (13). Four decades later, Babcock (14) renewed interest in the vaginal approach by reporting removal of 13 ovarian tumors in 200 vaginal hysterectomies. In 1942 Heaney (15) admonished, â€œThe appendages are now inspected by drawing them into the operative field and are left or removed as seems advisable. It is rare that they cannot be inspected and examined or operated upon as easily through the vaginal incision as by the abdominal route, opinions of inexperienced operators to the contrary notwithstanding.â€• Counsellor (16), Coulam and Pratt (17), Campbell (18), and others referred to the procedure of vaginal adnexectomy, but these master vaginal surgeons did not share their techniques, until Smale et al. (19) detailed a five-step technique for salpingo-oophorectomy that included removal of a portion of the round ligament. In their series of 355 cases, no ureteral injuries occurred and only one patient required laparotomy. Open discussion of this presentation raised the following points:

- The surgeon should consider dividing each round ligament separately, thereby opening a space between it and the adnexa.
- It is best to minimize tissue in the infundibulopelvic clamp.
- Medical literature contains â€œastonishingly littleâ€• information regarding oophorectomy at vaginal hysterectomy. (This point was later emphasized by Kovac (20) as a reason for the low vaginal hysterectomy rate in this country.)
- â€œâ€¦ we should not rigidly stigmatize the removal of tubes and ovaries by any fixed method. One needs to be innovative and meet problems as they are encounteredâ€• (19).

Subsequently gynecologists reported from 60% to more than 80% success of salpingo-oophorectomy at vaginal hysterectomy, but offered little explanation of the techniques used (1,17,21,22,23,24,25,26,27,28,29,30). Sheth and Malpani in 1994

(31), outlined his technique (successful in 94% of 740 cases), and demonstrated his especially designed clamp, which has become this author's choice of adnexal clamp. Sheth stated, â€œIt is strongly suggested that the selection of the vaginal route for hysterectomy should not deprive a woman of prophylactic oophorectomy, nor should the lack of expertise in performing oophorectomy at vaginal hysterectomy be the reason to adopt the abdominal route with its increased morbidityâ€• (32). Both Lee (7) and Sheth and Sonkawde (33) emphasized the importance of round ligament division for success and safety of vaginal adnexectomy. Another especially designed clamp was introduced by Gupta (34) in 1998. Additional variations of techniques were described by Jelen and Bachmann (35), Ballard and Walters (36), Magrina et al. (37), Zimmerman (38), Davis et al. (39), and Unger (40). The authors of the latter two reports used an anterior cul-de-sac approach for adnexectomy. Kovac (41) evaluated â€œpresumptive evidenceâ€• of risk of ureteral injury secondary to vaginal salpingo-oophorectomy. Findings included: a less than 1% failure rate of oophorectomy if there was at least minimal adnexal mobility, and no reports of ureteral obstruction in a literature review or in his own 187 patients. Naylor (1) came to a similar conclusion: At least 80% of ovaries could be removed at vaginal hysterectomy.

Preoperative Considerations

â€œObviously, the surgeon must use judgment in deciding whether the ovaries can and should be removed vaginallyâ€• Kalogirou et al., 1995 (42).

As outlined elsewhere in this book, there is a variety of indications for hysterectomy. Following appropriate consultation, decision, and permission, the patient and her gynecologic surgeon will discuss whether the vaginal approach is feasible. Vaginal salpingo-oophorectomy can be accomplished in a high percentage of procedures if the adnexa are of normal size and mobility, and if the informed patient so desires. Studies have shown that many times women are inadequately informed by their surgeons regarding the long term effects of preservation versus removal of ovaries (43,44,45), although the quality of life does not seem to be diminished (46,47). In most instances of indicated oophorectomy, nulliparity, uterine size, history of previous cesarean section, or myomectomy are not reasons to avoid vaginal hysterectomy.

Transvaginal ultrasound can be a useful adjunct to routine pelvic examination to rule out other significant pelvic pathology. If an adnexal mass is discovered, it needs objective evaluation, not automatic abdominal removal. The combination of lack of ascites on ultrasound and a normal serum CA-125 are important indicators that an ovarian cyst will likely be benign (48,49). Color Doppler, computed tomographic (CT) scan, and magnetic resonance imaging (MRI) testing may also be helpful. Appropriate guidelines for referral to a gynecologic oncologist have been reviewed by Im (48). In certain circumstances, benign large cysts can be drained and morcellated transvaginally. Laparoscopic evaluation may be helpful, but generally benign cysts 6 cm or less in diameter are removable vaginally. Laparoscopy will typically be more helpful in assessing adhesive diseases, such as in endometriosis, pelvic inflammatory disease, and postsurgical adhesions. The operator can then determine whether the disease process is confined to uterus and adnexa, and whether vaginal approach is appropriate for that patient.

Prophylactic Salpingo-Oophorectomy

â€œWhen, in retention of an ovary, is there any potential risk, or not, of a future oophorectomy for a benign or malignant disease?â€• Holub et al., 2000 (50).

The purpose of prophylactic salpingo-oophorectomy is to prevent a patient from developing a detrimental condition. Adnexectomy can be accomplished vaginally; there is controversy as to whether it should be done if there is no pelvic pathology. Ovaries left *in situ* at hysterectomy may be subject to future surgery. Holub et al. (50) found a 2.75% re-operation rate (all benign cysts), but only 0.69% rate after vaginal hysterectomy. Loizzi et al. (3) and PlÃ¶ckinger and KÃ¶lbl (51) reported re-operation rates of 2.4% and 3.95%, respectively. Ranney found a 1.09% re-operation rate; unfortunately about one-half of those had malignancy (52). A review by Kalogirou et al. estimated an overall 0.1% risk of cancer in retained ovaries (42). Each surgeon needs to make a mutual decision with the patient as to whether these risks warrant extending the vaginal operation to remove normal organs, even if laparoscopy or laparotomy might be required. This decision might be influenced by the following examples: One study found that the risk of developing ovarian cancer between ages 65 and 70 years is 0.2%, and between 65 and 95 years is 1.1% (53). Podczaski et al. (54) has stated that the lifetime risk of developing ovarian cancer decreases with age; it is 1.76% at birth, 1.52% at age 50, and 1.28% at age 60. Additional examples of conditions potentially preventable by salpingo-oophorectomy would include: endometriosis, pelvic pain, hydrosalpinx (55), fallopian tube prolapse (18,56,57,58). Other authors have discussed this controversy in more detail (59,60,61,62,63,64,65,66).

Instruments and Equipment

â€œâ€¦ only if trans-vaginal oophorectomy can be performed safely and under vision, should it be done.â€• Sheth, 1993 (32).

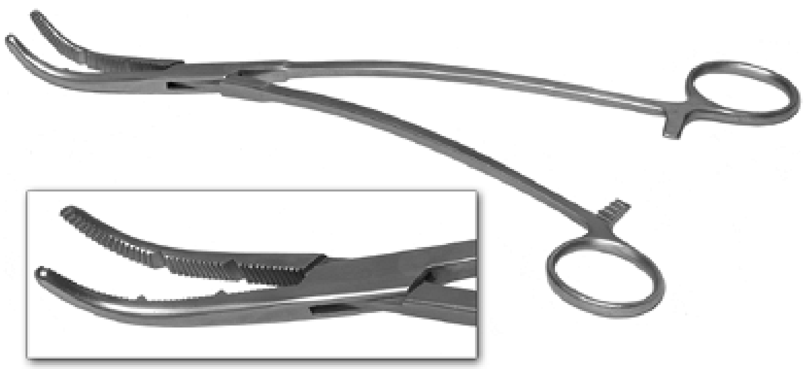

Figure 15-1 Original Sheth adnexectomy clamp. The jaws will fit in the ovarian fossa, and the curved shanks allow suturing without interference of an assistant's hand.

Routine vaginal hysterectomy can be accomplished using a set of standard instruments. Additional instruments are indicated for removal of the adnexa.

Heaney-Simon right angle and Wylie gallbladder (Pilling Weck Surgical, Fort Washington, PA) retractors are useful for displacement of contralateral structures. When removing a tube and an ovary, these will clear the field of the other adnexa, as well as vaginal tissue, bowel, and omentum. A clean, moist â€œbabyâ€• laparotomy pad placed high in the field will also keep those structures out of the operative field, as well as bring light and contrast into the area.

Vision

Two high-density spotlights will provide excellent illumination, with their beams following the vaginal axis when the patient is in a Trendelenburg position. Additional internal lighting can be obtained from a retractor or suction tip that has its own light source (VitalVue, Tyco Healthcare, U.S. Surgical Division, Norwalk, CT), from a laparoscope introduced vaginally, or from a flexible â€œlight-matâ€• that adheres to any retractor (The LightMat, Lumitex Inc., Strongville, OH). A sterile dental mirror (Marina Medical, Hollywood, FL) can be inserted high into the field for detailed examination of the infundibulopelvic ligament.

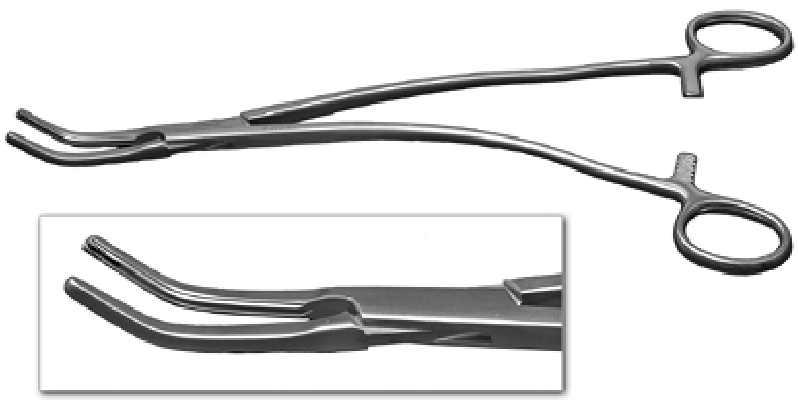

Figure 15-2 Currently available Sheth clamp. Zeppelin-style jaws have been added.

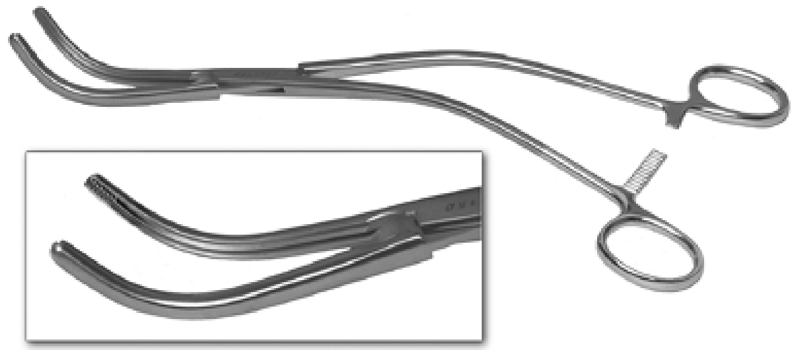

Figure 15-3 Infundibulopelvic clamp.

Clamps

There are several specialized clamps used for vaginal salpingo-oophorectomy. Sheth and Malpani (31) designed and modified (CooperSurgical, Trumbull, CT) the first adnexal clamp (Figs. 15.1 and 15.2). The curvature of its narrow jaws (3 mm) fits in the ovarian fossa to cross-clamp the mesovarium-mesosalpinx. It can also be used across the larger infundibulopelvic ligament because its jaws are relatively long and have an open ringed area for containing additional tissue. The shanks are relatively long and have a reverse curvature, allowing an assistant to hold the clamp without interference of the operator while cutting and suturing pedicles. Two clamps have a jaw width of 5 mm. The Gupta (34) clamp (Fig. 15.3) has a shape that is similar to that of the Sheth and is available in two lengths (Marina Medical). The Garland clamp (Fig. 15.4) has angled instead of curved jaws (J. Jamner Instruments, Inc., Hawthorne, NY). Standard Heaney or Heaney-Zeppelin clamps can also be used for adnexectomy. The length of these clamps and curvature of their jaws frequently require long Mayo scissors for pedicle transection. The curvature of their tips roughly matches the jaws of the adnexal clamps.

Suturing

A long Heaney needle holder will often be needed for securing the infundibulopelvic ligament. CT-2 size needle will fit conveniently in the limited area of the operative field. Endoloop (Ethicon Endosurgical, Cincinnati OH) also can secure this pedicle.

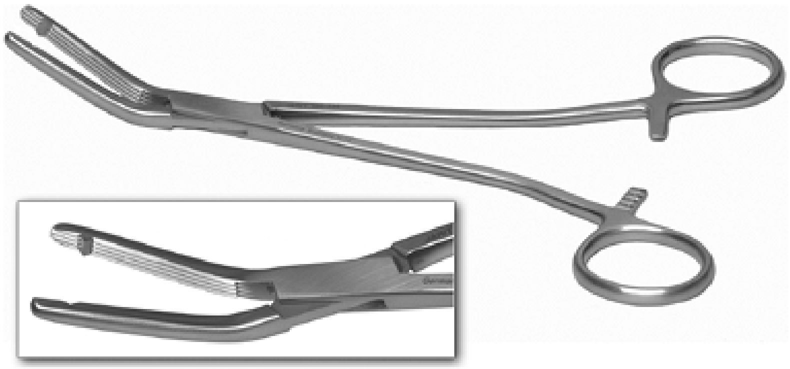

Figure 15-4 Garland clamp.

Anesthesia

Vaginal hysterectomy and salpingo-oophorectomy can be readily accomplished under spinal or epidural anesthesia, accompanied by light intravenous sedation, or with general anesthesia. With regional anesthesia, sufficient intravenous sedation is necessary to prevent diaphragmatic activity causing intestinal intrusion into the operative field.

Preparation

Prophylactic antibiotics, nonshaving, and bladder catheterization are standard for vaginal hysterectomy. However, bladder re-catheterization may be necessary for best access to adnexa prior to their removal.

Positioning

Spring-loaded universal stirrups (Yellowfin Stirrups, Allen Medical System, Acton, MA) work well for both vaginal hysterectomy and adnexectomy. Standard â€œcandy-caneâ€• stirrups can be another alternative. The surgeon must take great care, however, that the height of the stirrups is appropriate for length of the patient's legs, and that the hips and knees are at 90 degrees, respectively (67,68,69). The best visualization of the entire vaginal operative field will occur if the patient's buttocks are pulled down to the edge of the operating table and if the table is tilted 15 degrees or more, head down. Lastly, the operating table should be elevated to maximum height for the surgeon to stand erect and visualize the field without hyperextending the neck. These simple but important measures maximize the best vision, leverage, and prevention of surgeon's fatigue. In addition, the two assistants will be more effective if they are standing.

Exposure

A self-adhering plastic barrier drape applied on the patient's dried genital skin will stay in place and not allow shifting of the drapes during the operation. An Auvard weighted speculum is sufficient for most vaginal salpingo-oophorectomies, but the longer-bladed Steiner-Auvard weighted speculum (Sklar Instruments, Westchester, PA) may be helpful in some instances. Exposure will be improved with good lighting and a small laparotomy pad in the operative field. The bladder needs constant retraction. Ipsilateral vaginal retraction is of limited value and usually not necessary. The procedure will be facilitated by retraction of contralateral tissues such as ovary, tube, vagina, and bowel. At all times surgeon and assistants must retain flexibility to adjust and shift retractors for maximum exposure.

Miscellaneous

Other instruments, introduced vaginally, have been described to be helpful with salpingo-oophorectomy: endoscopic stapler (70,71), endoscopic ligature (71,72), bipolar endoscopic cutter (70), and laparoscope (22).

Techniques

â€œâ€¦ it is hard to argue in favor of preliminary laparoscopy to offset a 0.67% laparotomy risk in women without suspected adnexal or extrapelvic disease.â€• Figueiredo-Netto et al., 1999 (23).

Two commonly used vaginal adnexectomy techniques will be explained. However, because of variations in anatomy and pathology, the gynecologic surgeon must have a working knowledge of a variety of adnexectomy methods and must be prepared to use them in any patient.

Straightforward Anatomy

Once the uterus has been removed, the pedicle containing uteroovarian ligament, round ligament, and fallopian tube represents the cornual attachments. Lateral retraction on this pedicle with a tagged suture will expose the adnexa. As the tube and ovary come into view, medial traction with blunt forceps (e.g., Mayo-Russian tissue forceps) will expose the mesovarium and mesosalpinx and stretch them to their limit (Fig. 15.5). The Sheth clamp is applied, being careful to avoid incorporating a portion of the ovary. Long Mayo scissors will readily cut away the adnexa (Fig. 15.6). Suturing is most easily accomplished with a single figure-of-eight stitch using a CT-2 needle of 0 Monocryl suture

(Ethicon) (Fig. 15.7). The suture is united with the tagged suture of the cornual attachments. Light tension on these sutures in one hand, along with manipulation using long blunt forceps in the other hand, enables the surgeon to ensure that the pedicles are free of bowel and packing. The suture should be tied only after a complete visual inspection. A second stitch is not necessary on this small pedicle. Following removal of the other tube and ovary, traction on the sutures allows access for extraperitonealization of pedicles, thereby preventing exposure of raw surfaces within the peritoneal cavity.

Figure 15-5 Right salpingo-oophorectomy. *Long arrow*: lateral traction on the suture from the right cornual attachment pedicle. *Medium arrow*: Sheth clamp across the right mesovarium-mesosalpinx. *Short arrow*: Mayo-Russian forceps placing traction medially on the right fallopian tube and ovary. Gauze packing and a contralateral retractor can also be seen.

Figure 15-6 Right salpingo-oophorectomy. *Long arrow*: Sheth clamp across partially severed right mesosalpinx-mesovarium; excess tissue fits into ringed opening of the jaws. *Medium arrow*: medial traction on both right fallopian tube and right ovary. *Short arrow:* contralateral retractor providing a generous surgical field.

Figure 15-7 Right salpingo-oophorectomy. *Long arrow:* Sheth clamp with severed right mesovarium-mesosalpinx. *Short arrow:* Heaney needle holder is suturing the pedicle with a CT-2 needle.

Difficult Anatomy (e.g., Adhesions, Nulliparity, Obesity, and Ovarian Cyst)

The operator needs to assess lighting, retraction, and positioning, as well as to determine whether the bladder needs re-catheterization. The importance of performing the surgery in a standing position cannot be overemphasized. One should keep in mind how the steps would look â€œfrom above,â€• with releasing the round ligament and securing the infundibulopelvic ligament - similar to steps done at abdominal hysterectomy with salpingo-oophorectomy. Maximal traction is necessary on the cornual attachments for adnexal exposure; this can be provided by retaining the intact or morcellated uterus as a â€œhandleâ€• (Fig. 15.8) (73). Clamping, transection, and ligation of the round ligament 4 to 5 cm lateral to the uterus will expose the infundibulopelvic ligament (Fig. 15.9). Pushing the round ligament pedicle laterally with a finger will maximize the distance between it and the infundibulopelvic ligament. Added exposure of that ligament will be gained by placing a clamp on the uppermost broad ligament, extending partially into the mesovarium, and isolating the infundibulopelvic ligament (Fig. 15.10). Existing adhesions can be lysed to allow

further mobilization of the tube and ovary medially. The Sheth clamp is applied across the infundibulopelvic ligament, being careful to exclude the round ligament (Figs. 15.11, 15.12 and 15.13). Long Mayo scissors are used for transaction and the ligament is then ligated twice with 0 suture (Fig. 15.14). A safe method of ligation, using a transfixion suture, is illustrated in Figure 15.15 A, B. Before tying, the surgeon holds the clamp and suture in one hand and uses blunt forceps in the other hand, to move around bowel and packing, ruling out inclusion in the tie. After transection of the other infundibulopelvic ligament, the peritoneum is closed. Other variations of this technique have been summarized by Magrina et al. (37).

Figure 15-8 Left salpingo-oophorectomy. *Long arrow:* left round ligament in a Heaney clamp, applied four to five centimeters lateral to the uterus. *Medium arrow:* upper broad ligament, which will be secured later. *Short arrow:* severed and tagged left broad ligament and uterine artery. Exteriorization of the morcellated uterus pulls the structures into view.

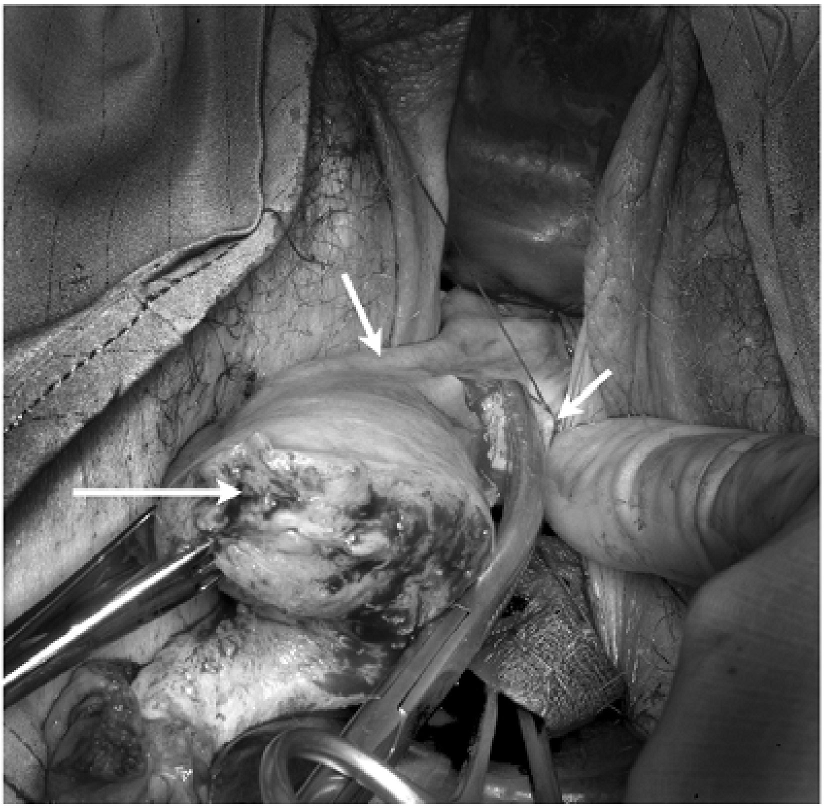

Figure 15-9 Left salpingo-oophorectomy. *Long arrow:* left half of the morcellated uterus is used for traction on the left infundibulopelvic ligament. *Medium arrow:* left fallopian tube; left ovary is underneath it. *Short arrow:* left round ligament is secured.

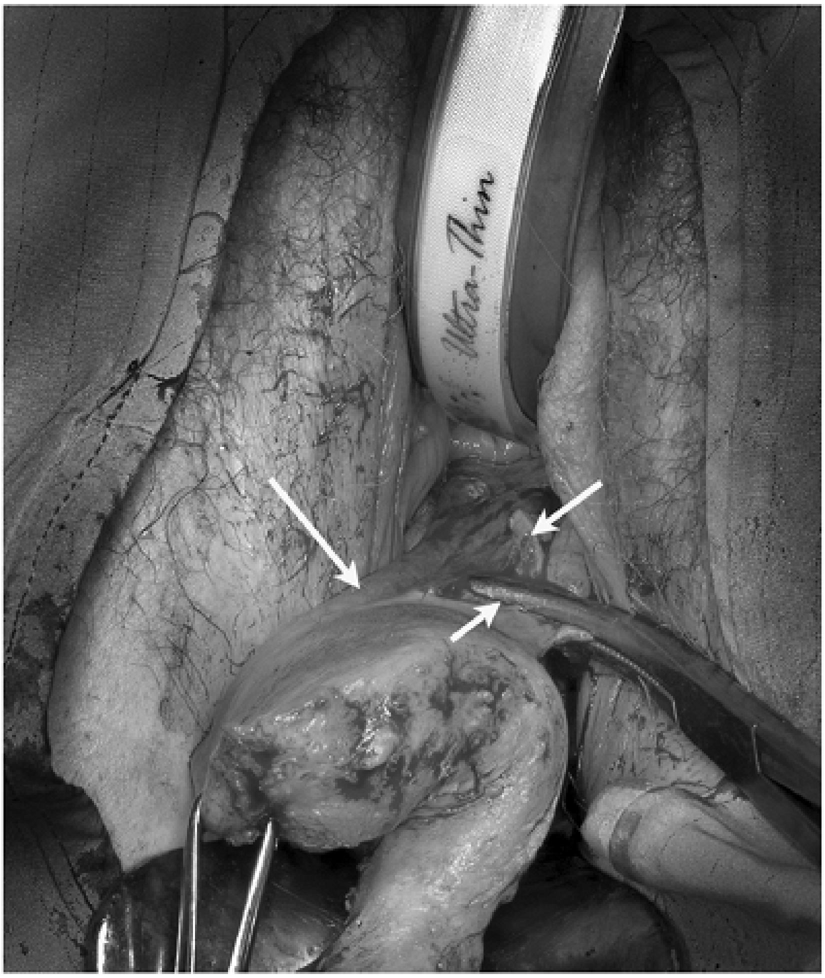

Figure 15-10 Left salpingo-oophorectomy. *Long arrow:* left fallopian tube. Medium arrow: severed left round ligament. *Short arrow:* Heaney clamp applied to the uppermost left broad ligament.

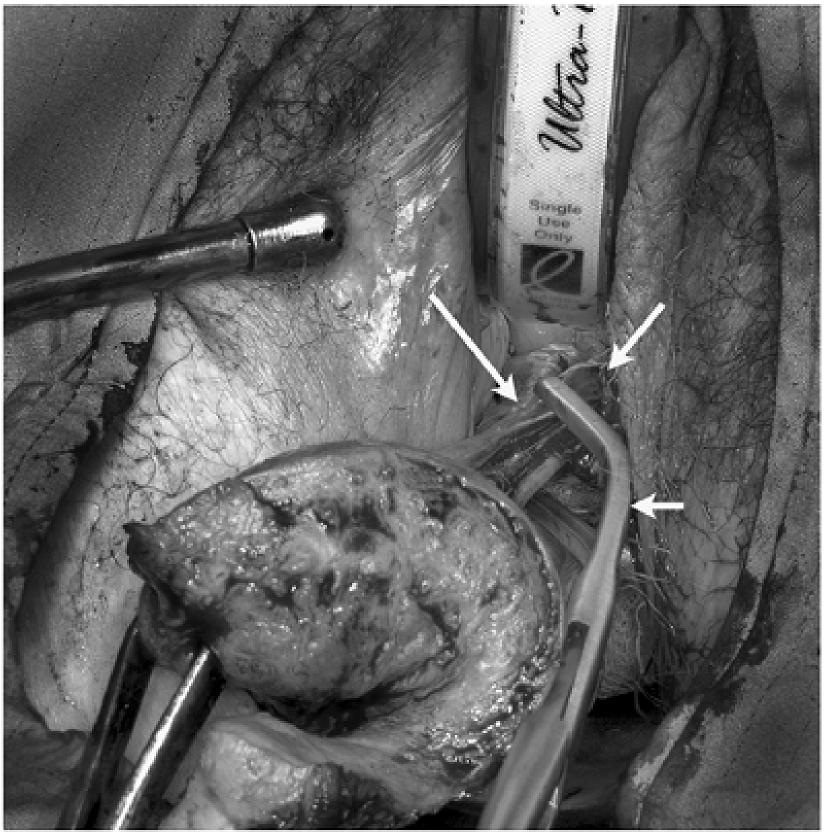

Figure 15-11 Left salpingo-oophorectomy. *Long arrow:* left fallopian tube. *Medium arrow:* severed left round ligament. *Short arrow:* Sheth clamp is approaching the left infundibulopelvic ligament. Broad ligament pedicles are behind and lateral to the Sheth clamp.

Figure 15-12 Left salpingo-oophorectomy. *Long arrow:* left fallopian tube; an edge of the left ovary is seen just below the arrow. *Medium arrow:* severed left round ligament. *Short arrow:* Sheth clamp is across the left infundibulopelvic ligament; tips of the jaws are free of any tissue.

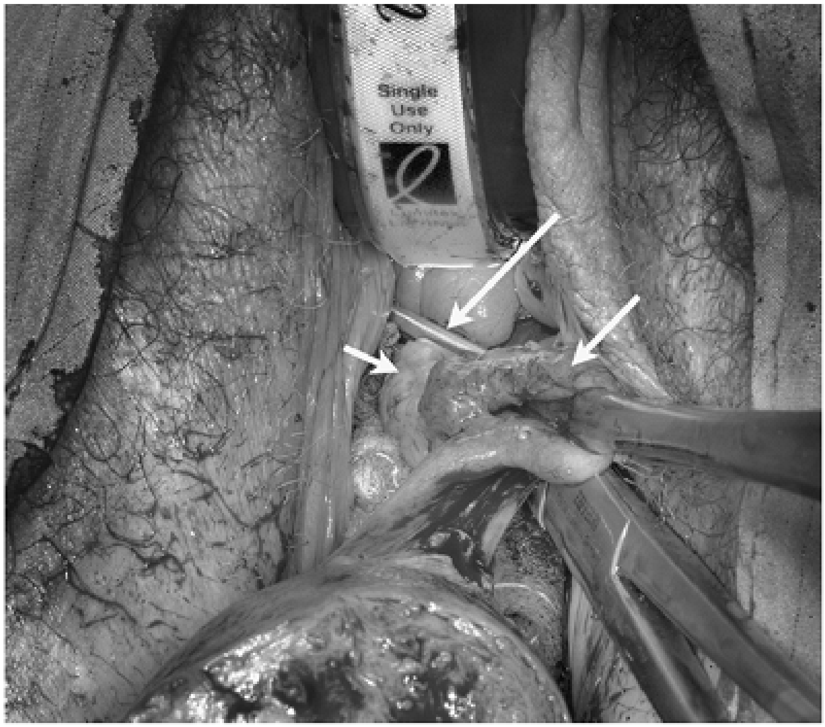

Figure 15-13 Left salpingo-oophorectomy. *Long arrow:* Sheth clamp across the left infundibulopelvic ligament. *Medium arrow:* left fallopian tube. *Short arrow:* left ovary. Tips of the clamp are visible, and bowel is in the background.

Less Common Conditions

Benign Ovarian Cysts

Typical benign ovarian cysts (such as dermoids) up to 6 cm, or even 7 cm, can be removed intact vaginally (Fig. 15.16). This often requires additional bites of upper broad ligament and attenuated mesosalpinx-mesovarium to achieve suitable mobility. Safe traction on a large cyst, pulling it down the vaginal canal, can be done with a disposable vacuum extractor (Mityvac Standard Bell, CooperSurgical, Trumbull, CT) (Fig. 15.17) or with suction applied through a reversed asepto syringe (Fig. 15.18). The infundibulopelvic ligament becomes accessible as the cyst is exteriorized (Figs. 15.19, 15.20 and 15.21). Similar to abdominal surgery, adhesions can be removed with sharp, blunt, and electrocautery techniques. If clinically advisable, cysts can be aspirated and drained transvaginally.

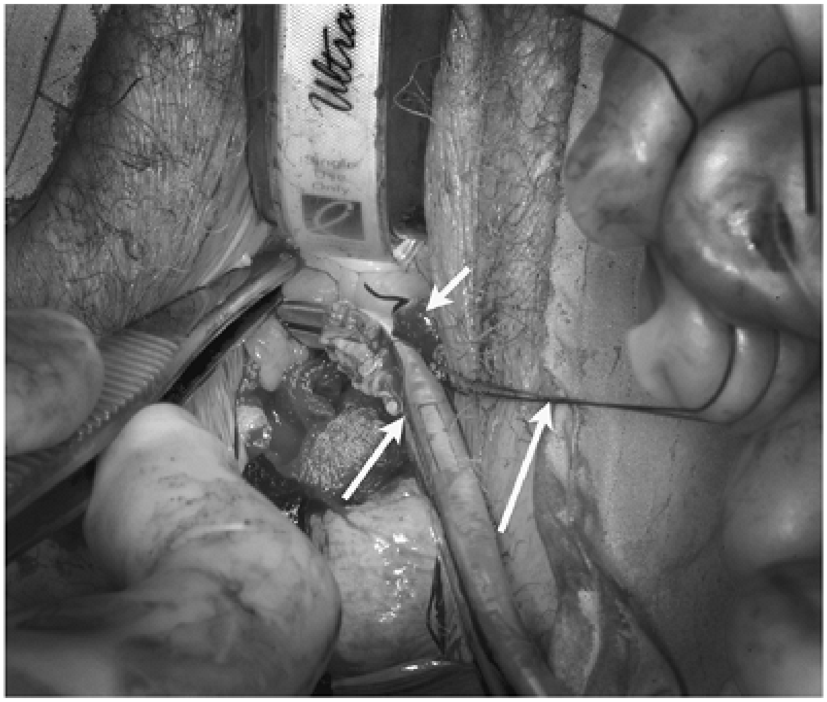

Figure 15-14 Left salpingo-oophorectomy. *Long arrow:* suture has secured the left infundibulopelvic ligament. *Medium arrow:* Sheth clamp across that ligament. *Short arrow:* severed left round ligament. Note: blunt Mayo-Russian forceps being used to verify that bowel, omentum, and pack are not included in the suture.

Salpingectomy Not Possible

A fallopian tube may not be accessible because of adhesions or previous adnexal surgery, such as cystectomy or tubal ligation. In these cases the Sheth clamp can be used to secure the mesovarium. Once the ovary is removed, the remaining portion of tube can be folded over the raw area (74).

Culdotomy

In those cases where the uterus is preserved, incision into the posterior vaginal wall between uterosacral ligaments will give access to the cul-de-sac of Douglas. On rare occasion this approach can be used for adnexal surgery, such as oophorectomy (75). Care must be taken to preserve uterosacral ligaments and to close the vaginal incision meticulously.

Operative Time

â€œOperating time â€¦ did not differ significantly in the bilateral salpingo-oophorectomy and ovarian conservation groupsâ€• Ballard and Walters, 1996 (36).

Once a vaginal surgeon masters a variety of techniques, salpingo-oophorectomy need not significantly extend the operative time of vaginal hysterectomy. Sheth (29) described the following range: 88 cases, less than 10 minutes; 548 cases, 11 to 20 minutes; and 78 cases, 21 to 30 minutes. Average increased operative times are quoted by these authors: Cooper and Riddick (73) and Doucette et al. (76)-â€œnone of significanceâ€•; Kammerer-Doak et al. (25)-11.4 minutes; Ballard and Walters (36) -13 minutes; Capen

et al. (77) and Silva-Filho et al. (78)-20 minutes; Sizzi et al. (30)-21.4 minutes; Davies et al. (22)-23 minutes. This author agrees that, for most operations, adnexectomy can be accomplished in 20 minutes or less.

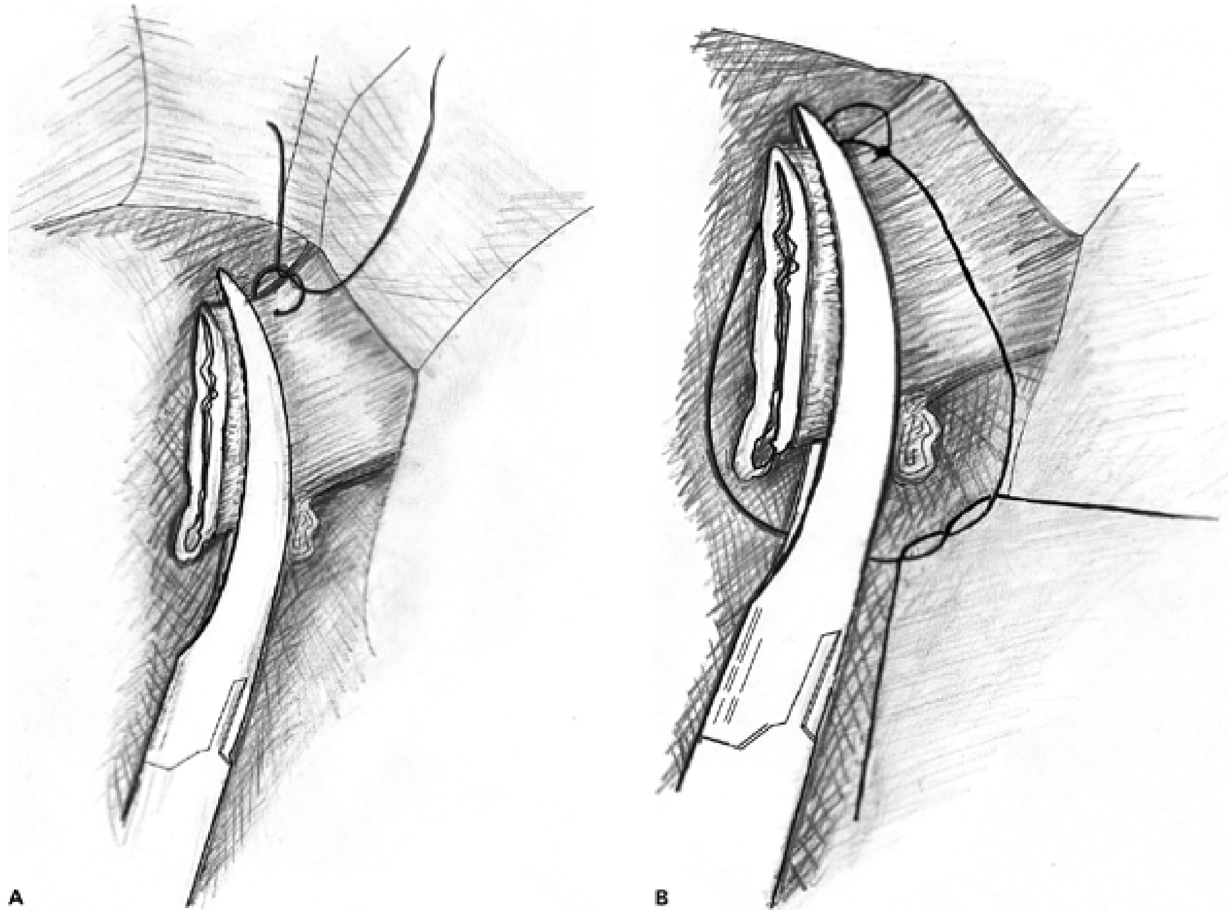

Figure 15-15 A: The ovary and tube are excised, and a transfixion suture of medium thickness is placed. B: After excluding bowel and packing, the tie is completed as the forceps is removed.

Success of Adnexectomy

â€œThe perceived difficulty with vaginal bilateral salpingo-oophorectomy led to this as an indication for LAVH â€¦â€• Meeks and Harris, 1997 (27).

Several authors have evaluated their rates of completion of adnexectomy at vaginal hysterectomy, but none has reported an increase in complications. Sheth (5) performed 702 oophorectomies, a 94% success rate. A similar rate was found by Figueirdo-Netto et al. (23) in 53 nonprolapsed patients. Of the three failures, two required laparotomy (one was transfused), and one needed laparoscopic adnexectomy.

Silva-Filho et al. (78) also studied nonprolapsed patients, and experienced no oophorectomy failures in 30 cases. Sizzi et al. (30) removed 90.6% of adnexa vaginally, even in the presence of pelvic pathology. All six failures were completed laparoscopically. Davies and Magos (79) compared 40 women having vaginal hysterectomy with oophorectomy to 48 who retained their ovaries. The success rate was 97.5% with no laparotomies. Kovac and Cruikshank (26), in reporting a 97% success rate, noted that the severity of the patient's pathology, not the surgeon's preference or experience, should determine vaginal oophorectomy. Kammerer-Doak et al. (25) achieved a 90% adnexectomy rate in 490 vaginal hysterectomies. Varma et al. (80) increased his vaginal hysterectomy rate from 32% to 95% over a 5-year period. In doing so, the oophorectomy rate rose from 0% to 88%. ColaÃ§o et al. (81) found a similar trend. A lesser percentage of adnexectomy at vaginal hysterectomy has been noted by some, for example 60% by Fylstra and Carter (24), 59% by Pratt and Daikoku (28), 57.5% by Reiner (82), 60% to 70% by Capen et al. (77). These results would support the recommendation by Meeks and Harris (27) that oophorectomy can be accomplished in about two thirds of vaginal hysterectomies. Davies and Magos (79) projected a 75%

chance of vaginal hysterectomy-oophorectomy in what he refers to as the â€œhysterectomy lotteryâ€• and directed a patient to a surgeon of appropriate attitude and experience. Added factors such as obesity (4,28) and previous surgery (17) need not deter an attempt at vaginal hysterectomy. Even if vaginal attempt of oophorectomy fails, laparoscopically completed vaginal hysterectomy (LCVH) can be used for adnexal removal before resorting to laparotomy (4,37,83,84,85).

In the author's experience of 1,554 vaginal hysterectomies, 589 patients younger than age 65 requested concomitant oophorectomy. This was successfully accomplished in 94.1%. Documentation of complete adnexal removal is shown in Fig. 15.22. Ninety nulliparas and 125 patients with previous major uterine surgery had success rates of 93.7% and 94.3%, respectively. In patients older than age 64, nationally only 7% of vaginal hysterectomies have accompanying salpingo-oophorectomy (2), compared with 40.2% of 122 of the author's cases. This emphasizes the fact that postmenopausal atrophy of adnexal supporting tissues may hamper vaginal adnexectomy (40).

Complications

â€œFor the endoscopists, LAVH has added benefits if adnexal surgery is planned in conjunction with the hysterectomy, because they believe that trans-vaginal adnexal surgery is often not feasible and that it increases the risk to the patientâ€• Shao and Wong, 2001 (5). These authors, and others, have not observed an increase of complications with vaginal salpingo-oophorectomy. The following is a review of potential complications.

Acute Bleeding

Hemorrhage can happen with breakage of a suture or slippage of a clamp. It is imperative, with the surgeon remaining composed and organized, that this event rarely will require laparotomy. Adequate lighting and exposure, plus suitable adjustment of retractors and packing, are mandatory. Long atraumatic pick-ups will not tear peritoneum, and will provide medial traction on adnexa or infundibulopelvic ligament. Other stout instruments, such as toothed pick-ups, Babcock or Allis clamps, may risk lacerating these

delicate tissues. Another helpful step is to â€œwalk upâ€• the broad ligament with blunt instruments, until the bleeding area comes into view. The upper part of the infundibulopelvic ligament tends to retract intraperitoneally; therefore, one should always pull down and inspect more pedicle than seems necessary. Using a dental mirror will help explore the area. The bleeding point can then be re-clamped and sutured or double-tied. If these steps do not prove satisfactory, the surgeon must determine whether laparoscopy or laparotomy would be prudent. Radiologic embolization is not an option, since it is to be used only before tissues undergo surgical manipulation (86).

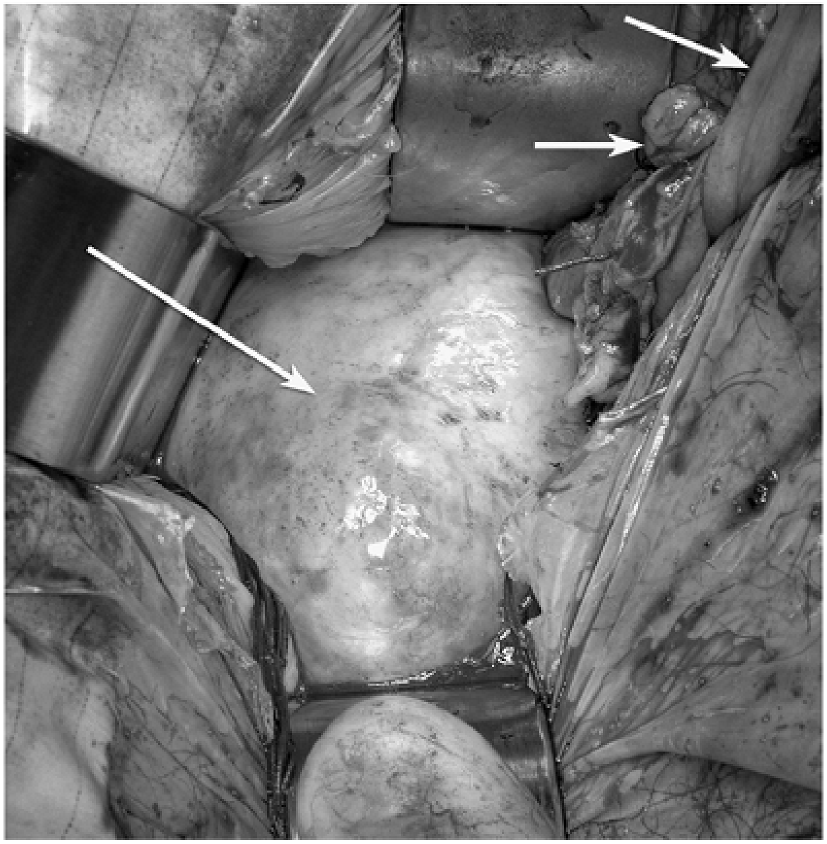

Figure 15-16 *Long arrow:* benign ovarian cyst in the vaginal operative field. *Medium arrow:* cornual attachments to the morcellated (bivalved) uterus are intact. *Short arrow:* upper broad ligament pedicle; other broad and cardinal ligament pedicles are seen.

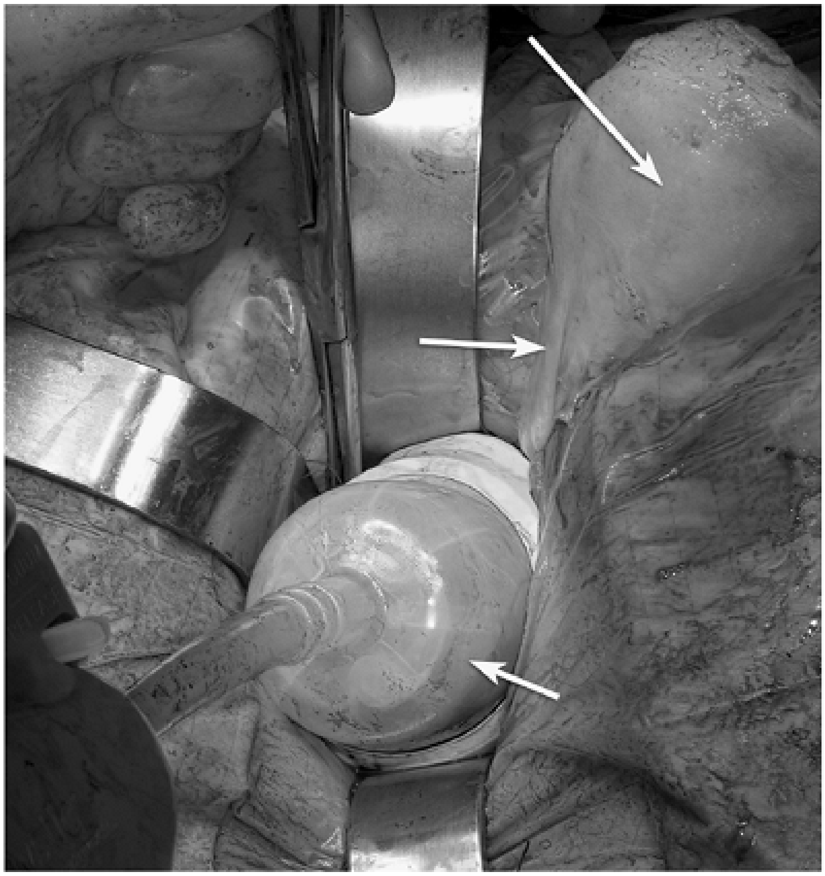

Figure 15-17 *Short arrow:* vacuum extractor applied to begin traction on ovarian cyst. *Long arrow:* bivalved uterus. *Medium arrow:* cornual attachments remain.

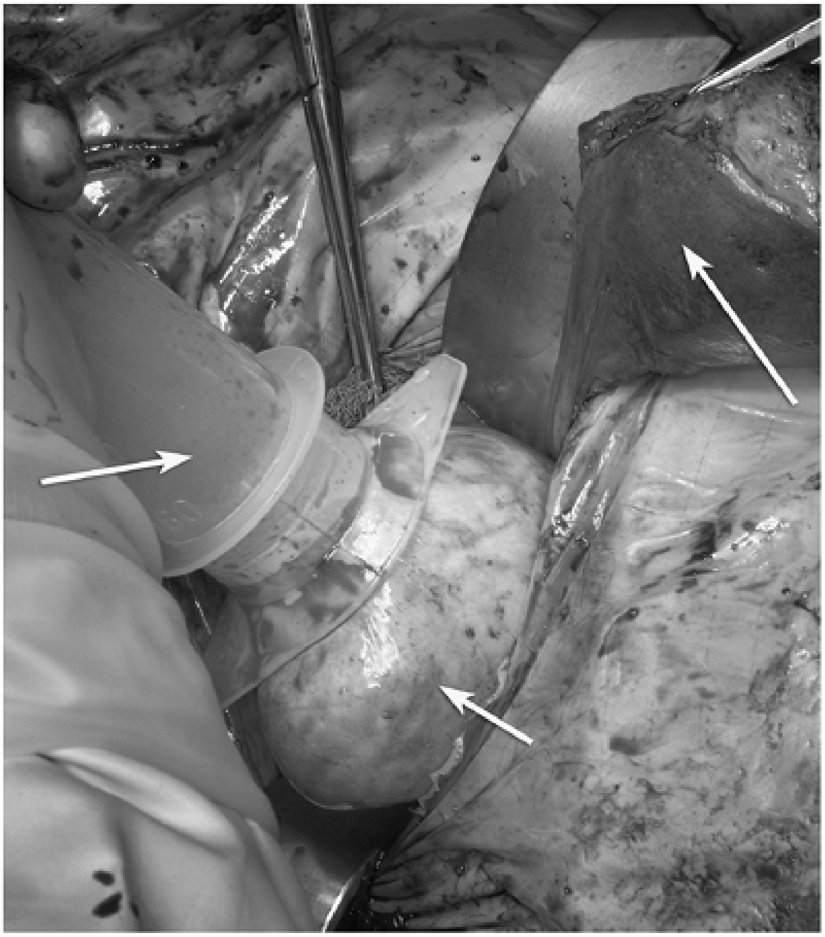

Figure 15-18 *Medium arrow:* suction on reversed asepto syringe begins traction. *Short arrow:* benign ovarian cyst. *Long arrow:* remaining adnexal attachments and morcellated uterus.

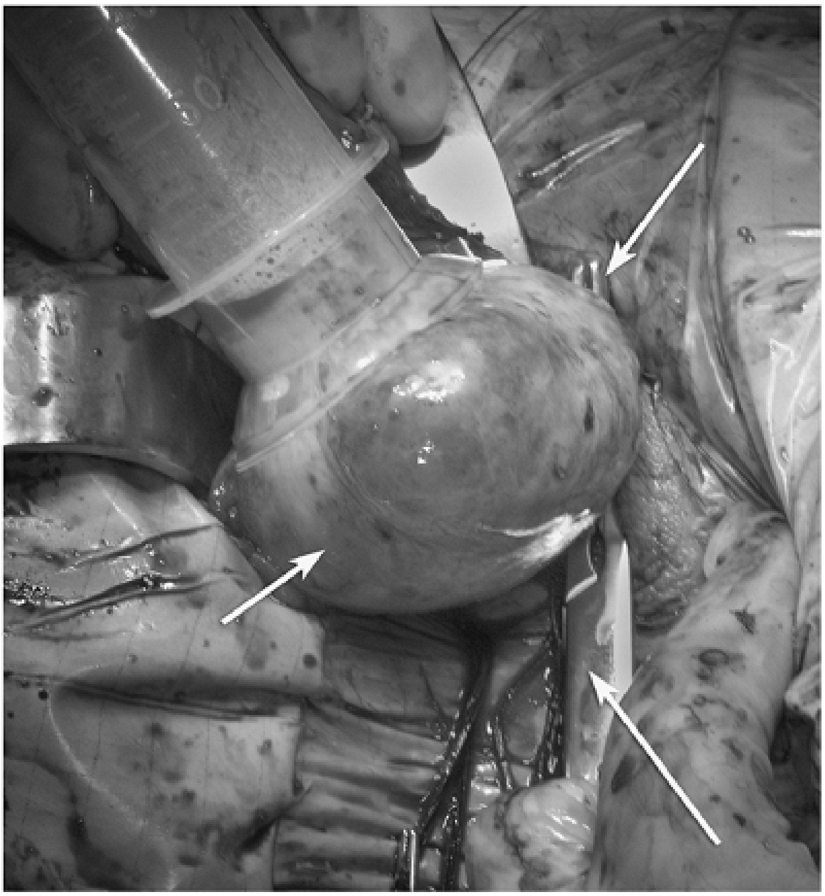

Figure 15-19 *Short arrow:* left ovarian cyst with suction on asepto syringe. *Long arrow:* Sheth clamp has secured left infundibulopelvic ligament safely. *Medium arrow:* tips of the Sheth clamp are demonstrated to be free.

Figure 15-20 *Long arrow:* left ovarian cyst severed from left infundibulopelvic ligament. *Short arrow:* transected ligament is in the Sheth clamp.

Late Bleeding

Clinical recognition of delayed postoperative bleeding will come from a variety of sources: inordinate pain, deterioration of vital signs, falling hemoglobin, presence of a mass, etc. If the surgeon's evaluation dictates intervention, radiologic embolization will succeed in most instances (87,88). Therefore, only in rare cases will a laparotomy be necessary.

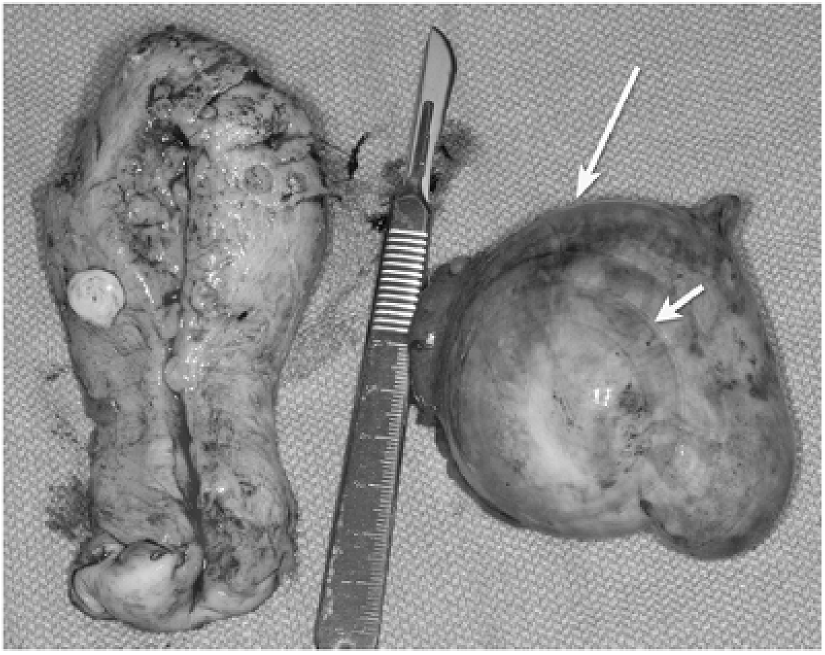

Figure 15-21 Morcellated uterus and scalpel. *Long arrow:* 6.3 cm. benign ovarian cyst. *Short arrow:* suction marks on its surface.

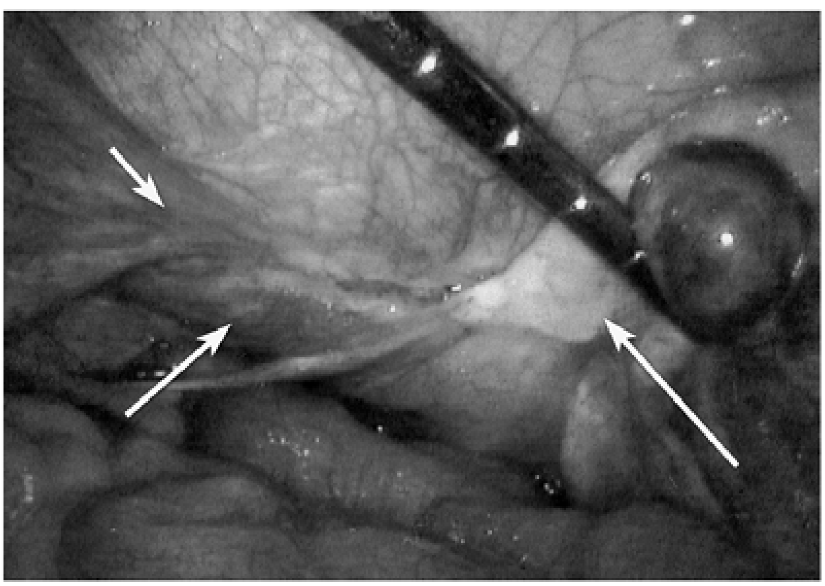

Figure 15-22 Laparoscopy years after left salpingo-oophorectomy at vaginal hysterectomy. *Short arrow:* remnant of round ligament. *Medium arrow:* scar of previous left adnexectomy. *Long arrow:* normal right tube and ovary, with corpus luteum.

Ureteral Injury

Hysterectomy places the ureter at approximately 0.1% to 2.4% risk of injury (89). Risk rate may be even higher, since total ureteral obstruction can be silent and unrecognized (90,91). Adnexectomy at vaginal hysterectomy, however, does not seem to jeopardize the ureter. For example, the following studies of large numbers of vaginal hysterectomy-oophorectomy procedures have no report of ureteral compromise: Kudo et al. (92)-1,899 cases; Coulam and Pratt (17)-872 cases; Sheth (29)-702 cases; Naylor (1)-473 cases; Kammerer-Doak et al. (25)-440 cases; Smale et al. (19)-355 cases; in addition to the author's total series of 791 cases. Recently Chan (93) reviewed anatomy of the ureter and methods of its protection.

Vaginal hysterectomy with oophorectomy is conspicuously absent from reviews of ureteral injury. Wang (94) found no vaginal hysterectomies in studying 23 cases of ureteral injury. HÃ¤rkki-SirÃ©n et al. (95) found only one vaginal hysterectomy in 18 injuries, but no mention was given as to whether oophorectomy was done. Harris (57), in reviewing hysterectomy complications, made no mention of vaginal adnexectomy as a cause of ureteral obstruction. He referred to the vaginal approach as â€œprotective.â€• Abdominal hysterectomy, as opposed to vaginal, was a more common cause of ureteral injury in Symmond's review; vaginal adnexectomy was not stated as a risk factor (91). Stanhope et al. (89) did find one obstructed ureter secondary to securing ovarian vessels. It was amongst 16 ureteral injuries in a review of 2,546 vaginal hysterectomies.

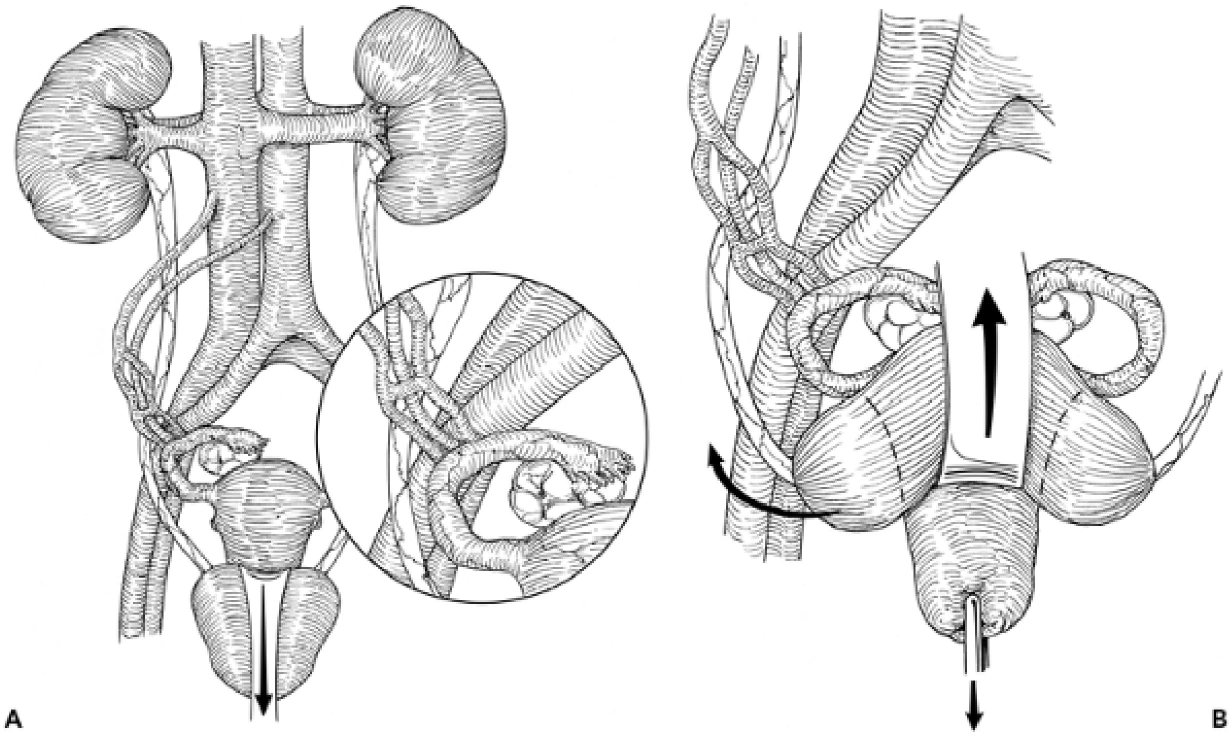

Figure 15-23 Ovarian artery and vein cross over the ureter. Medial and caudal retraction on the tube and ovary pulls the infundibulopelvic ligament away from the ureter for safe ligation. Retraction of the bladder superiorly will also move the ureter away from the ligation site.

Prevention of disability and potential litigation from this injury (96) relate to the following factors:

- Surgeons commonly avoid vaginal hysterectomy in the presence of known adnexal pathology. Patients with problems such as significant endometriosis will commonly be scheduled for abdominal or laparoscopically assisted vaginal hysterectomy (59).
- Medial and downward (caudal) traction on the tube and ovary pulls them away from the ureter as it courses toward the cardinal ligament (97). The gap between adnexa and ureter is thought to be about 1 to 2 cm (77,89) (Fig.

15.23). A clamp can be placed safely in this area.

- Upward elevation of the bladder will lift the ureters away from the adnexa (77,98). Retraction by a competent and well-trained assistant is a prerequisite to help maximize the distance between ureter and adnexa.
- Releasing the round ligament will increase mobility of the adnexa. This important step has been emphasized by many authors (7,31,33,35,36,37,39,40) as an additional measure to separate ureter from adnexa. Measurements by Sheth (33) indicate that the ligament should be transected at least 4 cm away from the uterine margin.
- Clamps specifically designed for salpingo-oophorectomy are available (31,34). The width of their jaws (3-5 mm.) is within the safety of the ureteral-adnexal space.

It is paradoxical that several authors have designed and emphasized techniques for ureteral protection at abdominal and laparoscopically assisted vaginal hysterectomy, when this complication is almost nonexistent at vaginal oophorectomy. The American College of Obstetricians and Gynecologists (99) cautions that the infundibulopelvic ligament is in a high risk location in laparoscopically assisted vaginal hysterectomy, but does not mention vaginal oophorectomy as a risk to the ureter Hasson and Parker (100), Paulson (101), and Parker (102) illustrated methods of ureteral protection at laparoscopy, the latter stating ureteral injury may be as high as 3%. As many as 50% of the reported injuries at laparoscopic procedures have occurred at the infundibulopelvic ligament, especially with use of cautery and staples (103).

Miscellaneous Complications

Other complications are possible, but seemingly uncommon. Infection can occur after hysterectomy, but there are no reports of increased rate of infection with vaginal salpingo-oophorectomy (25,28,37,104). In the author's experience, 1,128 women had vaginal hysterectomy without vaginal repair; 2.4% of 602 cases of vaginal hysterectomy-adnexectomy had a postoperative vaginal vault infection. Nonadnexectomy had a lower rate (1.3% of 526 cases), indicating a possible slight increased risk. Remnant ovary syndrome, due to incomplete ovarian removal, has been reported rarely after vaginal hysterectomy (105). Magtibay et al. (106) reported 180 cases of ovarian remnant syndrome; 14 (8%) followed vaginal hysterectomy. No instance of ovarian remnant was found in any of the author's

791 oophorectomy cases. Nevertheless, careful surgical steps must be used to ensure complete removal of the adnexa. This is especially important if endometriosis is encountered, since it is a risk factor in more than 50% of cases of this syndrome (107). One case of delayed small bowel obstruction has been reported after vaginal salpingo-oophorectomy using an endoscopic stapler (108). Manipulation of pelvic veins during adnexectomy could increase the possibility of postoperative venous thrombosis. However, a recent review of pulmonary embolism did not mention salpingo-oophorectomy as a risk factor (109,110). One case of nonfatal pulmonary embolus occurred in the author's 1,128 vaginal hysterectomy patients without repair; it was in the adnexectomy group.

Summary

â€œSurgeons who select potentially more morbid and costly approaches to hysterectomy (abdominal and laparoscopic) solely on the basis of a need to remove the ovaries without any other contraindications to the vaginal approach may need to rethink their surgical decision-making processâ€• Kovac and Cruikshank, 1996 (26).

Vaginal salpingo-oophorectomy can be combined with vaginal hysterectomy. Historical review shows infrequent references until the last 30 years, when reports of the procedure became more commonplace. Preoperative decision for oophorectomy involves discussion with the patient and objective evaluation of clinical evidence. The gynecologic surgeon is obliged to study a variety of appropriate surgical instruments and techniques, and must be flexible in the surgical approach. The following considerations should not deter an attempt at vaginal adnexectomy:

- Nulliparity, uterine enlargement, pelvic surgery, obesity, or pelvic adhesions.
- Presence of benign ovarian cysts.
- Fear of complication such as ureteral damage, bleeding, or incomplete removal.

Based on the experience of this author and other gynecologic surgeons, successful salpingo-oophorectomy is feasible in up to 90% of vaginal hysterectomies. If the vaginal attempt fails, one can promptly convert to adnexal removal by laparoscopy or laparotomy. This should not be considered a complication, in the properly informed patient.

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16

Repair of the Anterior Segment

S. Robert Kovac

Joseph T.F. Stubbs

> the reason for failure seems to be that the normal support of the bladder has not been sought and restored, but instead an irrational removal of part of the anterior vaginal wall has been resorted to, which could result only in disappointment and failure
>
> --George White 1909

For more than a 100 years there has been tremendous controversy regarding the anatomic cause of a cystocele and the best way to repair it. A cystocele is a hernia that results from a fascial disruption of the anterior vaginal wall. It may be either anterior or posterior depending on the relation to the interureteric ridge, and may exist individually or together. Previous editions of *Nichols' Vaginal Surgery* described a displacement cystocele as a result of lateral defects of the pubocervical fascia, and a distension cystocele as a result of central defects of the pubocervical fascia. Many do not support this classification for a variety of reasons. For years, gynecologists considered a cystocele that occurs following overdistension, stretching, or attenuation of the vaginal wall and underlying fascia during childbirth to be primarily of the distension type. Traditional repair of such defects involved midline plication of the â€œattenuated fasciaâ€• and removal of the excess overlying vaginal epithelium. The concept that a cystocele results from a stretching or thinning of the pubocervical fascia is, in fact, unproven. In 1948, Goff demonstrated that the pubocervical fascia was actually thicker in individuals with cystoceles than in normal individuals (1). However many believe the theory of fascial attenuation is inherently wrong and that nonanatomic, non-site-specific repairs, such as midline placation, are unreliable and unpredictable. The proper repair for the anterior segment must involve reconnecting the endopelvic fascia or, more specifically, the pubocervical fascia, to its original attachment sites: the pericervical ring proximally and the arcus tendineus fascia pelvis (ATFP) laterally.

In 1909 George White of Savannah, Georgia proposed that the anterior vaginal wall supports the bladder, and a cystocele occurred when the vagina broke loose from the white line or ATFP, which traversed laterally between the ischial spines and pubic bone (2). To remedy this condition, White believed it was necessary to restore the attachment between the lateral sulci of the vagina and the white line of the pelvic floor. Unfortunately White's report occurred during a period when gynecologists were discovering the abdominal approach for most of their operations. In addition, many â€œexpertsâ€• considered White's dissection to be too far lateral. The vesciovaginal space, which must be entered and extended laterally to the white line, was not believed to extend to the white line, and many of White's detractors thought his surgical technique would lead to uncontrollable hemorrhage. Very few surgeons chose to adopt White's ideas, and techniques for the repair of the anterior segment remained as numerous as those who performed them.

One such repair included the quick and easy method of excising an elliptical island of anterior vaginal wall and bringing the cut epithelial edges back together in the midline (Fig. 16.1). The fascial defects underneath the mucosa were ignored and forgotten. Others advocated dissecting the bladder from the anterior vaginal wall and suturing the base of the bladder to the anterior wall of the uterus. Some gynecologists were taught to dissect superficially just under the vaginal epithelium, thereby â€œleaving the fascia on the bladder not on the vagina.â€• With this splitting of the vaginal mucosa the avascular vesciovaginal space was never entered. Instead, the surgeon separated the underlying fibromuscular subepithelial layer of the anterior vaginal wall from the overlying mucosa, thereby artificially

creating a nonanatomic space that was invariably associated with bleeding. The subepithelium was then plicated and the pubocervical defects were covered up but not corrected (Fig. 16.2).

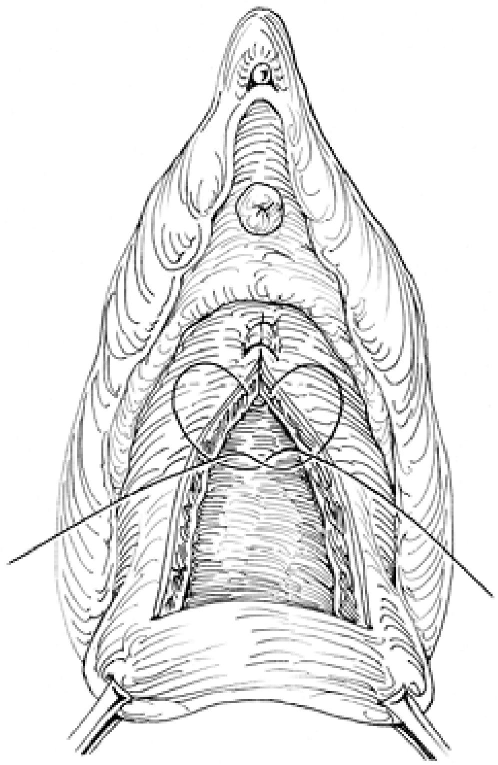

Figure 16.1 Excision of elliptical wedge of vagina and suturing the edges of epithelium back to the midline.

Probably the most common technique taught, and often used today, is anterior repair or colporrhaphy. It was first described by Kelly in 1913 and involved dissection under the full thickness of the vaginal epithelium followed by plication or bunching together of the pubocervical fascia over the bulging bladder, with excision of the overlying â€œexcessâ€• vaginal wall (Fig. 16.3). It was easy to perform and was rapidly adopted by most training centers. Kelly's influence was considerable and his anatomically distorting midline plications became the standard of care. All defects were considered midline attenuations, not midline defects.

Because urinary incontinence was frequently noted with cystocele, Kelly developed a technique intended to treat incontinence during repair of the cystourethrocele. The â€œKelly stitchâ€• was thought to correct the funneling of the urethra at the bladder neck by repairing what was presumed to be a separation of the internal urethral sphincter (Fig. 16.4). For years, funneling of the urethra was believed to reflect damage to the supports of the bladder, urethra, or both, and contributed to a functioning break in the bladder baseplate of Uhlenhuth and Hutch. Confusion existed between the importance of the posterior urethrovesical angle, the significance of the posterior inclination of the urethra, and the anatomic defect causing urethral funneling that was believed to shorten the effective urethral length, thereby favoring hydrostatic transmission of bladder pressure to urine inside the funnel. Over time these concepts of potential causes for incontinence were found to be incorrect.

Milley and Nichols believed that support of the urethra was to the pubic bone by bilaterally symmetrical anterior, posterior, and intermediate pubourethral ligaments (3). Therefore, a defect or injury resulted in loosening or lengthening the pubourethral ligaments and contributed to the occurrence or persistence of urinary incontinence. They thought that the vaginal ends of the pubourethral ligaments could be identified vaginally and repaired beneath the urethrovesical junction, and then continence restored (Fig. 16.5). After many cadaveric dissections, Julian postulated that the tissue Milley and Nichols brought beneath the urethra was, in fact, fascia from the obturator internus (personal communication).

Despite an unacceptably high rate of failure, Kelly's midline plication continues to be taught and performed today. The majority of these nonanatomic techniques are associated with significant risks of recurrence, vaginal compromise, and voiding dysfunction. No defect is ever sought or repaired, and, until recently, the permanent cure for the anterior segment remained a surgical dilemma.

In the latter half of the twentieth century, anatomists such as Richardson, Baden, Walker, DeLancey, and Gosling returned to the cadaver laboratory, and, through their insightful dissections, provided a clearer understanding of pelvic anatomy. They placed a strong emphasis on the importance of proper restoration of the normal anatomy in the surgical correction of pelvic support defects. In 1976, A. Cullen Richardson et al. of Atlanta, Georgia caused a paradigm shift in ideas regarding the anterior segment and the pubocervical fascia. Richardson did not subscribe to the theory of fascial attenuation. For any structure, such as the bladder, to be pushed out, Richardson theorized that there must be a break in the continuity of support within the endopelvic fascia (4). He divided the breaks or defects of the anterior segment into four types: paravaginal, transverse, distal, and midline or central (Fig. 16.6). Therefore, if a defect is present, there must be a break in the underlying fibroelastic connective tissue sheath of the vagina (4). These visceral sheaths are not parietal fascia, but lie beneath the parietal peritoneum and are made up of fused sheets of collagen, elastin, and smooth muscle. These sheets envelop the visceral structures for support of the anatomic structures, as well as the organs serviced. Richardson firmly believed that the only way to properly repair these hernias was to identify each break individually and repair each site specifically. With Richardson as the guide, correction of the anterior segment finally began to fulfill the first goal of reconstructive surgery: to restore normal anatomy.

Paravaginal Defect

The paravaginal defect is one of the more common defects of the anterior segment and the one with which gynecologists are most familiar. The overall prevalence of paravaginal defects with anterior vaginal wall prolapse was reported

by Youngblood to be between 75% and 80%; DeLancey reported an incidence of 87%, whereas Richardson reported an incidence of 67% (5,6,7). Barber et al. and Segal et al. found an overall incidence of paravaginal defects to be 42%, and Karram et al. reported an overall incidence of 37.7% (8,9). The authors' experience is about 25%, which is less than that in all five reports.

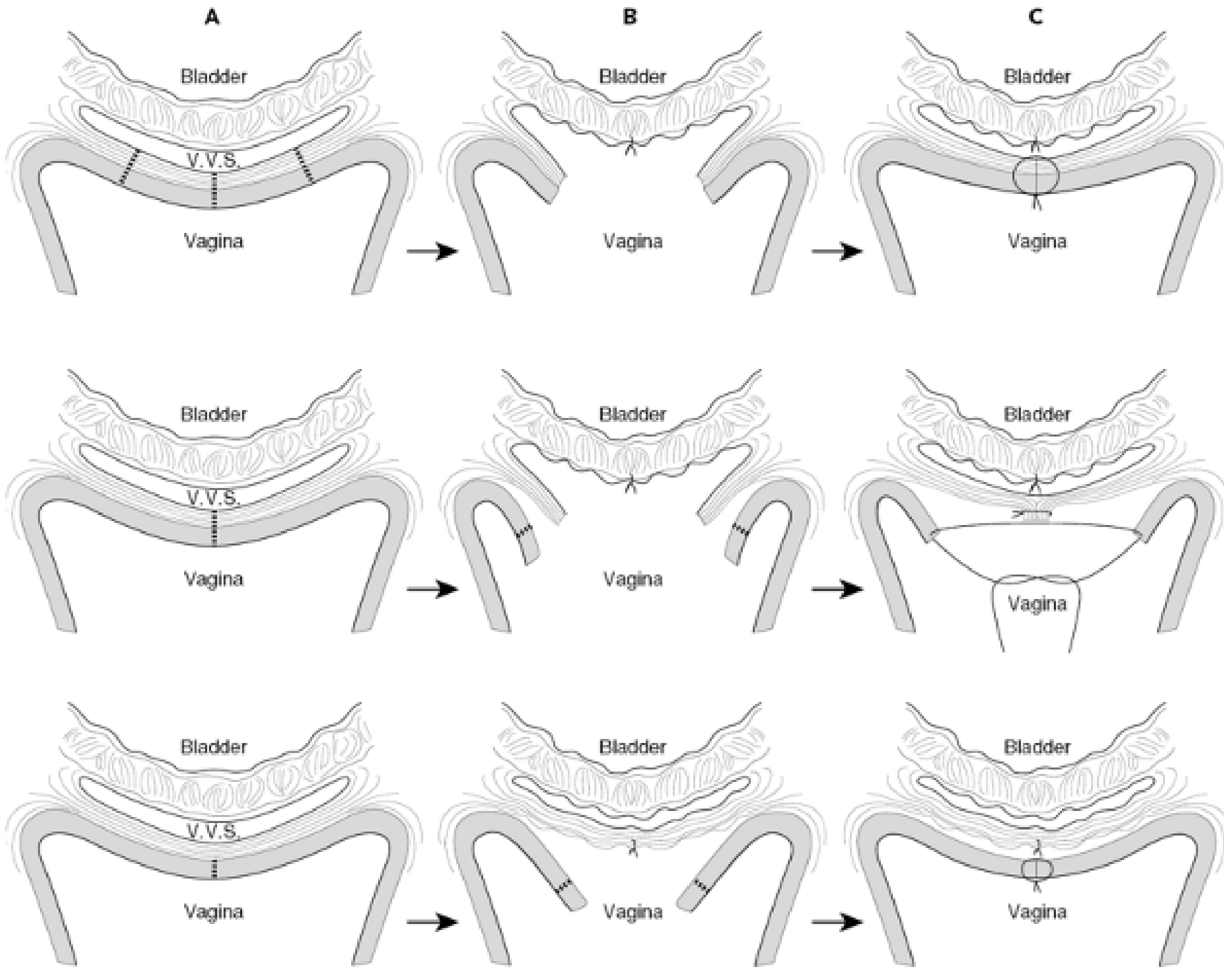

Figure 16.2 Three methods for performing anterior colporrhaphy are contrasted. In the top row (A) an incision into the vesicovaginal space is shown. The dotted lines lateral to the midline incision of the stretched vaginal wall is excised. In (B) the fibromuscular bladder capsule is plicated with sutures reducing the width of the vesicovaginal space. In (C) the vaginal wall is approximated with sutures.

In the middle row (A) the midline incision is made through the full thickness of the anterior vaginal wall into the vesicovaginal space. In (B) the bladder capsule has been plicated reducing the width of the vesicovaginal space. The fibromuscular layer of the vaginal wall is dissected from the under surface of the vaginal skin. In (C) the outer layers of the vagina are approximated with sutures.

The bottom row (A) demonstrates a frequent but most ineffective repair in which the vesicovaginal space is never entered. In (B) the underlying fibromuscular layer of the anterior wall is dissected from the under side of the vagina and then plicated. Excess vaginal skin is trimmed as indicated and the vagina closed with sutures (C)

The paravaginal defect occurs when the lateral attachment of the pubocervical fascia separates from its attachment to the fascial coverings of the obturator internus and the levator muscles: the ATFP. This defect permits a connection between the vesicovaginal space and the retropubic space (space of Retzius). The separation can be unilateral, mostly on the right, or bilateral. If there is total separation, then a cystourethrocele with hypermobility of the urethra can result.

Pelvic support defects are thought to occur, or are at least exacerbated, during the process of childbirth. The passage of the infant through the birth canal exerts such tremendous force and traction along the walls of pelvis that the endopelvic fascia is avulsed from its proximal attachment points. Zimmerman employs a trampoline analogy to illustrate the platform of the anterior segment on which the bladder rests (Fig. 16.7A, B) (personal communication). A

paravaginal defect would be represented by the unhooking of the springs from their insertion into the frame, thereby allowing the fabric of the trampoline to retract medially. This is a very important concept, because some gynecologists think that in order to properly repair a paravaginal defect, it must be approached abdominally, open, or laparoscopically; this is illogical. If the pubocervical fascia retracts medially, it comes to rest on the underside of the bladder (posterior to the bladder), which would make it out of the line of vision during an abdominal approach (Fig. 16.8). The only way to visualize this edge of detached pubocervical fascia would be through the vaginal approach. Although a paravaginal defect can be identified abdominally, it is not always easy to identify the detached edge of the pubocervical fascia because it may be retracted so medially that it cannot be visualized as it lies beneath the bladder. Therefore the best way to identify the retracted fascia is through the vagina.

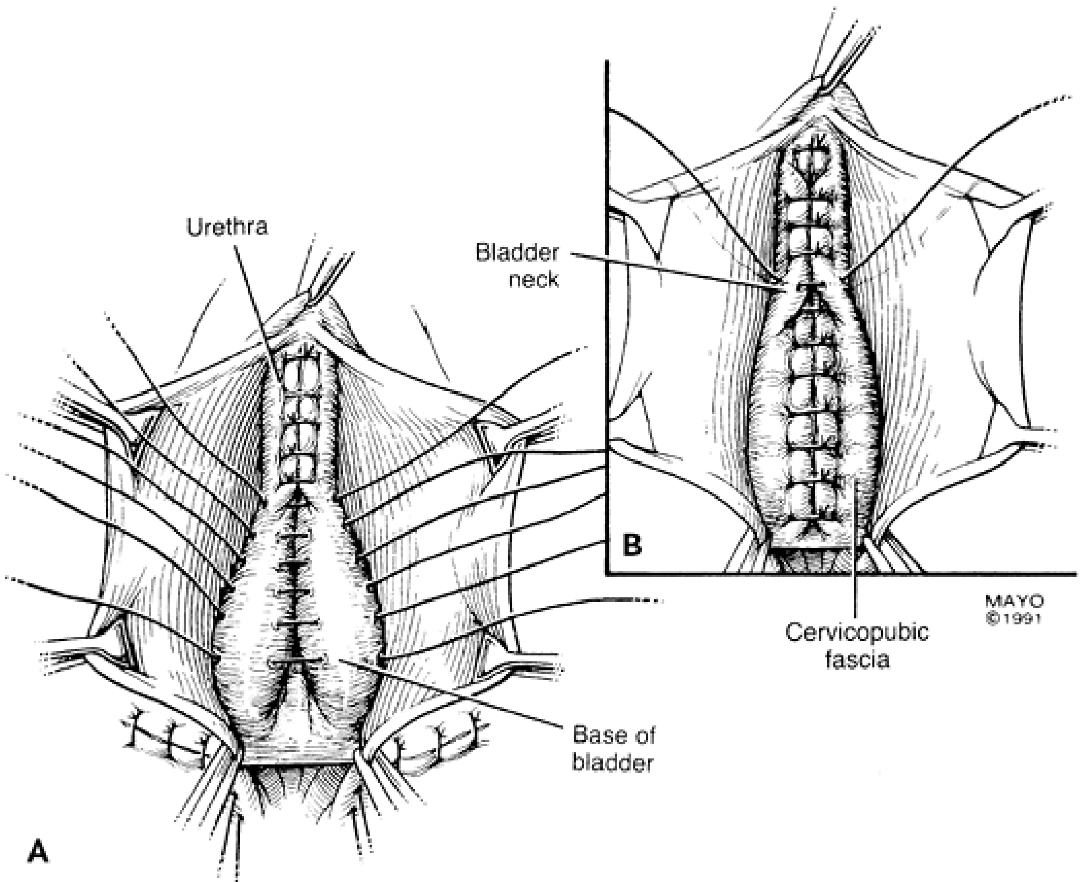

Figure 16.3 Midline plication or bunching together of pubocervical fascia over the bulging bladder followed by excision of overlying vaginal epithelium. (From Lee RA. *Atlas of Gynecologic Surgery. Philadelphia:* WB Saunders, 1992.
)

Success of the abdominal paravaginal repair is similar to White's experience. In White's dissection, he opened the lateral sulci, but he did not totally separate the bladder from the overlying vagina, thus never fully developing the vesicovaginal space or identifying the detached edge of the pubocervical fascia. However, he found that by restoring the attachment between the lateral sulci of the vagina and the white line of the pelvic floor, the prolapsing anterior segment would be corrected. Both White's technique and the abdominal paravaginal repair provide a closer, but not complete, reapproximation of the pubocervical fascia to its original attachment sites. Only the vaginal approach affords the surgeon the opportunity to accurately evaluate the anterior segment and identify the retracted pubocervical fascia, thereby resulting in an anatomic repair that is reproducible and successful in the long term.

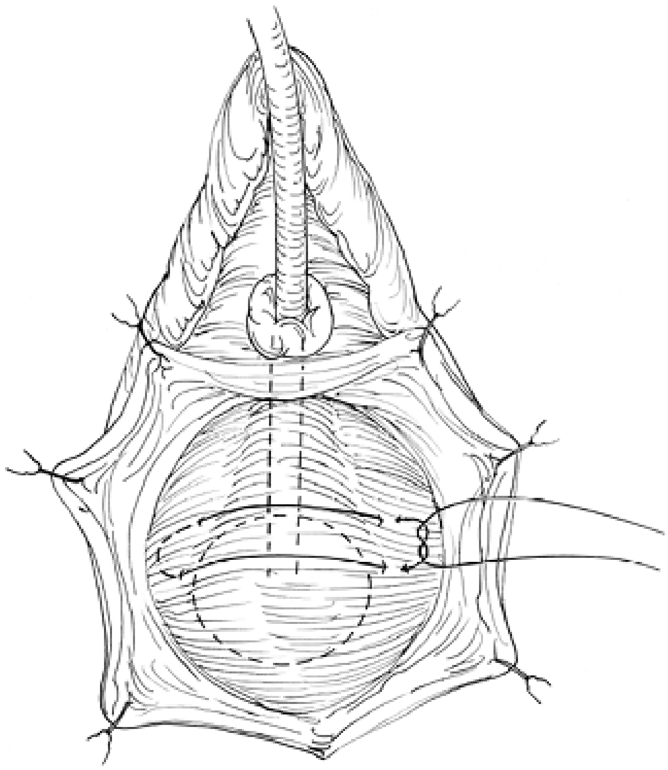

Figure 16.4 Kelly stitch.

Transverse Defect

A transverse defect occurs when the pubocervical fascia separates from the pericervical ring of fibromuscular tissue at the level of the ischial spine (Fig. 16.9A-C). This

is considered by many to be the most common cause of a cystocele. This defect may occur in conjunction with a paravaginal defect, which is frequently the case with total prolapse, or may occur alone. When this defect occurs alone, it can result in a very large cystocele. To identify which defect exists once the vesicovaginal space has been exposed, the surgeon should determine if the patient has a paravaginal defect or a transverse defect (Fig. 16.10). These are the only real causes of cystoceles. The authors have never seen a midline defect caused by a separation of the fascia in the midline with the bulging of the bladder beyond the edges of any separation of pubocervical fascia in the midline. If a paravaginal defect cannot be found, the most likely cause of the bulging cystocele is a separation of the pubocervical fascia from the pericervical ring (Fig. 16.9A-C). Scarring at the proximal edge of the bladder can frequently be seen pulling the bladder downward and outward (Fig. 16.11A). Excision of the scar exposes the lower edge of the trapezoidal-shaped pubocervical fascia, and the prolapsed bladder can be seen protruding beneath the edge of the fascia as it prolapses like a trap door sprung open (Fig. 16.11B,C). This edge needs to be reattached to the pericervical ring with interrupted 2-0 Ethibond suture (Fig. 16.12). The bladder cannot descend if the edge of the fascia is reconnected to the pericervical ring proximally and to the prespinous fascia anterior to the ischial spine, even if a paravaginal defect is present (Fig. 16.13A,B). It is the experience of both authors that repair of a transverse defect is simple to perform, it restores the normal anatomy, and it is a very durable repair with few, if any, recurrences. Because of its anatomic location posterior to the bladder, this defect is difficult, if not impossible, to identify abdominally (Fig. 16.8). Thus, it may be the cause of a recurrent cystocele if unrecognized and unaddressed during an abdominal approach. Some surgeons think that a persistent bulging of the bladder in the operating room, following a paravaginal repair, represents a midline attenuation of the fascia (distention cystocele) (Fig. 16.14A,B). This type of repair requires that the surgeon believe both that the defect is caused by a cystocele (i.e., paravaginal defect) and the attenuation of pubocervical fascia. This does not seem logical. In the experience of the authors of this chapter this persistent bulge is the result of an unrecognized transverse defect (Fig. 16.14C). Repair of the transverse defect to the pericervical ring and the lateral edge of the fascia to the fascial attachments at the ischial spine will properly restore the anatomic defect that causes most

cystoceles. Midline plications are useless; they repair nothing and are anatomically incorrect. The transverse defect is discovered in more than 85% of all anterior vaginal wall prolapses, but it is frequently not appreciated preoperatively or intraoperatively.

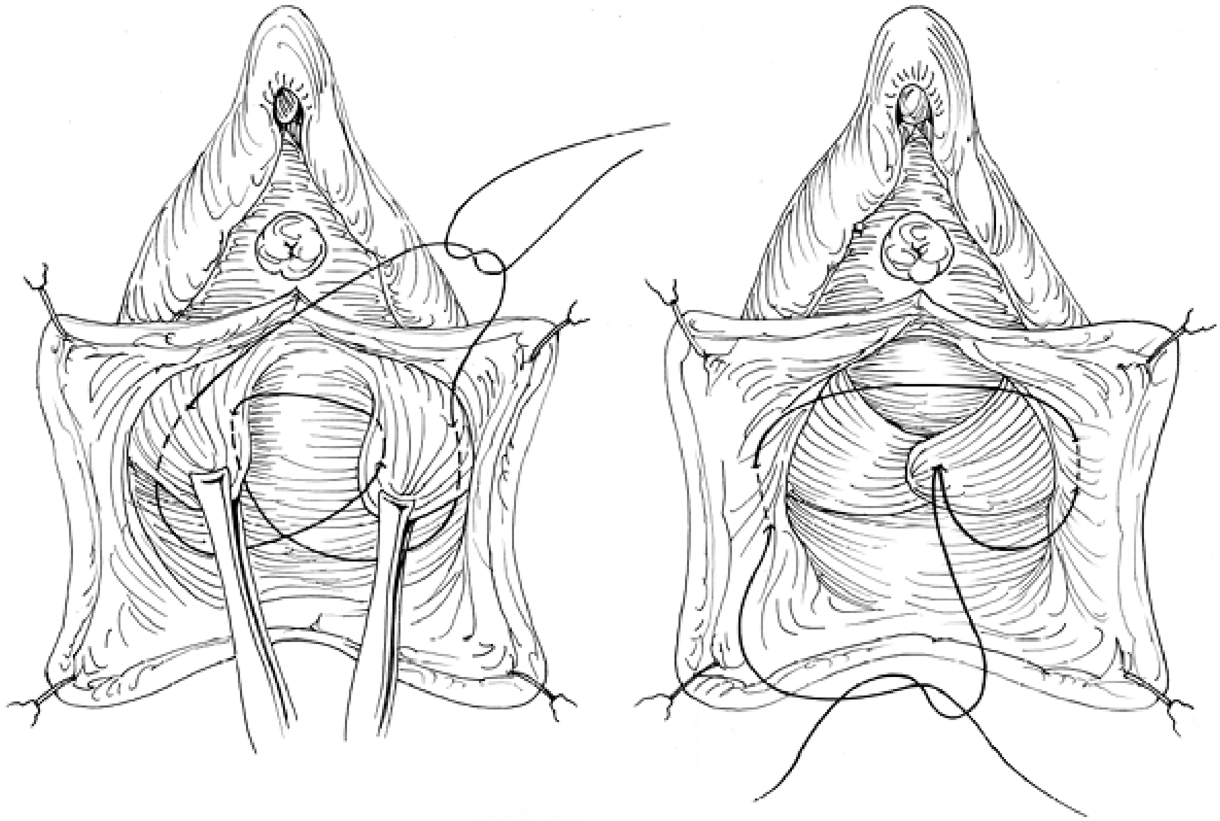

Figure 16.5 Pubocervical ligament placation of Milley and Nichols.

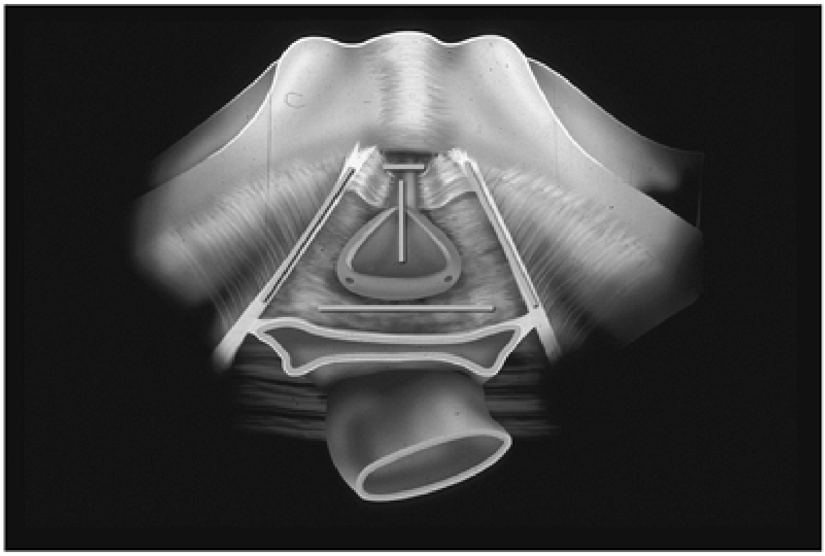

Figure 16.6 Four defects in the connective tissue supports of the anterior quadrant of the pelvis. (Modified from
Richardson AC, Lyon JB, Williams NL. *Am J Obstet Gynecol.* 1976;126:568â€“573.

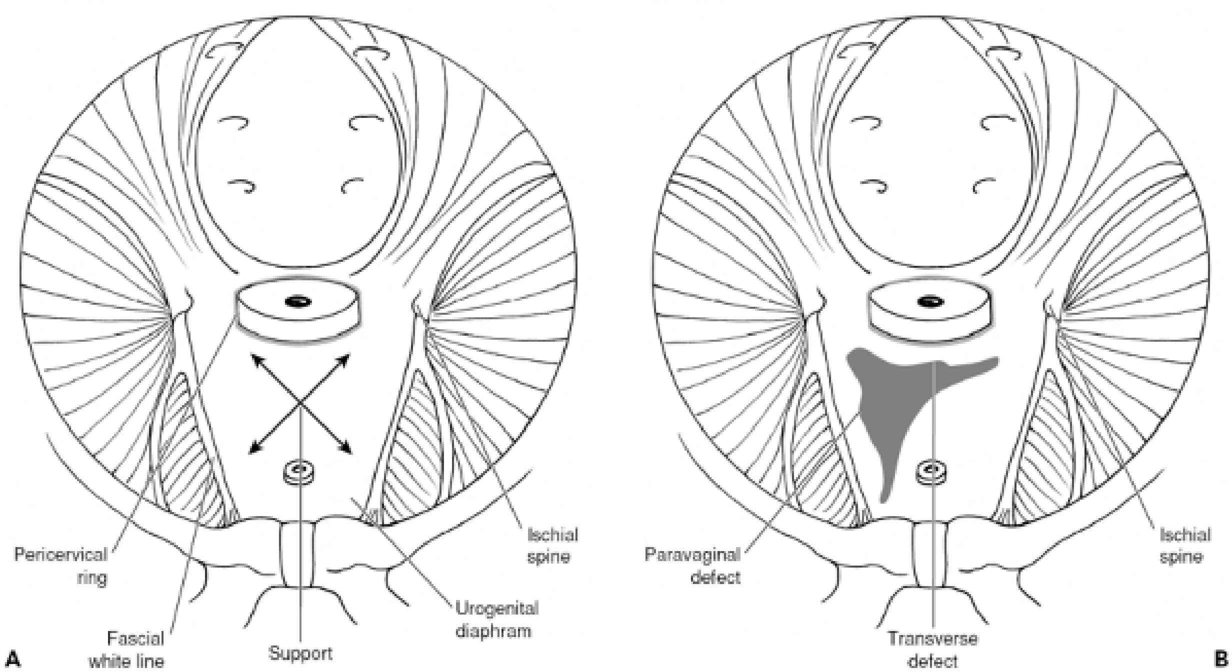

Figure 16.7 A: Trampoline effect of midvaginal lateral support of level 2 biomechanical function. B: Transverse and paravaginal defects converts the trampoline into a trap door through which the bladder is pushed out as a cystocele.

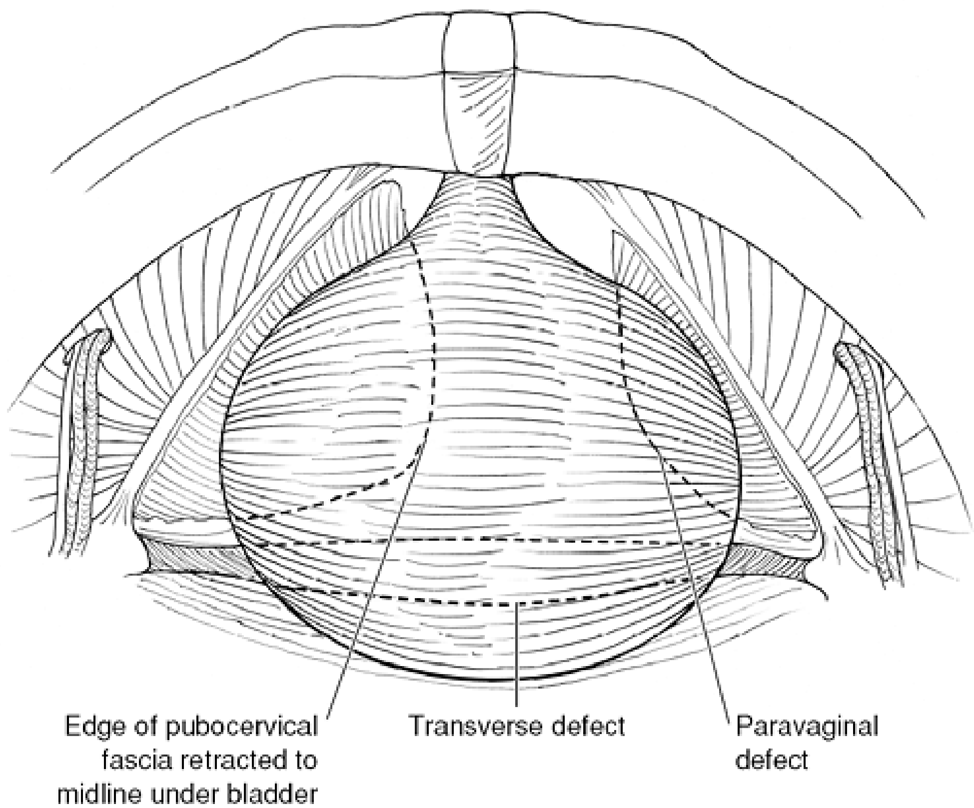

Figure 16.8 Paravaginal and transverse defects as viewed from the abdominal approach. A detached edge of pubocervical fascia is demonstrated reaching almost to the midline, which would make it difficult to identify for reconnection to the ATFP unless the dissection is performed beneath the bladder.

Distal Defect

The distal defect is a result of the distal urethra being detached or separated from the overlying symphysis and often produces distressing incontinence. As with the other

anterior segment defects, it is best identified and repaired by the vaginal approach.

Central Defect

Central defects are any breaks in the central portion of the pubocervical fascia between its lateral, dorsal, and ventral attachments. They usually accompany visible scars in the underlying vaginal epithelium suggesting obstetric lacerations. Using Zimmerman's trampoline analogy, a central defect would represent a tear in the fabric of the trampoline with all other support remaining. Julian found that by using cystoscopy, central defects could be readily identified. With cystoscopic transillumination, Julian noted variations in the thickness of the posterior bladder wall, and believed this finding would help differentiate between paravaginal and central defects. (Society of Pelvic Reconstruction Meeting, 1994) This defect can easily be identified and repaired by the vaginal approach.

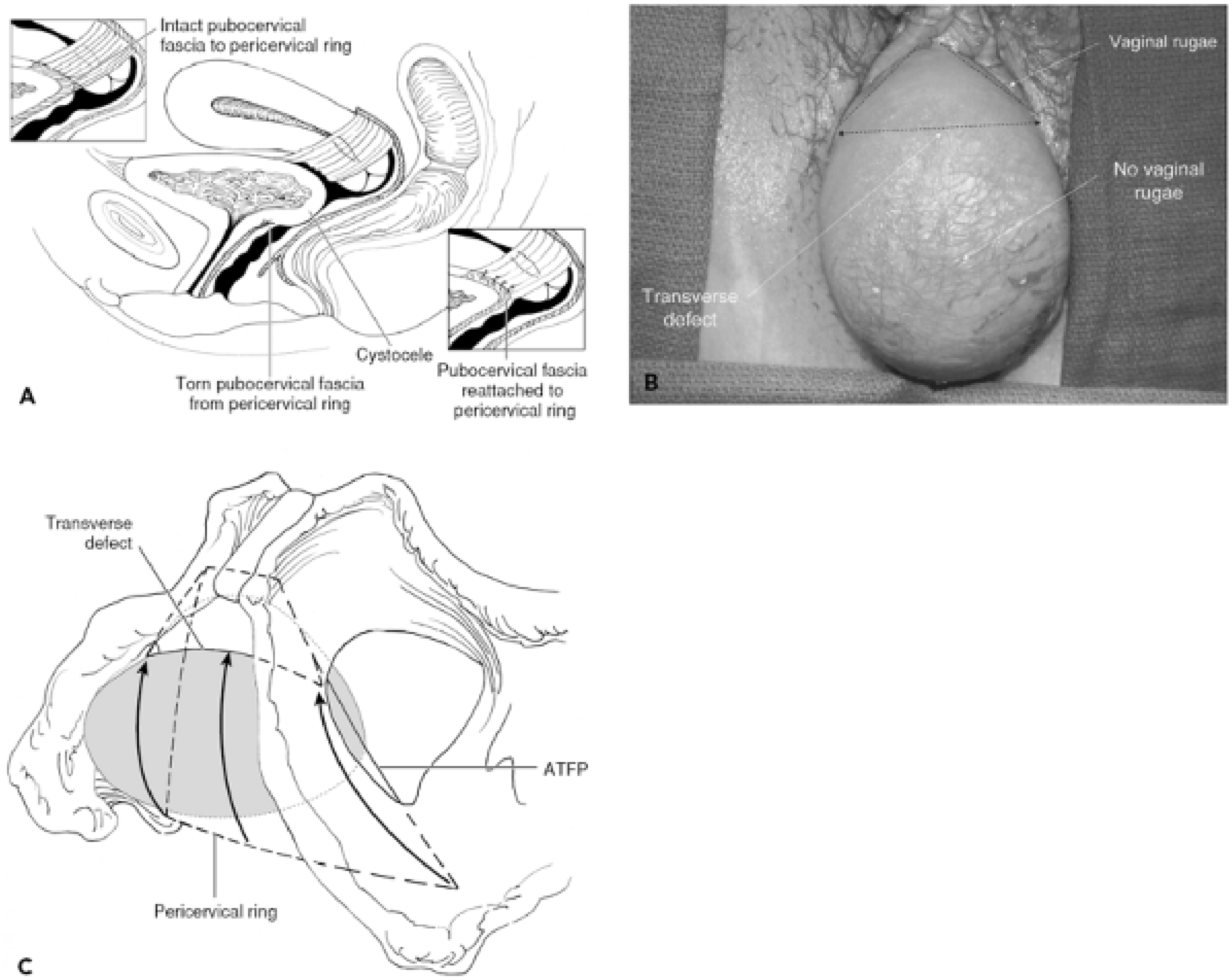

Figure 16.9 A: Lateral view of transverse defect. Insert A-1 shows intact connection of pubocervical fascia to pericervical ring. Insert A-2 shows repaired transverse defect. B: Surgical view of transverse defect with large cystocele. Triangular area with underlying fascia is shown with the presence of vaginal rugae. Large protruding cystocele is without rugae. C: Repair of transverse defect involves reconnecting the edge of pubocervical fascia to the pericervical ring and to the prespinous fascia anterior to the ischial spine.

Midline Defect

Rarely, if ever, is there a midline central linear defect as demonstrated graphically by Richardson. Midline defects, as described by Richardson et al., could be better described as fascial separations (4). For a true midline defect to exist, the bladder must advance beyond the edges of the fascial break. The only midline linear separations of the pubocervical fascia encountered by the authors were iatrogenic and occurred during the initial undermining of the vaginal epithelium, in which the dissection went too deep into the pubocervical fascia. These â€œpseudodefectsâ€• do not have the bulging bladder protruding distal to the edges of the fascia, but instead represent fascial â€œwindows,â€• with the bladder remaining proximal to the freshly cut fascial edges.

Proper repair of the pelvic support defects requires the surgeon to: (i) know the surgical anatomy, (ii) apply the knowledge of surgical anatomy, (iii) identify all the defectsâ€”whether they are symptomatic or not; and (iv) repair all these defects individually in a site-specific manner.

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There is no place in pelvic reconstructive surgery for any procedure that does not restore normal anatomy and allow for proper form and function.

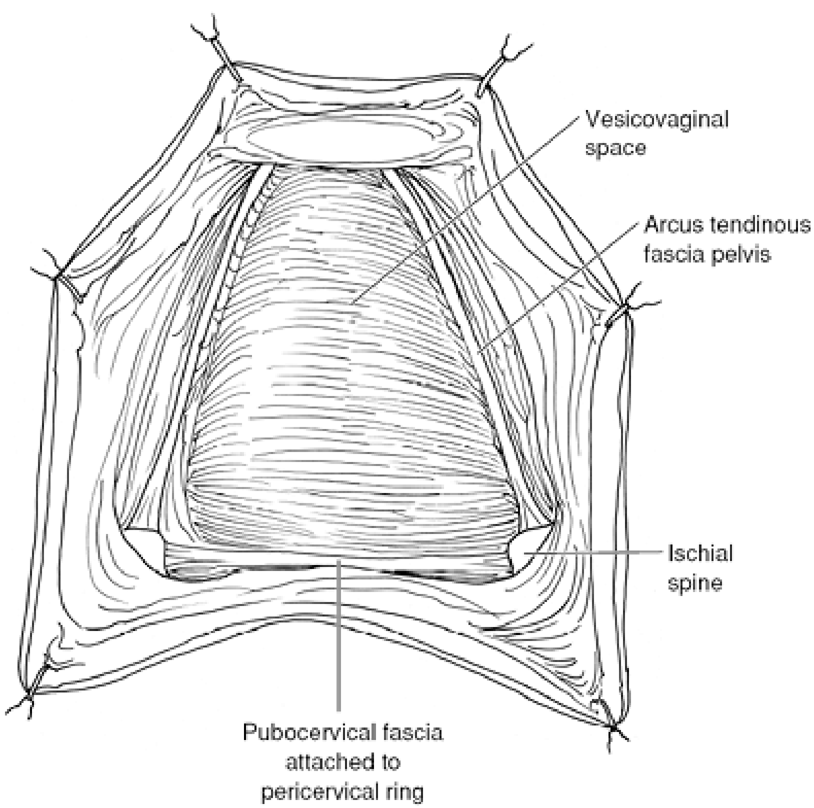

Figure 16.10 Vagina opened with midline incision and retracted laterally with tissue hooks. Vesicovaginal space is fully developed as the dissection extends to the arcus laterally and the pericervical ring proximally.

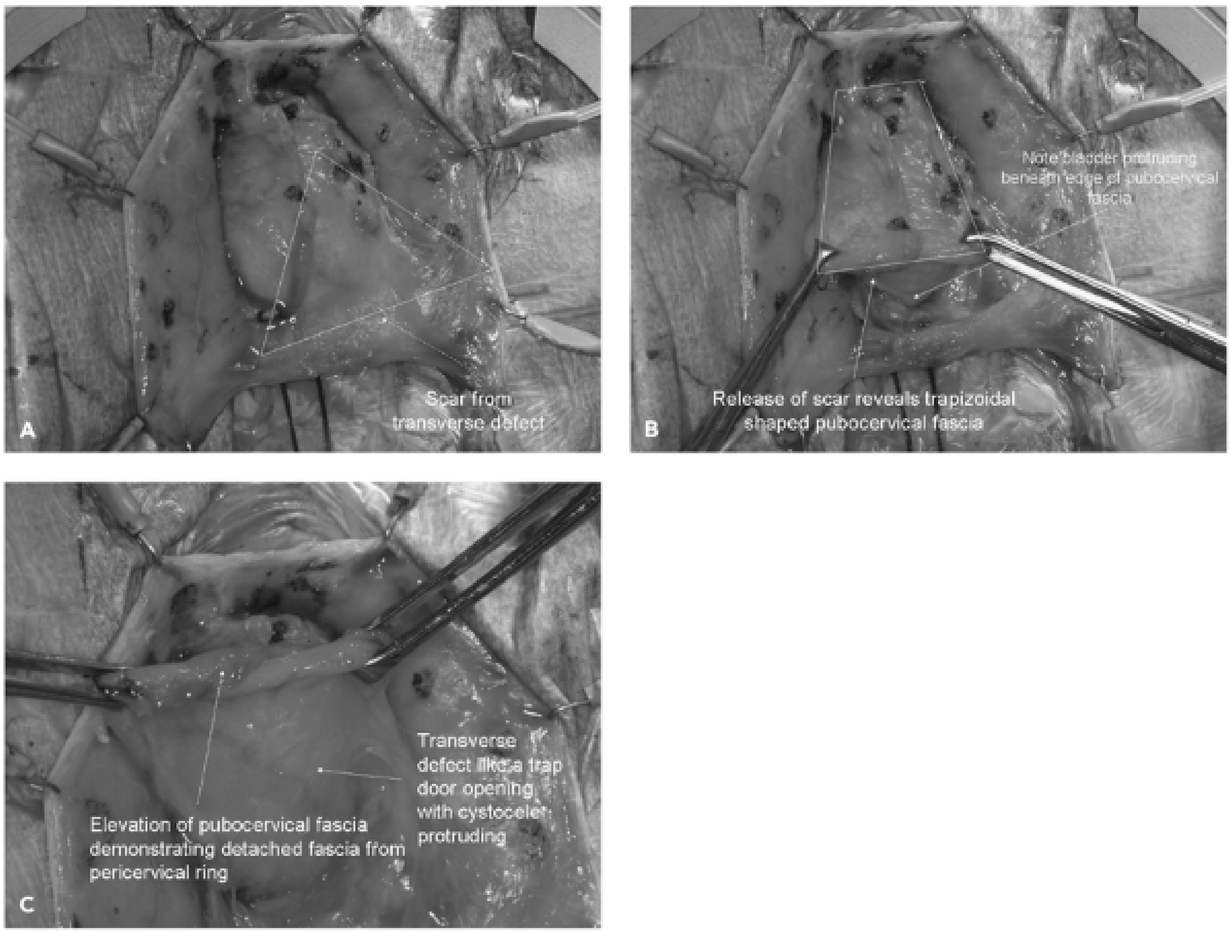

Figure 16.11 A: Triangular scar developed from a transverse tear pulls the bladder downward and outward. B: Transverse defect with separation of the pubocervical fascia from the pericervical ring is revealed after the scar from the transverse tear is excised. C: Transverse defect with break in the underlying fibroelastic connective tissue sheath of the vagina with protruding cystocele is shown as the fascial edge of pubocervical fascia is elevated.

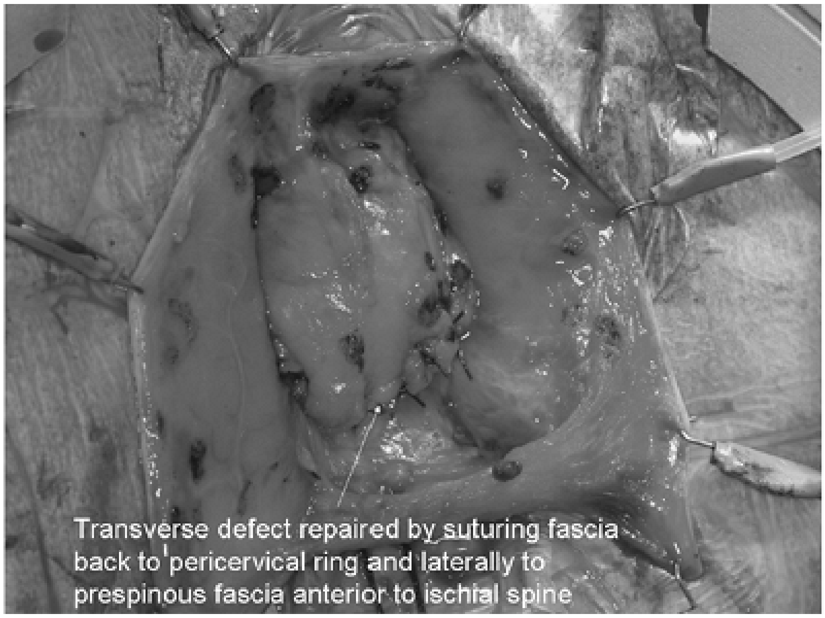

Figure 16.12 Site-specific repair of cystocele caused by transverse defect.

In order to identify each defect vaginally, the surgeon must dissect under the full thickness of the vaginal epithelium to expose the vesicovaginal space between the inferior pubic rami from the urethrovesical junction to the vaginal apex and laterally to each ATFP. Unless this trapezoidal vesicovaginal space is totally exposed, the various defects of the pubocervical fascia cannot be appropriately identified. Failure to identify and repair all fascial defects must be considered as potential factors in subsequent recurrence.

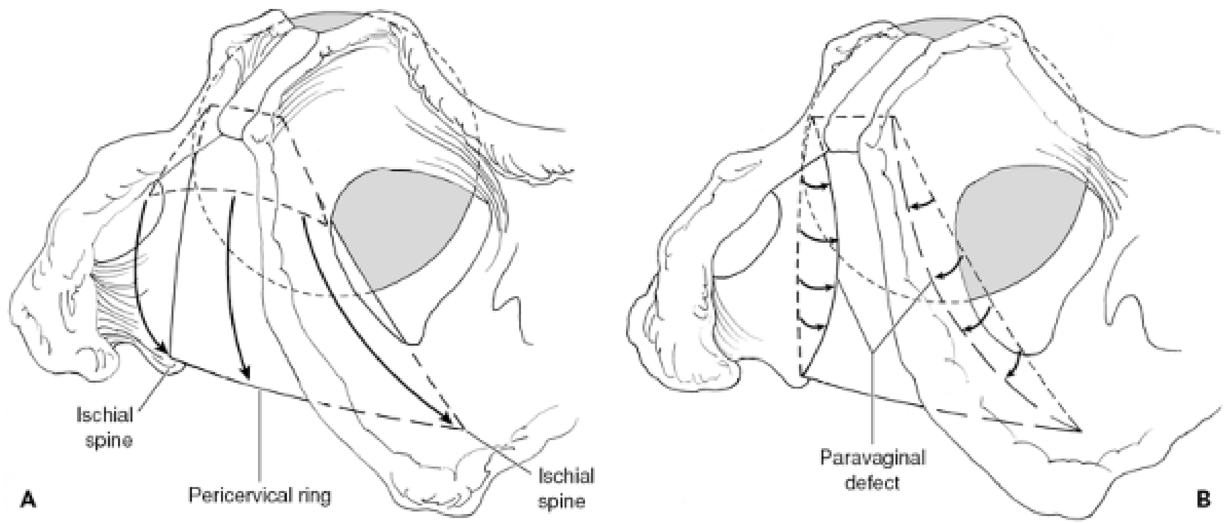

Figure 16.13 A: Graphic description of site-specific transverse defect repair. Pubocervical fascia is reconnected to the pericervical ring in the midline after the bladder has been elevated. The lateral edge of the fascia, which has been torn from its attachment to the ischial spine, is reattached to the prespinous fascia anterior to the ischial spine. B: Graphic demonstration that even if the patient has a unilateral or bilateral paravaginal defect a cystocele of clinical significance can not occur as long as proximal attachment of the pubocervical fascia to the pericervical ring and ischial spine remain intact.

Technique

Many modern-day gynecologists are reluctant to abandon the anterior colporrhaphy, which they view as a quick and easy procedure associated with little morbidity and rapid recovery. In addition, the vaginal paravaginal repair is believed to be a technically difficult operation associated with a great potential for uncontrollable bleeding. But as George White noted in the early 1900s, this is not the case (2). Although some pelvic surgeons perform their vaginal-paravaginal repairs through separate sulci incisions, others prefer a full-thickness single midline approach to expose the entire vesicovaginal space: proximally, laterally from arcus to arcus, and distally.

This incision begins at the proximal edge of the anterior segment, and with curved Mayo or Cottle scissors, the vaginal epithelium is undermined and incised directly in the midline distally toward the external urethral meatus. Baden and Walker described clinical techniques to differentiate between paravaginal and midline defects (11). However, others believe that only through adequate dissection can the defects of the anterior segment be determined accurately. If only a cystocele is to be repaired, the upper edge of the incision need not be carried farther than the urethrovesical junction. The cut edges of the vagina are held stationary with hooks placed on a Scott retractor (Lone Star, Houston, Texas). This provides constant, balanced retraction that cannot be equaled by an assistant holding the vagina on stretch with Allis forceps. The fibrous attachment (fascia endopelvina), which is found on the underside of the vagina laterally, is separated and cut with the scissors to expose the lateral margins of the vesicovaginal space. This exposes the entire sheath of the trapezoidal pubocervical fascia and opens the vesicovaginal space so that all defects can be recognized and repaired. The blunt finger of the operator is used to carefully separate any fibrous tissue that exists between the vagina and the pubocervical fascia laterally to its attachment to the ATFP. The surgeon must be very careful with dissection because artificial disruption of the connection between the pubocervical fascia and the obturator internus muscle can occur if the blunt dissection toward the retropubic space is performed too aggressively.

The paravaginal defect is noted when the surgeon's finger progresses passively through a defect between the lateral attachment of the pubocervical fascia and the obturator internus fascia and falls into the retropubic space. This space can be confirmed by the visualization of fat, which does not belong in the vagina. If this defect is not present, it

should not be purposefully made. It either exists or it does not. Sometimes the attachment consists of fibrous bands as if the pubocervical fascia is not completely torn away from its lateral attachments. In such cases, a reinforcement of the pubocervical fascia to the obturator fascia should be performed. With complete separation, the surgeon's finger can be placed through the paravaginal defect and identify the retropubic space anterior to the ischial spine. The index and middle finger of the left hand is placed through the defect on the left side of the patient and the right fingers through the right side. When the wrist is supernated, the palm side of the fingers can easily palpate the ischial spine as well as the obturator internus muscle, and the condensation of the ATFP as it travels from the ischial spine to the back of the posterior-inferior part of the pubic bone to insert on the pubic bone.

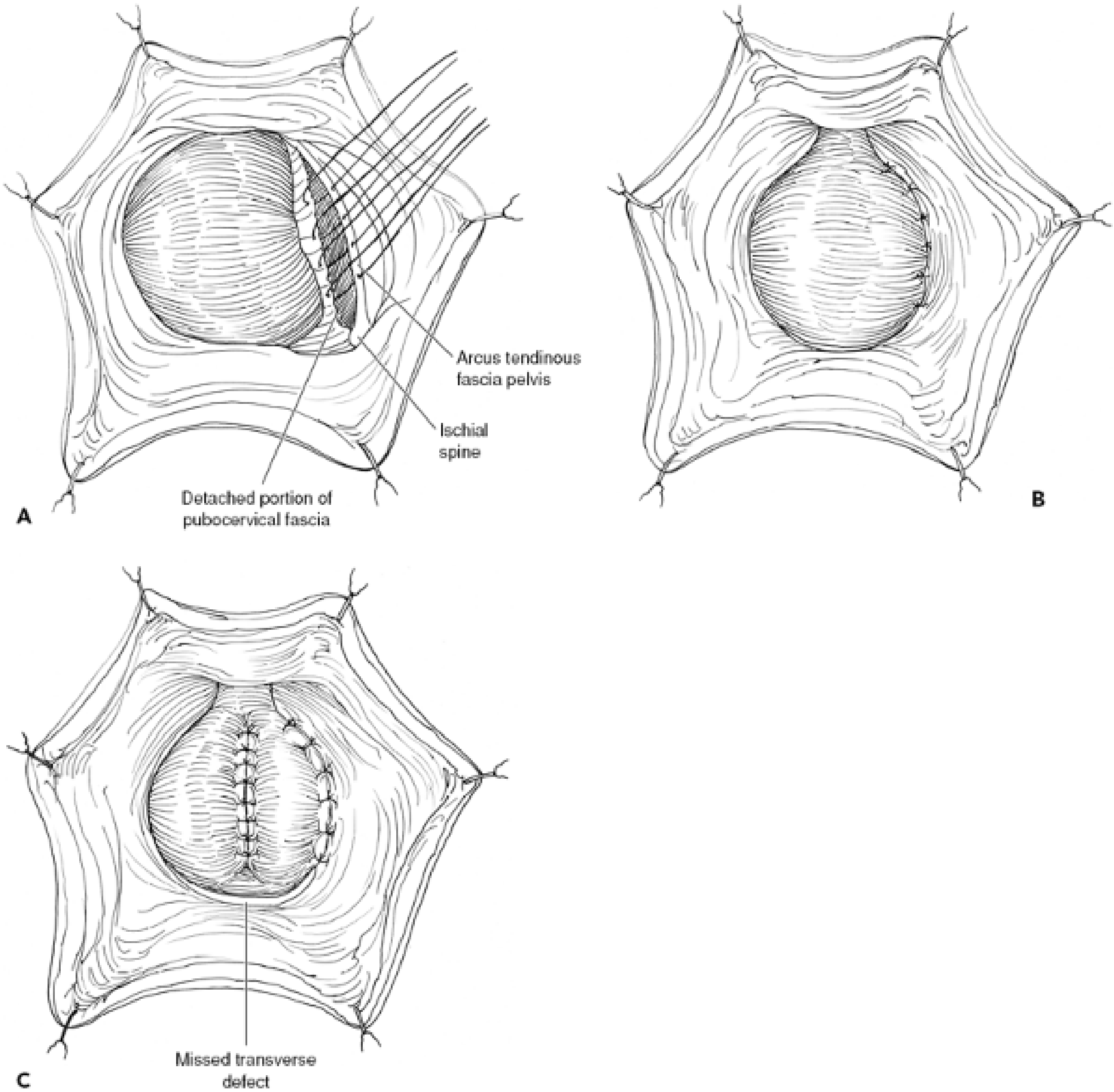

Figure 16. 14 A: Paravaginal defect repair. Restoring the detached lateral edge of pubocervical to the ATFP. B: Paravaginal repair completed. (Note: bulge of cystocele still persists.) C: Illogical midline plication performed with paravaginal repair. Restoration of the missed transverse defect would correct a true break in

the connective tissue sheath at the pericervical ring and properly correct the only two causes of cystocele, that is, transverse and paravaginal defects.

With a 10-inch needle holder, a 2-0 Ethibond suture (Ethicon, Somerville, NJ) attached to a round tapered needle is placed through the ATFP, approximately 2 cm anterior to the ischial spine. The easiest place to palpate the arcus is at the ischial spine. The use of wide, 30-mm Breisky-Navratil retractors help retraction and visualization. This first stitch is similar to the â€œkey sutureâ€• in the abdominal approach, as it determines where along the pelvic sidewall the vagina is attached. This suture is not tied but rather positioned into the grooves provided by the Scott retractor. Traction on this suture makes it easier to visualize the entire tendinous arch. Each subsequent suture is placed

superiorly toward the insertion of the arcus into the back of the pubic bone. As with the first, each suture is positioned in the grooves of the Scott retractor without being tied, until all of the sutures have been placed through the arcus. Four to six sutures are usually required from the ischial spine to the insertion of the arcus into the back of the pubic bone.

Starting with the â€œkey suture,â€• the end of each suture is attached to a No. 6 Mayo needle that first penetrates the lateral margins of the pubocervical fascia and then the underside of the vaginal epithelium, as high on the underside of the vagina as possible. The needles are directed toward the side that is to be repaired (i.e., toward the left side if the defect is on the left). This suture is then tied. The same steps are applied to each suture as they are placed from caudad to anterior to the back of the pubic bone. This re-suspends the trapezoidal sheath of pubocervical fascia back to its lateral attachments to the ATFP, and the bulge of the cystocele is reduced.

In some cases, it is impossible to identify adequate pubocervical tissue to reconstruct the anterior segment. The reason for the fascial deficiencies is unclear, but regardless of the cause, these patients will require a bolster. This bolster should fill the trapezoidal shape of the vesicovaginal space and be secured by permanent suture to the sites that normally support the pubocervical fascia (i.e., the ATFP laterally and the pericervical ring proximally). Either a woven, single-strand, monofilament permanent interlocked polyester mesh such as Gynecare Gynemesh (Ethicon) or SIS mesh (Cook, Spencer, IN) can be used.

Occasionally following a bilateral or unilateral paravaginal repair, there still may be a bulge in the midportion of the pubocervical fascia. In their description of paravaginal repairs Shull and Baden, Nichols, and Karram suggest that this midline bulge should be corrected by midline plication of the pubocervical fascia (12,13,14). To perform both a defect repair procedure (i.e., paravaginal repair) and attenuation procedure (i.e., a midline plication) on the same area appears to violate the principles of site-specific repairs. It is not believed that this bulge results from a midline defect (distention cystocele), but instead from a transverse defect, which is a proximal detachment of the trapezoidal pubocervical fascia from the pericervical ring allowing it to descend toward the introitus. Fibrous bands can be visualized pulling the bladder outward and downward. Excision of these bands exposes the edge of the pubocervical fascia that has become separated from each ischial spine. Correction of the transverse defect involves reattachment of the pubocervical fascia more proximally in the midline to the pericervical ring and laterally back to the origin of the arcus tendinous fascia pelvis (ATFP) at the ischial spine, thereby reestablishing the pubocervical fascia to its normal attachment sites. Failure to do this could possibly result in recurrence of anterior segment apical prolapse. Interrupted sutures of 2-0 Ethibond (Ethicon) are used for this repair.

Recently a number of â€œquick fix,â€• one-size-fits-all kits have become available. These kits are touted as requiring only minimal dissection to correct advanced pelvic organ prolapse. They offer both permanent and biologic bolsters, and the size of these bolsters is much larger than that traditionally used. The bolsters are meant to replace the endopelvic fascia entirely. For the anterior compartment, the bolster originates proximally at the pericervical ring, spans bilaterally from arcus to arcus, and terminates distally at the bladder neck. In the majority of the kits, the bolster used is a knitted monofilament macroporous polypropylene precut mesh. Delivery of the bolster is facilitated via cannulas or trocars introduced retroperitoneally through the obturator foramen. With these kits, there is supposedly no need to identify the fascial defects; instead the surgeon just opens up the epithelium, lays down the bolster, and then closes the epithelium. These kits are being marketed as a fast and easy method to correct advanced pelvic organ prolapse with minimal dissection, and the suggestion of minimal risk. Unfortunately some supporters of these kits are equating minimal dissection with the minimal surgical skill required by that of the surgeon.

Vaginal paravaginal repair is an advanced surgical technique that, in general, is not performed by the average obstetrician/gynecologist or urologist. A great majority of advanced prolapse cases are referred to the better-skilled pelvic reconstructive surgeon. The danger posed by these new prolapse kits is that some surgeons who previously did not feel comfortable correcting multicompartment, advanced pelvic organ prolapse are being falsely empowered by the push of â€œIndustry.â€• What happens when the â€œquick fix,â€• prolapse-kit surgery does not go as planned and the less-skilled surgeon must rely on her/her surgical acumen or lack thereof to correct the problem intraoperatively? The operating room is not the place to discover that a case is beyond a surgeon's ability. For even the most seasoned pelvic reconstructive surgeon, the surgical management of advanced pelvic organ prolapse can prove difficult at times. It is mandatory that the surgeon possess the skill-set requisite to repair these defects safely and consistently. To suggest that such skills are unnecessary and the surgeon need only to rely on the kits is inaccurate and dangerous.

Each week, there seems to be another â€œnew and improvedâ€• device launched that claims to make surgery faster, easier, less risky, and with better success rates. In many instances, these products are made available to anyone and everyone, irrespective of their skill or knowledge. There are a multitude of issues regarding this new phenomenon of the tail (Industry) wagging the dog (surgeons) that are beyond the scope of this book. As previously stated, one major issue is that a less-skilled surgeon may be seduced into attempting the more difficult cases that perhaps he/she routinely would not or should not attempt. As learned from TVT, minimally invasive devices and techniques may seem relatively safe, easy, and provide excellent long-term results, but they may also result in major morbidity and

mortality. Surgical kits and devices may aid the already skilled surgeon, but they are not a substitute for good surgical technique. In addition, before these new devices are readily adopted into everyday practice, well-designed, randomized controlled trials are needed to evaluate their true efficacy and potential adverse events.

Many believe the operation for correction of the anterior compartment is a vaginal one. The advantage of the vaginal route is that the surgeon can directly view the entire pubocervical fascia from one arcus to the other, can adequately identify any separation of the fascia from the arcus laterally or the pericervical ring proximally, and can reconstruct in a site-specific manner all defects laterally, centrally, proximally, and distally. Fascial breaks should be repaired with permanent suture, and, where needed, permanent grafts employed. Biologic grafts currently available are not reliably consistent in their quality or efficacy. Midline plication techniques, although still very popular, are anatomically distorting operations that have no place in pelvic reconstructive surgery and as such, should be abandoned.

Gynecologists of the first half of the twentieth century were not concerned with the anatomically distorting nature of midline plication operations, as most women of that time were through with intercourse by the time their surgery was performed. Women of the latter half of the twentieth century and certainly the twenty-first century remain sexually active up to their 80s or beyond. Therefore, gynecologic surgeons must advise women, during the informed consent process, if they plan to perform midline plication operations. These surgeons must be cautious in their informed consent and inform patients that this type of repair might prevent them from future sexual activity. Emphasis on restoring the anterior vaginal segment must be placed on restoring normal anatomy and function after surgery, and, with the techniques described herein, the pelvic surgeon should be able to reestablish the normal form and function of the anterior segment with reproducible long-term success.

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17

Posterior Vaginal Reconstruction with Bilateral Vaginal Uterosacral Colpopexy

Carl W. Zimmerman

The posterior vaginal wall and its associated structures are singularly important in normal pelvic anatomy. The primary suspensory axis of the uterovaginal complex courses along the posterior vagina from the perineum, through the rectovaginal septum, past the posterior pericervical ring, and along the uterosacral ligaments to its insertion into the presacral periosteum overlying sacral vertebrae 2, 3, and 4 (Fig. 17.1) (1,2,3,4,5,6,7,8,9,10,11). Disruption of the normal anatomic integrity anywhere along this series of structures allows pelvic support and suspensory defects to develop with sufficient time and physical stress on the pelvic floor.

In this chapter, a review of normal posterior vaginal anatomy will be followed by a description of how the forces of labor specifically damage the support and suspensory structures of the deep endopelvic connective tissue in the posterior vagina. Finally, site-specific surgical techniques that allow repair and reconstruction of the posterior vagina will be outlined. Understanding the pathophysiology and biomechanics of damage to the structures of the posterior endopelvic fascia allows the pelvic reconstructive surgeon to restore normal form and consequently maximize the opportunity to restore normal function for the patient.

The concepts of proximal and distal will be used in the anatomic and surgical descriptions in this chapter. The point of reference for these terms will be the interspinous diameter. For example, in reference to structures below the ischial spines, proximal refers to proximity to the interspinous diameter, and distal refers to proximity to the perineum. The same convention will be used for structures located above the interspinous diameter. In describing the uterosacral ligament, proximal refers to proximity to the interspinous diameter, and distal will imply proximity to the presacral periosteum.

Normal Posterior Vaginal Surgical Anatomy

The vaginal opening is separated from the anal verge by the perineum. The perineum is a dense fibromuscular structure that is triangular in shape. The base of the pyramid is visible at the introitus, and the apex is located proximally where the distal rectovaginal septum merges with the central perineal tendon, or perineal body. Four named muscles are contained within the perineum. The superficial transverse perinei muscles course between the ischial tuberosities and the midline of the perineum. As these muscles approach the midline, they merge with the bulbocavernosus muscles that descend from the labium majus. These two paired muscles intermesh in the midline of the perineum and form the most ventral portion of the perineum when viewed from below. Immediately proximal to these structures are the deep transverse perinei muscles that follow the same course as their superficial counterparts. Both the deep and superficial transverse perinei muscles are difficult to discern as distinct surgical entities.

The most dorsal structure of the base of the perineum is the external anal sphincter. It is a voluntary red muscle

that encircles the anal verge in the shape of a torus. The external anal sphincter is encased within a capsule of parietal fascia that is distinctly visible when the muscle is transected and no scarring is present. Immediately cephalad to the external sphincter is the internal anal sphincter. A white muscle, the internal anal sphincter, is a continuation of the circular component of the bowel wall. The anal sphincters function in concert with the ventral displacement caused by the puborectalis muscle to create a continent bowel mechanism. The remainder of the perineum is superior to the sphincter ani muscles and comprises dense fibroelastic connective tissue known as the central perineal tendon or perineal body. The perineum is stabilized laterally to the ischial tuberosities by the transverse perinei muscles and suspended proximally by the rectovaginal septum along the suspensory axis of the posterior vagina.

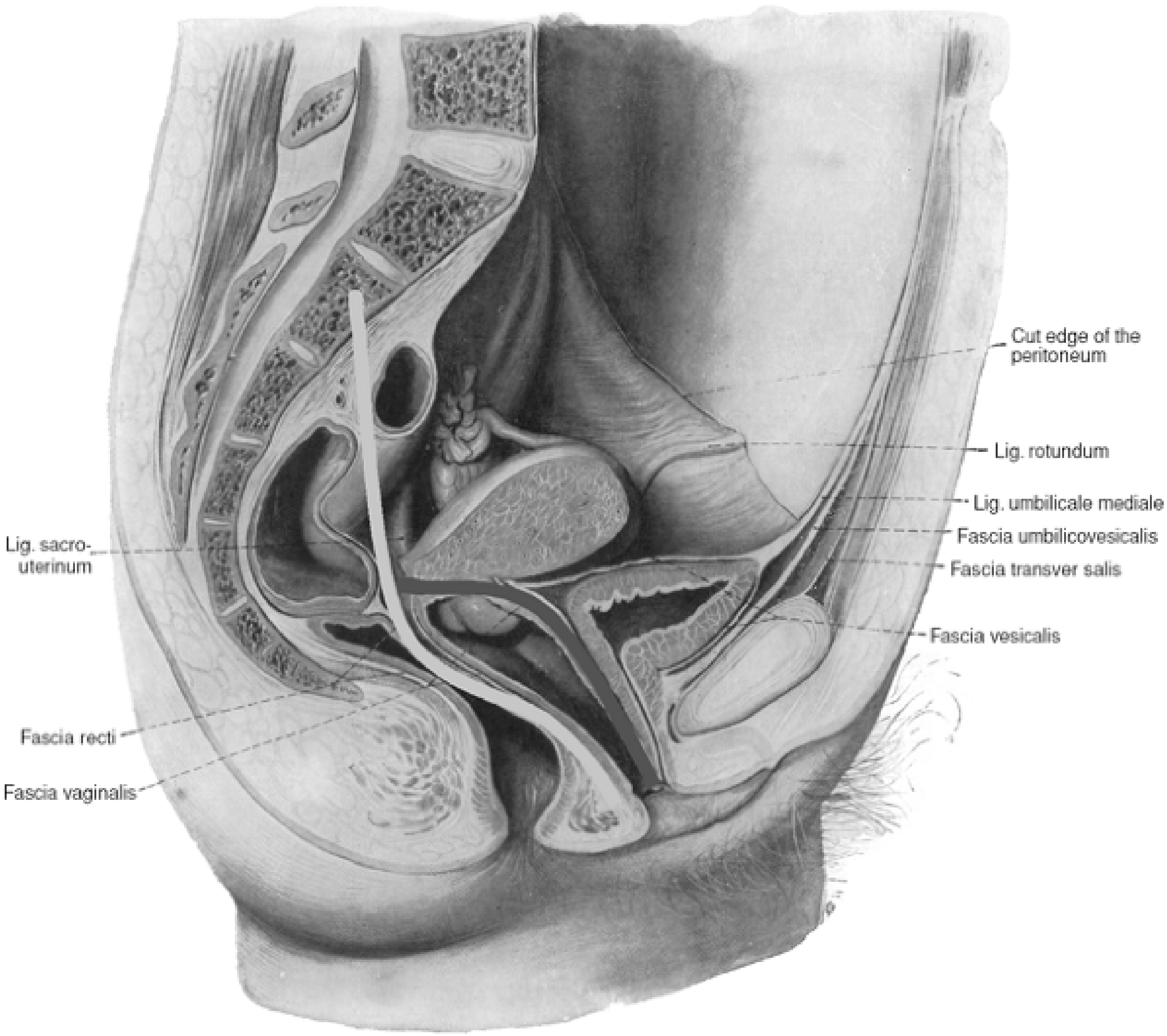

Figure 17.1 Suspensory axis of the uterovaginal complex. The primary suspensory axis of the uterovaginal complex is in the posterior pelvis. Perineum â†' rectovaginal septum â†' pericervical ring â†' uterosacral ligament â†' presacral periosteum. The secondary anterior axis is also shown. Adapted from, Peham H, Amreich J. *Operative Gynecology*. Philadelphia: Lippincott, 1934:190 , Figure 138, with permission.

The rectovaginal septum, a sheetlike condensation of the deep endopelvic connective tissue, separates the vaginal canal from the rectum (Fig. 17.2) (1,4,5,6,11,12,13,14,15,16). It extends proximally from the perineum to the interspinous diameter where it merges with the uterosacral ligaments laterally and the pericervical ring centrally (Table 17.1) (17,18). Laterally, the septum merges with the superior fascia of the pelvic diaphragm. The proximal two thirds of this lateral attachment are called the arcus tendineus fascia pelvis or fascial white line. This line also serves as the lateral attachment for the pubocervical fascia in the anterior vaginal wall (5). The distal one third of the midvaginal lateral attachment for the rectovaginal septum courses posteriorly from the white line and is called the arcus tendineus fascia rectovaginalis (Fig. 17.3). The rectovaginal septum is a component of the deep endopelvic connective tissue or endopelvic fascia. The endopelvic fascia, a part of the subperitoneopelvic connective tissue, is located between the dependent portion of the pelvic peritoneum and the superior fascia of the pelvic diaphragm. It is composed of fibroelastic connective tissue with a smooth muscle component. Although the septum loosely adheres to the vaginal wall and the visceral fascia of the rectum, it is located within the avascular rectovaginal space and can be exposed surgically along its entire length. The rectovaginal septum maintains normal vaginal depth, separates the vagina from the rectum, guides the leading edge of a descending bowel

movement toward the anal opening, and functions as an integral part of the suspensory axis of the uterovaginal complex.

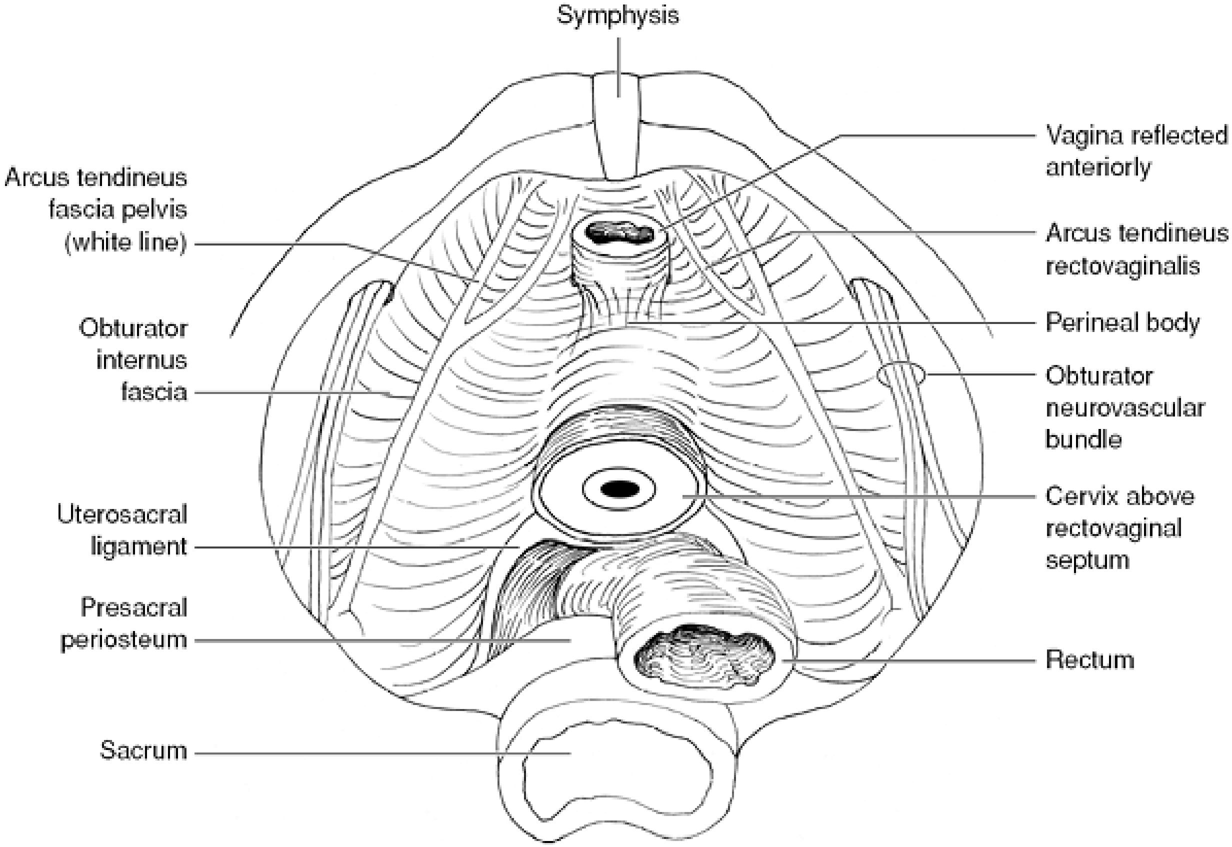

Figure 17.2 View of the superior side of the rectovaginal septum.

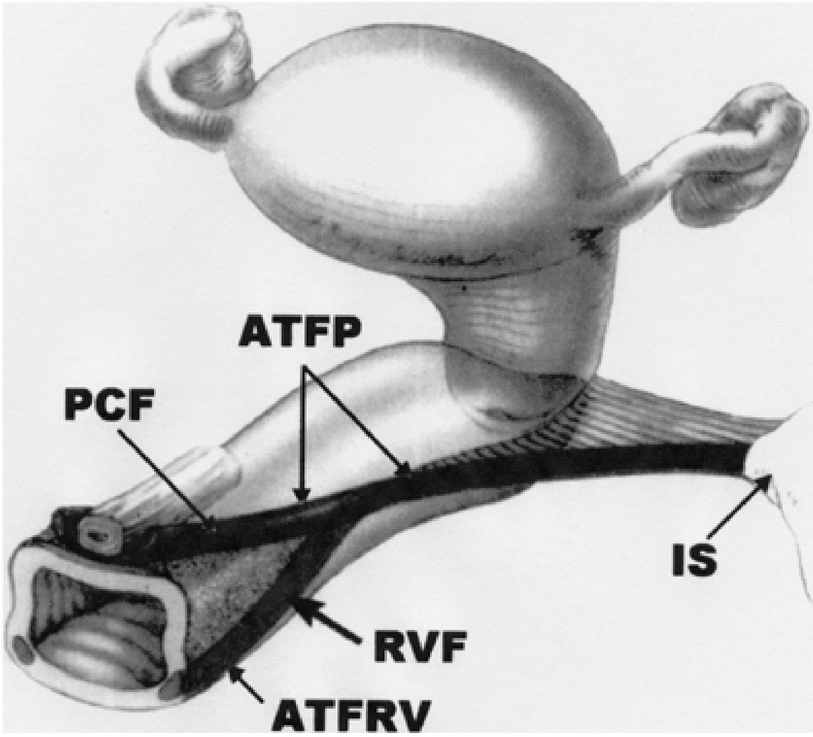

Figure 17.3 Lateral attachments of the pubocervical and rectovaginal fasciae. The lateral attachments of the pubocervical fascia (PCF) and the rectovaginal fascia (RVF) to the pelvic sidewall are illustrated. Also shown are the arcus tendineus fascia pelvis (ATFP), arcus tendineus fascia rectovaginalis (ATFRV), and ischial spine (IS). (From,
Leffler KS, Thompson JR, Cundiff GW, et al. Attachment of the rectovaginal septum to the pelvic sidewall. *Am J Obstet Gynecol.* 2001;185:41â€“43.
)

Table 17.1 Rectovaginal Septum

â€¢ Shape: Trapezoidal with the narrow end located distally

â€¢ Contents: Fibroelastic connective tissue and smooth muscle

â€¢ Function: Posterior vaginal support, stabilization of the rectum, and perineal suspension

â€¢ Synonym: Denonvilliers fascia

â€¢ Boundaries:

â€” Distal: Fusion with the proximal perineal body at the central tendon of the perineum

â€” Lateral: Attachment in the distal one third of the vagina to the arcus tendineus fasciae rectovaginalis and in the proximal two thirds of the vagina to the arcus tendineus fasciae pelvis

â€” Proximal: Fusion with the uterosacral ligaments laterally and the pericervical ring centrally

â€” Superior: Adjacent to the epithelium of the vagina

â€” Inferior: Adjacent to the visceral fascia of the rectum

Zimmerman CW. Pelvic organ prolapse. In: Rock JA, Jones HW, eds. *TeLinde's Operative Gynecology*. 9th ed. Philadelphia: Lippincott Williams & Wilkins, 2003:927â€“948 (Table 35A.7.).

The interspinous diameter of the pelvis is the narrowest diameter in the human pelvis.

Within this plane, all named structures of the deep endopelvic connective tissue converge and connect with the pericervical ring (Table 17.2). This ring encircles the supravaginal cervix, which is suspended in midpelvis by the six ligamentous components of the deep endopelvic connective tissue (Fig. 17.4). Posterior displacement of the cervix is physiologic. For that reason, the strength of the pubocervical ligament anterior to the cervix is minimal. The cardinal ligaments prevent lateral displacement of the cervix. These ligaments function primarily as hypogastric mesenteries for the uterine vasculature and conduits for the distal ureter. They

have secondary importance in the suspension of the cervix and uterus. Because side-to-side stabilization does not require significant load bearing capacity, the cardinal ligaments are only required to be intermediate in strength. The uterosacral ligaments are the primary apical suspensory elements of the uterovaginal complex (Table 17.3) (11,19,20). They are key components in the suspensory axis of the central pelvic organs. The uterosacral ligaments extend from the interspinous diameter, where they merge with the rectovaginal septum and the pericervical ring to the presacral periosteum of sacral segments 2, 3, and 4. Although these ligaments do contain significant neurologic and muscular components, the most important function for these structures is suspensory.

Table 17.2 Pericervical Ring

â€¢ Shape: Collar of connective tissue encircling the supravaginal cervix

â€¢ Contents: Fibroelastic connective tissue

â€¢ Function: Cervical stabilization within the interspinous diameter by connecting with all other named components of the deep endopelvic connective tissue

â€¢ Synonym: Supravaginal septum

â€" Anterior: Located between the base of the bladder and the anterior cervix where it connects with the pubocervical ligaments at the eleven and one o'clock positions and the proximal pubocervical septum centrally

â€" Lateral: Cardinal ligaments at the three and nine o'clock positions

â€" Posterior: Located between the rectum and the posterior cervix where it connects with the uterosacral ligaments at the five and seven o'clock positions and the proximal rectovaginal septum centrally

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Zimmerman CW. Pelvic organ prolapse. In: Rock JA, Jones HW, eds. *TeLinde's Operative Gynecology*. 9th ed. Philadelphia: Lippincott Williams & Wilkins, 2003:927â€"948 (Table 35A).

The distal cardinal and uterosacral ligaments are contiguous as they approach the pericervical ring. The ureter descends under the uterine artery and courses through the superior or ventral portion of the cardinal ligament (9). The base of the functional portion of the uterosacral ligament is surgically accessible within the pararectal space medial to the ischial spine. The ligament is approximately 3 cm from the most dependent portion of the ureter (Fig. 17.5). The ureter remains close to the uterosacral ligament as the sacrum is approached.

DeLancey accurately described the biomechanics of pelvic support and suspension (2,3,4). The mechanism of support and suspension of the vagina and the other central pelvic organs can be conveniently divided into three parts (Table 17.4). The proximal vagina is dependent on suspension to the presacral periosteum via the uterosacral ligaments. The midvagina is attached laterally to the superior fascia of the pelvic diaphragm at the fascial white line (Fig. 17.3). The distal vagina fuses with the proximal perineal body posteriorly and the urogenital diaphragm anteriorly.

Any successful pelvic reconstructive surgery must be designed to account for all three levels of vaginal support and attachment (21). Because of its relative inaccessibility, the suspensory level is the most frequently omitted in pelvic reconstructive surgery. Failure to include one of these levels will place the patient at an unnecessary risk for failure of the operation.

The Effect of Vaginal Delivery on the Posterior Vagina

Childbirth is a necessary, but not an automatically sufficient, cause for the development of pelvic support defects. One must analyze the forces of childbirth in order to understand the cause and usual location of defects in the deep endopelvic connective tissue (10,11,22). These defects eventually lead to the development of central pelvic hernias within the urogenital hiatus. The seven cardinal movements of labor occur during descent of a fetal presenting part through the obstetric axis of the pelvis. Significant pressure and strain are placed on all pelvic structures during the process of vaginal delivery, including the deep endopelvic connective tissue. A particularly important point of stress is the junction of the proximal rectovaginal septum, the pericervical ring, and the two uterosacral ligaments. This junction is located within the interspinous diameter. This diameter is the narrowest pelvimetric measurement in the human pelvis and consequently is the area of greatest pressure in the process of childbirth. All named anatomic components of the deep endopelvic connective tissue intersect with the pericervical ring in the interspinous diameter (Table 17.2). A logical and inescapable fact is that damage to the pelvic support and suspension structures is greatest within the interspinous diameter.

In a normal vaginal delivery, internal rotation occurs when the fetal vertex encounters the bony narrowing at the level of the ischial spines. The baby rotates from either the left or right occipitoanterior position to the occipitoanterior position in order to pass through the interspinous diameter. Flexion of the head is also necessary to allow passage of the occiput under the pubic arch anteriorly. During these two maneuvers, force is exerted on the junction of the rectovaginal septum with the pericervical ring and uterosacral ligaments. Pressure during labor can exceed the tensile strength of the connective tissue elements located within the interspinous diameter. A frequent result is rupture of the uterosacral ligaments away from the rectovaginal septum. The ligaments remain intact above the interspinous diameter. As the fetal head continues to descend, the anterior concavity of the sacrum and coccyx causes a gradual extension of the head to occur as the occiput continues to pass under the pubic arch. The result in the overwhelming majority of cases is a transverse tear of

the rectovaginal septum, which allows it to separate from the uterosacral ligament and the pericervical ring. In this situation, no deep endopelvic connective tissue remains in the apical posterior vagina. This defect creates the potential for development of rectocele, enterocele, and perineal descent in the future.

Table 17.3 Uterosacral Ligament

â€¢ Origin: Periosteum of S2, 3, & 4

â€¢ Insertion:

â€” Posterior and lateral supravaginal cervix (five and seven o'clock positions) and the pericervical ring at the level of the interspinous diameter

â€” Blends as a continuous structure superiorly and laterally with the cardinal ligaments

â€¢ Contents: Fibroelastic connective tissue matrix â€” Neurologic: uterosacral plexus

â€” Vascular: minimal

â€” Muscular: rectouterine muscle

â€¢ Functions:

â€” The primary proximal support and suspensory element of the uterovaginal complex

â€” Anteflexion of the uterus

Zimmerman CW. Pelvic organ prolapse. In: Rock JA, Jones HW, eds. *TeLinde's Operative Gynecology*. 9th ed. Philadelphia: Lippincott Williams & Wilkins, 2003:927â€“948 (Table 35A.3).

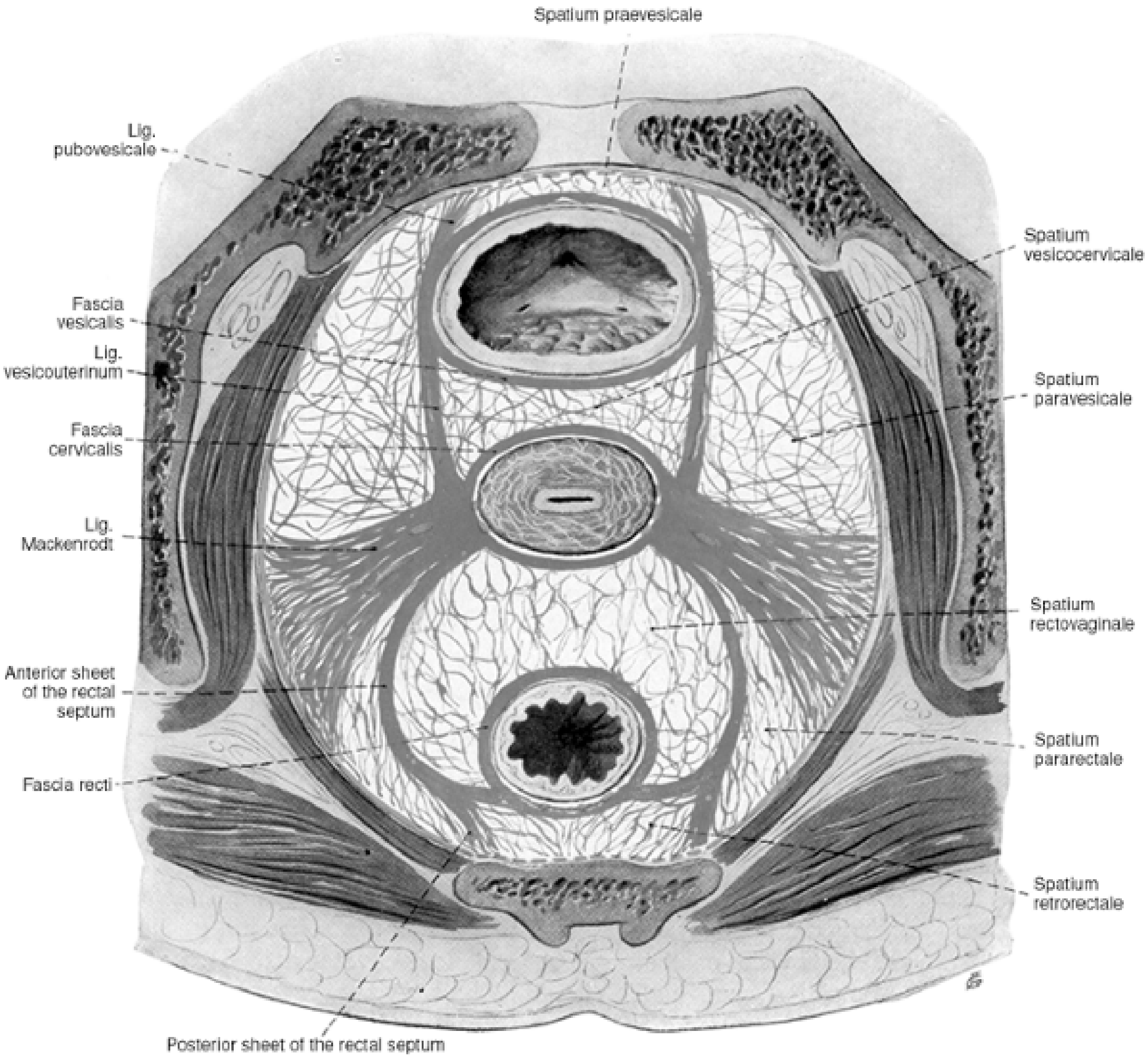

Figure 17.4 The pericervical ring, the ligamentous attachments, and the avascular spaces of the pelvis. (From,
Peham H, Amreich J. (*Operative Gynecology.* Philadelphia: Lippincott, 1934:180, Figure 132.)

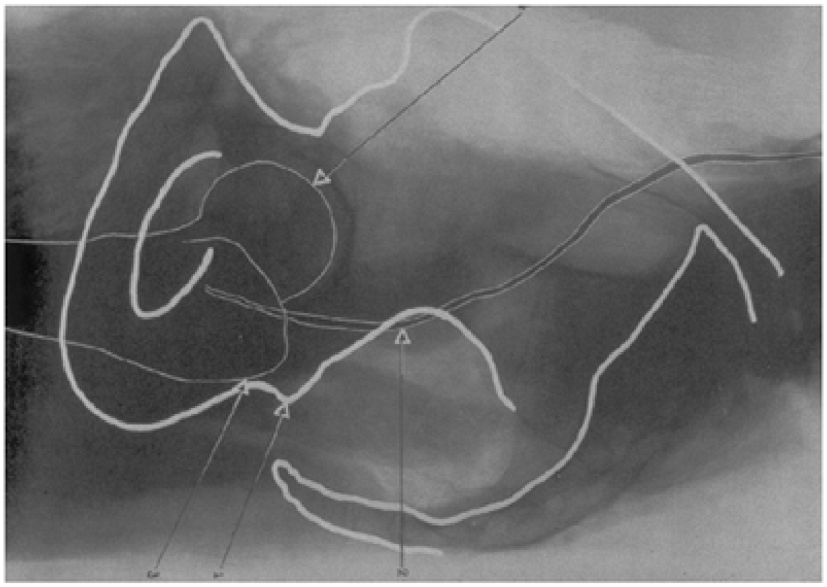

Figure 17.5 The location of the ureter in relation to the ischial spine. (From, Uhlenhuth E. *Problems in the Anatomy of the Pelvis.* Philadelphia: Lippincott, 1953:193
, Figure N 1.)

Table 17.4 Delancey's Biomechanical Levels of Posterior Vaginal Anatomy

â€¢ Level 1: Proximal suspension by the uterosacral ligaments

â€¢ Level 2: Midvaginal lateral attachment to the superior fascia of the pelvic diaphragm

â€¢ Level 3: Distal fusion with the perineal body

Continued fetal descent and extension causes the septum to be displaced further and further toward the perineum. No separation of the rectovaginal septum from the perineum occurs in the absence of a significant obstetrical laceration. Both rectoceles and enteroceles descend through the defect caused by the proximal separation and distal displacement of the rectovaginal septum. A larger defect causes the septum to retract closer to the perineum. Sufficient descent of the rectovaginal septum allows for simultaneous development of lateral paravaginal pararectal defects. These defects occur when the midvaginal lateral attachment of the rectovaginal septum to the arcus tendineus fascia pelvis or arcus tendineus fascia rectovaginalis is interrupted. When labor proceeds with an occipitoposterior presentation, the pressure on the posterior pelvis is even greater than in the more normal occipitoanterior orientation. Fetal flexion and extension movements are restricted in occipitoposterior presentations resulting in greater molding, greater posterior vaginal pressures, and more stress on the rectovaginal septum within the interspinous diameter. In an occipitoposterior delivery, support of the anterior vaginal wall is often relatively preserved.

The substantial and potentially damaging forces of labor are directed from cranial to caudal as the baby descends downward through the obstetrical axis of the pelvis. In a system where the pressure and movement are unidirectional, the displacement of structures should follow in the same direction. Clinical examination of cystoceles, rectoceles, enteroceles, paravaginal defects, rotational descent of the urethrovesical junction, and uterine prolapse conforms to this expectation (6,10,11,12,23,24,25,26). Logic dictates that displacement of disrupted connective tissue should also be in the direction of the causative forces. In symptomatic prolapse, damage to the normal connections and attachments of the endopelvic fascia are greatest in the interspinous diameter, and disrupted connective tissue structures are displaced caudally. For these reasons, disruption of the rectovaginal septum away from the perineum is very rare. The only possible explanation for such a perineal separation is iatrogenic or obstetrical damage to the perineum.

Signs and Symptoms of a Disrupted Posterior Vaginal Axis

Most patients with symptomatic pelvic organ prolapse will have damage to the anterior, posterior, and superior segments of the vagina (7). All of the vaginal segments are interconnected, and their support is interdependent (2,3,4). Repair of an isolated segment in the presence of unrecognized or incipient damage to another segment is clinically inappropriate. Care must be taken to fully assess all aspects of pelvic support when planning a procedure.

With very few exceptions, signs and symptoms of posterior vaginal prolapse are a result of the proximal disruption of the rectovaginal septum. This disruption initially leads to the characteristic bulging in the posterior vaginal wall and is normally associated with development of a rectocele and enterocele. These bulges may be internal or external, generally are progressive once they can be clinically detected, and may become quite large. Usually there is no pain; however, vague abdominal discomfort may accompany a large enterocele if sufficient traction is placed on the mesenteries within the abdomen. Patients often complain of a feeling of heaviness or fullness when these hernias are present. Descent of rectoceles and enteroceles may accompany changes in position, for example, arising from a night's sleep. Conversely, during recumbent periods, these hernias may retract within the introitus. Rectoceles become symptomatic when the anterior rectal wall forms a pocket that protrudes into the vagina. With descent of the leading edge of a bowel movement, the stool enters the rectocele because the rectovaginal septum is disrupted and cannot guide the bowel movement into the anus. Entrapment of the leading edge of the bowel movement may cause intense rectal pressure during attempted defecation. The usual reaction of the patient is to use Valsalva maneuver in an effort to try to alleviate the bowel pressure and to eliminate the entrapped bowel contents. By fixing the respiratory diaphragm, intentionally relaxing the pelvic diaphragm, and bearing down, the leading edge of the bowel movement becomes further impacted within the rectocele. When repeated on a daily basis, the rectocele becomes larger, and the associated obstructed defecation symptoms gradually worsen. Perineal descent occurs because the rectovaginal septum is displaced. The constant pelvic pressure that accompanies perineal descent develops at some point in this progression of events. Perineal descent is a late development in posterior vaginal disruption and often causes the symptoms that are responsible for the patient to seek surgical treatment.

Disruption of the perineum may occur. These defects are most commonly iatrogenic or obstetric in origin. In such cases, the distal vaginal fusion of the rectovaginal septum to the proximal perineal body at the central perineal tendon may be damaged. If sufficient interruption of the perineum is present, an alteration in the anal continence mechanism may occur. Attenuation of the perineum may be scored in a manner similar to the ordinal system that is used for episiotomies. Third- and fourth-degree disruptions of the external anal sphincter commonly result in varying degrees of anal incontinence.

Physical examination of the posterior vaginal anatomy should be full-length and full-width (7). When a prolapse that is large and symptomatic is encountered, the examiner should first determine whether it is anterior, posterior, or apical. Any large dominant prolapse may occupy the available space in the urogenital hiatus and, as a result, prevent the descent of any other incipient prolapse. The presence of a dominant prolapse does not preclude the presence of suspensory or lateral attachment damage to the other vaginal segments. The dominant prolapse should be replaced and a careful inspection made for other areas of damage.

The pattern of rugae will give clinical evidence of the presence of deep endopelvic connective tissue. In the posterior vaginal segment, little variation in the general pattern of fascial damage occurs; therefore, a relatively constant pattern of these rugations is encountered. The proximal epithelium will be very smooth, and the distal epithelium will become progressively more deeply and densely marked by rugae. This pattern results from the displacement of the rectovaginal septum. Careful clinical inspection will reveal this pattern consistently. A larger prolapse will displace the connective tissue more and more distally. Rectoceles and enteroceles descend through the same defect in the rectovaginal septum. When one of these hernias is present, the other is also present.

Two systems to grade prolapse are in frequent clinical use. Both the pelvic organ prolapse quantification (POP-Q) and Baden-Walker methods have strengths and weaknesses (see Chapter 3). Both convey a large amount of anatomic detail that may be quickly encoded within a small amount of recorded information. Serious clinicians may debate which system is the best in particular circumstances; however, all agree that abandonment of the mild, moderate, and severe classification is desirable. POP-Q and Baden-Walker systems both significantly improve the accuracy of clinical communication. Precise evaluation of prolapse assists in developing treatment plans and in following these conditions over time.

Posterior Vaginal Reconstruction with Bilateral Vaginal Uterosacral Colpopexy

The goal of posterior pelvic reconstruction is to identify the specific pattern of apical separation of the rectovaginal septum and then successfully reestablish its continuity with the uterosacral ligaments and pericervical ring within the interspinous diameter. Reattachment of the rectovaginal septum to the superior fascia of the pelvic diaphragm repairs any pararectal defects. Central defects within the rectovaginal septum and distal separations of the rectovaginal septum from the perineum may be encountered occasionally and should be repaired in a site-specific fashion. Reconstruction of the perineum may also be necessary and should be performed anatomically. Site-specific techniques that identify damage to connective tissue elements and restore these structures to their normal anatomic relationships have the best long-term functional results (27,28,29,30,31,32,33,34,35,36,37,38). Permanent sutures should be used for all connective tissue reattachments with the exception of the introital portion of the perineum. Anatomically distorting midline plications are of historical interest only (15,16,23,39,40,41,42). They do not restore normal anatomy and often result in permanent pain and sexual disability.

A posterior midline incision is made in the vaginal epithelium and extended as far superiorly as necessary to create adequate exposure. The initial goal of posterior vaginal reconstruction is full-length and full-width dissection of the rectovaginal space. Deep endopelvic connective tissue is carefully separated from the vaginal epithelium. The proper plane will most successfully be entered by beginning this separation at the medial edge of the vaginal epithelium with sharp dissection. The undersurface of the vaginal epithelium is smooth, slick, and shiny. If not previously dissected and scarred, this plane will be mostly avascular. Once the proper plane is entered, blunt dissection will extend very quickly to the normal boundaries of the rectovaginal space. Occasional bands of connective tissue may require sharp division. Previous anatomically distorting surgeries, for example, levator ani plication procedures, may require significant sharp dissection in order to fully expose the rectovaginal space. In patients with previous operations, neovascularity will be encountered. A key lateral landmark in this dissection is the superior fascia of the pelvic diaphragm or pelvic sidewall. A full-width dissection of the rectovaginal space is needed to identify this structure. Vaginal arterial and venous vessels may be encountered at the three and nine o'clock positions. Proximally, the dissection must extend to the ischial spines. The uterosacral ligaments terminate within the interspinous diameter, and reconstruction of the suspensory axis of the vagina requires identification of these ligaments.

After the rectovaginal space is exposed completely, careful inspection of the tissue separated from the undersurface of the vaginal epithelium will reveal the presence of several different types of tissue. The rectovaginal septum will be continuous with the perineum and will appear as whitish connective tissue with a finely uneven surface created by the tropocollagen fibrils that are the major component of this tissue. The proximal edge can be visually identified and grasped with Allis clamps in preparation for the suspension to the uterosacral ligaments (Fig. 17.6). Immediately

proximal to the superior edge of the rectovaginal septum, longitudinal fibers of the muscular wall of the rectum may be seen representing a rectocele. In a patient with prolapse, most of the exposed tissue within the proximal rectovaginal space will be retroperitoneal and represent an enterocele. Visually, this tissue is very smooth and thin, and the characteristic yellow color of retroperitoneal fat will be noted. Frequently the proximal edge of the rectovaginal septum will be transverse. The transverse proximal margin may be displaced all the way to the perineum, especially in advanced cases of prolapse. Another common pattern of fascial damage is an intact connection of the septum to the uterosacral ligament on one side and a complete separation with a full-length pararectal defect on the side with the uterosacral disruption. In these cases, the rectovaginal septum will be retracted to the side with the intact uterosacral attachment. With the edge of the septum identified and grasped, the surgeon can begin to release secondary adhesions and surgically sculpt the rectovaginal septum to its original length (Fig. 17.7). Even in elderly patients, connective tissue does not atrophy significantly. When the rectovaginal septum is scarred and retracted within the rectovaginal space, the original complement of tissue is present. With careful and skillful surgical technique, most, if not all, of the original form of the septum can be recreated. The key to this entire exercise is identification and elevation of the proximal edge of the connective tissue continuous with the perineum. Meshes and bolsters are much more valuable in anterior vaginal reconstruction than in posterior vaginal reconstruction. Restoration of vaginal depth is usually possible with available connective tissue posteriorly. Recall that the pubocervical septum is shorter than the rectovaginal septum by the diameter of the cervix. In the posthysterectomy patient, no anatomic way to compensate for the absence of the cervix exists, without shortening the vagina or the use of a bolster. Conversely, failure to compensate for the connective tissue defect created by the absence of the cervix is a major risk factor for failure of the surgery.

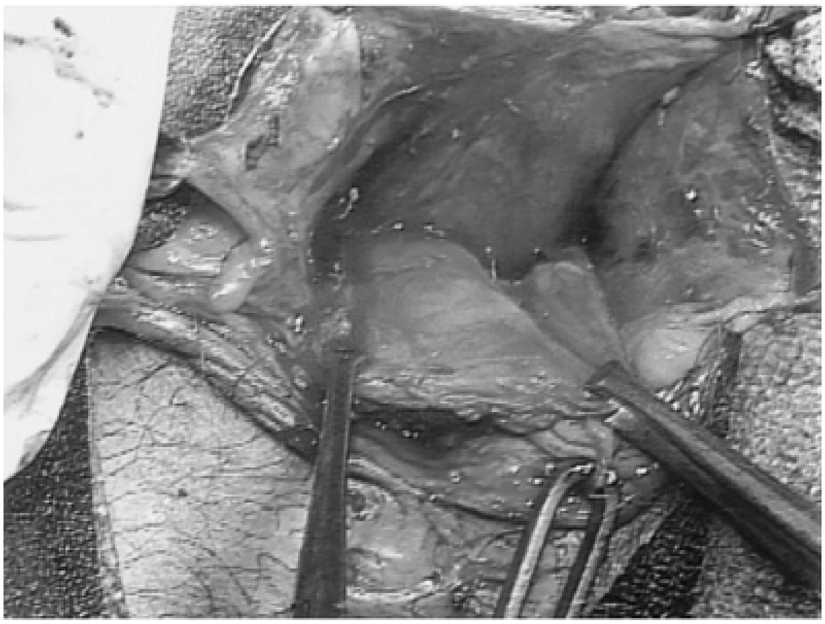

Figure 17.6 Identification of the proximal edge of the rectovaginal septum with Allis clamps.

Figure 17.7 Fully exposed rectovaginal septum.

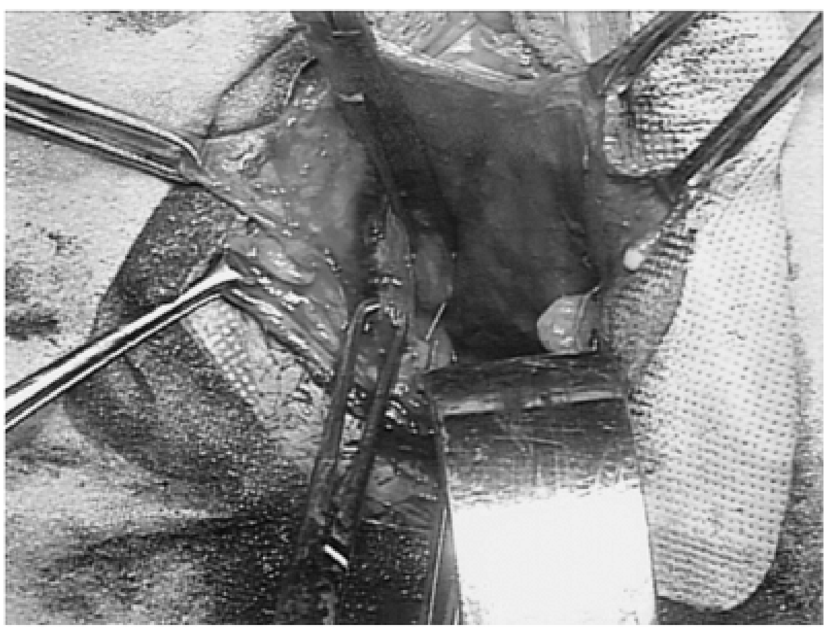

Figure 17.8 Identification of the uterosacral ligaments in the pararectal space.

After the rectovaginal septum is dissected and prepared for suspension, the next step of the operation is identification of the uterosacral ligaments (1,19,30). The key landmarks for this part of the surgery are the ischial spines. All soft tissue obstructing easy digital access to the spines should be bluntly swept or sharply dissected away. If the spines are small or difficult to locate, simply follow the coccygeus muscles and the overlying sacrospinous ligaments to their lateral terminus. The ischial spines are also located at the proximal terminus of the white lines. The broken ends of the uterosacral ligaments will be found within the pararectal spaces immediately medial to the ischial spines, and are sometimes visible and identified by their characteristic longitudinal connective tissue fibrils of tropocollagen. With a Heaney retractor inserted until the tip is adjacent to the ischial spine, downward traction is applied (Fig. 17.8).

A long Allis clamp may be used to grasp the ligament. The application of the clamp should be side-to-side, with the tip of the clamp elevated in order to grasp the tissue immediately medial to and slightly above the ischial spine. If difficulty is encountered, an examining digit inserted within the rectum may be useful in helping to identify the uterosacral ligament. Tension on the uterosacral ligament allows it to be easily palpated beside the rectum. Auxiliary lighting with the VersaLight (Lumitex, Strongsville, OH) is extremely helpful in the apical and restricted space. A pelvic reconstructive surgery drape that contains a finger cot is available (American Medical Systems, Minnetonka, MN). It allows the surgeon to perform a rectal examination and search for the uterosacral ligament without violating the sterile field. Because the ligament is suspensory, it is commonly strong enough to move the patient on the table. The characteristic cordlike configuration of the uterosacral ligament is most apparent when light traction is applied to the structure. After identification is complete, a double-pass permanent suture is placed into each of these ligaments (Fig. 17.9). Sutures are passed through the proximal edge of the rectovaginal septum. When tied, these sutures complete a bilateral uterosacral colpopexy, suspending the rectovaginal septum to the uterosacral ligaments. This critical and necessary part of the surgery reestablishes the integrity of the suspensory axis of the vagina (DeLancey Level I) and its associated structures. Perineal descent is also corrected with this maneuver.

Figure 17.9 Uterosacral colpopexy sutures.

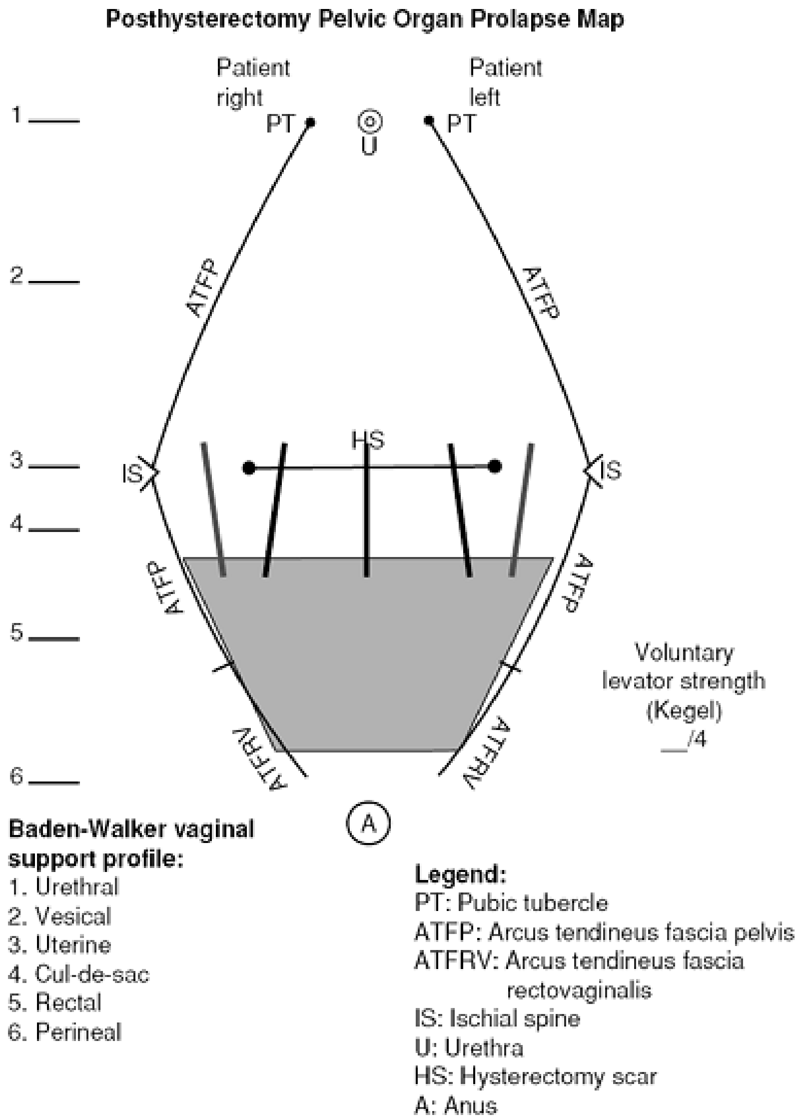

Figure 17.10 Schematic of the five key sutures in the bilateral uterosacral colpopexy and posterior vaginal reconstruction.

Alternative apical fixation sites have been described including the sacrospinous ligaments and iliococcygeus fascia (43,44,45,46). These suspension sites may be used if access to the uterosacral ligaments is not easily gained.

The next step in the operation is correction of rectocele and enterocele. Both of these hernias result from the same fascial defect. Proximal separation of the rectovaginal septum and subsequent distal retraction allow rectoceles and enteroceles to protrude through the resulting defect. Repair is accomplished by placing permanent sutures to connect the hysterectomy scar and the central portion of the rectovaginal septum. Usually three sutures are used for this portion of the operation. One of these sutures is placed in the midline, and the other two are placed equidistant between the midline suture and the uterosacral colpopexy sutures (Fig. 17.9). A complete suspension of the rectovaginal septum involves five permanent sutures. The lateral two are uterosacral colpopexy sutures, and the medial three repair the rectocele and enterocele (Fig. 17.10). When they are tied, even a large rectocele/enterocele will be successfully and completely reduced. Traditionally, enteroceles have been opened, excess peritoneum resected, and connective tissue plicated to repair apical defects (16,41,47,48,49,50). No need exists to open the enterocele sac and risk enterotomy or other complications. Correction of the fascial defect effectively repairs the enterocele, even if it is quite large. If the uterus is undescended and to be left *in situ*, the central sutures should be placed within the posterior supravaginal cervix at the level of the pericervical ring in order to repair the hernias. After completion of the suspension, any

evident central defects in the rectovaginal septum should be repaired with permanent suture.

Perineorrhaphy may be necessary. The perineum should be reconstructed to a width of approximately 4 cm. Absorbable sutures should be used for this part of the surgery unless an anal sphincteroplasty is required. Permanent or delayed absorbable sutures are permissible in the fascial sheath surrounding and investing the external anal sphincter. The goal of this portion of the surgery is anatomic restoration of the perineum. Artificially aggressive narrowing of the introitus or plication of the puborectalis muscles is ultimately counterproductive and has no place in site-specific techniques. Plications should be avoided.

Difficulty may be encountered in sculpting the rectovaginal septum to its original length, especially in patients who have significant obstetric scarring or those individuals who have had previous pelvic reconstructive surgery. Usually, careful release of all lateral and distal secondary adhesions and scars will allow the septum to reach the interspinous diameter and uterosacral ligaments without excessive tension. When properly performed, suspension of the septum will result in elevation of the perineum. For that reason, some suspensory tension is desirable so that the perineum is raised to a normal position within the gluteal fold. When perineal descent is pronounced, this structure descends below the level of the ischial tuberosities, and the patient is forced to tolerate the discomfort of constantly sitting on her anus. Although not necessary in most cases, a bolster may be used to attain additional length in the rectovaginal septum. One goal of pelvic reconstructive surgery is to reestablish normal vaginal anatomy including depth, axis, and caliber. The presence of normal anatomy maximizes the likelihood of regaining normal function. Many materials are available to assist the surgeon in accomplishing these goals. No one material has proven to be significantly better than the others, and all are capable of causing postoperative complications. Polyester and polypropylene have the longest record of clinical use; however, biologically derived products of several varieties are now marketed. If artificial material is used, copious and frequent irrigation, coupled with anatomic placement, helps to prevent the complications of rejection, exposure, and erosion. Direct attachment of bolsters to the vaginal epithelium should be avoided. The use of non-native grafts and bolsters should be minimized in pelvic reconstructive surgery unless a specific need exists. These surgical adjuncts should never be used as a substitute for biomechanically sound surgical technique.

Usually, a clearly discernable transverse detachment of the rectovaginal septum will be responsible for posterior vaginal prolapse. Some variation in pattern does exist. For example, attachment of the rectovaginal septum to the uterosacral ligament may be preserved on one side or the other. In this situation, the descent of rectocele and enterocele may be accompanied by a pararectal paravaginal defect on the contralateral side of the vagina. These pararectal defects are repaired by reattachment to the arcus tendineus fascia pelvis in a manner similar to the way that paravesical paravaginal repairs are performed in the anterior vaginal segment. Bilateral pararectal detachments may be present in large or advanced cases of prolapse. Permanent sutures are used for the repair of these defects in midvaginal lateral attachment (DeLancey Level II).

Development of improvements in surgical technique, tools, and materials are necessary to improve operative outcomes for the patient. The most recent innovation that relates to the posterior vaginal segment is the development of posterior vaginal slings (51,52). Trocars are inserted through the gluteal skin and guided through the fatty tissue within the ischioanal fossa to the apex of this recess. After a full-length dissection of the rectovaginal space, the surgeon's fingers are inserted into the rectovaginal space to the level of the ischial spine. Lateral pressure is exerted on the pelvic diaphragm adjacent to the ischial spine, and the trocar is gently passed through the inferior fascia of the pelvic diaphragm, the pelvic diaphragm, and the superior fascia of the pelvic diaphragm. The central device in the trocar sleeve is then used to withdraw the mesh from inside the pelvis through the ischioanal fossa and subsequently through the gluteal skin. After the procedure is repeated on the opposite side, traction on the free ends of the mesh results in a strip of permanent material that spans the interspinous diameter. Because all named connective tissue elements in the pelvis intersect with the interspinous diameter, this mesh can serve as a neocuff (Fig. 17.11). Especially useful in posthysterectomy or advanced prolapse patients, the mesh serves as an objective attachment point or scaffolding for proximal suspension and support. All five of the permanent sutures described previously in this chapter can be attached to the tape. The two lateral uterosacral colpopexy sutures are passed first through the uterosacral ligaments in the pararectal space and then passed through the tape before attachment to the proximal rectovaginal septum. With this technique, the load-bearing, suspensory axis is secured to the uterosacral ligaments and the full thickness of the pelvic diaphragm bilaterally. Both the tape and the suspensory axis of the vagina are stabilized further by this significantly increased distribution of load. This type of bilateral suspension is much more anatomic than a sacrospinous ligament fixation. The three central permanent sutures used to correct the rectocele/enterocele are attached to the tape. The tape may be sutured to the hysterectomy scar if no anterior prolapse is present. Alternatively, the proximal edge of the pubocervical septum may be attached to the tape if a multisegment vaginal repair is being done. If properly inserted after a full-length dissection and in conjunction with a site-specific set of repairs, a posterior vaginal sling can greatly assist in performing restoration of vaginal anatomy that has the capacity to stand the test of time.

In posterior vaginal reconstruction, restoration of DeLancey Level I suspension should precede correction of DeLancey Level II lateral attachment. After these two

levels of anatomy are corrected, DeLancey Level III distal fusion may be addressed if necessary. Surgical reconstruction should progress from proximal to distal. If the pelvic surgeon accounts for all normal connective tissue attachments in all of these segments, the best chance of good results will be attained.

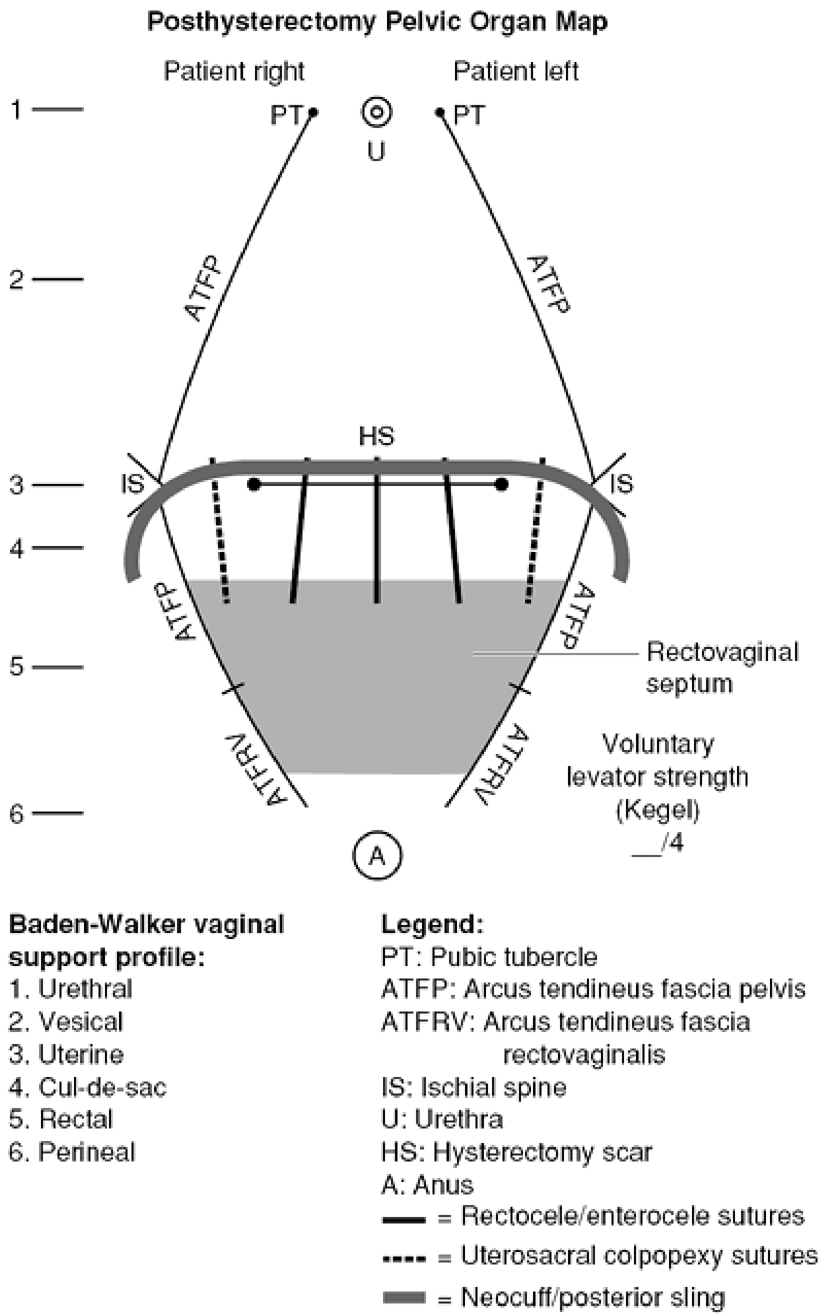

Figure 17.11 Schematic of the five key sutures in the bilateral uterosacral colpopexy and posterior vaginal reconstruction with the addition of a neocuff.

Knowledge of the common pattern of connective tissue damage to the posterior vaginal segment assists the surgeon in achieving an anatomic repair. An anatomically restorative repair that is permanent is the gold standard of pelvic reconstructive surgery.

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18

Surgical Repair of the Superior Vaginal Segment

Stephen H. Cruikshank

Preventing vaginal vault prolapse by supporting the vaginal cuff is an essential part of a hysterectomy, be it abdominal or vaginal. The incidence of posthysterectomy vaginal prolapse varies from 0.2% to 4.3% (1,2). Most American literature talks about an incidence of 1% to 2%, but in the world literature and with the advent of increasing longevity, we now know that more women are presenting with superior vaginal prolapse. Preventing complications is a *sine quo non* in surgery. In either transvaginal or transabdominal hysterectomy, it is necessary to use the pelvic supporting structures (uterosacral, cardinal ligaments, bone, uterosacral, and other ligaments) to support the vaginal cuff. A successful repair will restore normal anatomy and a functioning vagina.

Various principles of superior vaginal fixation are discussed in this chapter. These principles include attaching the vagina to the pelvic supporting structures, correcting or preventing an obvious or potential enterocele, and both vaginal and abdominal colpopexy.

Anatomy

The normal vaginal axis lies almost horizontal and superior to the levator plate (3). The levator plate is the area in which the levator ani muscle is fused posterior to the rectum, points caudally, and attaches to the coccyx. The vagina lies parallel to the levator ani and not directly over the genital hiatus. The genital hiatus is the separation in the levator ani muscles through which the urethra, the vagina, and the rectum pass. During increased intra-abdominal pressure, the levator plate and the endopelvic fascia (especially the cardinal/uterosacral complex) hold the cervix and upper vagina in their proper positions. The endopelvic fascia includes not only the cardinal and uterosacral ligaments but also the fascia that is on the superior surface of the levator ani in the pelvis. This fascia attaches to the arcus tendineus fascia pelvis, which is a line of fascial condensation between the levator muscle and the obturator internus muscle.

Stretching and laceration of the previously described supportive structures can result in uterine or vaginal prolapse. The etiologic factors include childbirth, trauma, menopausal atrophy and attenuation, and pudendal neuropathy, with loss of levator and endopelvic fascia integrity. The uterus and vaginal then overlie the genital hiatus, which leads to prolapse of these organs.

This chapter presents methods to help repair and prevent site-specific prolapse. These steps are performed both routinely and adjunctly, and they call strict attention to attaching the uterosacral and cardinal ligaments to the vaginal membrane. Also discussed are techniques that can be used to close the cul-de-sac of Douglas to prevent enterocele formation and to correct prolapse with uterine preservation.

Preventing Vaginal Prolapse During Hysterectomy

During transvaginal hysterectomy, care must be given to reattach the uterosacral/cardinal ligament complex to the vagina, including the rectovaginal septum. The following steps can be performed at the beginning or end of the case.

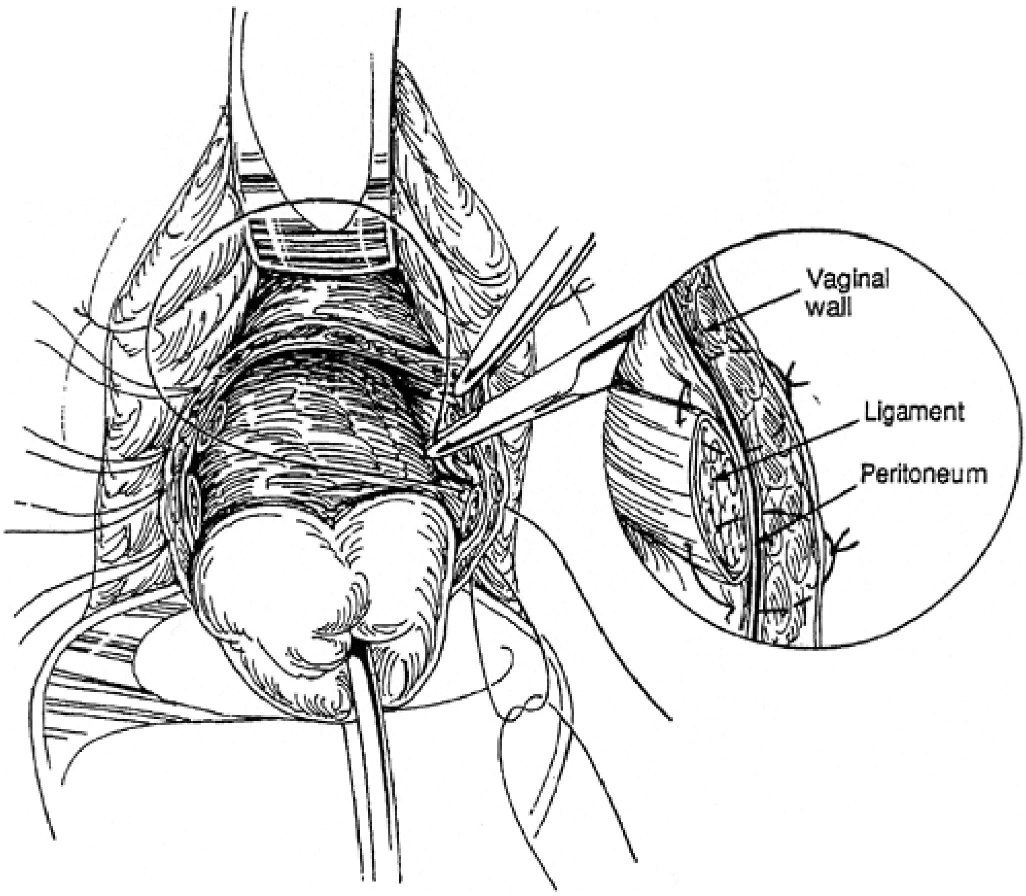

Figure 18.1 Schematic drawing showing utero-sacral-cardinal ligaments attached to vaginal membrane (without attenuation) (From, Reference 19, with permission.)

After the anterior and posterior cul-de-sacs are entered, the uterosacral and cardinal ligaments are cut and ligated. If these supporting structures are not frail or attenuated, the pedicles should be immediately sutured to the vaginal membrane (Fig. 18.1). The vaginal membrane includes the vaginal epithelium as well as the fascial layers (sheath) that surround the vagina. By suturing the supportive pedicles to the lateral angles of the vagina, the superior vault is supported. In addition, the lateral angles of the vagina are a common source of postoperative bleeding, and by incorporating them in a suture containing the fascial pedicles, they are secured. These steps are completed during any transvaginal hysterectomy. If the indication for hysterectomy includes uterovaginal prolapse, any laxity in these ligaments will require shortening. Shortening can be accomplished at the beginning of surgery provided the anterior cul-de-sac has been entered and the bladder retracted. This step elevates the bladder and ureters out of harm's way. Should the uterosacral/cardinal ligaments need shortening but the hysterectomy must be performed without entrance into the anterior cul-de-sac, the steps for shortening can be done after the uterus is extirpated and the bladder and the ureters elevated. The uterosacral ligament must be attached to the sacrum for the shortening to be effective. The ureters are actually protected by cutting the cardinal ligaments at the start of the surgery (4). This step allows the ureters to fall laterally and be retracted toward the lateral pelvic side wall.

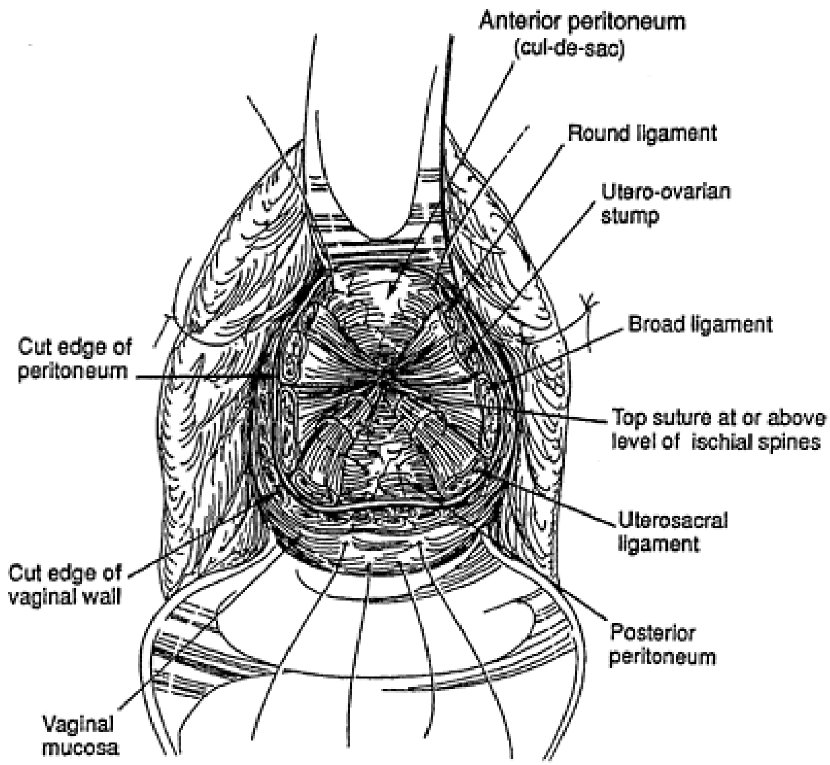

Figure 18.2 The modified McCall culdoplasty (From, Reference 6, with permission.)

Preventing Enterocele

The McCall culdoplasty or a modification of the procedure is a means of supporting the vaginal cuff during transvaginal hysterectomy (5,6,7). This culdoplasty helps to support the posterior superior vagina through the use of certain supportive structures in the pelvis. This procedure incorporates the uterosacral ligaments with the posterior deep peritoneal surface. The sutures are attached in such a manner that when tied, the uterosacral/cardinal ligaments are plicated toward the midline, which helps to close off the cul-de-sac. In addition, when the suture is tied, it draws the posterior vaginal apex up to the supporting structures, elevating it to a normal position. This procedure can be performed with one or several sutures (Fig. 18.2). The only

drawback to this type of culdoplasty is a theoretical increased incidence of kinking or ligating the ureter because it is close to the uterosacral ligament. There is no specific type of hysterectomy that requires the use of the McCall culdoplasty. The procedure should be performed at least to the level of the ischial spines. It is the best way to close the deep cul-de-sac and support the vaginal cuff at the time of hysterectomy. There are other methods discussed in this chapter, but they do not prevent enterocele. These methods only close the cul-de-sac.

The important point is to remember to follow these steps during transvaginal hysterectomy. During an abdominal hysterectomy, the uterosacrals should also be attached to the vaginal cuff. As soon as the uterus and cervix are removed, the cardinal and uterosacral pedicles are sewn to the lateral angles of the vagina. This step does not have to employ any type of elaborate angle suture as long as the endopelvic fascia is sutured to the vaginal fascia at either angle, with care taken by the surgeon to not incorporate the ureter. The ureter at this point is crossing the vagina at approximately a 45-degree angle into the base of the bladder. There is no need to incorporate the round ligaments in the attachment to the vaginal cuff, because this does not aid in cuff suspension. They may draw the ovaries to a position overlying the vaginal apex, thereby predisposing the patient to dyspareunia.

An enterocele is much like any other type of hernia, in which a sac or viscus protrudes through a defect in its normal supporting structures. In this instance, the enterocele is specifically referred to as a hernia that dissects and divides the rectovaginal septum (or the fascia of Denonvilliers). When this occurs, the peritoneal sac can elongate and become deepened to the point where it dissects far down the rectovaginal septum. Many times this condition will present as a bulge in the posterior superior segment of the vagina along the posterior wall. The condition can occur with the cervix intact or when the cervix is absent. This development is often misinterpreted as a high rectocele or vaginal vault prolapse. At times, there is no bowel in the sac but there is a large peritoneal sac dissecting the rectovaginal septum. This condition could be called a culdocele because there is no bowel protruding. Whenever there is a superior vaginal bulge, enterocele should be suspected. Another step that aids in preventing complications and transvaginal or transabdominal hysterectomy is caring for the cul-de-sac of Douglas. Whether a normal cul-de-sac, a deep cul-de-sac, or an obvious enterocele is found, an attempt should be made to avert future enterocele formation to identify and correct an obvious one.

The author believes that peritoneal closure should be performed during vaginal hysterectomy. This procedure alone does not prevent enterocele formation. It is now known that closure of the peritoneum itself is unnecessary for proper healing. However, if a deep cul-de-sac or obvious enterocele is not repaired, the condition will lend itself to future enterocele formation and possible vaginal vault prolapse. During transvaginal hysterectomy, the cul-de-sac should be closed by means of a modified culdoplasty. Beginning at the twelve o'clock position, a full-length, long-acting, absorbable or permanent suture is placed through the anterior peritoneum (Fig. 18.3).

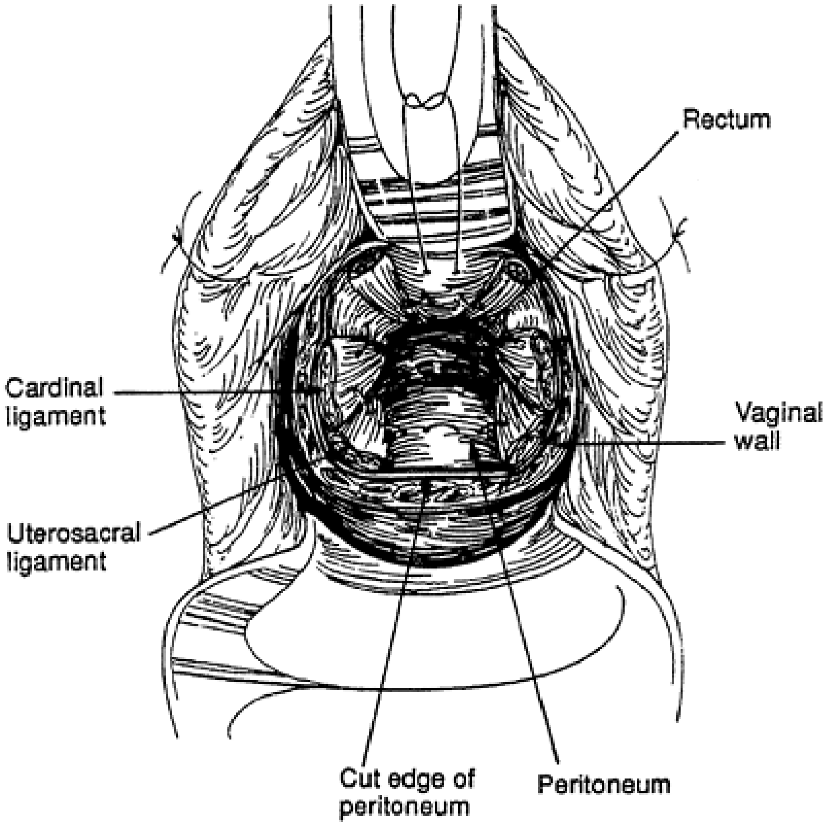

Figure 18.3 Closure of the cul-de-sac and peritoneal cavity during vaginal hysterectomy (From, Reference 19, with permission.)

In a clockwise fashion, a running purse-string suture is placed in the peritoneum (it may be placed counter-clockwise if the surgeon is left-handed). At the level of the uterosacral and cardinal ligaments, a bite is taken through each of these ligaments proximal to the ligature that connects the pedicle to the vagina. The suture is then passed through the rectal serosa and muscularis about 3 to 4 cm above the level of the peritoneal reflection. Although this technique simulates a Moschcowitz procedure, it does *not* prevent enterocele like a McCall-type procedure.

Several other methods have been described to care for the posterior cul-de-sac of Douglas in both transvaginal and transabdominal hysterectomy (5,6,7,8,9,10,11). These methods vary only slightly in technique, but the goal remains the same: to prevent or repair an enterocele. However, none of these procedures accomplish this goal. They do, however, close the cul-de-sac.

The Moschcowitz procedure was first described as a method of closing off the deep cul-de-sac in cases of rectal prolapse. It has since been modified and heralded as a technique for closing the cul-de-sac during the course of different kinds of abdominal procedures (e.g., hysterectomy, abdominal sacral colpopexy, and abdominal procedures performed for genuine stress incontinence). The Moschcowitz procedure is a circumferential suture that closes the cul-de-sac. (Figs. 18.3 and 18.4). The anterior portion of this ligature is attached to the posterior side of the lower uterine segment (if the uterus is left *in situ*) or the posterior

vaginal wall after hysterectomy. The author's method of cul-de-sac closure, described previously for transvaginal hysterectomy, is in essence a modification of the Moschcowitz suture. Whether performed abdominally or vaginally, care must be taken to avoid the ureter. This check can be done by direct palpation and identification of these sutures while placing the cul-de-sac placating ligatures (11). This procedure does not prevent enterocele unless the proximate portion of the uterosacral ligament is incorporated as well.

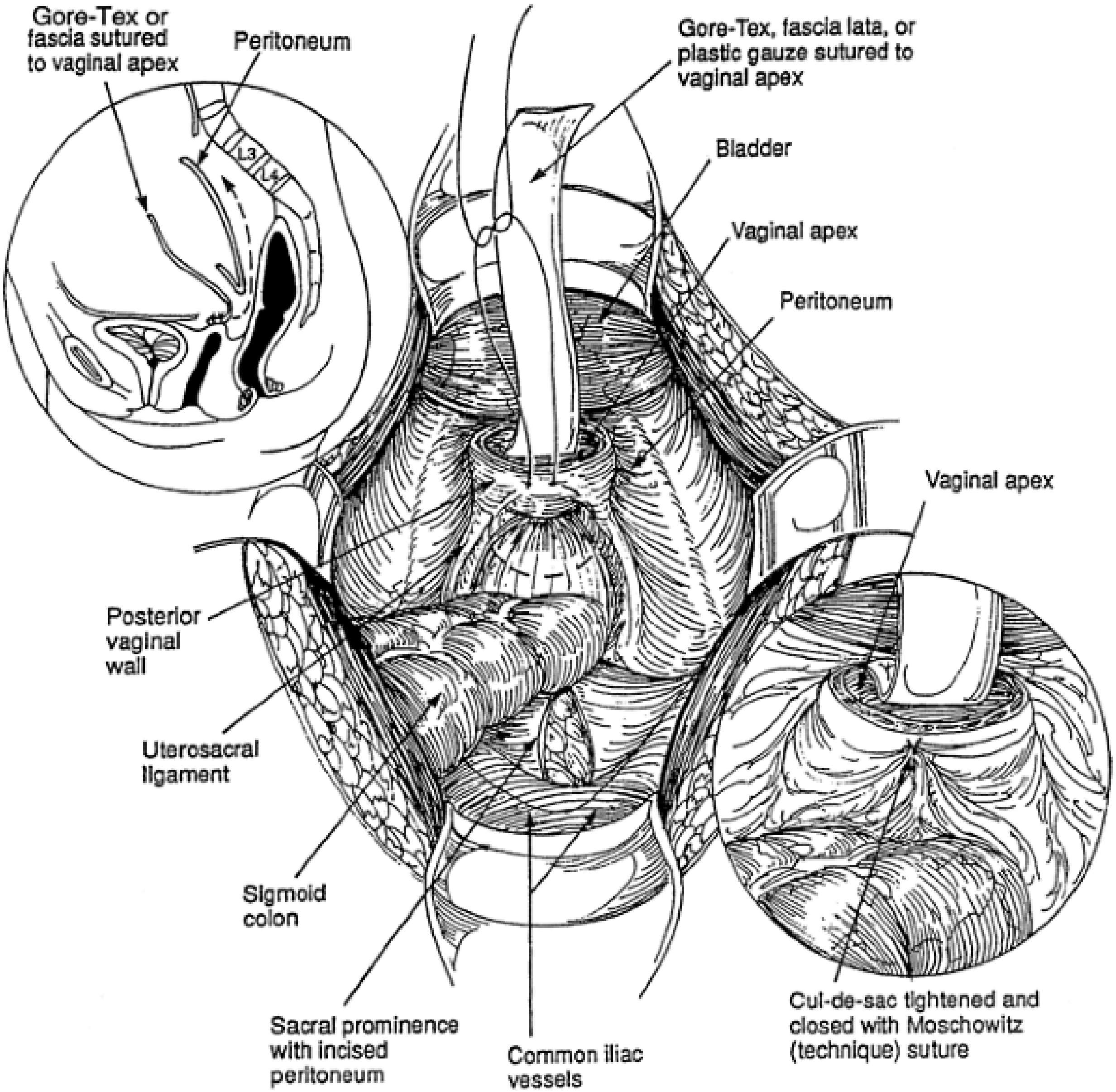

Figure 18.4 Shown is the Moschcowitz procedure to close deep cul-de-sac during an abdominal colposacropexy (From, Reference 6, with permission.)

Enterocele formation is more common than recognized. Ranney reported an incidence of 18.1% in patients undergoing major gynecologic operations (8). Failure to close a deep cul-de-sac at the time of hysterectomy or other procedure can result in hernia formation. Whether the surgeon is repairing or preventing an obvious or potential enterocele, the objectives are the same: (i) to restore function and anatomy, (ii) to prevent recurrences, and (iii) to use an appropriate procedure. As previously stated, it is important to perform both an office and an interoperative evaluation of the cul-de-sac. There are those who advocate laparoscopic obliteration of the cul-de-sac, but this technique has not been proven to be effective by any randomized study, and it is truly an operative laparoscopic procedure that is along the spectrum of difficult procedures. It should not be taken lightly as a procedure that can be performed just because the laparoscope is in place.

Adjunct Support of the Vaginal Cuff

Most hysterectomy cases have some degree of uterovaginal descensus. At times, the primary indication for the hysterectomy is symptomatic pelvic relaxation. For cases in which uterovaginal prolapse exists, adjunct vaginal apex support may be necessary. Stage I uterovaginal prolapse is defined as the presentation of the cervix past the midpoint of the vagina at rest, or to the hymen as a result of Valsalva maneuver. Stage II uterovaginal prolapse is defined as the presentation of the cervix at the hymen at rest, and past the hymen with Valsalva maneuver. In stage III uterovaginal prolapse, the cervix protrudes through the hymen with or without Valsalva maneuver and in stage IV the

complete uterus protrudes past the hymen (Figs. 18.5 and 18.6) (12).

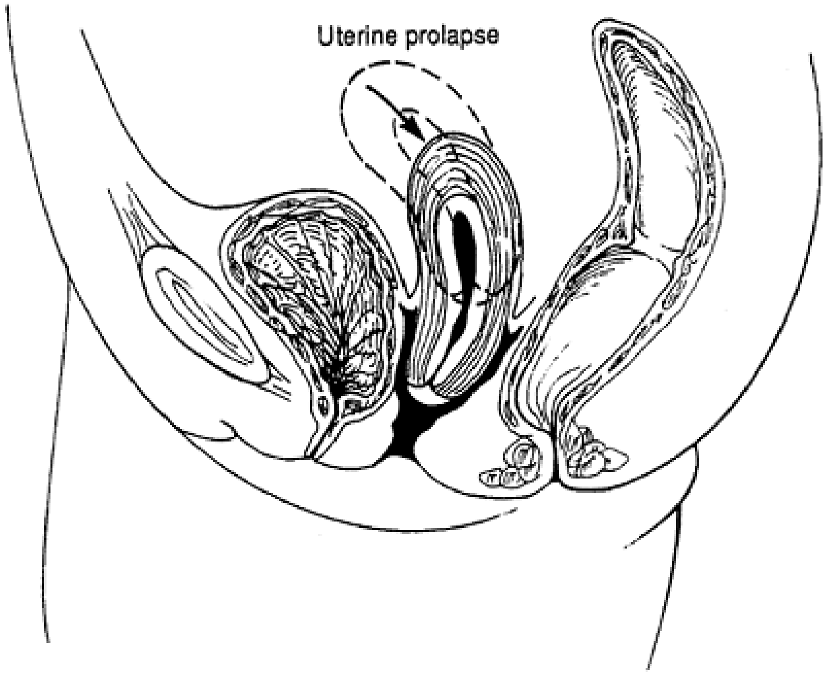

Figure 18.5 Stage 1 uterovaginal prolapse (From, Reference 13, with permission.)

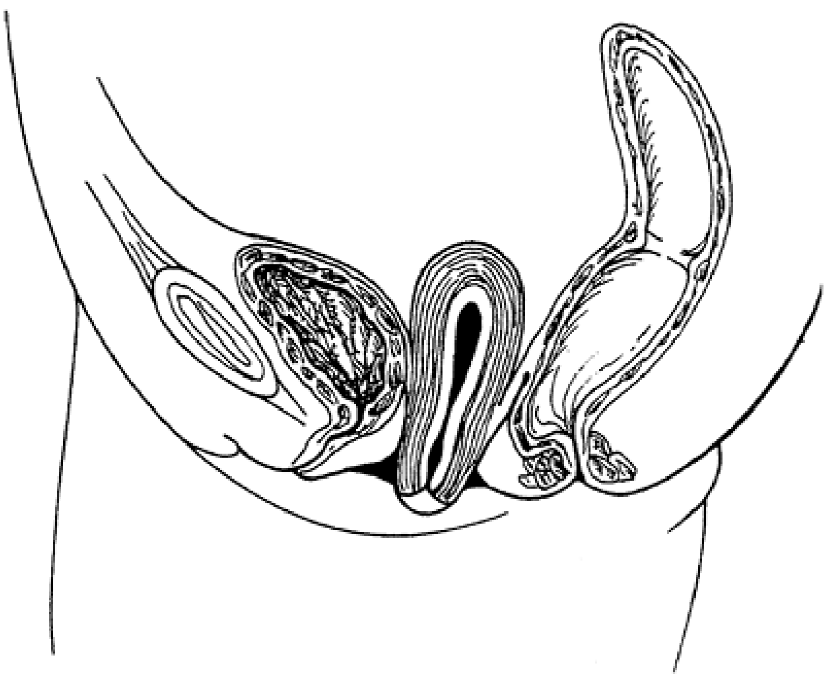

Figure 18.6 Stage III uterovaginal prolapse (From, Reference 13, with permission.)

If any of these degrees of relaxation are present before surgery, the patient may be a candidate for more than just uterosacral/cardinal ligament complex attachment to the vaginal membrane. Moreover, there will be patients who do not present preoperatively in this manner, but after vault support and any plastic vaginal repairs, the vaginal vault may still be pulled either to or past the introitus. This condition needs to be repaired at the time of surgery. Both preoperative and intraoperative evaluation of pelvic support must be performed in order to repair all defects. There are several ways in which to define uterine or uterovaginal prolapse. The important thing to remember is individual consistency. If you have one method of grading or defining uterovaginal prolapse, then this method should be used consistently. At all times, you should have a bony landmark that acts as your point of reference for what is considered â€œnormal.â€• Once this landmark is defined, it should be used for the office evaluation of pelvic support in the following manner: (i) the patient should be examined in both the supine and standing positions, and (ii) while the patient is in these positions, she should be asked to perform the Valsalva maneuver, to perform Kegel exercises, and then to relax.

Sacrospinous Fixation

Traditionally, sacrospinous fixation of the vagina and abdominal sacral colpopexy have been regarded as therapeutic tools to be used only for the repair of vaginal vault prolapse and certain types of enteroceles (13,14). However, either of these procedures may also be used as adjunct to prevent post-hysterectomy vault prolapse. Not every hysterectomy patient is a candidate. If a loss of the pelvic supportive structures (the uterosacral-cardinal ligament complex) is noted during hysterectomy, an attempt to use their proximal remnants should be made. However, sacrospinous fixation as an adjunct will prevent further vault prolapse. If, for some reason, an abdominal hysterectomy is indicated in a patient with uterovaginal prolapse, the abdominal sacral colpopexy can be performed as an adjunct. The sacrospinous ligament fixation is an excellent procedure for restoring the vagina to its anatomic position. The procedure does so by attachment of the posterior vaginal epithelium with its endopelvic fascia to the sacrospinous coccygeus complex. The sacrospinous ligament is covered by the coccygeus muscle and may be palpated deep in its body. Once the sutures have been placed through the sacrospinous ligament and the coccygeus muscle, the sacrospinous ligament is then attached in an almost horizontal position in the pelvis. Although it can be a relatively short and efficacious procedure, the sacrospinous ligament fixation procedure is not to be taken lightly. There have been cases of death resulting from this procedure due to hemorrhage, neuropathy from tying off branches of the sciatic nerve, and pudendal nerve and vessel damage. The sacrospinous ligament fixation procedure is performed as follows:

- The posterior vaginal wall is opened to the apex and the rectovaginal space is entered.
- The rectovaginal space is dissected, with the operator's finger at the level of the ischial spines.
- At that time, the descending rectal septum (pillar) is perforated, opening the pararectal space (Fig. 18.7).
- With additional blunt dissection, the ischial spine and coccygeus muscle-sacrospinous ligament complex are palpated and identified visually.

- Long-acting, absorbable sutures or monofilament, permanent sutures are placed through the ligament.
- These sutures are held and left untied until any additional reconstructive procedures are finished.
- Finally, the ligament fixation is carried out by using both safety and pulley stitches (Fig. 18.8).

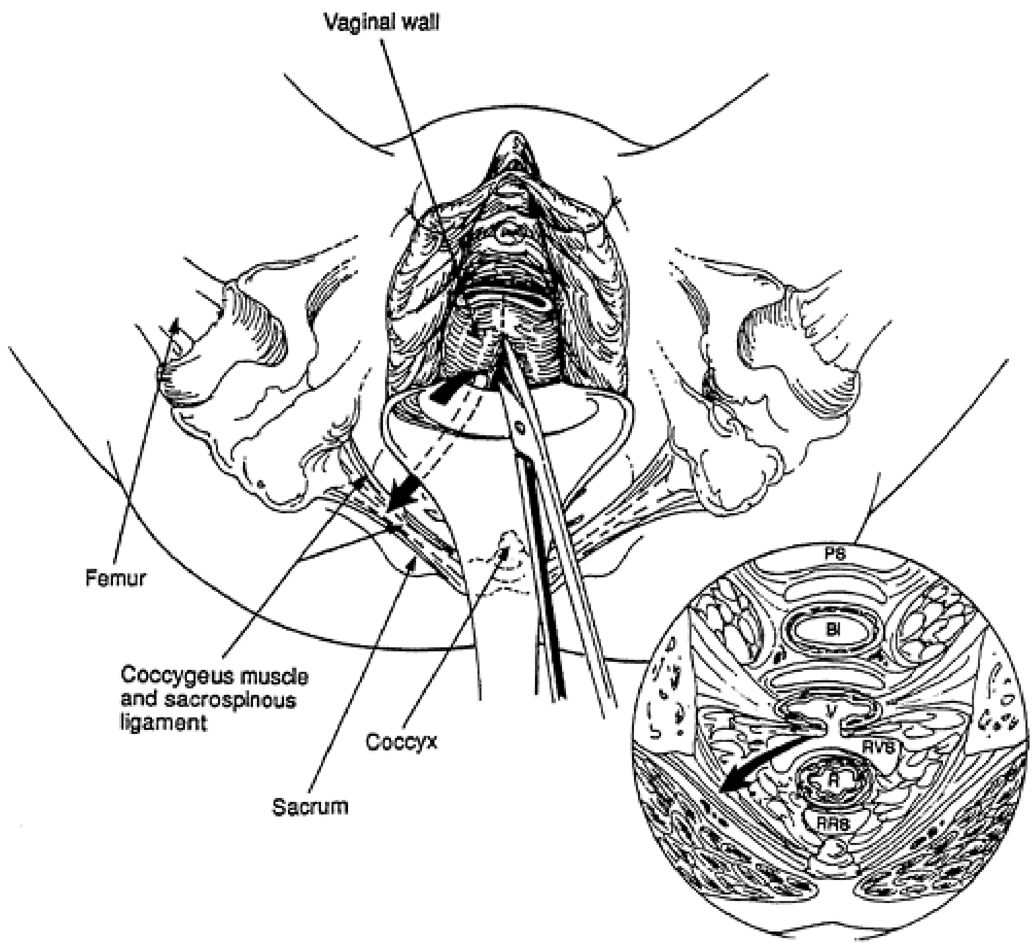

Figure 18.7 Dissection of rectovaginal and pararectal spaces (From, Reference 13, with permission.)

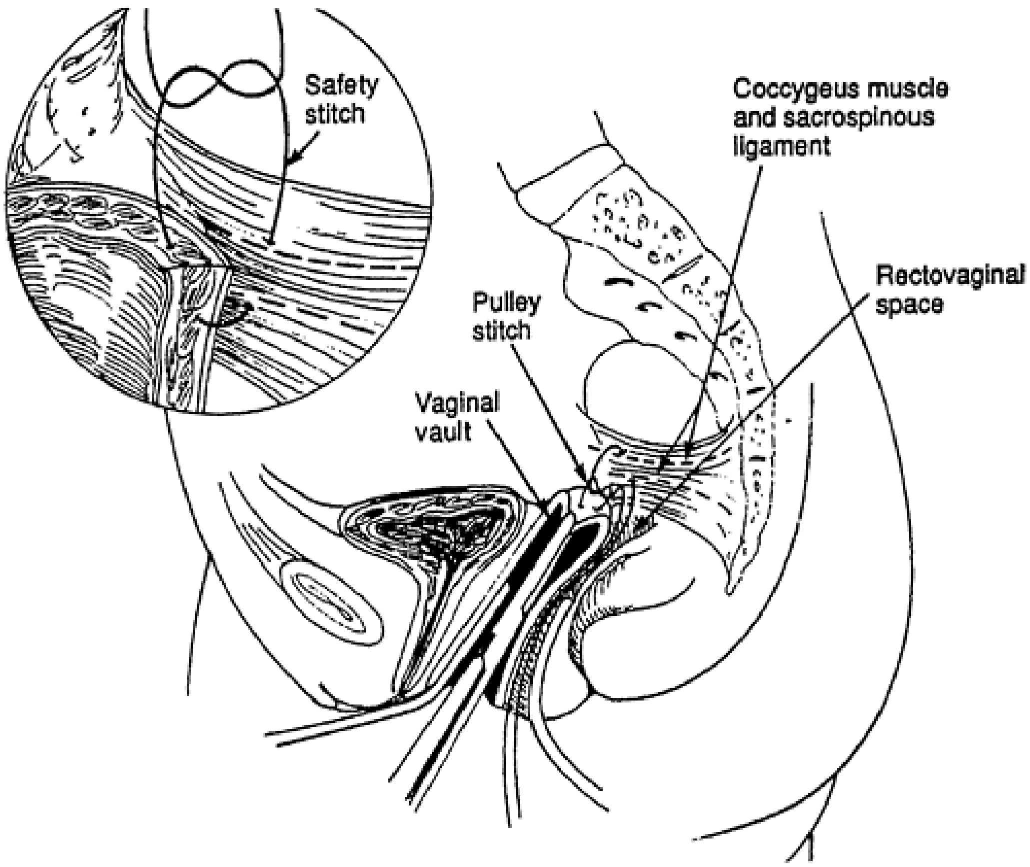

Figure 18.8 Fixation demonstrating pulley and safety stitches (From, Reference 13, with permission.)

If, for some reason, an abdominal hysterectomy was indicated despite the presence of uterovaginal prolapse, an abdominal sacral colpopexy can be performed. There are several modifications of abdominal sacral colpopexy, but this discussion is limited to a modification of two types (15,16).

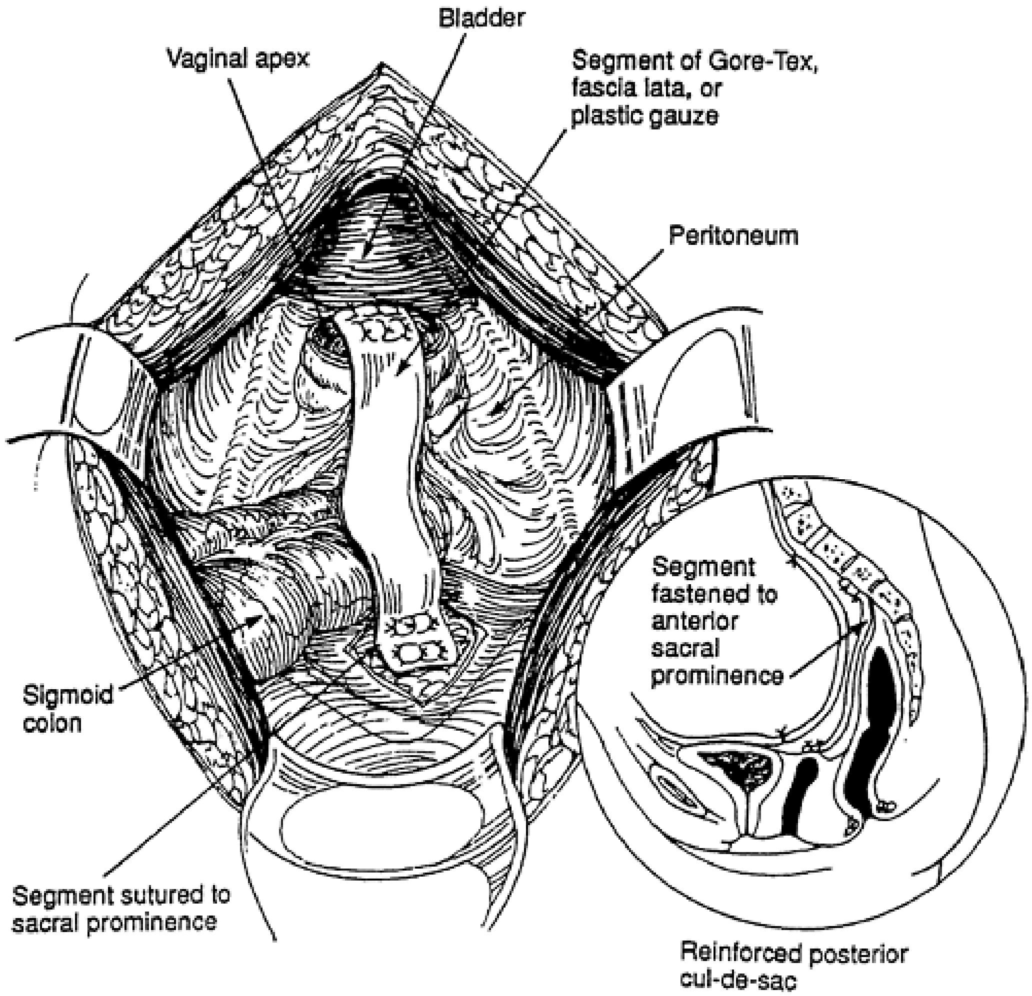

Figure 18.9 Abdominal sacral colpopexy (From, Reference 6, with permission.)

- An incision is made in the peritoneum in the hollow of the sacrum from the sacral promontory downward as far posteriorly as possible.
- The cul-de-sac is obliterated by the Moschcowitz operation.
- Three to five permanent sutures are placed in the periosteum approximately 1 cm apart. These sutures are used to hold one end of the graft (Teflon, Mersilene [Ethicon], Gore-Tex [W. L Gore, Flagstaff, AZ] or homologous fascia) to the sacrum.

- The other end of the graft is sewn to the vaginal vault and sacral promontory periosteum. At the time, the graft is secured to the underlying serosa of the sigmoid with two or three 2-0 nonabsorbable sutures (Fig. 18.9). The author's preference for this type of graft is homologous fascia, and to date has performed 695 successful sacrospinous fixations (17).

Prolapse with Uterine Preservation

Sacrospinous ligament fixation is an established treatment for vaginal prolapse and uterovaginal prolapse (18,19). One report described the use for this procedure in five women for management of uterine prolapse. The results of the use of this procedure in 27 women with uterovaginal prolapse have also been reported (20). Eight of these patients have delivered vaginally (one patient delivered vaginally twice). This is believed to be the first report of successful pregnancies and vaginal deliveries after sacrospinous uterosacral fixation.

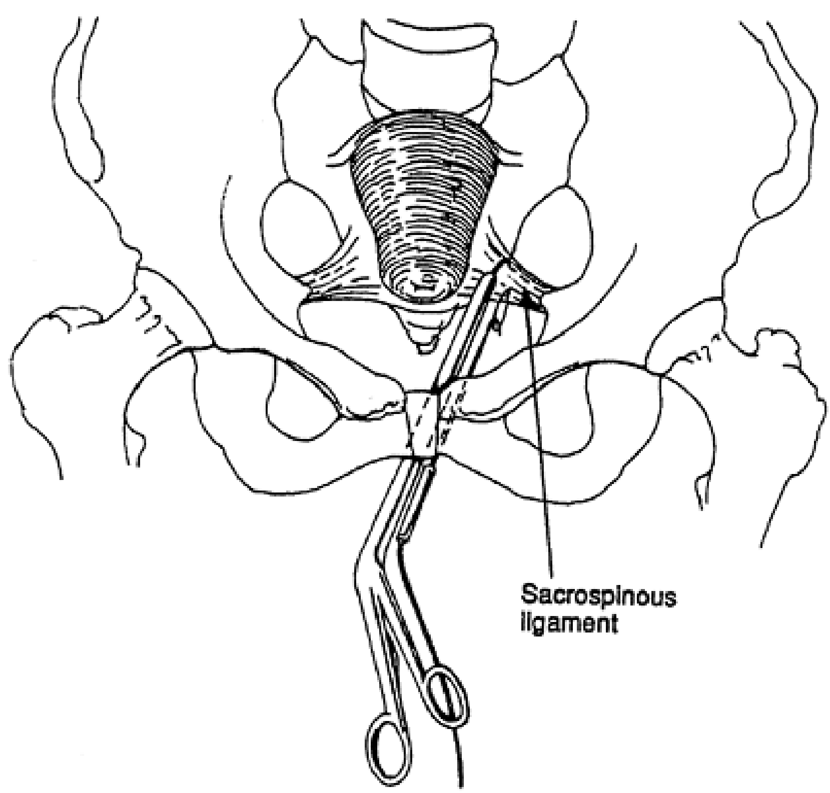

Figure 18.10 Placement of sutures into ligament (From, Reference 20, with permission.)

In this study, 27 patients underwent transvaginal sacro-spinous uterosacral ligament fixation. In all of the 27 patients, the uterosacral ligaments were attenuated but

identifiable for fixation. Ligament fixation was performed as follows:

- The posterior vaginal wall was opened to the level of the cervix and the rectovaginal space was entered.
- The rectovaginal space was dissected bluntly to the level of the ischial spines.
- The descending rectal septum (pillar) was perforated, which opened the pararectal space. At this point, the peritoneal cavity could be opened and any obvious enterocele repaired.
- The uterosacral ligaments were exposed with further direction. If the peritoneal cavity had already been entered, the uterosacral ligaments were easily visualized and dissected. These ligaments were grasped with Babcock clamps for identification, traction, and suture placement.
- If the procedure was to be performed unilaterally, the right sacrospinous-coccygeus complex was visualized. If the procedure was to be performed bilaterally, both sacrospinous-coccygeal complexes were identified. With the Mayo hook, two 0-polydioxanone (among these patients, eight cases) or two a-polypropylene sutures (11 cases) were placed, either both to one side (for a unilateral procedure) or one to each sacrospinous ligament (for a bilateral procedure).
- One end of each suture was placed on a Mayo needle and sewn to each uterosacral ligament to be tied (Figs. 18.10 and 18.11). The uterosacral sutures were tied within 1 to 2 cm of the cervical attachment of the uterosacral ligament.
- Traction on the other end of the suture drew the uterosacral ligaments and

cervix lateral and cephalad above the levator plate. If a bilateral procedure was performed, one or two additional sutures were placed in the uterosacral ligaments, plicating them in the midline to close off the cul-de-sac (Fig. 18.12). All sutures were left untied until additional adjunct procedures were completed. The sacrospinous uterosacral sutures were then tied.

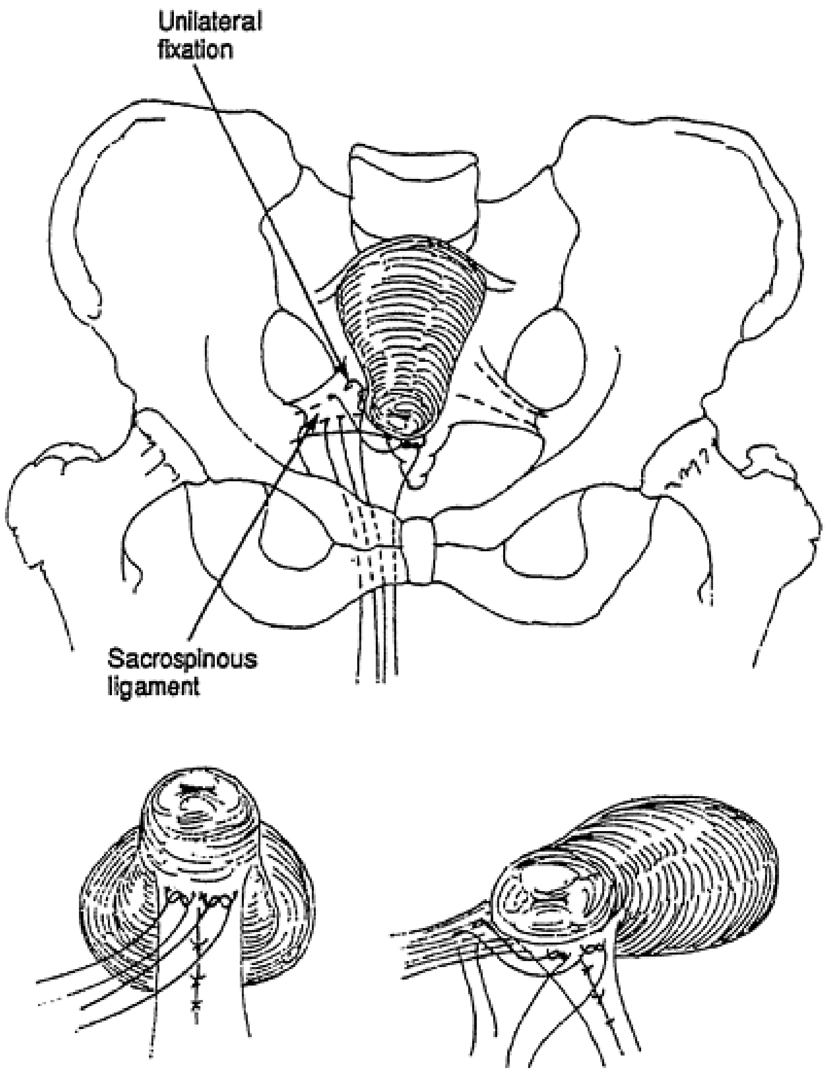

Figure 18.11 Unilateral sacrospinous uterosacral fixation, showing how the cul-de-sac is closed (From, Reference 20, with permission.)

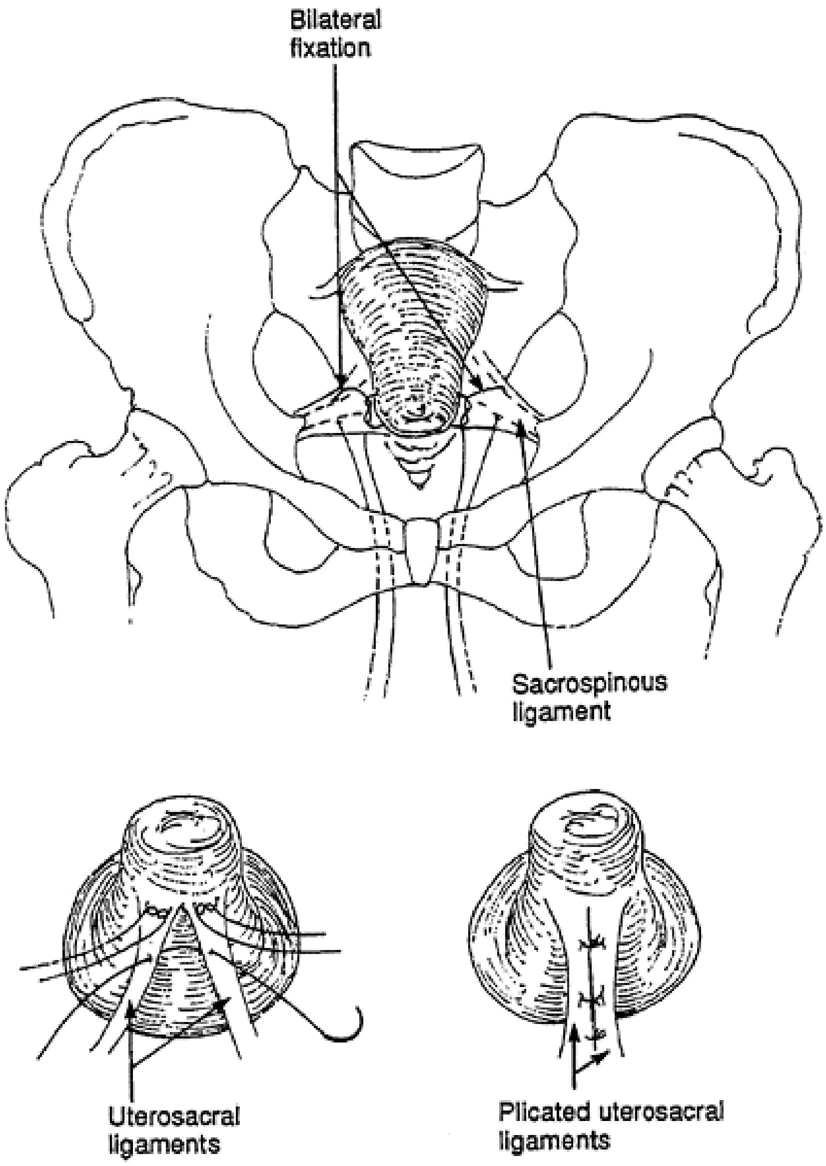

Figure 18.12 A bilateral sacrospinous uterosacral fixation and uterosacral placation is shown (From, Reference 20, with permission.)

Past approaches to uterine suspension had adverse effects: Fertility was low, dyspareunia was apparent, and uterine prolapse recurred. Moreover, procedures that used the anterior abdominal wall as the point of attachment allowed intra-abdominal pressure to be transmitted into the cul-de-sac, possibly causing an enterocele. In the

Manchester procedure (vaginal approach), the uterosacral and cardinal ligaments are shortened and reattached to the anterior

cervical fascia. In addition, a portion or all of the cervix is amputated. Fertility is decreased and pregnancy wastage is reported to be as high as 50%. Fertility with successful pregnancies occurred in the 27 study patients nine times (33%), a significant increase compared with the original result of the Manchester procedure.

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19

Surgery of the Urethra

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T. Casey Woodring

While the urethra, bladder, and urethrovesical junction are often discussed as separate entities, they are, in reality, integrated components of an organ system designed to store and expel urine. Urethral diverticula, urethrovaginal fistula, and pathologic urethral lesions are common conditions that may require surgical intervention and are detailed here. Knowledge of normal urethral development is important for a thorough understanding of various conditions seen in the female urethra. Furthermore, knowledge of normal anatomy and physiology will help the surgeon to plan effective management schemes to address abnormalities of the female urethra.

Embryology

Approximately 15 days after fertilization, the ectoderm and endoderm layers of the presomatic embryo are in close proximity to one another at the cloacal plate. At the same time, the allantois forms as a diverticulum from the yolk sac, and the hindgut enlarges to form the cloaca. About 28 days after, fertilization mesoderm from the allantois advances toward the cloacal membrane and forms the urorectal septum. During somite development, the embryo undergoes dramatic growth that causes a 150-degree rotation of its caudal region. This rotation shifts the cloacal membrane to a ventral position and brings the urorectal septum into apposition with the cloacal membrane. Mesoderm of the lateral cloaca grows toward the urorectal septum. These events partition the cloaca into a ventral urogenital sinus and a dorsal anorectum. The area where the urorectal septum and lateral mesoderm fuse to the cloacal membrane forms the future perineal body (1).

At the point where the mesonephric (Wolffian) ducts join with the urogenital sinus, it is divided into the vesicourethral canal cranially and the definitive urogenital sinus caudally. The cranial-most portion of the vesicourethral canal is destined to be the definitive bladder, which is endodermal in origin. The segment of the mesonephric duct distal to the ureteric bud is absorbed into the urogenital sinus and forms the bladder trigone, which is of mesodermal origin. The caudal portion of the vesicourethral canal does not dilate and forms the urethra. The urethra adjacent to the trigone is also derived from the mesonephric ducts and, therefore, is also of mesodermal origin. These events are usually completed around 40 days after fertilization. Separate development of the trigone and bladder may explain why muscle of the trigone is contiguous with that of the ureter but not of the detrusor muscle. It may also explain why the pharmacologic responses of the trigone and bladder neck differ from those of the detrusor.

The paramesonephric (Mullerian) ducts are the primoidium of the uterus, and cervix and the mesonephric ducts are precursors of the urinary tract. They are closely related in the early embryo and both participate in development of the female urethra and vagina. Traditional theories of developmental anatomy supported that the superior vagina arose from the parmesonephric (Mullerian) ducts and the distal vagina from the urogenital sinus. Recent evidence suggests that the sinovaginal bulb is an extension of the caudal segment of the mesonephric (Wolffian) duct and supports its participation in embryonic development of the vagina. At the most caudal portion of the Mullerian duct (uterine and cervix primordium) and the adjacent dorsal wall of the urogenital sinus, the sinovaginal bulb forms. Cells of the sinovaginal bulb proliferate to create the vaginal plate, which pushes the uterus away from the urogenital sinus (2). The vaginal plate rests dorsal to the urethra. The lumens of the urethra and vagina are separated by continued proliferation of the sinovaginal bulb. After the cloacal membrane canalizes by apoptotic cell death, the definitive urogenital sinus remains as the vaginal vestibule into which the urethra and vagina open. The anorectal portion of the cloacal membrane canalizes in a similar manner, creating a pathway from the rectum to the outside.

Outcroppings from the urethra form the paraurethral (Skene's) glands. These events occur between the tenth and twentieth weeks (3).

Anatomy of the Urethra

The urethra is a narrowed extension of the bladder that forms a cylindrical fibromuscular tube designed for passage of urine. The female urethra is normally 4 cm in length from the bladder base to its meatus at the vaginal vestibule and about 6 mm in diameter. The site of transition from bladder to urethra is designated the urethrovesical junction or bladder neck. The base of the bladder rests on the anterior vaginal wall caudal to the cervix. The urethra passes through the retropubic space and penetrates the perineal membrane. The urethral meatus opens on the vestibule ventral to the vagina. The caudal urethra is lined by nonkeratinized, stratified squamous cells similar to those found on the vestibule, while the cephalad-most urethra is lined by transitional cells akin to those of the bladder. Throughout its length, the urethra is closely related to the anterior vaginal wall. The portion near the bladder is relatively easy to separate from the vagina, while the more caudal urethra is fused with connective tissue of the anterior vaginal wall.

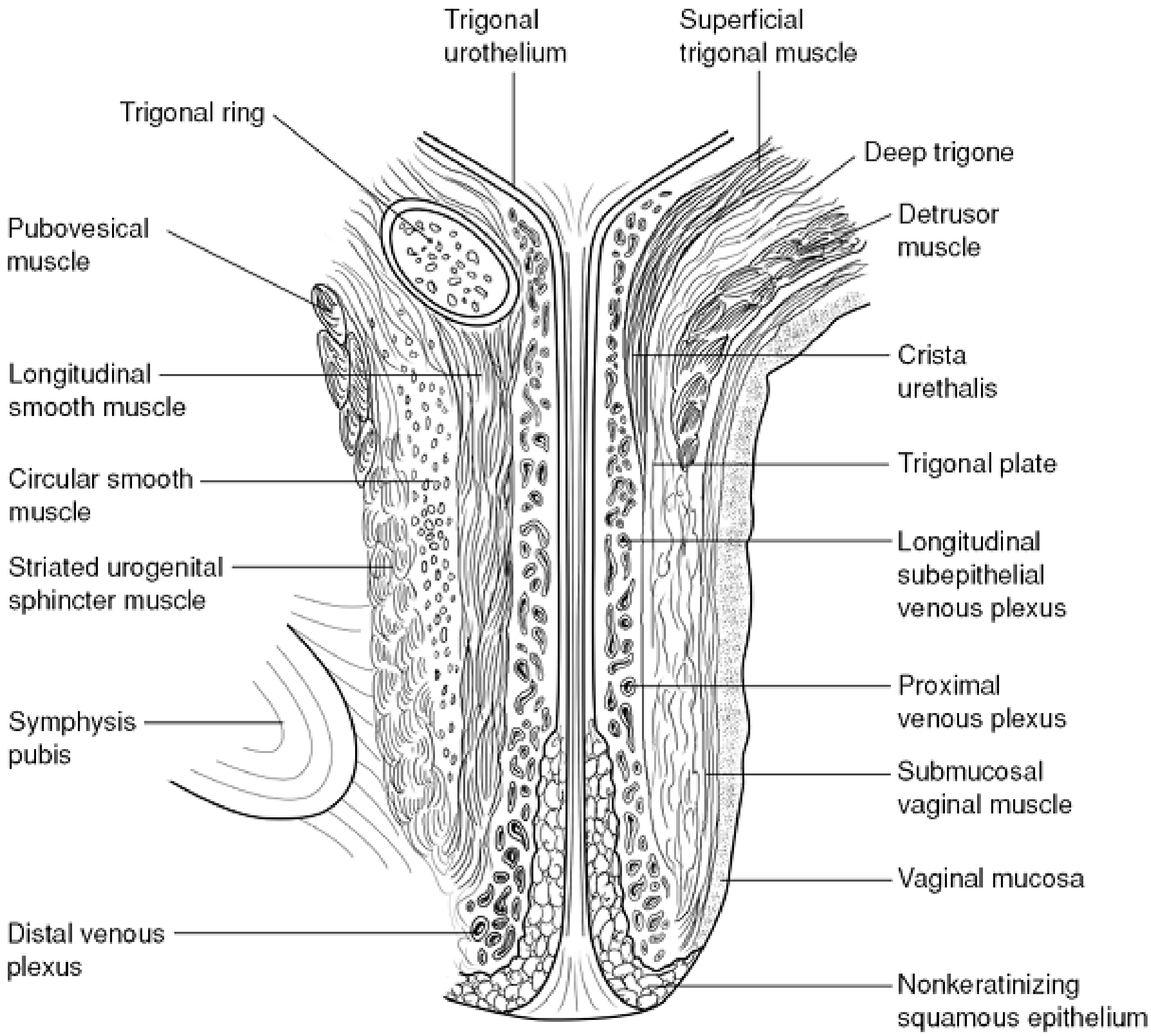

Figure 19.1 Longitudinal anatomy of the female urethra. (From, Strohbehn K, DeLancey JOL. The anatomy of stress incontinence. *Operat Tech Gynecol Surg*. 1997;2:13
, with permission.

At rest, the urethra is collapsed on itself, creating longitudinal folds of the uroepithelium. The folds give the appearance of glands when viewed in cross section; however, they are merely crypts created by redundant tissue. Tissue redundancy allows for significant expansion of the urethra when urine is expelled under pressure. While the urethra itself is not glandular, many small mucous-producing glands surround the urethra and open into its lumen. The glands are concentrated in the caudal urethra near the meatus. These organized collections of glands, which empty through ducts into the caudal urethra, are designated as Skene's glands.

The uroepithelium is surrounded by loose areolar connective tissue with a large concentration of collagen and elastin and a rich vascular plexus. Because of its superficial location, the plexus is susceptible to trauma that may lead to significant hemorrhage. The mucosa and submucosa are surrounded by a thick meshwork of smooth muscle, which is contiguous with muscle of the bladder. The innermost smooth muscle layer is more prominent and is oriented in a longitudinal direction. These muscle fibers insert onto the periurethral fatty and fibrous tissue. The outer layer is thinner and oriented in a circular direction (Fig. 19.1). While both layers of smooth muscle are easily identified, they are neither as well organized nor as distinct as are those of the gut. The circular muscles are thought to constrict the urethra, thus enhancing urethral pressure and resisting flow of urine. However, the longitudinal layer is also thought to help maintain continence. The smooth muscle is rich in alpha adrenergic sympathetic receptors, which stimulate

contraction (4). The longitudinal muscle may assist micturition by shortening and widening the urethral lumen. The smooth muscle of the urethra and the bladder base are clinically designated as the intrinsic urethral sphincter.

Distinct striated muscle bundles can be identified along the course of the urethra and are currently designated as the sphincter urethrae, the urethrovaginal sphincter, and the compressor urethrae (5). They function in concert to compress the urethra, thus creating a continence mechanism. The sphincter urethrae, the innermost striated muscle, surrounds the cephalad and mid urethra. The compressor urethrae and the urethrovaginal sphincter arch over the urethra as it passes under the pubic symphysis. The urethrovaginal sphincter encircles both the urethra and vagina. Contraction of the urethrovaginal sphincter narrows the urogenital hiatus. The compressor urethrae fans out along the inferior border of the pubic rami, and contraction compresses the urethra against the vaginal wall (Fig. 19.2). The striated muscles function as a single unit and are clinically designated as the striated urethral sphincter or external sphincter.

Individual striated muscle fibers are designated slow twitch (Type I) and fast twitch

(Type II). Type I fibers respond relatively more slowly but are fatigue resistant, enabling them to provide nearly constant low-level tension. Striated muscles of the urethra are composed primarily of slow-twitch fibers. Because slow twitch fibers are fatigue resistant, they provide steady long-term resting tone and maintain closure of the urethra. Type II fibers are capable of a rapid respond, but they fatigue quickly. Thus, their response is limited in duration, and their actions tend to be phasic. Fast-twitch fibers can respond acutely to sudden increases of abdominal pressure, such as with a cough or sneeze. This acute response assists with maintaining of continence by enhancing urethral closure pressure.

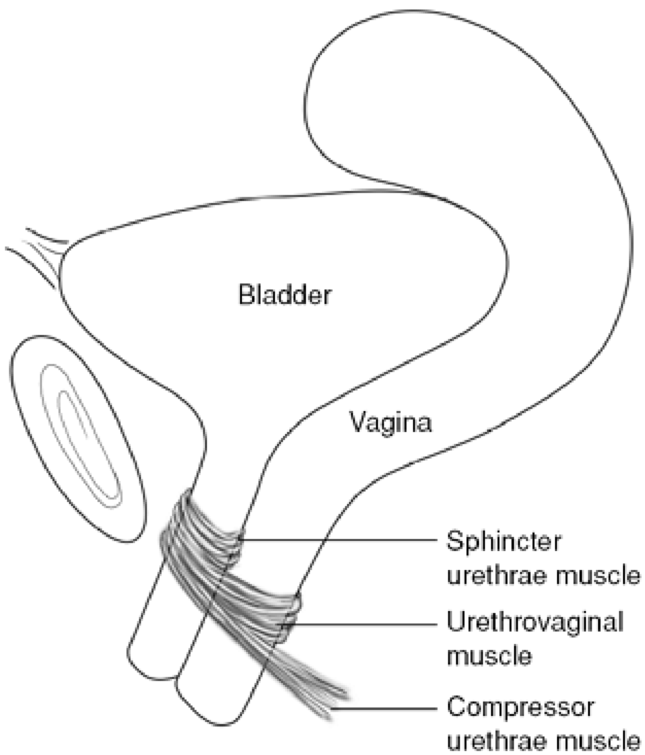

Figure 19.2 The striated urethral sphincter muscles: sphincter urethrae, urethrovaginal sphincter, and compressor urethrae.

The vascular plexus in the submucosa, smooth muscle, and striated muscle contribute in approximately equal portions to intrinsic urethral pressure. When each of these three components functions properly, a hermetic seal is created, maintaining continence. If any of the components are compromised, intrinsic urethral pressure is reduced. When urethral pressure is significantly reduced, incontinence may worsen if already present or develop de novo. In extreme cases, urine may passively drain from the bladder.

Pelvic Organ Support

The pelvic diagram consists of both muscle and connective tissue that collectively maintain the normal anatomic relationships of the urethra, bladder, and pelvic organs. Connective tissue, which is anchored to sites within the pelvis, provides passive static support. The levator ani muscles provide active dynamic support of the pelvic floor. The connective tissue includes relatively well-defined aggregates of dense collagen called *ligaments* and less well-organized collections of collagen, smooth muscle, elastin, fibrin, neurovascular tissue, and fibrovascular bundles coined *endopelvic fascia*. However, these tissues do not resemble ligaments or fascia found in the extremities. Clinically identifiable structures are termed the *uterosacral* and *cardinal ligaments* (6). They suspend the upper vagina to the lateral pelvis sidewall and sacrum. The arcus tendinous levator ani (ATLA) and arcus tendinous fascia pelvis (ATFP) are condensations of obturator and levator ani fascia. The ATLA overlies the obturator internus muscle and can be identified on a course between the pubic rami and ischial spines about 2 cm dorsal to the obturator neurovascular bundle. The ATFP is more medial and extends from the pubic symphysis to the ATLA near the ischial spine. These structures are denser and are more organized than other areas of endopelvic fascia. Caudal fibers from the ATFP fuse with the perineal membrane (urogenital diaphragm). A trapezoidal-shaped layer of connective tissue connects to the pubic bone, lateral pelvis at the ATFP, and ischial spines. This layer of tissue creates a hammock on which the bladder and urethra rest and which supports the vagina. This hammock also creates a backstop against which the urethra can be compressed (7).

The trapezoid of connective tissue is separated into three levels. That portion of tissue that suspends the apex of the vagina is designated as Level I. That portion of fascia that attaches the middle portion of the vagina to the pelvic sidewall is designated as Level II. That portion of fascia that is fused to the caudal vagina at the urethra and perineal body is designated Level III. Damage to Level I support leads to prolapse of the vaginal apex. Damage to Level II leads to paravaginal defects. Damage to Level III is associated with fusion defects between the urethra and pubic bone and may

compromise the integrity of the perineal body. The end result of Level III defects is hypermobility of the urethra with the potential for incontinence.

Three striated muscle groups support the pelvic floor. They function as a unit and clinically are known as the *levator ani muscles* (8,9). The iliococcygeus and coccygeus muscles form a diaphragm that is attached to the pubic bone, ATLA, anococcygeus raphe, and coccyx, and which supports the pelvic organs and abdominal contents. The pubococcygeus (puborectalis) muscle forms a pubovisceral sling, which surrounds the colon at the anorectal junction. However, some muscle fibers interdigitate across the midline and surround the vagina. Tonic contraction of the pubococcygeus acutely angulates the bowel at the anorectal junction; this stops fecal material from entering the anus and aides bowel control. Additionally, when the puborectalis muscle contracts, the urogenital hiatus is closed, and the vaginal angle is maintained. The posterior vaginal wall being drawn toward the pubic bone indirectly supports the urethra and vesical neck (10). Normal relaxation of the pubococcygeus opens the genital hiatus and allows micturition and defecation. If relaxation is persistent or excessive, the genital hiatus appears to be gapping. Incontinence of urine and stool is likely (11).

Because the levator ani muscles are primarily slow-twitch and fatigue-resistant fibers, they constantly maintain tone, thereby keeping the genital hiatus closed. They counteract stresses applied to the passive support during routine activities. Type II fibers are found in highest concentration in the perianal and periurethral area. They can react to sudden increases in abdominal pressure to help maintain continence.

Pelvic Floor Innervation

Storage of urine and micturition are controlled by complex interactions of the peripheral nervous system (PNS) and autonomic nervous system (ANS). The PNS is responsible for striated muscle stimulation and proprioception, while the ANS controls smooth muscle through sympathetic and parasympathetic innervation. These local actions are modulated by the central nervous system (CNS). When the CNS is mature and functionally intact, it can inhibit or enhance the local reflex pathways of the PNS and ANS to coordinate storage of urine and appropriately timed voiding. These modulating impulses originate in the cortex, brain stem, and spinal cord. Injury or destruction of neurons at any of these levels may lead to abnormal storage and abnormal micturition due to detrusor instability, hyporeflexia, or areflexia (12).

Parasympathetic, sympathetic, and somatic nerves convey afferent sensory input to the CNS. Sensory afferent nerves from the bladder and urethra include myelinated Type A fibers and unmyelinated Type C fibers. Type A afferent nerves are moderately sized delta fibers with intermittent conduction velocity. Type A fibers primarily innervate mechanical receptors and are active during normal filling. Type C fibers are small nerves with relatively slow conduction velocity and high stimulatory thresholds. They are normally quiescent during filling but transmit sensations of bladder urgency. They also transmit sensations of pain with noxious stimuli such as infection, elevated potassium, or excess acidity. Sensory afferent stimuli from the bladder and urethra trigger impulses that travel along afferent parasympathetic fibers to the S2, S3, and S4 nerve roots and afferent sympathetic fibers to the T10 through L2 nerve roots. These sensory afferent neurons run in the pelvic and hypogastric nerves, respectively. Both parasympathetic and sympathetic afferent nerves synapse in the posterior gray horns of their respective spinal cord segments. Impulses then proceed to the continence center in the pons, periaqueductal gray matter in the midbrain, thalamus, and finally, the cingulate gyrus (13). Afferent nerve activity during bladder emptying seems to be essential for the voiding reflex. Destruction or neuropathy of the afferent nerves leads to voiding dysfunction or even the inability to void in extreme situations. Somatic afferent impulses are conveyed from the urethral sphincter and perineum via the pudendal nerve and parasympathetic pathways.

Efferent impulses from the CNS are conveyed to the bladder and urethra by the pelvic nerve, pelvic plexus, and the hypogastric nerve. Parasympathetic efferent stimuli are conveyed by cholinergic preganglionic neurons from S2, S3, and S4, which travel in the pelvic nerve and synapse in the cholinergic ganglia of the pelvic plexus and bladder wall. Parasympathetic impulses stimulate detrusor contraction through nicotinic acetylcholine receptors and inhibit urethral smooth muscle contraction. Sympathetic efferent impulses from the T10-L2 nerve roots travel through cholinergic preganglionic neurons to the corresponding chain ganglia and synapse with postganglionic sympathetic neurons. Postganglionic sympathetic neurons are noradrenergic and travel in the hypogastric nerve. They synapse in adrenergic ganglia of the pelvic plexus and bladder. Sympathetic impulses stimulate urethral smooth muscle contraction and inhibit detrusor activity (Fig. 19.3A).

The detrusor muscle has cholinergic and beta adrenergic receptors. The cholinergic receptors are more prominent in the body of the detrusor, while the beta adrenergic receptors are more prominent in the base of the bladder. The trigone and urethra have almost exclusively alpha adrenergic receptors. Cholinergic receptors stimulate detrusor tone and lead to contraction. Beta adrenergic receptors relax smooth muscle at the bladder neck, and alpha receptors contract smooth muscle of the urethra, facilitating storage of urine. If the adrenergic receptors are blocked, the bladder contracts and the urethra relaxes, facilitating voiding (4).

Efferent motor impulses originate in Onuf's nucleus found in the ventral horn of the S2, S3, and S4 nerve roots (Fig. 19.3B). These impulses are conveyed by the pudendal

nerve to the striated urogenital sphincter and pelvic floor. They control pelvic floor striated muscles, including the levator ani, external urethral sphincter, and external anal sphincter. The external anal sphincter is innervated by the inferior rectal (hemorrhoidal) nerve, and the external urethral sphincter is innervated by the perineal nerve. Both are terminal branches of the pudendal nerves (14). The levator ani muscles receive redundant innervation on their cephalic surface directly from the S3 and S4 motor roots.

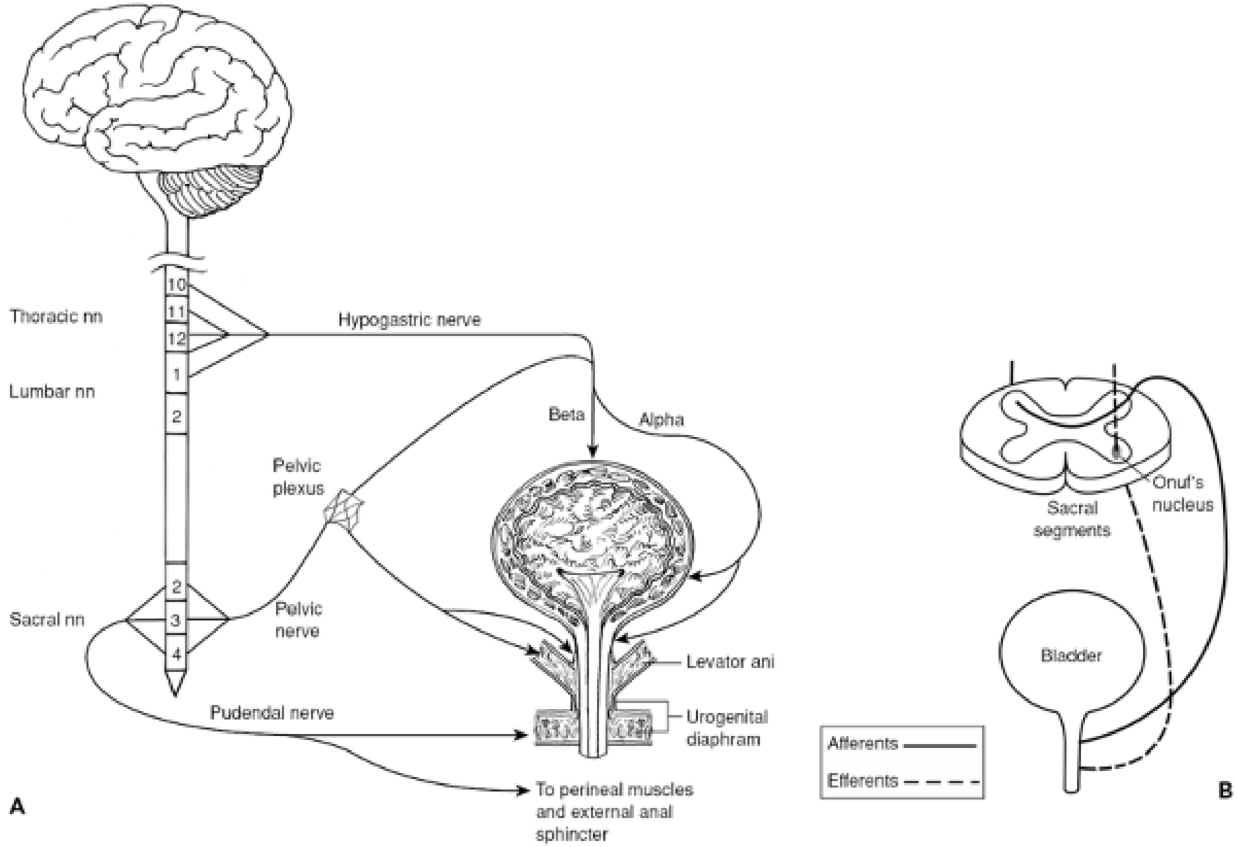

Figure 19.3 A: Innervation of the lower urinary tract in women. (From, Walters MD, Karram MM, eds. *Urogynecology and Reconstructive Pelvic Surgery*. St. Louis, MO: Mosby; 1999:16
, with permission.) B: Efferent stimuli from Onuf's nucleus are transmitted by the pudendal nerve to the urethra.

Storage of urine is facilitated by inhibitory stimuli from the inferior frontal gyrus of the frontal lobes. The frontal gyrus diminishes urinary urgency by inhibiting the cingulate gyrus, reduces bladder tone by inhibiting the preoptic parasympathetic area, and suppresses the pontine micturition center by inhibiting the periaqueductal gray matter. The pontine continence center tonically stimulates Onuf's nucleus, which in turn recruits the striated muscle of the external urethral sphincter and thus increases urethral pressure. The cerulean nucleus of the pontine continence center, through preganglionic sympathetic neurons in the L1-L2 segments of the spinal cord, suppresses detrusor contractions while enhancing smooth muscle of the urethra.

Finally, the motor cortex stimulates contraction of the pelvic floor muscles.

The desire to void is a response to bladder filling and is triggered by intense afferent nerve activity, which is directed to the periaqueductal gray matter (PAG) of the midbrain. Efferent impulses from the PAG stimulate the pontine micturition center of the pons. The pontine micturition center increases bladder pressure by stimulating preganglionic parasympathetic neurons from the S2-S4 segments, which stimulates detrusor contractions. Urethral pressure is diminished by stimulation of neurons in the dorsal gray horns of the spinal cord that suppress urethral smooth muscle and by the cuneform nucleus of the pons that suppresses Onuf kern1pt's nucleus, which is responsible for striated external urethral sphincter. Finally, pelvic floor muscles relax because stimulation by the motor cortex is less. When an individual decides that micturition is socially appropriate, suppression from the frontal gyrus stops, and the preoptic parasympathetic area of the hypothalamus is free to join in stimulation of the pontine micturition center. Flow of urine through the urethra initiates positive feedback reflexes that further enhance bladder emptying.

Urethral Diverticulum

A practical definition of *urethral diverticulum* is a fluid-filled mass identified along the anterior and lateral vaginal wall that communicates with the urethra. Urethral diverticula may be congenital or acquired, although the congenital origin has been questioned because they are so rarely diagnosed in childhood. Postulated mechanisms of congenital diverticula include persistent cloacal cell rests, faulty fusion of embryonic primordial tissue, and remnants of mesonephric (Wolffian) ducts. When an ectopic ureter drains into the urethra, it often has the appearance of a urethral diverticulum (15).

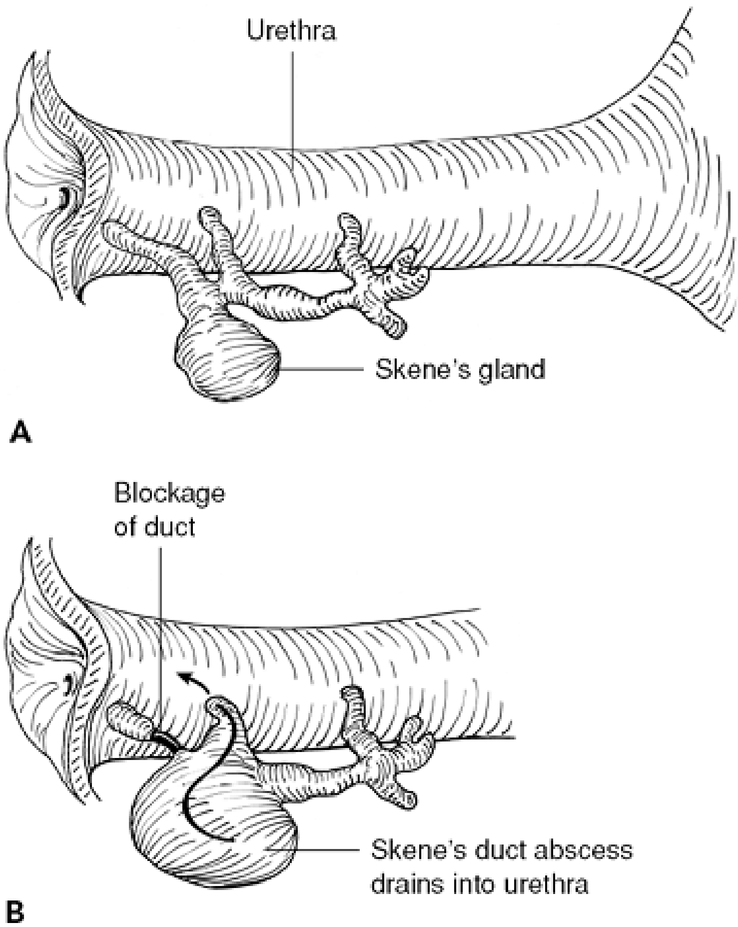

Figure 19.4 Diagram of Skene's glands. A: Anatomy of the distal urethra. B: Mechanism of acquired diverticulum. Obstruction of the Skene's duct results in an abscess of the gland. Perforation into the urethra leads to formation of a diverticulum.

Up to 8% of adult women are diagnosed with a urethral diverticulum, and they are more common in parous women and those of African descent. The vast majority are thought to be acquired (16). Acquired urethral diverticula are associated with infection of periurethral (Skene's) glands, urethral instrumentation, and birth trauma. Infection of periurethral glands is thought to be the leading cause of urethral diverticula. The fact that 80% of diverticula arise in the distal urethra, which is the site of the highest concentration of periurethral glands, further supports this contention (Fig. 19.4A,B). When an abscessed gland drains into the urethra, urine can be forced into the cavity (17). Commonly, implicated infectious agents are *Neisseria gonorrhea*, *Chlamydia trichomatis*, and *Trichomonas vaginalis*. A myriad of other gram-positive and gram-negative organisms have been cultured from abscesses. Because the urethral mucosa is delicate, instrumentation can disrupt the mucosa and create false channels. When these channels epithelialize and fill with fluid, a diverticulum is created. Descent of the fetal head against the anterior vagina is thought to traumatize the urethra, which allows uroepithelium to prolapse through the smooth muscle and thus predisposes to formation of a urethral diverticulum.

Clinical Diagnosis

The classic symptom of urethral diverticulum is postvoid dribbling; however, this history often cannot be elicited. Associated symptoms include dysuria and dyspareunia. Together, this triad of symptoms is â€œthe 3 Dsâ€• of diverticulum. Other common symptoms include urinary frequency, urinary urgency, urinary incontinence, and recurrent urinary tract infection, which are refractory to treatment. However, many disorders of the lower urinary tract share these latter symptoms. The most common sign is an anterior vaginal wall mass, often recognized incidentally during physical exam or as part of an unrelated imaging study.

Based on the presence of an anterior vaginal wall mass and the ability to express fluid from the urethra, clinical diagnosis is accurate in two thirds of cases. Diverticula can easily be overlooked during routine pelvic exam, especially when the patient is asymptomatic or the mass is small. The average size of the diverticula when diagnosed is 2 to 3 cm in diameter, but they may be as large as 6 cm in diameter. Further diagnostic testing is needed to show the site of communication with the urethra and to determine the number of the diverticula present. Urethroscopy and cystoscopy are now first-line diagnostic procedures. Inspection of the urethra is best done using the zero-degree lens with a round sheath. If the urethrovesical junction is occluded, hydrostatic pressure distends the urethra, which enhances visualization (Figs. 19.5A,B). The increased pressure also may distend the neck and sac of the diverticulum. In some 30% of cases, the communication with the urethra is not visualized because it is too small or obscured by tissue edema. Massage of the suspected diverticulum may cause fluid to be expelled through the communication into the urethra.

When endoscopy alone does not confirm the diagnosis, further imaging studies such as voiding cystoure throscopy (VCUG) and positive pressure urethrogram (PPU) are needed. To perform a voiding cystourethrogram, the bladder is filled with radiographic contrast, the patient voids, and then radiographs are obtained. Obliquely angled films and cinefluoroscopy during micturition with the patient in an upright position may improve diagnostic yield. Subtraction views obtained during computed tomography (CT) may help to define the neck of the diverticulum. Positive pressure urethroscopy was developed specifically for

diagnosis of diverticula (18). A double-balloon catheter designed to occlude the bladder neck and urethral meatus is inserted. Dilute contrast is then infused into the urethra via a third port between the occlusive balloons. Pressure forces the contrast into the diverticulum sac (Fig. 19.5C). A drawback to PPU is that distention of the urethra invariably produces some degree of patient discomfort (19). These techniques have not been randomly compared to determine if one is superior to the other. Lacking such a comparison, VCUG is perhaps the better first option because it is less invasive. If a diverticulum is not demonstrated, PPU can be performed.

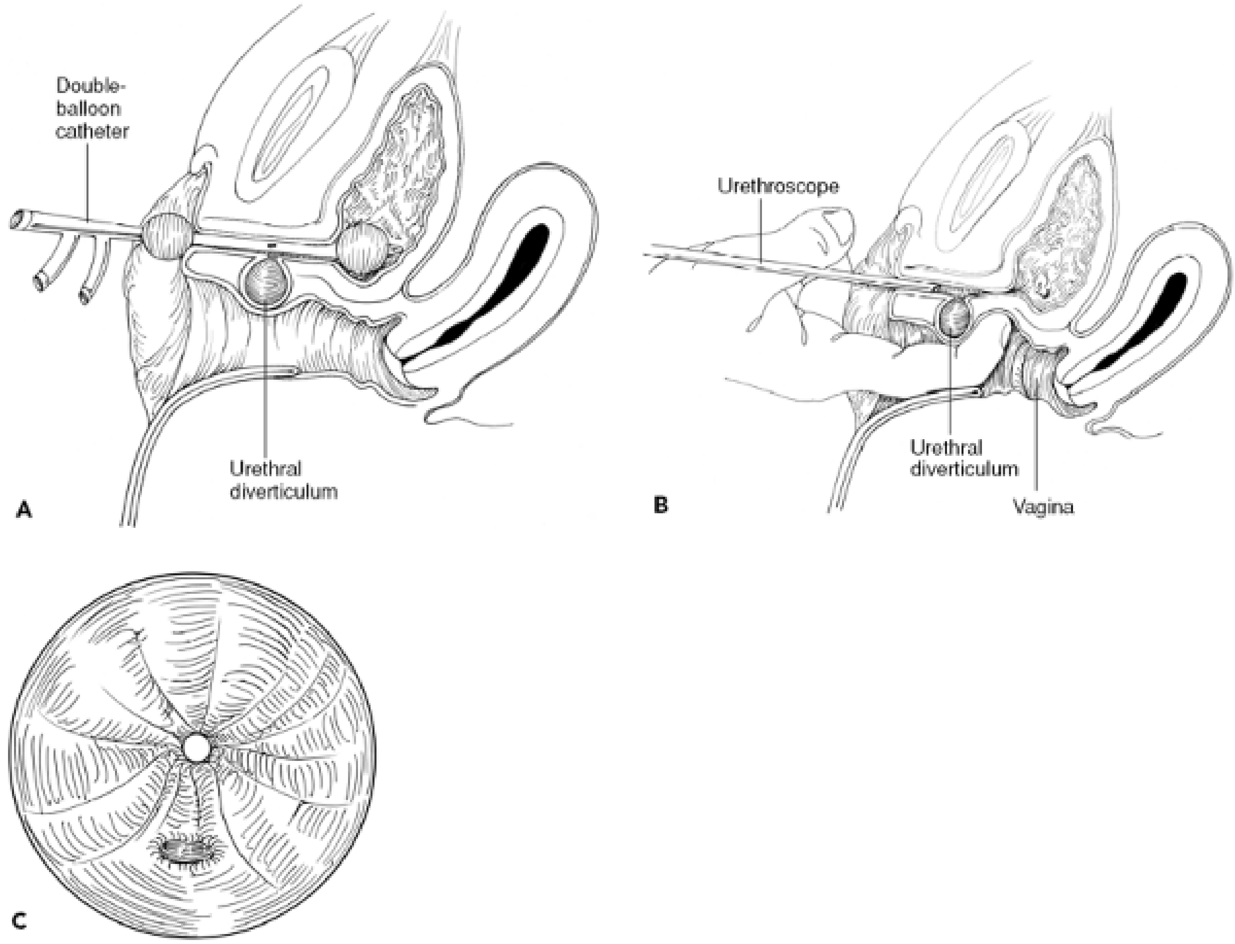

Figure 19.5 Evaluation of the urethra. A: Double-balloon urethral catheter. Instillation of x-ray contrast under pressure fills the diverticulum. B: Urethroscopy. With occlusion of the bladder neck, cystoscopy fluid fills the diverticulum. C: Opening into the urethra. Communication with the urethra may be obscured with edema.

Pelvic sonography and magnetic resonance imaging (MRI) demonstrate periurethral masses with a high degree of certainty but lack the ability to show communication (20,21). Based on the practicality of being able to obtain these studies more easily, they are sometimes ordered in lieu of the VCUG and PPU. Intraluminal sonography is a novel adjunctive tool that more accurately defines the diverticulum. In theory, it may reduce the risk of damage to the urethra from excessive dissection around the diverticulum and reduce the risk of cystotomy (22). Complex urodynamic studies are often performed to assess urinary incontinence. Urethral pressure profilometry in women with a diverticulum may show a biphasic pressure curve (23). When present, the notch corresponds to the site of the diverticulum and demonstrates its relationship to the site of maximum urethral closure pressure. When the opening is caudal to maximum urethral closure pressure, surgical repair is less likely to worsen incontinence. Conversely, if a diverticulum is cephalad to the site of maximum urethral closure pressure, incontinence is common.

Surgery

Women with small asymptomatic urethral diverticulum usually require no further management. Conversely, the majority of symptomatic women require surgery for relief of symptoms. Several surgical techniques have been used to successfully repair suburethral diverticula. Because no head-to-head comparison of these techniques is available, the choice of procedure is driven by the patient's presentation and the unique anatomy as well as the surgeon's choice. Common surgical options are diverticulectomy, partial ablation, and marsupialization (24,25,26,27,28).

Distention of the urethral diverticulum assists not only with its identification but also with dissection. In most situations, the diverticulum is distended by the irrigation fluid used during urethroscopy. Alternatives include instilling fluid with the aid of a urethrography catheter or injecting fluid directly into the sac with a needle passed transvaginally. Some have advocated use of fluid colored with a dye. The diverticulum may be distended mechanically with passage of transurethral sound, coiling of the ureteral catheters, inflating a Fogarty or pediatric catheter balloon, and packing with fine gauze. Finally, injection of silicone or deposition of a coagulum of cryoprecipitate has been used to assist with identification.

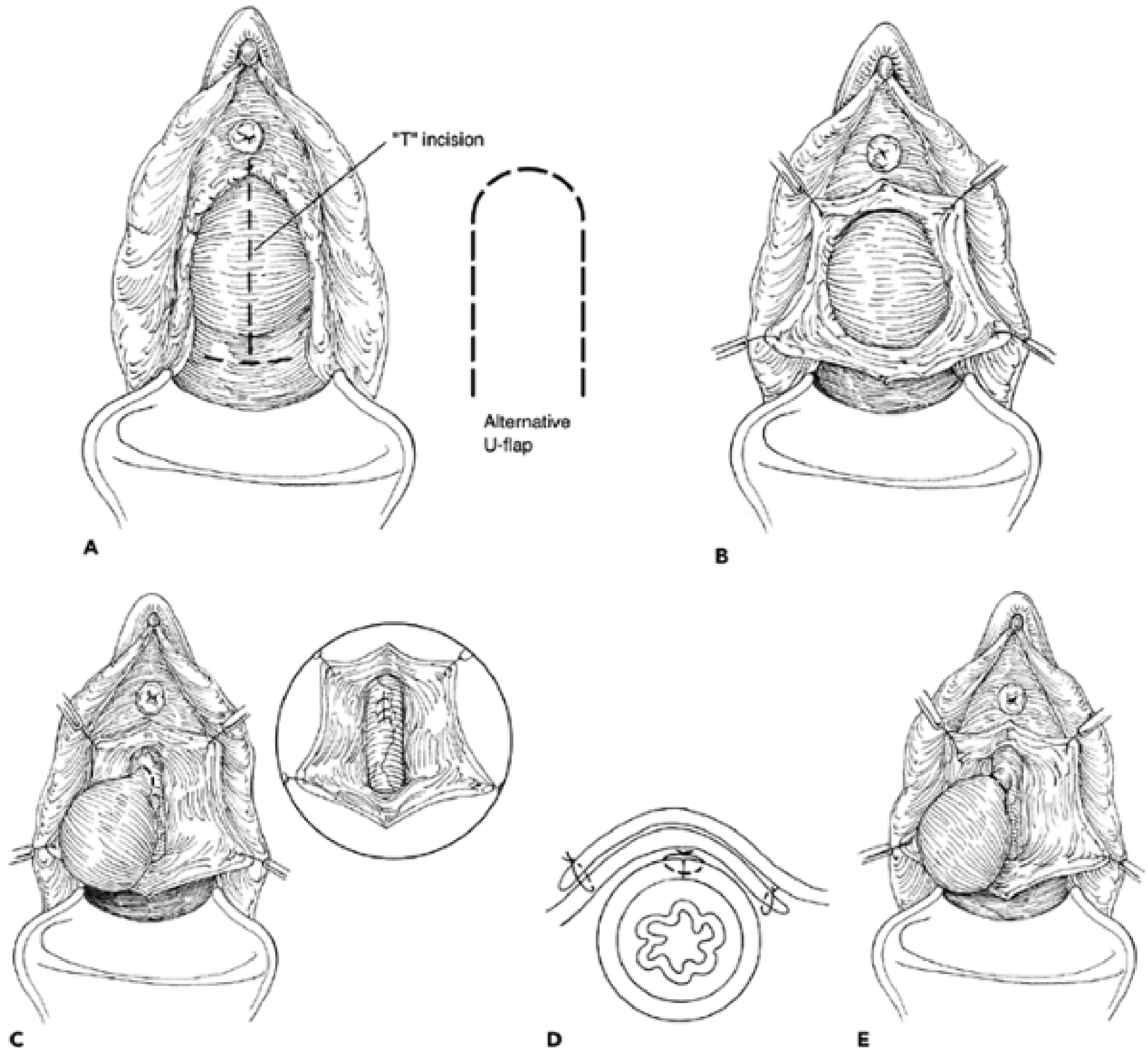

Figure 19.6 Suburethral diverticulectomy. A: Incision of the vaginal epithelium. B: Dissection of the pubocervical fascia and isolation of the neck of the diverticulum. C: Excision of the neck and longitudinal repair of the urethra. D: Vest-over-pant closure of the pubocervical fascia and repair of vagina. E: In the partial ablation technique, the neck is not excised from the urethra.

Diverticulectomy may be used at any site along the urethra. Principles of the repair include mobilization of the vaginal epithelium, separation of the fascia from the diverticulum, isolation of the sac and neck, excision of the neck from the urethra, closure of the communication(s) with the urethra, and layered reconstruction of defect in the wall of the urethra. A midline incision through the entire thickness of the vaginal epithelium is started within a few millimeters of the urethral meatus and is extended to near the cervix or vaginal cuff. A transverse incision is then made at the cephalad pole of the midline incision, giving the appearance of an inverted â€œTâ€• (Fig. 19.6A). The vaginal epithelium is separated from the pubocervical fascia

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to the lateral fornices. The fascia overlying the diverticulum is incised and mobilized to fully expose the diverticulum and its neck (Fig. 19.6B). A clear plane of cleavage between the diverticula sac and the periurethral fibroelastic connective tissue (pubocervical fascia) frequently cannot be delineated. Once the sac is isolated, it is excised completely from the urethra. The defect in the urethral mucosa is closed longitudinally with fine-gauge absorbable sutures over a small catheter (Fig. 19.6C). The pubocervical fascia is approximated over the urethra. A vest-over-pant technique is preferred if enough tissue is present for closure without tension (Fig. 19.6D). This technique provides two layers of tissue and prevents overlapping suture lines. Simple closure is the alternative. The vaginal epithelium is approximated with medium-gauge absorbable sutures. The vaginal epithelium may also be overlapped. Variations of incision, dissection, and closure have been described, but with the lack of direct comparisons, specific recommendations are not possible. Urinary drainage is instituted and continued for at least 10 days to allow initial healing. Controversy continues regarding whether suprapubic catheter drainage or transurethral drainage is preferred. Patients should refrain from sexual intercourse, wearing tampons, and douching for a minimum of six weeks or longer to allow the surgical site to heal.

Diverticulectomy has some shortcomings. First, complete dissection, especially around the neck of the diverticulum, is often tedious because a plane of cleavage between the fascia and diverticulum is impossible to develop. Second, when this technique is used in the cephalic urethra, there is a relatively high incidence of urethral fistula or vesicovaginal fistula. Poor wound healing is invariably associated with fistula formation. Diabetes, smoking, infection, small vessel disease, chronic steroid use, and prior surgery increase the risk of wound failure. Even when the integrity of the urethra is re-established, the patient may have worsening symptoms of urinary incontinence or develop de novo symptoms.

These limitations have led to the development of partial diverticulectomy (partial ablation technique) as an alternative. This technique may be used for a diverticulum at any point along the urethra but may be best for those near the bladder neck or cephalad to the point of continence. The steps of the partial diverticulum ablation technique are similar to complete diverticulectomy. The differences focus on the degree that the fascia is separated from the diverticulum sac and the manner in which the communication between the diverticulum neck and urethra is managed. Once the sac has been identified, it is mobilized and opened. The communication between the urethra and diverticulum is identified. The sac is resected near the urethra, but no effort is made to completely enucleate the sac from the urethra. The remaining sac is closed side to side with fine absorbable sutures (Fig. 19.6E). A second layer of sutures imbricates the first. The remainder of the tissue is closed as described for diverticulectomy, and urinary drainage is managed in a similar manner.

Marsupialization of diverticula is appropriate only for those near the meatus. The tip of one blade of dissecting scissors is passed through the meatus and into the depth of the urethral diverticulum. The other blade rests in the vagina oriented to the 6 o'clock position of the urethra. The meatus, urethra, and urethral diverticula are incised. Redundant urethral mucosa and vaginal epithelium are excised. The edges of the urethra and the urethral diverticulum are sutured to the adjacent vaginal epithelium. Postoperative drainage is not mandatory. Because a spraying urinary stream is often an annoying sequela, this technique is not commonly employed by the authors.

Complications related to the repair of urethral diverticula have been reported in as many as 25% of patients (29). These include urethral vaginal fistula, recurrent urethral diverticulum, urethral fistula, *de novo* or worsening stress incontinence, urethral stricture, urethral pain syndrome, and recurrent urinary tract infection. Fistula may be related to poor blood supply, prior trauma or surgery, or small vessel disease associated with diabetes or smoking. Placement of a Martius pedicle graft has been advocated as a way to reduce the risk of complications. The graft provides a source of neovascularization as well as relaxing tension on suture lines. Closing the urethral mucosa over a small caliber catheter or stint may lessen the risk of stricture formation. If urinary incontinence is present, a complementary incontinence procedure should be considered. The stress incontinence procedure, however, should not compromise the diverticulum repair.

Urethrovaginal Fistula

Fortunately, damage to the urethra that leads to loss of structural integrity is uncommon. Parturition, gynecologic surgery, pelvic radiotherapy, pelvic trauma, and sexually transmitted infections that are associated with tissue destruction are common antecedent events. From a historical prospective, prolonged obstructed labor caused virtually all urethral injuries. The frequency of the antecedent events associated with fistulas has now developed a rather marked dissimilarity in medically served areas and medically underserved areas. In developed countries, complications of surgery for urethral diverticulum, cystocele, or urethral hypermobility head the list and account for more than 90% of urethrovaginal fistulas (30). The remainder are preceded by intrapartum obstetric events, especially operative vaginal delivery, pelvic radiotherapy, and traumatic disruption. In medically underprivileged areas, prolonged obstructed labor remains the leading cause and accounts for well over 90% of women with urinary fistulas (31). In addition to urinary incontinence, other pelvic floor abnormalities such as anal incontinence are common. Devastating neurologic injuries impact the ability to walk and work. These women almost always become social outcasts because of debilitating incontinence and loss of sexual function. Only rarely is the infant of such a traumatic labor spared.

New-onset urinary incontinence is the first hint of urethrovaginal fistula and should trigger a diagnostic evaluation. The algorithm for evaluation of fistula is similar without regard to its etiology. Because most fistulas are easily seen on visual inspection, a thorough physical examination is critical. However, when inspection does not reveal the fistula, additional studies are needed. If fluid has collected in the vagina, it should be analyzed for urea (BUN) and creatinine to confirm that it is urine. Retrograde instillation of methylene blue or sterile infant's formula, or antegrade coloration of urine with indigo carmine or phenazopyridine may show the site of leakage. A double-balloon urethrogram may reveal an otherwise undemonstrated fistula by increasing pressure in the urethra and forcing fluid through the opening. Because urethrovaginal fistula may be complex and associated with injuries to the bladder and ureters, the integrity of the entire urinary tract must be assessed. Cystogram, voiding cystourethrogram, and intravenous pyelogram (IVP) assess integrity of the bladder, urethra, and ureters, respectively. The next step is to define the relationship of the fistula to the urethrovesicle junction with cystoure. Knowing the relationship of the fistula(e) to the bladder neck, urethral sphincter, and point of maximum urethral pressure will help to predict postoperative incontinence. Urine culture will guide appropriate antibiotic therapy.

Once the defect has been fully defined, the technique for surgical restoration is chosen, and the timing of repair is planned. Because urethrovaginal fistula is an uncommon problem even in referral centers, the surgical approach, timing of repair, and postoperative management lack standardization. The choice of procedure is therefore surgeon driven and depends on clinical acumen and experience. For the most part, the extent of tissue damage and amount of remaining tissue that can be mobilized dictate surgical decision making.

More than 90% of women with a urethrovaginal fistula have had gynecologic surgery involving the urethra. By far and away, the most common etiology is failure of the urethra to heal properly following surgery to remove a suburethral diverticulum. Indeed, some 15% to 20% of women who have diverticulectomy develop a fistula during the postoperative period. If the integrity of the urethra is not re-established, urine begins to drain from the vagina immediately after removing the urinary catheter. If the fistula occurs secondary to tissue necrosis associated with ischemia or infection, leakage may not be obvious for two or more weeks following the sentinel surgery.

For the most part, principles of repair are the same without regard to the original gynecologic surgery. Fistulas that follow gynecologic surgery are usually a few millimeters in size. Those that are asymptomatic require no intervention. However, most will be associated with an abnormal voiding stream or incontinence of urine and warrant repair. Timing of repair for fistula associated with gynecologic surgery continues to be debated (32,33). While a few surgeons repair fistulas early, historical tenets advocate waiting 3 months after the inciting event. This delay allows the inflammatory response to subside, edema to resolve, revascularization to occur, and pliability of tissue to return. For an otherwise uncomplicated fistula, operative reconstruction begins with a linear incision through the entire thickness of vaginal epithelium, much like that made for repair of a suburethral diverticulum or anterior colporrhaphy. The incision extends from near the urethral meatus to slightly beyond the urethrovesical junction and encompasses the margins of the defect (Fig. 19.7A). The vaginal epithelium is widely dissected from the pubocervical fascia to mobilize tissue and to exposure the fistula tract (Fig. 19.7B). Scar tissue from the edge of the fistula may be excised so that undamaged tissue can be approximated. The mucosa of the urethra is closed with fine-caliber synthetic absorbable sutures with meticulous hemostasis. Closure of the fistula in a longitudinal direction lowers the chance of shortening the urethra. The presence of a small catheter in the urethra may facilitate identification of mucosa edges and precise placement of sutures. If possible, sutures should avoid the urethral lumen because the foreign body may be a nidus for encrustation or stone formation. However, hemostasis trumps extraluminal placement. Imbricating the pubocervical fascia over the first creates a second layer of tissue. Because the pubocervical fascia is not specifically mobilized as is the case during diverticulectomy, a vest-over-pant closure is not suitable. The imbricating sutures should begin slightly beyond the limits of the first row of sutures. The imbricating layer may be extended to the bladder neck when warranted, which further relieves tension and may enhance continence (Fig. 19.7C). The edges of the vaginal epithelium are approximated with medium-caliber synthetic absorbable sutures. When the vaginal epithelium is redundant, a vest-over-pant (double-breasted) closure may be possible. This latter technique interposes an additional layer of healthy tissue and also offsets the suture lines. Urinary drainage and pelvic rest follow the recommendations with diverticulum repair.

In patients who have a larger fistula, urethral restoration is more difficult, and establishment of urinary continence is less predictable. The large defect creates the impression that an extensive amount of tissue has been lost (Fig. 19.8A). However, this appearance is often caused by retraction of disrupted urethral muscles. Normal tissue is retracted to the roof of the urethra in the retropubic space. The basic tenets of repair are similar to those for a small fistula. The vaginal epithelium is incised to encompass the defect. After wide mobilization of the vagina, the urethral tissue is mobilized (Fig. 19.8B). The edges of the native urethral tissue are then approximated. Because the tissue is contracted, isolating the edges may be difficult. A small catheter can be used as a stint over which the urethra can be repaired (Fig. 19.8C). If possible, a second row of sutures is placed in the urethra to imbricate the first (Fig. 19.8D). The

caliber of the repaired urethra is usually narrow but does contain functional muscle. Both features offer potential advantages for urinary continence. The pubocervical fascia is plicated over the urethra (Fig. 19.8E). The layer may be extended to the bladder neck to enhance continence. The vagina is closed (Fig. 19.8F).

In some cases, the urethra cannot be isolated. In this situation, a neourethra must be fashioned. A classic technique for creating a neourethra utilizes vaginal flaps from the remaining healthy epithelium (34). The vaginal epithelium is incised along the edges of the defect and is extended to create a U-shaped incision. The vaginal lateral to the incision is widely mobilized. The U-flap is dissected from the underlying pubocervical fascia and is hinged at the cephalic margin of the defect. The flap is rotated in a caudal direction, and the edges of the flap are sutured to the medial aspects of the ipsalateral incision adjacent to the defect, creating an epithelialized tubular neourethra. The pubocervical fascia is plicated over the neourethra. The plication sutures extend to the bladder neck in an effort to establish continence. This technique also offsets the suture lines. The vaginal epithelium is closed with medium-gauge sutures, if this can be done without tension. A pedicle graft is appropriate to eliminate tissue tension, fill a defect in the vagina, and enhance cosmesis. Numerous other pedicle grafts have been described as sources of tissue to reconstruct a destroyed urethra. These include pedicles mobilized from vaginal epithelium and skin from the vulva, buttock, or labia minora. (35,36).

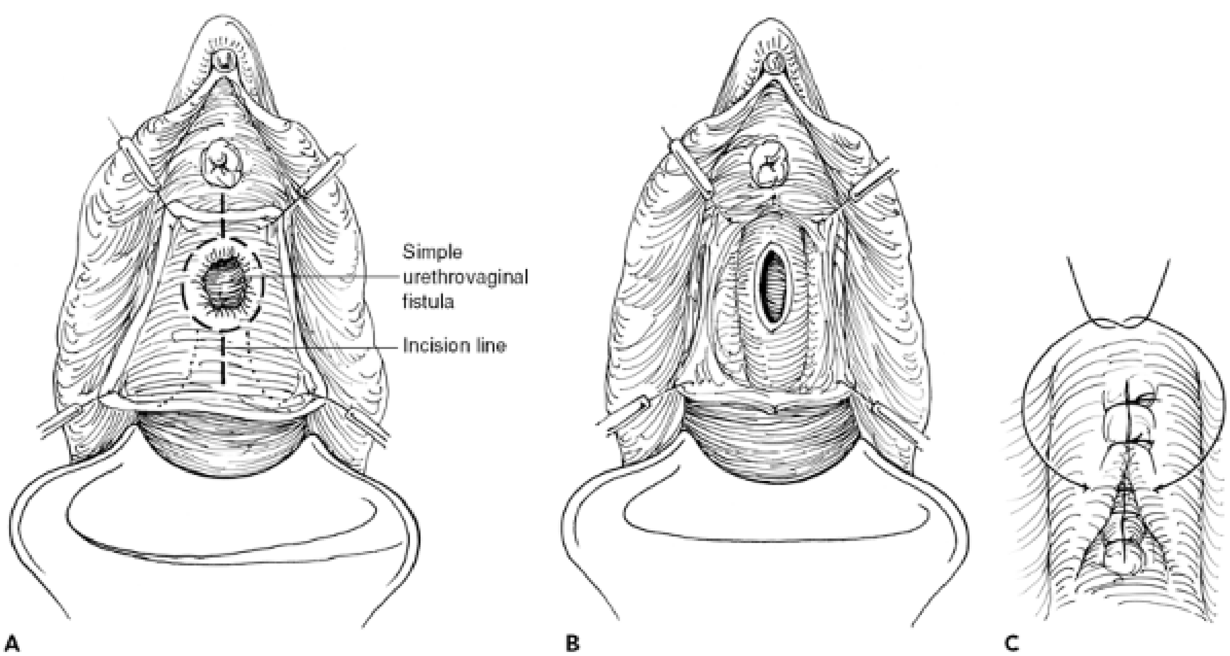

Figure 19.7 Simple urethrovaginal fistula. A: Incision of the vaginal epithelium. B: Mobilization of the vagina to expose the urethral defect and periurethral

fascia. C: Plication of the pubocervical fascia over the repaired urethra.

Pedicles from the buttock have advocated for especially large defects. The anterior bladder wall can be mobilized via a retropubic approach through the vagina and used to fashion a neourethra (37). An alternative method is to harvest patch grafts from the detrusor and to use the patch to form a tubular structure (38,39). None of these techniques has been proven to have a clear advantage over another as a primary procedure. Therefore, use of these grafts is individualized to meet individual patient needs.

Trauma to the urethra is estimated to cause some 4% of fistulas. The vast majority of traumatic urethral disruption occurs in conjunction with fracture of the pubic bone and laceration of the urethra with bone fragments. Much less often, soft-tissue injuries to the vagina and perineum are associated with disruption of the urethra (40). These soft-tissue injuries may be associated with blunt trauma to the perineum, operative vaginal delivery, and sexual activity. Blunt trauma is less likely to cause a traumatic injury to the urethra in women than in men, because the female urethra is only loosely attached to the perineal membrane. However, the typical injury may be severe and result in avulsion of the urethra from the perineal membrane. Vacuum-assisted operative vaginal delivery causes urethra injury when the suction cup catches the vaginal mucosa overlying the urethra. As the infant's head passes through the introitus, the vagina stretches and the urethra

fractures (41). Traditional forceps lacerate the urethra as the forceps blade passes over the urethra. Sexual intercourse, especially if coerced, may traumatize the vagina and the underlying distal urethra. The meatus is the most vulnerable site for injury. Children and menopausal women are at increased risk probably due to low estrogen effect.

When disruption of the urethra is associated with trauma, a well-defined area is usually involved. Leakage of urine is recognized immediately after the injury or soon after the urinary catheter is removed. Surgical repair of a traumatic injury can be undertaken within a few hours if the patient is medically stable. In the case of bone fracture, blunt trauma, and operative delivery, a satisfactory anatomic repair may be hindered by the retropubic location of the tear. These fistulas may be difficult to reconstruct in a manner to preserve continence because the tears are often near the bladder neck and above the point of continence.

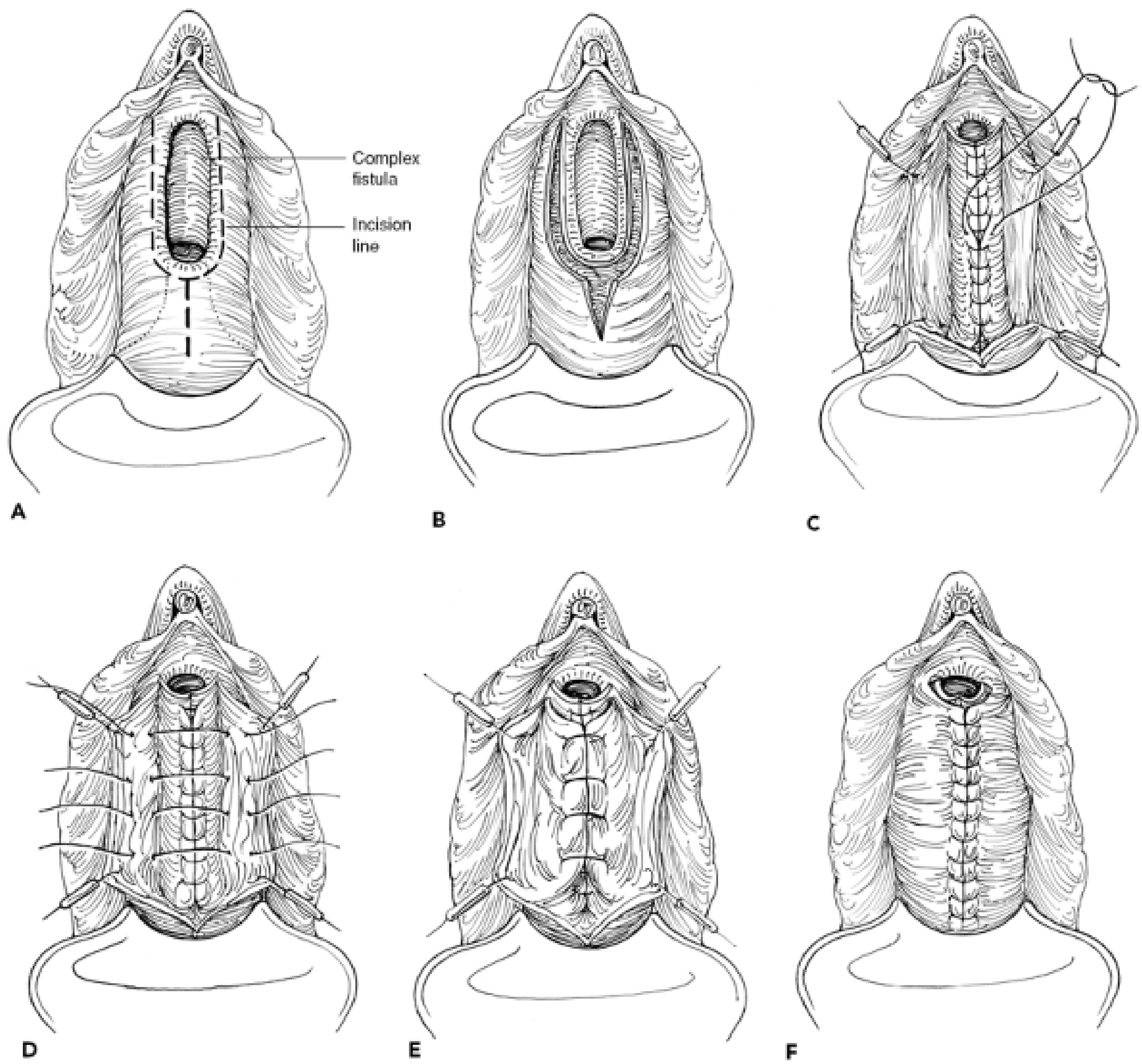

Figure 19.8 Complex urethrovaginal fistula. A: Loss of a significant portion of the urethra. B: Mobilization of the vagina to expose the urethral defect and periurethral fascia. C: Closure of the urethra. D: Sutures placed in the periurethral fascia. E: Pubocervical fascia imbricated over the repaired urethra. F: Vaginal epithelium repaired.

Reconstruction of the urethra begins with wide mobilization of the vaginal epithelium from the pubocervical fascia and identification of the disruption. The cephalic and caudal edges of the urethra are isolated. If a catheter can be passed through the urethra, the site of injury may be more easily identified. The edges are approximated circumferentially. Once the anastomosis is complete, the vagina is closed (Fig. 19.9). Distal defects are repaired in a layer-by-layer technique or are closed similar to the

marsupialization for distal diverticulum. The catheter is left in place for 5 to 7 days and then removed to allow return of normal micturition. Urinary incontinence is uncommon. Pelvic rest is recommended for at least 6 weeks.

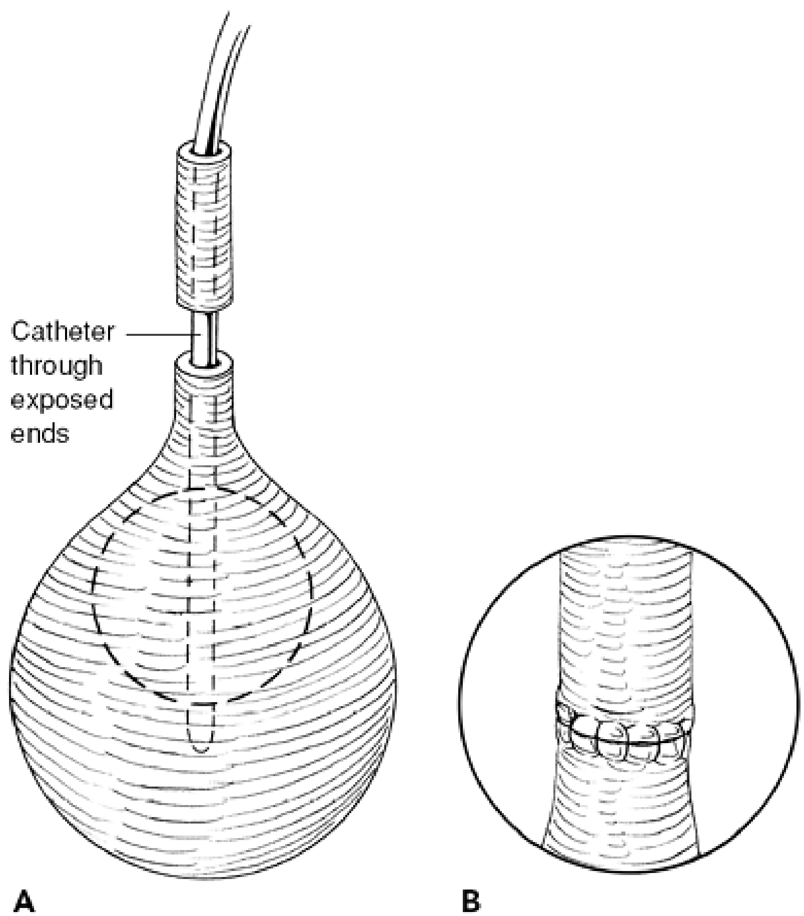

Figure 19.9 Traumatic disruption. A: Isolation of the cephalic and caudal edges of the disrupted urethra with a catheter. B: Circumferential closure.

The largest urethral defects are related to complications of labor in medically disadvantaged countries. In the case of obstructed labor, varying portions of the urethra, urethrovesical junction, the trigone, and bladder neck may be sloughed. The etiology of the fistula is pressure necrosis of soft tissue from impaction of the fetal head against the pubic bone. Childbirth injuries present the most challenging management issues because of considerable tissue loss, damage to the sphincter mechanism, and cicatrization. If significant vascular compromise occurs, repair of the fistula is compromised further. Neurologic injuries impact normal function even with a good anatomic repair.

Fistula that involve only the urethra and do not extend to the bladder neck are best repaired by simple mobilization of vaginal tissue and layered closure. This technique is similar to those for fistulas related to gynecologic complications. Complex fistulas involve not only the proximal urethra but also bladder neck, detrusor, or ureters. In these extensive fistulas, the urethra is often fixed to the pubic bone. The vaginal epithelium is incised in a manner like the extensive gynecologic fistula but is slightly farther away from the defect, leaving a slightly wider strip of vagina on the edges of the defect. The lateral vaginal epithelium is widely mobilized to expose the fistula and to eliminate tissue tension. The urethral muscle and detrusor are mobilized. This mobilization typically extends into the base of the bladder and beyond to ensure tensionfree closure. Closure of the fistula is initiated by placing sutures in the pubocervical fascia, which are oriented parallel to the edges of the defect. The sutures are secured by tying them only on the ipsalateral side of the defect, but they are not tied across the midline. Suture placement is far enough from the edges of the fistula so that the bladder and urethra can be closed without difficulty. In effect, the pubocervical fascia, which will be the second tissue layer, has sutures placed first. Ostensibly, this technique protects the ureters by allowing them to be visualized directly through the defect as the wide tissue bites are placed. The edges of the urethra and the bladder are then sutured together to create a tubular neourethra. The sutures in the pubocervical fascia are then tied across the midline, creating the second layer of tissue. A third layer may be created by plicating additional pubocervical fascia. The vagina is closed.

If the entire urethra is lost or if retropubic fixation prevents mobilization of the urethral edges, the anterior bladder wall is mobilized through the space of Retzius. The bladder edges and remaining urethra are fashioned into a neourethra (Fig. 19.10). The remainder of the procedure is accomplished as described earlier. Loss of tissue followed by extensive surgical dissection may lead to significant vaginal stenosis or gynatresia. These patients have a reported incidence of stress urinary incontinence in nearly 50% (30). Vaginal caliber and depth may be maintained by utilizing a Martius pedicle graft with full thickness of overlying skin. Placing the pedicle may also enhance continence.

Pelvic radiotherapy is responsible for 6% of fistulas. They are among the most intractable because of marked tissue scarring, contracture, immobility, and devacularization. Furthermore, radiation effect may also produce dysfunction and fibrosis of both the urethra and detrusor. However, the most significant problem is the vascular compromise. Urethrovaginal fistula induced by radiotherapy may develop within a few weeks because of immediate necrosis of malignant tumor. More commonly, they are secondary to radiation-induced endarteritis and are not manifest until years later (42). If the patient has a malignancy, a minimum delay of 6 months is recommended, and even 12 months has been suggested by some. This delay allows the acute radiation injury to subside and necrotic changes to mature. The delay allows further assessment of the patient's health status. Prior to repair, the edge of the fistula should be biopsied to exclude cancer. Repair must be tailored to the patient's anatomy and the extent of tissue loss. The techniques described earlier may be appropriate. Because irradiated tissue may be quite rigid, closure of the vaginal incisions may be difficult to achieve without tension. Additionally, vascular compromise may impair healing. These situations make use of a pedicle graft very attractive.

Urinary Continence

Continence of urine is dependent on urethral pressure exceeding bladder pressure. Urethral pressure is dependent on normal anatomic support that provides a hammock of tissue against which the urethra can be compressed and that limits urethral mobility. This support comes from the pubocervical fascia and the pelvic floor muscles. Urethral pressure is also dependent on intrinsic pressure generated by the muscles and vascular plexus of the urethra. Normal pudendal nerve function is necessary for proper muscle stimulation (43). Intrinsic urethral function appears equally important to extrinsic support in maintaining continence. Both mechanisms may be damaged when a urethral fistula occurs. Loss of urethral muscle mass, poor muscle contractility, fixation of the urethra from scar, and denervation are responsible for diminished urethral pressure. Furthermore, surgical dissection to repair the fistula can damage urethral muscles, the vascular plexus, and the nerves that stimulate the urethra.

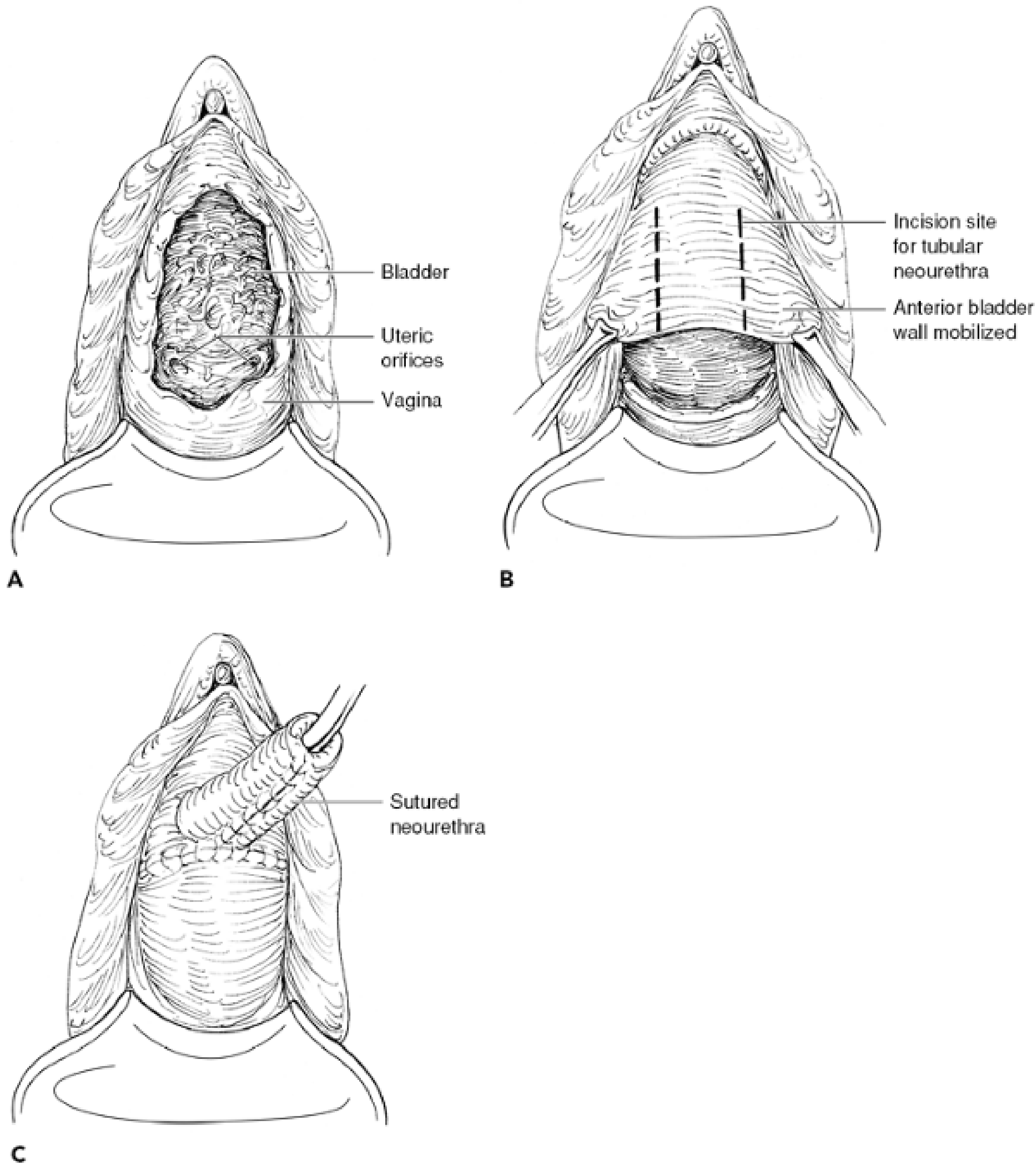

Figure 19.10 Neourethra. A: Loss of the urethra and bladder base. B: Anterior bladder wall mobilization retropubically. C: Bladder flap sutured to create the tubular neourethra.

Restoration of the urethra is not synonymous with physiologic function, and incontinence mars otherwise successful surgery in more than half of the cases (44). Incontinence is particularly common when repair involves the mid urethra, bladder neck, or detrusor. Numerous techniques have been described to enhance continence; however, surgery to achieve continence must not compromise the primary procedure. Fortunately, some procedures like plicating the

pubocervical fascia, suburethral buttress sutures, and the Martius pedicle graft can be performed as part of the primary repair (44,45).

A second-stage procedure is appropriate for patients who have an apparently well-healed urethra but remain incontinent. Both vaginal and abdominal second-stage incontinence procedures are successful. The Martius graft has been shown to provide continence in at least half of women who have only this procedure (46). Outcomes with retropubic urethropexy, needle suspension, and suburethral slings have been positive (30,47,48). Short-term success is also possible with periurethral bulking agents (49). Muscle fibers mobilized from the bladder and arranged concentrically around the bladder neck can be a functional substitute for the urethral sphincter (50). Some have advocated a combined abdominal and vaginal procedure for the best results (51).

Enhanced Vascularity and Tissue Expansion

The Martius pedicle has a proven record of success for closure of complicated fistulas (52). The pedicle provides a de novo blood supply. The procedure as originally described isolates the bulbocavernosus fat pad from the overlying vulvar skin. The pedicle is separated from the underlying tissue but remains attached to its blood supply either at the ventral or dorsal margin. The pedicle is tunneled under the labia minora and vaginal epithelium and is sutured at the site of repair. It must not be constricted. The bulbocavernosus muscle may also be mobilized as part of the pedicle when the defect is large or especially complicated. Pedicles can also be mobilized bilaterally. Success has been especially gratifying in radiation-induced fistulas (53,54). The vaginal mucosa is then closed over the pedicle to conclude the procedure.

Coincident with damage to the urethra, a significant portion of the anterior wall may be lost. If lost tissue precludes closure of the vagina without tension, a Martius pedicle graft with overlying vulvar skin can be used to fill the defect and relieve tension as well as provide additional vascularity. The additional surface area of the skin pedicle also preserves vaginal caliber as well as depth (55,56). The pedicle is tunneled just as if the skin were not part of the pedicle (Fig. 19.11A,B). An alternative technique creates a U-shaped pedicle from the vulva (Fig. 19.11C). The vulvar flap is mobilized with its underlying subcutaneous tissue. A drawback to vulvar skin is that it is covered with hair. The hair may be a nidus of encrustation of vaginal secretions and interfere with sexual activity. To avoid these difficulties, a pedicle can also be created from an area on the buttock where the overlying skin is hairless (57). Because the full skin thickness pedicles have a tendency to obscure the meatus, they may need to be tailored so that urine can flow freely. Flaps are secured with medium-gauge synthetic absorbable sutures. A z-plasty is often needed to close the graft site (Fig. 19.11D).

Patients should not void during the initial postoperative period. Urinary drainage should be continued for at least 2 weeks following surgery. Both transurethral and suprapubic bladder drainage are options. Currently, neither method has proven to be superior. Advocates of transurethral drainage believe that the catheter serves as a stint during healing. Advocates of suprapubic drainage believe that the transurethral catheter may compromise healing because of excessive pressure at the repair site. Suprapubic drainage also has the advantage of convenient voiding trials. Patients should refrain from sexual intercourse for 12 weeks.

Congenital Lesions

Three congenital periurethral masses are described in infants. All are cystic and share common symptoms of pain and voiding dysfunction. They may be asymptomatic and recognized as incidental findings. Periurethral (Skene's duct) cysts are found lateral to the urethral meatus and displace the urethra medially. Unlike a diverticulum, these cysts do not communicate with the urethra. The vaginal epithelium overlying the mass is yellow or white rather than pink. Although some masses resolve spontaneously or rupture, most require drainage due to pain or obstructive voiding symptoms. Needle aspiration can quickly decompress the cyst and relieve symptoms, but incision of the mass with removal of its lining is required if aspiration is not successful (58).

The mesonephric (Wolffian) ducts involute in embryonic life, but remnants commonly persist. Because these remnants are blind ending, they may become cystic as fluid collects. Mesonephric cysts are most commonly seen in the lateral wall of the anterior vagina, but remnants can also be seen in mesosalpinx and meso-ovarium. They are called *Gartner's duct cysts* by eponym. Most are asymptomatic and incidental findings. However, some may attain considerable size, and if they are located near the urethral meatus, they often create symptoms of voiding difficulty. The masses are best characterized with sonography (59). While most require no therapy, symptomatic or large cysts must be drained. Marsupialization is the procedure of choice. If marsupialization is not definitive, the cyst wall must be excised. It should be noted that these cystic masses may represent an ectopic ureter. The ectopic ureter may end blindly or be connected to a normal kidney (15).

Acquired Lesions

The etiology of urethral prolapse is unclear. It may be associated with straining, trauma, or inflammation associated with infection. Although uncommon, urethral prolapse

may occur from childhood to menopause. The incidence seems to be higher in individuals of African descent. Primarily, the uroepithelium and submucosal tissue prolapse. As the tissue engorges, it become friable, vascular, and tender. The mass bleeds on contact and frequently causes dysuria. Symptom relief is the goal of therapy. Warm baths followed by cold compresses are soothing. First-line medical management for all ages is application of topical estrogens (60). Topical therapy is successful in approximately half of these patients and seems to be especially effective in nonestrogenized children and menopausal women. A few weeks of therapy is usually successful. When conservative measures are not effective, excision of the mass is required. The prolapsed tissue is excised, and the intraurethral mucosa is sutured to the vestibular skin (61).

A urethral polyp may prolapse through the urethral meatus. Polyps have a typical polypoid appearance and are typically benign. More commonly, they are diagnosed with cystoure or when a filling defect is seen on VCUG. Urethral polyps are rare, but they should be included in the differential diagnosis of hematuria. Transurethral resection meets with nearly universal success, and recurrence is uncommon (62).

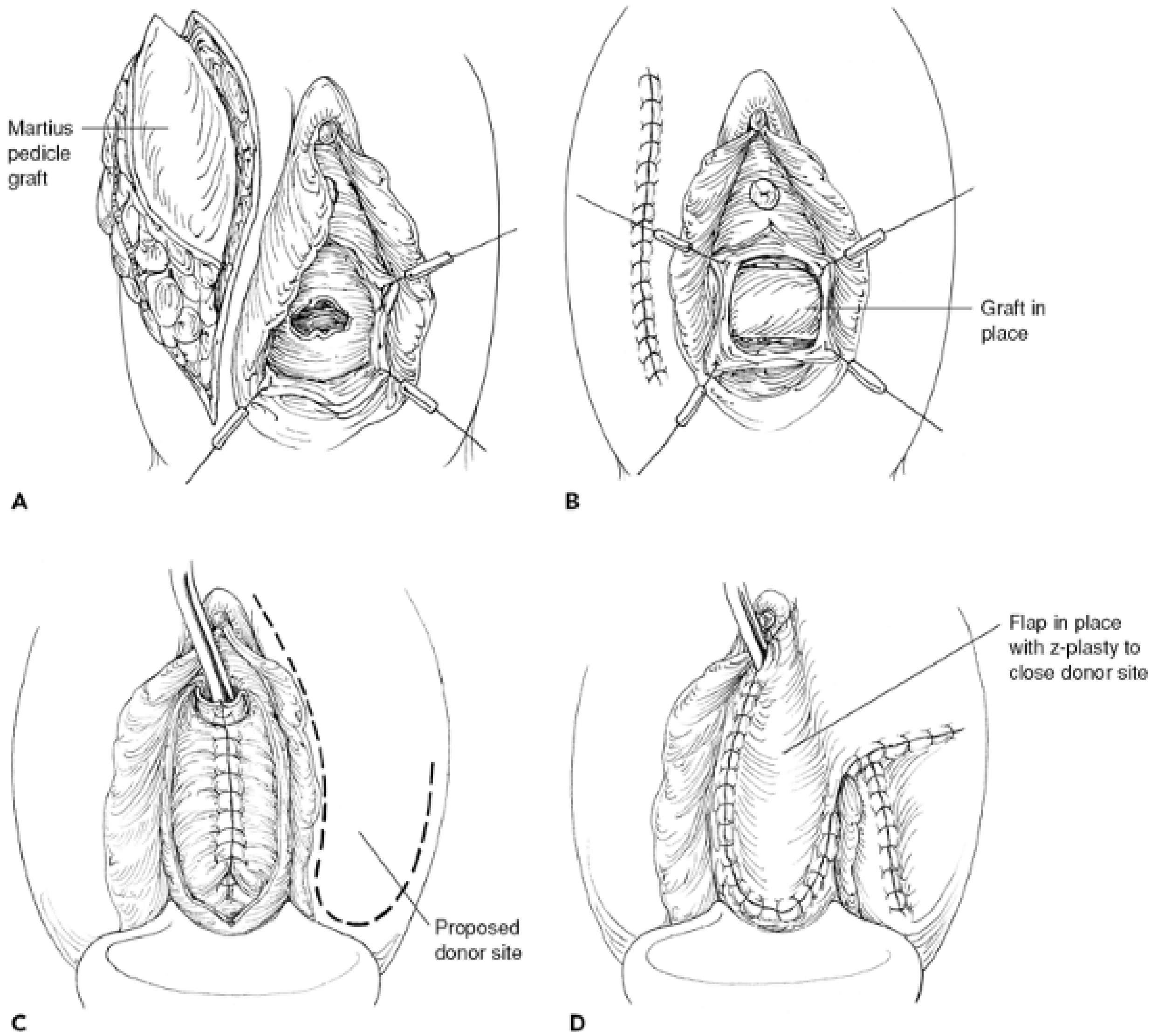

Figure 19.11 Grafts. A: Martius pedicle with full-thickness skin. B: Pedicle site closed. Martius graft placed over the defect. C: Alternative skin graft pedicle. D: Z-plasty to close donor site.

Urethral caruncles present as a red, tender mass protruding from the urethral meatus toward the vaginal side. Separating this mass clinically from urethral prolapse or urethral polyps is challenging. They share common features of hematuria and voiding dysfunction. Excision is highly successful, and recurrence is uncommon. The diagnosis is confirmed by microscopy, showing a highly vascular fibrotic tissue stalk infiltrated by leukocytes. On rare occasions, colonic mucosa may be seen, which suggests that these may be congenital remnants of hindgut cell rests (63).

Rare Conditions

Urethral duplication is most commonly associated with two bladders, both with full-thickness muscular walls that are fused. Each has its own urethra. The goal of treatment is union of the bladders and urethras with preservation of the urethrovesical junction (64).

Congenital urethral stricture is often suspected in women with recurrent urinary tract infections. When imaging studies are performed, urethral dilatation may be seen above a narrowed area. The appearance is sometimes designated as a â€œspinning top.â€• While some true strictures occur, most physicians now feel that the spinning top represents a dysfunctional voiding pattern. When urethral dilatation with internal urethrotomy was compared with antibiotic therapy alone, no significant difference in outcome was noted (65).

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20

The Neovagina

Lesley L. Breech

Vaginoplasty is a procedure relevant to the care of all female patients, both young and old. care for children with complex pelvic congenital anomalies, adolescents with vaginal agenes vaginal stenosis secondary to other exposures such as radiation therapy. Vaginal agenesis is condition that may result from a variety of different underlying diagnoses. Mayer-Rokitansky (MRKH) syndrome, the most common clinical scenario the general gynecologist will encount vaginal agenesis with variable mÃ¼llerian duct development and possible associated renal, auditory abnormalities. It is generally thought that MRKH affects 1 in 5,000 live-born female may not personally perform the surgery to create a neovagina; however, an appreciation of methods used to create one is essential to provide counseling to patients and families regar potential reproductive consequences.

The timing of intervention is an important consideration. Vaginal agenesis is a particularly c for gynecologic and genitourinary surgeons. For patients with multiple organ system involve threatening conditions should be stabilized and addressed before operative planning is unde neovaginal creation. Both nonsurgical and surgical interventions that require continued dila maintenance have historically been deferred until adolescence or adulthood. Reconstructio often does not require continued dilation, can be accomplished at any age. Hendren et al. h intervention during childhood (2). Hendren maintains that young girls suffer significant psy social trauma from knowing that they lack a vagina and from the necessary surgical interve that he has not seen a traumatic response to surgical revision of a previous vaginoplasty cre well, Hendren emphasizes the outpatient nature of a revision and that it is regarded by pati with less importance than the original construction of a neovagina. This must be weighed ag psychological effects of potential daily vaginal dilation or stenting in prepubertal girls. Graf techniques that require persistent stenting or dilation may be unsuitable for younger patien requisite maturity and motivation required for maintenance. Bowel substitutions may be ap ranges of patients, even infants. Long-term functional studies are needed to assess introital satisfaction with consideration of timing of surgical intervention. An evaluation of the psych related to technique, the age at diagnosis, and age of repair is also necessary.

Nonsurgical creation of a neovagina can be a highly successful method of vaginoplasty. In 19 described a method of creating an artificial vagina using a set of graduated, hard glass dilat reported remarkably satisfactory results in eight cases treated by this method (4). His follo that a vagina formed in this manner remained permanent in depth and caliber, even in pati dilatation for more than 1 year. It has been emphasized that the pelvic floor itself is embry in some patients. Indeed, the ease with which some patients are able to create a vagina wi alone or with other intermittent pressure techniques can be explained on this basis. The Fr successful in motivated patients with an appreciable, anatomical vaginal dimple but also ha in patients with only a minimal indentation.

Ingram's modification of Frank's technique may minimize the awkward nature of dilation ex emotionally and physically by many young women (5). By instructing his patients in the inse specially designed for use with a bicycle seat stool, Ingram was able to produce satisfactory coital function in 10 of 12 cases of vaginal agenesis and 32 of 40 cases of various types of st method, a dilator is placed on a bicycle seat that is mounted on a stool, thus allowing atten at other activities while dilating. The patient is shown how to sit on a racing-type

bicycle seat that is placed on a stool 24 inches above the floor. She is instructed to sit leani with the dilator in place for at least 2 hours each day at intervals of 15 to 30 minutes. The p usually at monthly intervals and can be expected to graduate to the next size larger dilator month. An attempt at sexual intercourse may be suggested after the use of the largest dilat months. Continued dilatation is recommended if intercourse is infrequent. Functional succe outstanding. Roberts and Rock reported the largest series of vaginal agenesis patients who u method of dilatation to create a neovagina (6). The records of 51 patients with mÃ¼llerian reviewed: 37 patients attempted vaginal dilatation, while 14 young women underwent a sur Functional success was defined as satisfactorily achieving intercourse or accepting the large discomfort. All patients were followed for at least 2 years and for an average of 9.25 years. was achieved in 91.9% of those who attempted dilatation. Thus, passive dilatation should be initial therapy for vaginal creation. Success of the nonsurgical approach is largely dependen motivation and strict compliance. If dilatation is unsuccessful, operative vaginoplasty is ind

Over time, many methods of surgical vaginoplasty have not only been described but also adv today, there is no consensus regarding the best surgical approach. The primary goal of a neo create a vagina adequate for satisfying sexual interactions. In patients with a uterus, adequ menses and the potential to accommodate a vaginal delivery are also of paramount importa goals should also include normal amounts of secretions and lubrication, the absence of malo maintenance care. Unfortunately, one method has not yet been demonstrated to achieve al Management options are described addressing procedure types, advantages, disadvantages, Controversy continues regarding the best technique, as little complete long-term data, inclu identity and function data, about any procedure is available.

A method familiar to many gynecologic surgeons is the Abbe-McIndoe vaginoplasty (7 ,8). Th utilizes a split-thickness skin graft to line a neovaginal canal, dissected in the potential spac urethra and rectum. The three most important principles in performing this procedure are c adequate space; inlay of a proper split-thickness skin graft; and continuous, prolonged dilat contractile phase of healing. For cosmetic reasons, the skin graft is most commonly harveste buttock region. A split-thickness skin graft is taken approximately 0.018-inch thick and 8- to total graft length should be 16 to 20 cm. If the entire graft cannot be taken from one buttoc to 10-cm long will be needed from each buttock. The perineal dissection should be carried a without entering the peritoneal cavity and without cleaning away all tissue beneath the per thickness skin graft will not take well when applied against a base of thin peritoneum. All bl should be ligated. It is essential that the vaginal cavity be dry to prevent bleeding beneath will cause the graft to separate from its bed, resulting in the inevitable failure of the graft area and in local graft necrosis. Early skin grafts were formed over balsa, which has the adv inexpensive and easily available. Balsa is a light wood that can be sterilized without difficul uneven pressure from the form can cause a skin graft to slough in places, and excess pressur associated with an increased risk of fistula formation.

The Counseller-Flor modification of the McIndoe technique uses a foam rubber mold shaped cavity instead of the rigid balsa form. This mold is created from a foam rubber block and is condom (9). The foam rubber is gas sterilized in blocks. The block is shaped with scissors to twice the desired size, compressed into a condom, and placed into the neovagina. The skin placed over the form and its undersurface exteriorized and sewn over the form. Where the approximated, the undersurfaces of the sutured edges are also exteriorized. The edges of th meticulously approximated around the form without gaps. Granulation tissue develops at an

form is not covered with graft. Contraction usually occurs where granulation tissue forms. A
been placed in the neovaginal space, the edges of the graft are sutured to the skin edge wi
left between sutures for drainage to occur. The postoperative course includes a week-long h
complete bed rest to allow appropriate graft take. After 7 to 10 days, the vaginal cavity is i
saline solution and inspected, and the form is removed and replaced. After 6 weeks, a neop
much easier to remove and keep clean than a foam rubber form, is substituted for the origi
essential to continue constant dilation for the first 3 months following the procedure and th
regular sexual intercourse occurs.

Many consider this technique unsuitable for children, as it requires strict adherence to dilat
intercourse occurs. In addition, it is unclear how well this type of neovagina will grow with
successfully been reported in patients with vaginal agenesis who undergo the procedure as l
young adults. Templeman et al. (13) published a review of the procedure and included the
surgeons (10 ,11 ,12 ,13 ,14 ,15 ,16 ,17) (Tables 20.1 , 20.2). Success rates vary from 80%
on the experience of the surgeon. Complications to consider include failure of graft take, re
during dissection, and fistula formation.

The advantages of the Abbe-McIndoe procedure include the long-term experience with exce
results, low complication rates, and the avoidance of a laparotomy

and intestinal complications. Disadvantages include prolonged postoperative hospitalization
continued dilation, and the visible skin scar from acquisition of the skin graft. Some authors
difficulties with lubrication and dyspareunia (18).

Hojsgaard & Villadsen (13)
23
5.5
12.8
3
9.5-cm length
78
Rock et al. (7)
79
(1â€“27)
8.4
(1.0â€“20.0)

â€”
(2.0â€“60.0)
5[a]
3.7-cm width
91[b]
100
Buss & Lee (14)
47
6.5
8.0
(2.0â€“12.0)
5[c]
â€”
â€”
85
Wiser & Bates (10)
92
â€”
8.0
2
97
96
Alessandrescu et al. (15)
201
3.0â€“16.0
6.0
â€”
length >6.0 cm 93[d]
94[e]
Garcia & Jones (20)
54
3.0â€“8.0
â€”
â€”

â€”
99
Farber & Mitchell (17)
12
4.0 monthsâ€“8.0 years
â€”
2
7.5 cm (5â€“9)
80

[a] Defined as >25% contracture of the vaginal space

[b] Defined as anatomical success by the examining physician.

[c] Only one patient required reoperation.

[d] 188 patients followed up.

[e] 156 patients followed up.

Adapted from Templeman CL, Lam AM, Hertweck SP. Surgical management of vaginal agene *Surv.* 1999;54(9):583â€“591, with permission.

Reference	Number of Patients Followed up	Follow-up (Years)	Use of Postoperative Dilatation (months)	Number of Women with Postoperative Contracture	Postoperative Vagi Dimensions/Functio Success (%)

Table 20.1 Functional Outcome of The McIndoe Vaginopla

Hojsgaard & Villadsen (13)
â€”
26
â€”
65.00
11.5
3.80
7.60
Rock et al. (11)

19.5 (17.0â€“36.0)
79
â€”
2.50[c]
2.50
â€”
â€”
Buss & Lee (14)
20.0 (16.0â€“34.0)
50
11
2.00
6.00
â€”
4.00
Wiser & Bates (10)
â€”
92
1
1.00
â€”
1.00
1.00
Alessandrescu et al. (15)
20.5 (14.0â€“41.0)
201
â€”
1.40
â€”
0.50
0.50
Garcia & Jones (16)
19.2 (15.0â€“35.0)
64

â€”
0.01
0.01
0.01
0.03
Farber & Mitchell (17)
17.3 (14.0â€“25.0)
12
â€”
â€”
8.00
â€”
â€”

[a] Previous attempt at correction of vaginal agenesis.

[b] Primary graft failure defined as <50% graft take.

[c] An additional 19 patients had areas of granulation tissue, suggesting variable graft take.

Adapted from Templeman CL, Lam AM, Hertweck SP. Surgical management of vaginal agene
Surv. 1999;54(9): 583â€“591, with permission.

Reference	Age (years)	Number of Patients	Previous Surgery[a]	Primary Graft Failure[b] (%)	Hematoma (%)	Rec Perfo (%

Table 20.2 Perioperative Complications of The McIndoe Va

Several authors have described an approach similar to the Abbe-McIndoe; however, they ha synthetic materials to wrap around the vaginal mold and line the neovaginal space. Jackson reported the use of oxidized regenerated cellulose (Interceed) after a

P.242

segment of amnion was inadvertently contaminated during a surgical neovaginoplasty (19). described 10 patients who were diagnosed with vaginal agenesis and were also treated with regenerated cellulose fabric (Interceed) (20). Operative time (<30 minutes) and postoperat (2 days) were significantly shorter than that for the traditional skin graft method. Vaginal d cm, and no significant operative complications were reported. At the time of publication, p

been followed for 6 months; however, vaginal intercourse was already described as easy and
Interestingly, the procedure was also utilized in patients with cervicovaginal agenesis.

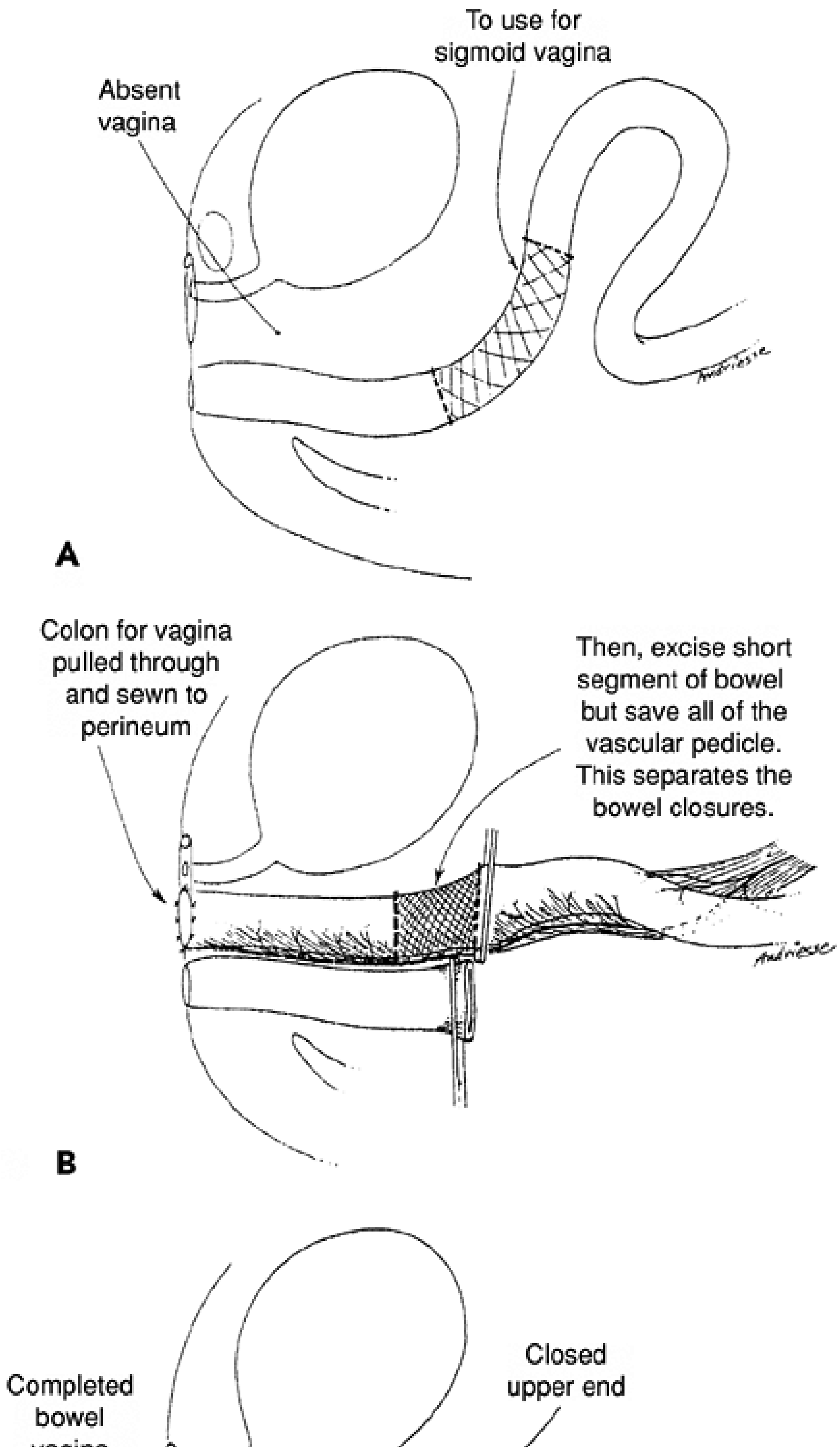
Benefits of this intervention include short operative time and hospitalization. The procedure
easier without acquisition of a skin graft. No scarring, as occurs in a skin graft procedure, is
Although short follow-up is reported, patients have early satisfactory sexual interactions. As
procedure, continued postoperative dilation is necessary. It is essential to provide additiona
up data regarding this procedure to truly assess its role in patient care.

Skin grafts provide a thin lining for the neovaginal cavity that does not alter the length and
dissected neovaginal cavity during the operation. Split-thickness skin grafts have been used
long-term follow-up has demonstrated a patent and functional vagina. The split-skin segmen
its original morphological and histochemical characteristics, but atrophy of sweat glands and
been observed (21). The primary concern is possible inadequate take of the graft leading to
size of the neovaginal cavity during the contractile phase of healing (22 ,23). Patients are r
continuously wear a vaginal stent for many months to prevent contracture and stenosis. Full
grafts may have a decreased tendency to contract than split-thickness grafts during the con
healing. Additionally, full-thickness grafts may successfully grow in children (24). Reduced s
consistent dilation or intercourse may be especially beneficial in patients whose vaginal con
performed at an earlier age (22 ,23). It also has some benefit in select older patients who r
more significant psychological distress with dilation. Since sebaceous and sweat glands are b
full-thickness grafts, secretions produce vaginal lubrication within 4 to 5 months postoperat
Although the full-thickness graft method may be acceptable for neocolporrhaphy, most gyne
would have less expertise and would require plastic surgery collaboration for optimal results

An alternative technique for vaginal reconstruction is the utilization of intestinal segments.
reported the use of ileum in 1904 and 1907, followed by Wallace, who described the use of s
1911 (25 ,26 ,27). Wesley and Coran modified Baldwin's technique for the sigmoid colon (28
Pratt further

popularized the technique with the sigmoid colon (29). The purported benefits of using inte
include the lack of obligatory continued dilation or stenting, the potential for growth in sma
beneficial lubrication. Rajimwale et al. published a meta-analysis of seven recent series of r
with bowel (2 ,18 ,28 ,30 ,31 ,32 ,33 ,34). Patient ages ranged from 4 days to 26 years. Bov
demonstrated a complication rate of 35% with a reoperation rate of 4% in 202 cases. The au
the postoperative complications after bowel vaginoplasty may be managed more simply, usi

minor surgical repairs, than those associated with skin grafting techniques. They also note t
bowel transposition is broader, as it can be employed in a wider age range and for a variety
compared with skin grafting techniques, which are primarily described in the more isolated



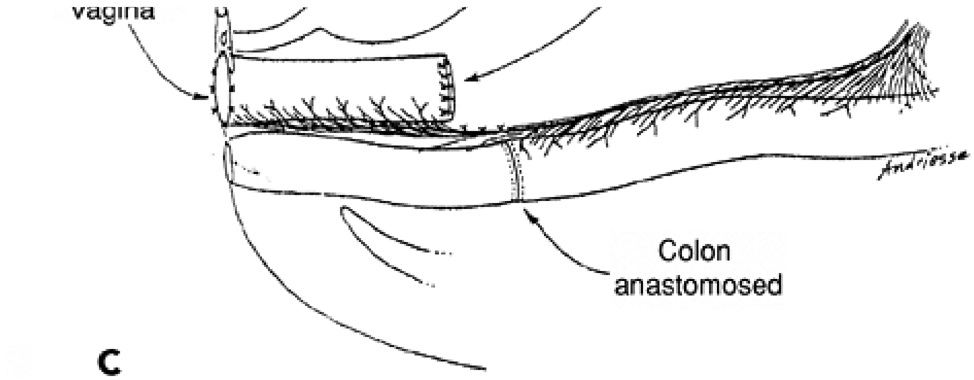


Figure 20-1 *Technique for sigmoid vaginoplasty* . A: Identification of distal sigmoid with blo
reach to the perineum. The bowel segment should not be isolated and divided at both ends
length of mesentery be misjudged. B: Distal end of the bowel segment is divided and pulled
perineum and sewn there, which ensures that the bowel comes down with the adequate sla
on its mesentery. Only then is the upper end of the bowel segment divided, with care being
its adjacent blood supply. Removing the short segment of bowel above that will separate th
anastomosis from the closure of the upper end of the bowel used for the vagina to protect a
formation. C: Completed sigmoid vagina. (From,
Hendren WH, Atala A. Use of bowel for vaginal reconstruction. *J Urol.* 1994;152:752
, with permission.)

Several segments of intestinal vaginoplasty replacement have been described: ileum, cecum
rectosigmoid. Selection may relate to the availability of a suitable segment of an appropriat
also undergoing bladder augmentation or other more complex repairs may have any combina
large bowel for reconstruction, dependent on the needs of other reconstruction.

Ileal or cecal segments may be problematic due to a shorter mesentery, which may produce
neovagina; Hensle and Reiley reported a higher incidence of stenosis attributed to this conc
complex anomaly cases, the ileum may be the only bowel segment available for use in vagir
The rectum and sigmoid may be more optimally utilized in other urinary or bowel reconstru
important to recognize the role of the ileocecal valve within the gastrointestinal tract and t
morbidity associated with any disruption. Pratt reported a higher incidence of dyspareunia a
mucus secretions with ileal vaginoplasty (29).

Sigmoid vaginoplasty has been the favored bowel segment because of its potential advantag
length, natural lubrication, and early coitus in older patients. The sigmoid neovagina is thou
lubricating without the excess mucus production associated with segments of small bowel (1

stenosis is small without the requirement of continuous dilation or stenting. Mobilization of pedicle is usually straightforward and has been accomplished using a minimally invasive, lap approach (35 ,36). When replacement is performed during childhood, the potential for ade adulthood still remains unclear. Rajimwale et al. describe the sigmoid neovagina as aesthet more compatible with sexual activity (30). The thickness of the sigmoid tissue may withstar associated with sexual intercourse better than small bowel or skin grafts. Freundt et al. rep psychosexual and psychosocial performance in adult patients with a sigmoid neovagina (37) included eight patients with vaginal agenesis and one patient with androgen insensitivity. Ps profiles, as determined by patient questionnaire, indicated that most of these patients achi outcomes with respect to sexual relations, function, and satisfaction. The validity of the ev to interpret, as the same questionnaire was used in trans-sexual patients. Communal et al. sexual outcomes of 12 patients with MRKH syndrome who underwent sigmoid neocolpopoiesi standardized questionnaire, the Female Sexual Function Index (FSFI), a validated assessmen of life and sexual function in adults (38). Six separate domains of female sexual function ar questionnaire: desire disorder, arousal disorder, orgasmic disorder, sexual pain disorder, qu lubrication, and sexual/relationship satisfaction. The authors also added details on sexual ir discharge, self-esteem, and anxiety. They reported that patients had a normal sexual life. S percent of patients had vaginal intercourse at least once weekly; however, 18% had severe Vaginal discharge was described as almost constant, but the daily discomfort score was â€œ Patients who were â€œdryâ€• preoperatively later reported wearing one to two pads daily. development of colitis in the graft, which may play an integral role in the development of p discharge, is essential (39 ,40). In severe cases of colitis, pain, irritation, and bleeding may necessitating vaginoscopy. Stenosis of the introitus may occur related to excessive traction transposition, or limited perineal cleavage may necessitate dilation or additional surgery. Si neocolporrhaphy has historically involved a major laparotomy and the associated risks of bo including perforation. In patients with more isolated vaginal anomalies, sigmoid neovaginop potential of a laparoscopic-perineal approach to decrease operative morbidity and adverse consequences associated with a laparotomy. Darai et al. conducted a preliminary study of s MRKH syndrome, confirming the feasibility of the laparoscopic approach when performed by experience in both gynecological and gastrointestinal laparoscopic surgery (41). The mean 312 minutes (range 220 to 450 minutes). No intraoperative complications were reported, an laparotomy was never necessary. The mean fall in hemoglobin was 3.6 g/dL (range 2 to 4.4 hospital stay was 7.7 days (range 6 to 12 days). The mean length of the neovagina was 11.5 documented shrinkage over the initial 6-month follow-up. Mean follow-up was 31 months (ra months). The mean interval between surgery and first intercourse was 4 months (range 3 to promising results in this small population, randomized and/or multicenter trials are necessa advantages.

The role of rectosigmoid neocolporrhaphy is unclear. Reports are dominated by trans-sexual dysphoric patients (32 ,42). This adult population represents a unique

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cohort of patients undergoing creation of a neovagina. Kim et al. reported the outcomes of 10-year period (42). The mean follow-up period was 5 years (range 1 to 10 years). A 10- to intestinal segment was utilized to create a neovagina. After 1 year, the mean depth of the 12 to 13 cm. Excessive mucous discharge and malodor were reported in 8.6% of patients. Fo period as well, 27 of 36 patients were sexually active, and 89% reported experiencing orgasr

Possible advantages of the use of rectosigmoid, as in other bowel neovaginoplasty, are the a term stenting or dilation and the rare contraction of the neovagina. Potential disadvantages complexity of the surgical procedure, generally requiring laparotomy or extensive laparosco significant mucous discharge reported by patients, and postoperative complications. Perium vaginal intercourse attributed to traumatic stretching of the graft vascularity and problems (constipation) are not uncommon.

In 1965, Giuseppe Vecchietti described what is known as the Vecchietti operation (43). He reported his cumulative 14-year experience in 1979 and 1980 (44 ,45). Veronikus et al. revi the technique and described a laparoscopic modification that combines cystoscopy to confir integrity (46). The Vecchietti procedure is a surgical technique that constructs a dilatation 7 to 9 days. The procedure utilizes specialized equipment, including a traction device, a lig an olive-shaped acrylic vaginal dilator (47). The process involves two steps that have essen postoperative components. The operative phase involves positioning the olive at the perineu traction sutures are positioned extraperitoneally. Classically performed through a Pfannenst although it may be approached laparoscopically, the ligature carrier introduces the suture i dissected vesicorectal space (48). The olive is threaded with suture at the perineum, and th reintroduced into the abdomen. The suture is then guided lateral to the rectus muscles, bila subperitoneal fashion, and advanced along the sidewall (Fig. 20.2). The traction device, wh constant traction on the olive, is positioned on the abdomen. During the postoperative inva neovagina is created by applying constant traction to the olive. The process reportedly occu to 1.5 cm per day, developing a 10- to 12-cm vagina in 7 to 9 days. Patients are instructed c vaginal obturator to be used as an outpatient. Borruto reported on Vecchietti's personal seri

agenesis patients, comprising 522 consecutive patients (49). The surgical complications incl
and one rectal puncture, with the ligature carrier and three cases of vaginal vault bleeding.
was 100% follow-up at 1 month, and dyspareunia was initially reported to be 12%, which reso
by 3 months. There were no reported failures of

the neovaginal construction with 1- and 2-year follow-up of 70% and 30%, respectively.

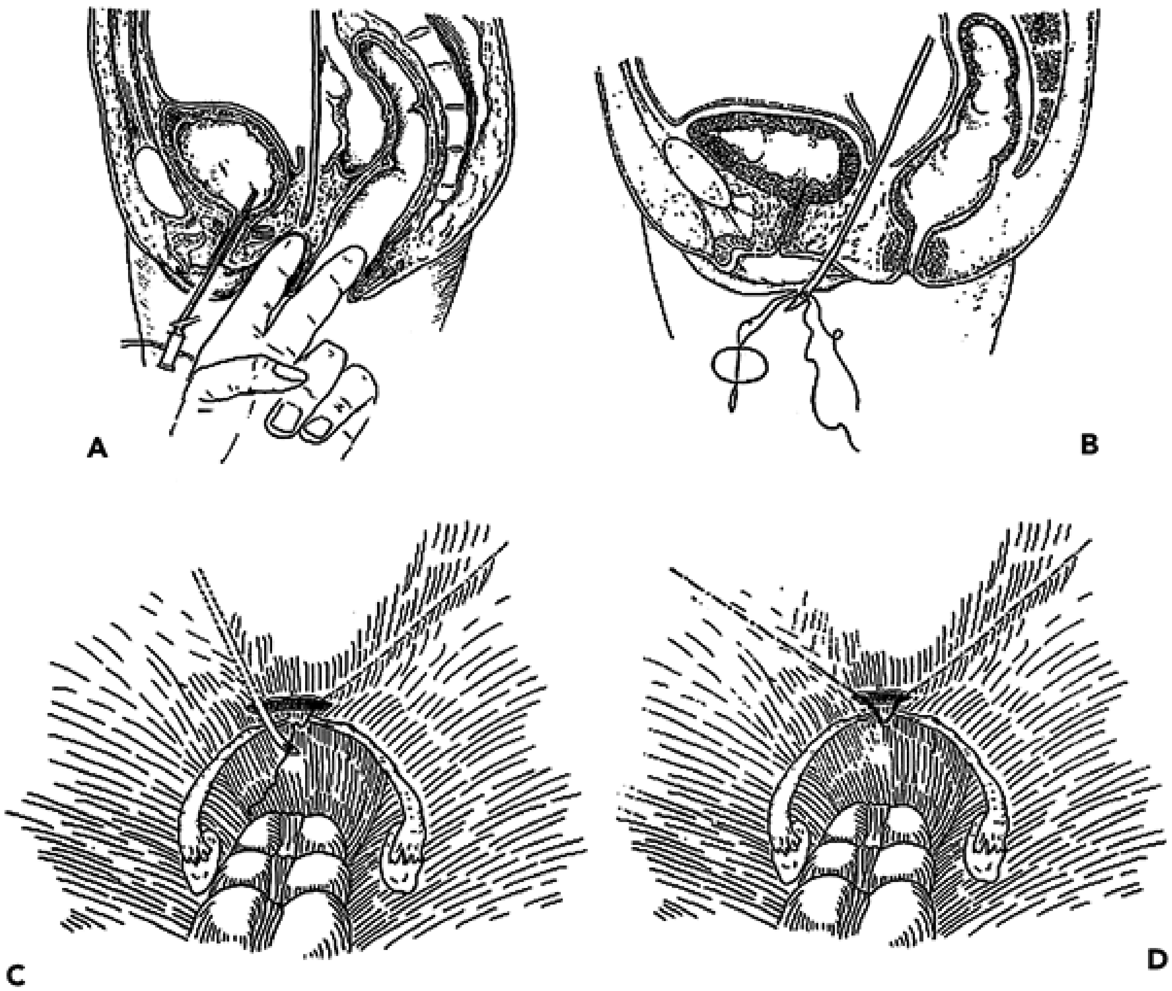

Figure 20-2 *Relevant steps of the Vecchietti procedure* . A: The Vecchietti straight thread-needle subperitoneally reaches the space between the bladder and rectum, then traverses i the pseudohymen. B: The needle perforates the pseudohymen centrally and hooks the threa acrylic olive. C: One thread is withdrawn subperitoneally from the abdomen; the loose one the same path contralaterally. D: A view of the pelvis at the end of the operation. The cour visible at the level of the uterine remnant. (Reprinted from,
Fedele L, Bianchi S, Zanconato G, et al. Laparoscopic creation of a neovagina in patients wi

syndrome: analysis of 52 cases. *Fertil Steril.* 2000;74(2):384â€“389
, with permission.)

The Vecchietti procedure is an interesting procedure that applies the principles of progressi
the vaginal dimple in an innovative fashion. Notable benefits are the avoidance of vesicorec
postprocedure visible scarring, in addition to the opportunity for a laparoscopic approach. F
rates vary from 98% to 100% (50 ,51). Disadvantages include poor lubrication, long-term dila
who are not sexually active, and a significant risk of neovaginal prolapse.

Williams described a vulvovaginoplasty procedure in 1964 and advised that it could be used
canal (52). He reported that the procedure was unsuccessful in only one of 52 patients (53
reported that the anatomic results were good in 22 of 26 patients (54). A horseshoe-shaped
the vulva to extend across the perineum and up the medial side of the labia to the level of
urethral meatus. The success of the operation depends on the appropriation of sufficient ski
vagina. For this reason, the initial mucosal incisions are made as close to the hairline as pos
approximately 4 cm from the midline. After complete mobilization, the inner skin margins a
together with knots tied inside the vaginal lumen. A second layer of sutures approximates su
and perineal muscles for support. Finally, the external skin margins are approximated with i
sutures. If the procedure is performed properly, it should be possible to insert two fingers in
depth of 3 cm. The patient is confined to bed for 1 week in an effort to avoid tension on the
Examinations are avoided for 6 weeks, at which time the patient is instructed in the use of
and Gallego devised a modification of the Williams technique (55). They make the U-shape
skin of the labia majora at the level of the urethra or even lower, claiming that this modific
more anatomically normal vulva that avoids trapping of urine in the vaginal pouch.

Some advantages of the Williams operation are the technical simplicity, the absence of seri
complications even when performed as a repeat procedure, the ease of postoperative care,
recovery, and the possible elimination of dilators. The technique is not applicable to patien
developed labia. It results in an unusual angle of the vaginal canal, which is reported to stra
normal direction with vaginal intercourse. If a very high perineum is created, urine can mor
the pouch after voiding, giving the impression of postvoid incontinence. Failure of the sutur
primary intention will result in a large area of granulation tissue and most likely an unsatisfa

As no one procedure seems to meet all the desired goals, authors continue to develop innov
for creation of a neovagina. Ozgenel and Ozcan developed a surgical procedure to create a
the neovaginal cavity using multiple split-thickness buccal mucosa patch grafts (56). They r

promising outcome in all four patients described. Patients self-reported satisfactory sexual
dyspareunia. Patients were followed for 10 to 22 months. The length of the neovagina range
and the width from 4 to 5 cm. In all cases, the donor site healed uneventfully with no chang
opening. Multiple full-thickness mucosal patch grafts were placed directly into the neovagin
mucosal lining spread to replace expected scar contracture. Lin et al. reported a case series
women with MRKH who underwent neovaginoplasty with autologous buccal mucosa (57). Th
was marked to avoid injury to the Stenson duct and the neurovascular supply to the buccina
length of the graft was approximately 2.5x7 cm. Pinhole incisions were used to increase the
vaginal mold was continuously maintained for 3 months postoperatively. Postoperative comp
bladder injury and vaginal bleeding. At 6-month follow-up, vaginal length was 8 cm (range 6
Hospital stay ranged from 11 to 18 days. Following surgery, patients were placed on a liquid
day and a regular diet on the sixth day.

The advantages of using buccal mucosa in neovaginal construction are the relative ease in w
the procedure, a thin, mucosal-lined neovagina with a normal amount of secretion, minimal
postoperative dilation, low risk of vagina stenosis, and a substantial improvement in donor-s
Disadvantages of the procedure include a need for general or plastic surgery involvement, a
of bed rest postoperatively, likely extended hospitalization, discomfort during healing at th
potential delay in feeding, and an unclear duration of obligatory postoperative dilation.

Davydov described a three-stage surgical creation of a neovagina in 1969 (58). The procedu
dissection of the rectovesical space and abdominal mobilization of the peritoneum followed
the peritoneum to the introitus. Laparoscopic modifications to perform the rectovesical dis
purse-string closure of the abdominal neovagina have been described by several authors. Ad
et al. reported a total group of 45 patients without significant postoperative complications
common postoperative problem involved the formation of granulation tissue at the vaginal v
et al. described the laparoscopic mobilization of peritoneum for the creation of a neovagina
(61). The peritoneum was grasped through a perineal dissection and sutured to the introitu
closure was placed laparoscopically at the apex. Stenting of the neovagina was continued fo
postoperatively, followed by rigid dilator use. At the 9-month follow-up evaluation, an 8x2 c
described, with squamous epithelium present. Both groups claim the technique to be safe a
producing a neovagina with apical granulation tissue as the only complication.

As with any open abdominal procedure, laparoscopic conversion has allowed shorter hospita
morbidity, and a substantial decrease in visible scarring. However, the technically challengi

the laparoscopic approach may limit the use of this interesting technique. Additional follow will be helpful in determining its role in the care of young women.

Carcinoma of the neovagina is an extremely rare disease, at least 10 times less common tha which represents only 1% to 2% of all gynecological cancers (62). The first cases of a neopla neovagina involved the development of adenocarcinoma in small bowel grafts (63 ,64). Sub neovaginal squamous cell carcinoma was described as well as carcinoma in situ (65 ,66 ,67 , evidence supports a risk of neoplastic change in both skin and bowel grafts, with a reported from vaginoplasty to diagnosis on the order of 19 years (71). The use of bowel grafts in chil could result in the possibility of invasive adenocarcinoma developing in very young women. represents a risk for any particular colonic segment that may independently develop adeno whether it may be related to the transplantation of colonic tissue to a new environment. It important that patients with any type of neovagina have long-term follow-up examinations Patients should also undergo regular cytologic screening. Epithelium transplanted to the va oncogenic potential of the lower reproductive tract. Consideration of a plan for surveillance regarding transmission risk for virally related dysplastic change in the lower genital tract is important for any patients undergoing neovaginoplasty. Suspicious symptoms, such as bleed mass, should necessitate prompt evaluation.

Few cases of neovaginal prolapse have been reported in the literature. Prolapse may be a c managed surgically or nonsurgically. Creation of a neovagina with dilation may be at risk, as anchored to any supporting structures or ligaments. O'Connor et al. reported a patient who conversion to a sigmoid neovagina following complete prolapse of the vagina after progressi Some authors note a significant incidence of neovaginal prolapse, which may be attributed normal supporting ligaments (32). A similar phenomenon may also occur in bowel transposi prolapse requiring trimming of the exposed mucosa or anchoring of the bowel segment to th to occur. Hendren and Atala described 16 cases of eversion-prolapse of the bowel segment trimming (2). Hendren qualified the report as a simple eversion of the distal segment, not as in apical vaginal prolapse. He reported no significant change in the length of the neovagi of the prolapsed tissue. Although the etiology of neovaginal prolapse remains unclear, retro sacropexy may be a successful solution, especially when apical prolapse is the concern (73) incorporated anchorage of the distal end of the sigmoid neovagina to the fascia of the sacra the time of the neocolporrhaphy for prophylaxis of prolapse (38).

Regardless of the method of neocolpopoiesis performed, it is important that the operation correctly the first time. If the vagina becomes constricted because of granulation tissue for

adjacent structures, or failure to comply with postoperative maintenance, then subsequent
a satisfactory vagina will be more difficult. The first operation has the best chance of succe

Clearly, multiple techniques remain available for creation of the neovagina. There is no idea
secondary to the lack of clearly defined and compared measures of success. Commonly, the
on the degree and area of expertise of the gynecologic surgeon. The McIndoe vaginoplasty is
performed and offers the most long-term data regarding success. The Vecchietti procedure,
laparoscopically, has been performed more readily outside of the United States but has gain
recent years. The application of intestinal neovaginoplasty has also broadened in treating pa
isolated vaginal agenesis, in addition to patients with more complex anomalies. Innovative n
techniques, such as utilization of Interceed or buccal mucosa, may also have promise as mor
regarding long-term outcomes. Despite all the options, an appreciation of the varying metho
is essential to provide complete care and counseling to patients and families regarding outc
reproductive consequences.

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21

Colpocleisis

Carl W. Zimmerman

Colpocleisis refers to a set of operations that totally or partially occlude the urogenital hiatus. These operations are intentionally anatomically distorting and use the vaginal walls and perivaginal connective tissue to block prolapse of the central pelvic organs through the urogenital hiatus. Various methods have been developed to accomplish this goal. Because this operation renders an individual incapable of coitus, patient selection and informed consent are particularly important. In general, colpocleisis is less invasive, is easier to tolerate, and carries a lower risk of complication than traditional pelvic reconstructive surgery. Shorter surgery time reduces the duration and stress of anesthesia. Fewer deep pelvic manipulations decrease the surgical burden on the patient. These operations have not been widely applied by gynecologists. The techniques are less technical, and the operations are easier to perform than complex and time-consuming site-specific procedures that are used to treat pelvic organ prolapse. Colpocleisis is not too difficult for the average gynecologic surgeon. Familiarity with these operations can provide patients with a valuable alternative treatment, particularly in troublesome cases of prolapse.

Colpocleisis is applicable in a variety of circumstances. Elderly patients with high-grade prolapse may experience sufficient erosion of lifestyle to qualify for this operation (1). An advanced prolapse may become incarcerated to a degree that interferes with urinary and gastrointestinal function. Urinary obstruction, hydroureter, hydronephrosis, renal failure, and obstipation are potential consequences. In addition, hygiene is made difficult, and pressure (decubitus) ulcers frequently develop. The patient's medical condition may prevent the consideration of a full reconstructive surgery. Typically, all types of colpocleisis are well-tolerated soft-tissue procedures (2,3). Blockage of the urogenital hiatus may restore urinary and intestinal outflow integrity, increase patient mobility, and allow ulcerations to heal. In a circumstance with these signs and symptoms, loss of vaginal depth is an acceptable concept for the patient to consider.

A prolapse that has recurred may be sufficiently troublesome to patients and make the concept of colpocleisis acceptable. Statistically, 30% of traditional prolapse procedures will eventually fail. If an individual has no desire for coital function, the superior strength of some colpocleisis procedures may be appealing. Likewise, some individuals with high-grade prolapse prioritize preservation of lifestyle over vaginal depth. In this circumstance, a site-specific colpocleisis with vaginal paravaginal repair and total vaginectomy is the best option for the patient.

In the past, colpocleisis has been considered a rescue procedure in debilitated and fragile patients with limited expectation of longevity. However, younger individuals who are properly informed have the right to consider these operations as well. Colpocleisis procedures meet certain patients' specific needs better than other types of pelvic reconstructive surgery. For that reason, these operations should be included in the spectrum of interventions that are offered to patients with high-grade prolapse. Failure to inform a patient of these options may prevent the selection of the best operation for her individual circumstances.

Le Fort Colpocleisis

The Le Fort technique for colpocleisis is the most widely used and most commonly described variation of this operation (4,5,6,7,8,9,10). The goal of the procedure is to appose the anterior and posterior vaginal walls in a minimally invasive way. This operation is particularly applicable to the elderly debilitated patient with limited mobility. In order to be a candidate for this procedure, the patient should clinically be expected to experience an improvement in signs and symptoms related to her quality of life. Regional, local, or general anesthesia may be used.

After selection and administration of appropriate anesthesia, the patient is placed in the dorsal lithotomy position, and care is taken to protect the integrity of the bones, joints, and vulnerable vascular and neurologic pressure points. Unless a specific indication exists, hysterectomy is not a necessary part of this procedure. In fact, the procedure is designed to allow retention of the uterus to simplify and shorten the surgery. A rectangle of vaginal epithelium is removed from the anterior and posterior vaginal walls. These rectangular areas should be approximately the same size and shape. The long axis of the rectangles is oriented along the long axis of the vagina. The epithelium is removed in the avascular plane that separates the vaginal wall from the deep endopelvic connective tissue. The area selected for denudation should not extend to the pelvic sidewall. At least three reasons exist for preserving the lateral vaginal epithelium. In the midvagina, the lateral wall is a site of connective tissue attachment (DeLancey Level II). The major vascular supply of the vagina is located laterally. Avoiding this area by design helps to decrease blood loss. After completion of the Le Fort colpocleisis, the lateral tunnels of epithelium allow a connection between the uterine cervix and the vaginal introitus. If uterine bleeding occurs after the operation, the lateral tunnels permit recognition and appropriate treatment.

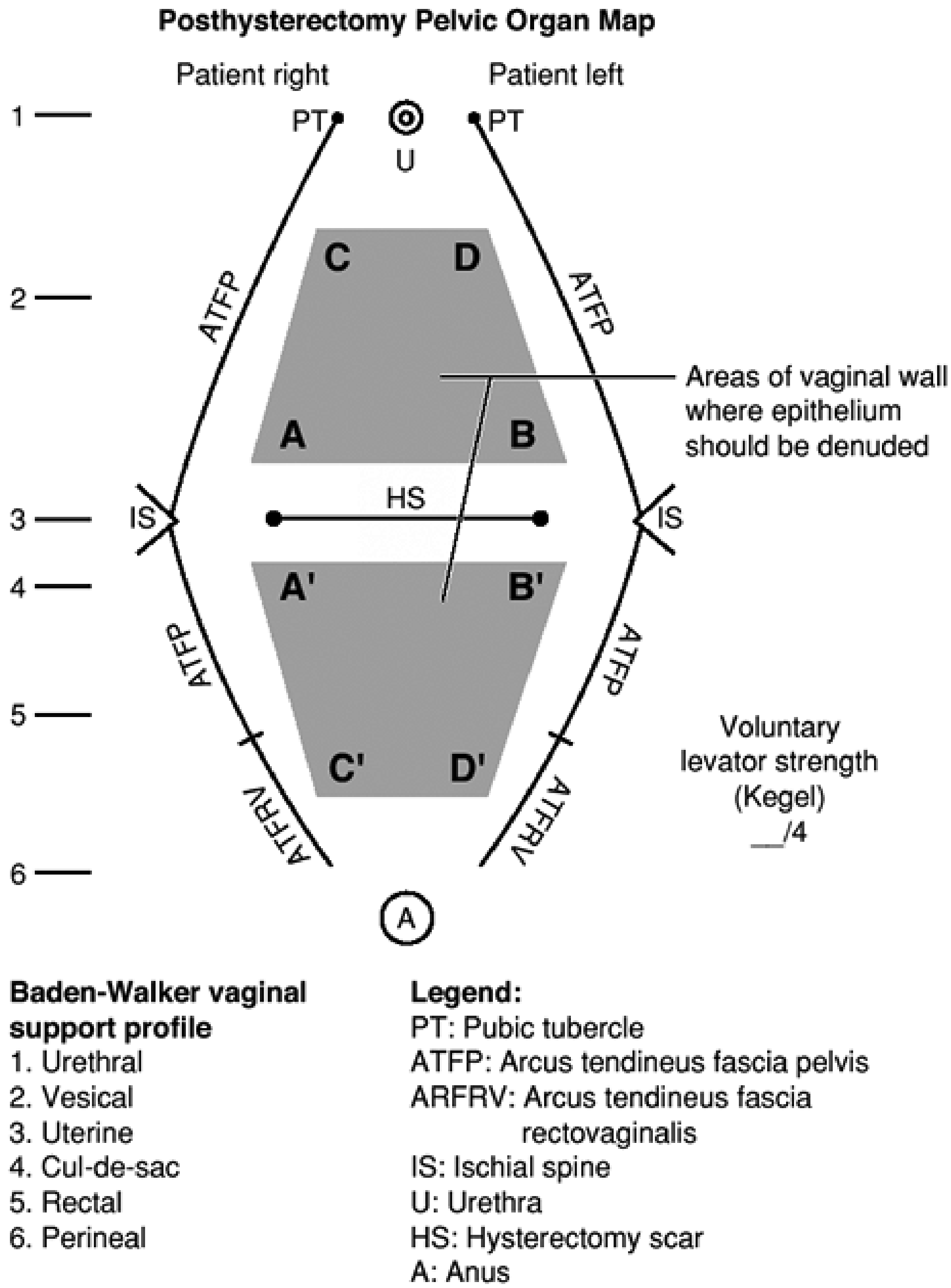

Figure 21.1 *Schematic of the Le Fort colpocleisis*. In the Le Fort colpocleisis, matching trapezoids of vaginal epithelium are removed from the anterior and posterior vaginal walls. To complete the operation, A is sutured to A', B to B', and so forth. Hysterectomy is not required for this procedure. Lateral epithelial tunnels remain open after the completion of the procedure. (Modified from Zimmerman CW. Pelvic organ prolapse. In: Rock JA, Jones HW, eds. *Te Linde's*

Operative Gynecology. 9th ed. Philadelphia: Lippincott Williams & Wilkins; 2003:943
, Figure 35A.14.)

Two denuded rectangles, one on the anterior vaginal wall and one on the posterior vaginal wall, have been created and will be sutured together in the next operative step. Figure 21.1 shows a schematic summary of attachments. Absorbable suture is used on the epithelial edges. The suture lines may be continuous or interrupted as the surgeon desires. Centrally, interrupted permanent or delayed absorbable sutures are used to help close the central area of denudation and bolster the overall strength of the operation. When the central closure is complete, two epithelial tunnels are present lateral to the margin of closure and medial to the vaginal sidewall. The operation is designed to allow egress of blood and normal vaginal secretions through the lateral tunnels. Obviously, packing of the vagina is not possible in this operation.

Some surgeons recommend the addition of introital occlusion to further bolster the operation (9). A high colpoperineorrhaphy may be used. An inverted triangle of perineal and vestibular skin is removed. Use of absorbable suture to plicate the denuded tissues mimics the technique of a Kelly-Kennedy plication. When a dilated introitus is present, this technique is especially useful because this portion of the procedure decreases the size of the vaginal opening.

Another introital modification is the Labhart procedure (9). Various degrees of labia minora are resected bilaterally. The resulting defects are then closed side-to-side with absorbable suture analogous to the way that the vaginal denudations are closed in this operation. Further bolstering of the structural integrity of the operation is attained by this technique. Care must be taken to leave enough room for urination at the anterior margin of the labial apposition. The colpoperineorrhaphy and Labhart techniques may be combined into one resection and closure.

Consideration of a urinary assessment and incontinence procedure is made when a colpocleisis is considered. Reduction of an advanced and chronic prolapse by any method may result in significant degrees of incontinence (11). Reverse kinking of the urethra masks both stress urinary incontinence and intrinsic sphincter deficiency. If this problem is not addressed, the patient's quality of life may improve from the surgery and worsen with the appearance of incontinence. At the very least, the unpredictability of urinary function in this complex set of circumstances should be acknowledged with the patient.

Success from this procedure in terms of reduction of prolapse is very good. Most series report long-term success in excess of 90%. Patient satisfaction is also very high.

Total Site-specific Colpocleisis with Vaginal Paravaginal Repair and Total Vaginectomy

Not everyone with high-grade, chronic, or recurrent prolapse is elderly, debilitated, and incapable of tolerating a surgery that is strong enough to withstand a normally active lifestyle. Reasonably healthy individuals whose quality of life is dominated by a troublesome prolapse may very well prefer occlusion of the vaginal vault to an unsuccessful prolapse repair. These individuals may have a chronically dilated urogenital hiatus, pelvic floor neuropathy, obesity, chronic cough, or other problems that may compromise the structural strength of a repair. The prolapse may be large enough to restrict mobility and significantly interfere with the activities of daily life (Fig. 21.2). These patients generally appreciate the opportunity to consider a complete colpocleisis (12,13,14,15,16,17,18). These procedures leave the external genitalia normal in appearance and provide excellent results in reducing prolapse. Any patient who is offered a colpocleisis must express her desire to be permanently incapable of coitus.

In this set of procedures, vaginal hysterectomy, with or without salpingo-oophorectomy, is performed if the uterus is present. Subsequently, all of the apical vaginal epithelium is removed, a vaginal paravaginal repair is performed, and the apical edges of the rectovaginal and pubocervical septa are sutured together (Fig. 21.3). Native connective tissue is used to permanently and effectively occlude the urogenital hiatus. Vaginal depth is normally 2 to 4 cm. External genitalia remain unaltered.

Figure 21.2 Total posthysterectomy prolapse with pressure ulcers.

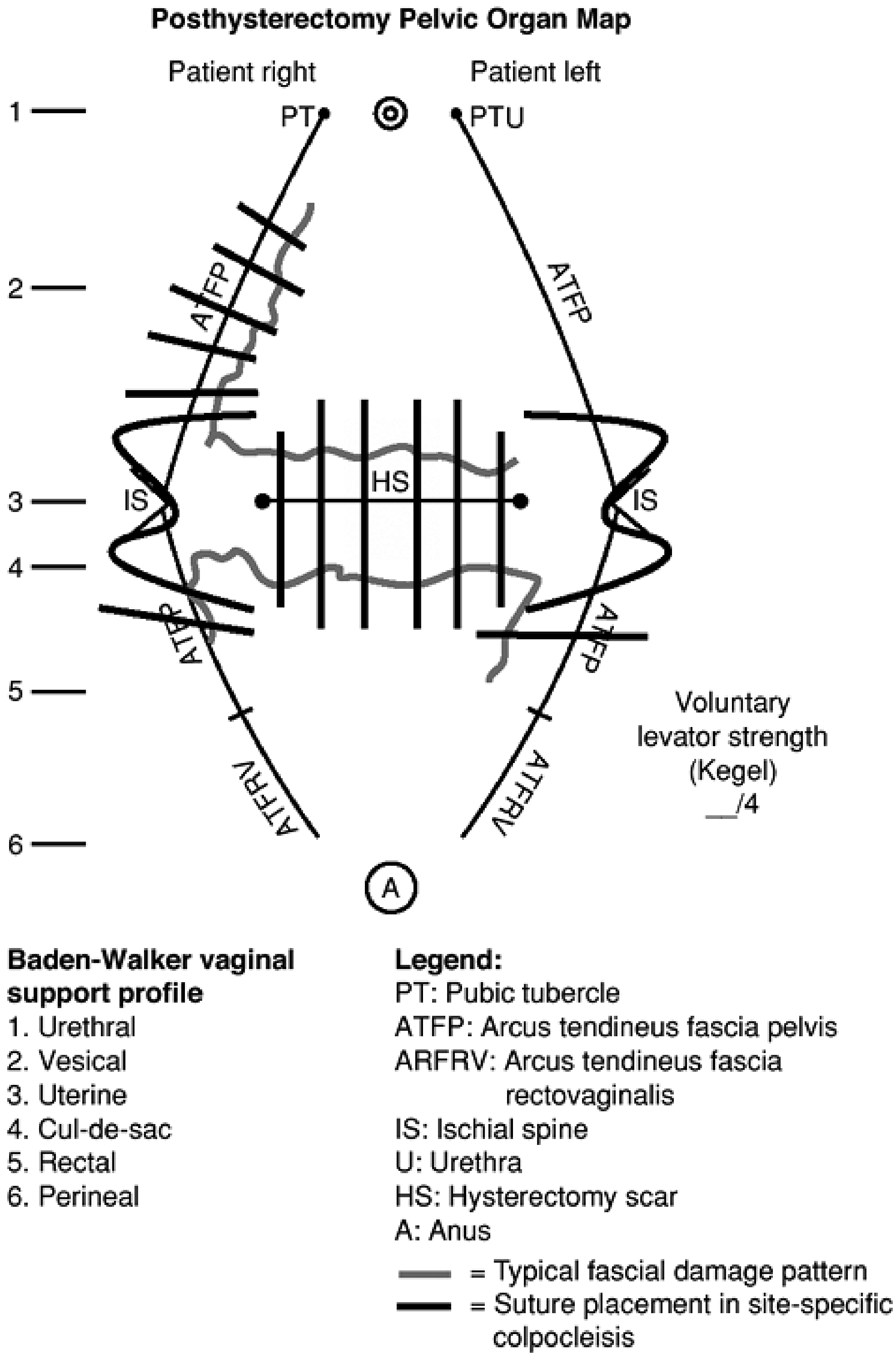

Figure 21.3 *Schematic of site-specific colpocleisis*. Following total vaginectomy, a vaginal paravaginal repair and apposition of the apical edges of the pubocervical septum and rectovaginal septum are performed with

permanent suture. Two lateral sutures incorporate the pelvic diaphragm. The net result is effective occlusion of the urogenital hiatus. All sutures illustrated in this diagram should be permanent. (Modified from
Zimmerman CW. Pelvic organ prolapse. In: Rock JA, Jones HW, eds. *Te Linde's Operative Gynecology*. 9th ed. Philadelphia: Lippincott Williams & Wilkins; 2003:943
, Figure 35A.14.)

Figure 21.4 The four quadrants of the total vaginectomy are designated with a surgical marking pen.

The vaginal hysterectomy is performed first. The open vaginal cuff serves as a convenient point to begin total vaginectomy. The vagina is divided into quadrants (Fig. 21.4), and the vaginal epithelium is removed by using

the avascular dissection plane between the vaginal epithelium and the deep endopelvic connective tissue (Fig. 21.5). Sharp, blunt, and electrical dissection may be used. A typical electrical tip (Valleylab, Boulder, CO), Colorado MicroDissection needle (Stryker Corporation, Kalamazoo, MI), or LigaSure Precise instrument (Valleylab, Boulder, CO) may expedite the dissection and help to minimize blood loss. Traction and countertraction help to identify the correct dissection plane. Particular care is taken on the lateral pelvic sidewalls, the location of the vaginal artery. After the epithelium is dissected in a particular quadrant, it is transected approximately 3 cm apical to the hymenal ring (Fig. 21.6). Total vaginectomy is accomplished.

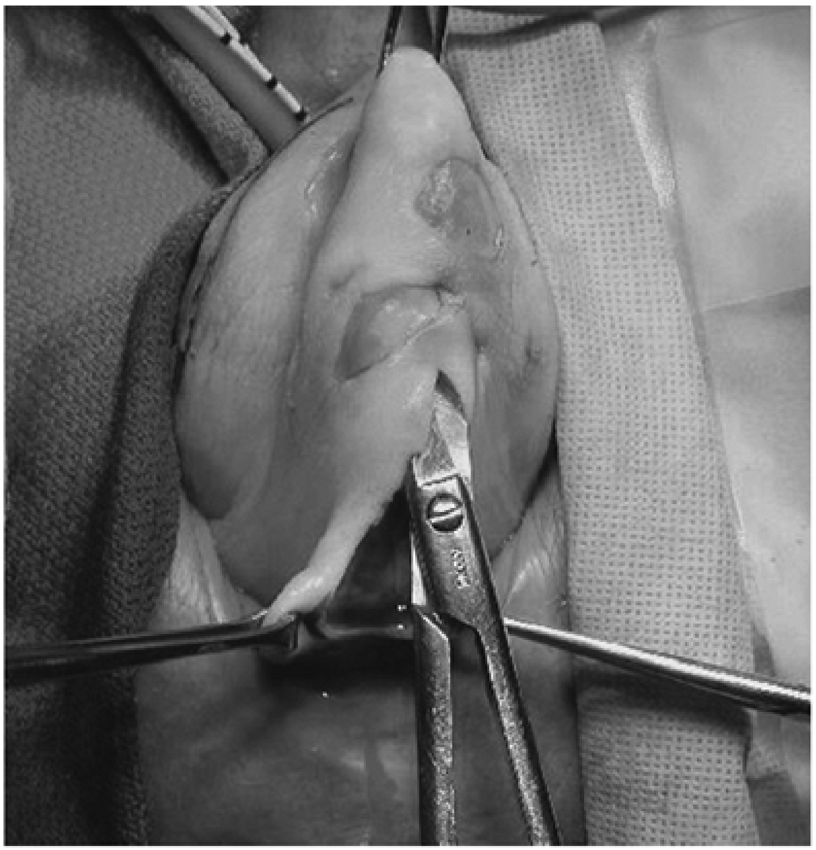

Figure 21.5 *The beginning of the total vaginectomy*. The posterior incision and excision of pressure ulcers are shown. Hydronephrosis and hydroureter are secondary to the chronic pseudoincarcerated prolapse and create the need for ureteral stents.

Figure 21.6 *Total vaginectomy*. Isolation of the right posterior vaginal quadrant with the area of excision marked with a dashed line.

Figure 21.7 *Identification of the pubocervical septum*. Allis clamps are applied to the apical transverse edge of the pubocervical septum.

After total vaginectomy, the pubocervical septum is identified, and the pattern of damage to this structure is assessed (Fig. 21.7). A paravaginal paravesical defect will likely be present (Fig. 21.8). Approximately 90% of the time, the paravaginal defect will be on the patient's right, and 10% of the time, it will be on the patient's left or bilateral. The defect is repaired by attaching the separated edge of the pubocervical septum to the arcus tendineus fascia pelvis (white line). Permanent sutures are used for this repair to restore midvaginal lateral support (DeLancey Level II). One benefit of the site-specific paravaginal repair is elevation of the bladder floor into its anatomical position to make a more normal voiding pattern possible in most patients. Residual urine volume is decreased to help reduce urgency symptoms. In addition, if an incontinence procedure is to be performed, restoration of a normal bladder floor will help to improve the efficacy of that procedure.

The rectovaginal septum is identified. Because the rectovaginal septum is an integral part of the suspensory axis of the vagina, it is thicker and whiter than the pubocervical septum. The fusion of the rectovaginal septum and the apical portion of the perineum is almost always intact (DeLancey Level III) unless the perineum is significantly

attenuated by an old obstetrical laceration or similar process. The disruption of this septum is always apical and leads to the formation of rectocele and enterocele. The site of disruption can easily be found by identifying the dense connective tissue of the perineum and by visually tracing the connective tissue apically to a clear and distinct boundary. Retroperitoneal fat and the outer longitudinal muscular wall of the rectum can frequently be identified immediately apical to the connective tissue boundary of the rectovaginal septum. Paravaginal pararectal defects may be present and are repaired in a manner analogous to anterior paravaginal defects. Permanent suture is used, and midvaginal lateral attachment is restored posteriorly.

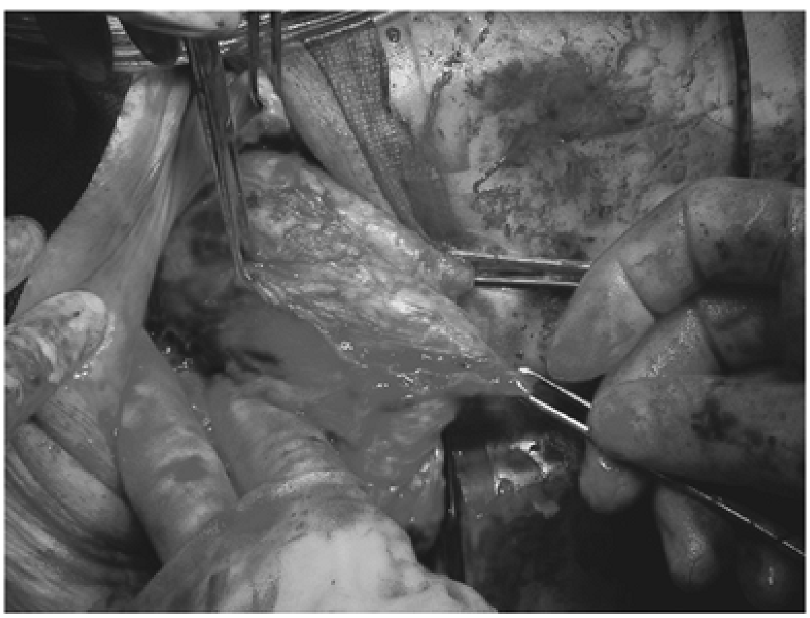

Figure 21.8 *Right paravaginal defect*. Identification of the right paravaginal paravesical defect. An Allis clamp is applied to the lateral edge of the pubocervical septum.

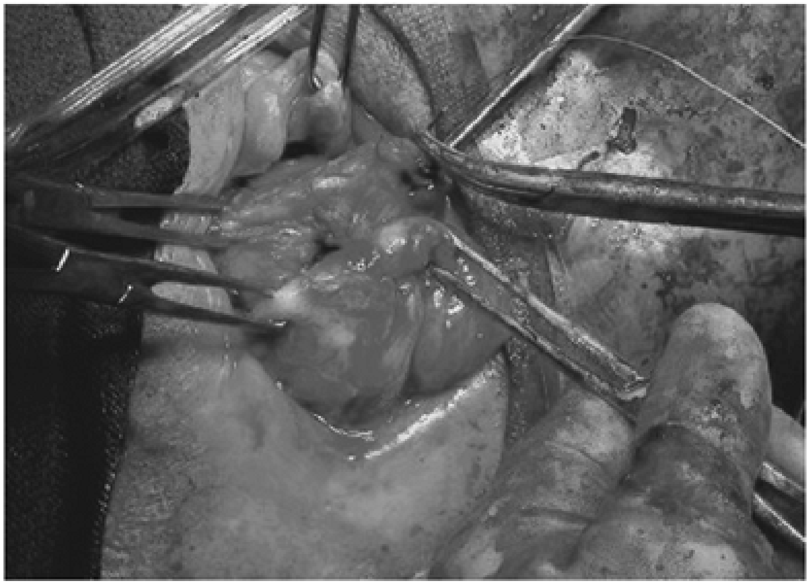

Figure 21.9 *Apposition of the pubocervical and rectovaginal septa*. Demonstration of a permanent suture that connects the apical edge of the pubocervical septum and the apical edge of the rectovaginal septum. Allis clamps mark the septa.

Figure 21.10 *Apposition of the pubocervical and rectovaginal septa*. A permanent suture connects the pubocervical septum and the rectovaginal septum to the right of the midline.

Figure 21.11 *Apposition of the pubocervical and rectovaginal septa*. The transverse fascial apposition is completed.

After completion of the paravaginal repair, the transverse apical edges of the pubocervical and rectovaginal septa are identified. Even in chronic advanced prolapse, these structures can be identified routinely. In fact, the search may be surprisingly easy to conduct. Patients who are candidates for colpocleisis often have a chronically irritated and calloused vaginal wall. Pressure or decubitus ulcers are frequently present. This chronic irritation often has a similar effect on the connective tissue septa to make them whiter, thicker, and more easily identified than in a less pronounced prolapse. The myth of attenuated endopelvic fascia has been dispelled by the ability of pelvic reconstructive surgeons to identify and operate on these structures. The apical transverse edges of the rectovaginal

and pubocervical fasciae are sutured together with helical permanent sutures (Figs. 21.9 and 21.10). A multifilament suture, such as braided polyester, is preferable to a monofilament suture. The ends of monofilament sutures have a tendency to become exposed through the epithelium. The suture line is horizontal (Fig. 21.11). Laterally, the superior fascia of the pelvic diaphragm (pelvic sidewall) is incorporated. A second row of sutures may be used to bolster the first if the surgeon desires. Once these two septa of deep endopelvic connective tissue are apposed, the urogenital hiatus is effectively blocked with a minimum of anatomical distortion. Use of the vaginal paravaginal repair in the operation improves bladder function. The surgeon may wish to perform a perineorrhaphy to further diminish the size of the vaginal opening; however, this step is seldom needed.

Figure 21.12 *Postoperative view*. The completed total vaginectomy, site-specific colpocleisis, paravaginal repair, and perineorrhaphy are shown. Figure 21.2 shows the same patient preoperatively.

This operation has the appeal of leaving a normal appearance to the external genitalia (Fig. 21.12). No entry into the peritoneal cavity is required or desirable.

The deep dissections and technically difficult maneuvers required to establish suspensory integrity of the vagina (DeLancey Level I) are avoided. Because this operation is confined to the pelvic soft tissues outside the peritoneal cavity, it is easily tolerated by the patient. Anatomically distorting, aggressive, and high colpoperineorrhaphies are avoided to reduce the pain experienced by the patient.

Summary

The various colpocleisis operations are valuable therapies to offer selected patients with advanced, high-grade, recurrent prolapse. Pelvic surgeons who treat these conditions should be familiar with the techniques in order to furnish complete informed consent to patients with these troublesome conditions.

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22

Neurological Examination for the Pelvic Surgeon

Niall T. M. Galloway

All pelvic surgeons are familiar with the patient who has had an appropriate procedure performed well by an experienced surgeon but with an imperfect outcome. The abnormalities of pelvic support anatomy might have been corrected, but normal function has not been restored. Surgeons can make structural and anatomical changes that often resolve the patient's problems. In surgical training, there is great emphasis on anatomy, technique, and selecting the optimal procedure as if it is the procedure and how it is performed that will uniquely determine the outcome.

In reality, the patient brings a wide variety of variables, and the experienced surgeon will recognize the critical part that the patient has to play in the therapeutic equation: *Patient plus Procedure equals Outcome*. It is in the initial conditions of the patient where critical variables may be found that can determine the outcome of our surgical treatments. There are fascial defects that can be repaired and detachments that can be restored, and at times it may be necessary to add a compensatory abnormality such as a sling. Ultimately, surgeons have to do the best they can with the patient's own structures.

The patient is less interested in subtle imperfections of support anatomy and is more interested in how the pelvic structures feel and how well they function. Of course, there is a relationship between structure and function, and surgeons strive to restore normal structural integrity and expect to achieve improved function with resolution of preoperative problems such as urinary incontinence, difficulty with evacuation of stool, or symptomatic vaginal prolapse. Frequently, they will meet these goals, but even in the best hands after optimal anatomical repairs, functional results may be imperfect and the patient will be disappointed. Some patients will pursue repeated surgical procedures in a vain search to correct a nonsurgical problem.

How the pelvic structures feel and how well they function depend on a variety of variables, some of which are quite independent of the anatomical support defects. When pelvic surgeons look for a defect in structure, they rely on physical examination, cystoscopy, ultrasound, or other radiological imaging. They have a narrow perspective that is focused on the pelvic organs and might assume the integrity of the innervation unless there are obvious external signs of a neurogenic deficit. When the structures appear to be complete but symptoms are prominent and persistent, the pelvic surgeon might consider psychological, behavioral, and other factors that could play a part. In the absence of an established neurological diagnosis, it might seem reasonable to assume the integrity of the nervous system. The physician may fail to consider the presence of subtle yet significant neurological deficits.

There are obvious examples of acquired diseases such as diabetic neuropathy, Parkinson disease, or a history of stroke that will immediately alert the surgeon. There are rare disorders of mitochondrial function associated with muscle weakness and common problems such as spinal stenosis that might influence outcomes. In the context of pelvic surgery, a history of pelvic fracture, pelvic surgeries, or radiation therapy might raise a flag for the surgeon.

In assessing a patient with significant symptoms and dysfunction, the physician is taught to examine the structures, and it is expected that complete structures will support complete function. However, when pelvic floor function is impaired or imperfect, it is often a reflection of

a defect in neurological structure. Clinical features might include symptoms of motor deficits such as weakness or paralysis; coordination problems of voiding difficulty or incomplete emptying;and sensory deficits such as lack of awareness, dysthesia, pain, or discomfort.

As the biology of patients is considered, there is a wide spectrum of individual variations in structure and function in all aspects of human form. Just as visual acuity varies from one patient to the next-one might have better than 20/20 vision and another has to use a guide dog-so it is with a patient's structures. The skin is different, the hair is different, and the pelvic floor structures are dramatically different from one patient to another.

It is easy for patients to recognize differences between themselves and others with regard to skin, hair, or eyesight. These are easy to compare, but pelvic floors are quite different. Each person knows his or her own structures and has a sense of â€œnormalâ€• based on personal experience and the observed behavior of others. Pelvic functions are private and discrete. Society is reluctant to consider most aspects of pelvic function, let alone urinary or fecal incontinence problems. There might be less reluctance now than before to talk about sex and sexual function, but there is a prevailing stigma associated with most aspects of pelvic health problems, disease, and dysfunction.

As there are no ready ways for a patient to compare pelvic structures with others, it might be easy to imagine that life is fair and that everyone has the same, but it is not so. Just as the local telephone book can be different in size for a large city compared with that used in a small rural township, so it is with the pelvic floor. For some, the pelvic floor is strong and versatile, and for others it is thin, weak, and quite unable to adapt. In labor and delivery, the experienced midwife will want to know how a patient's sister and other family members progressed with their vaginal deliveries. It is the family history that gives the best clues to what one might expect in birthing the new baby.

Those individuals who have the most complete structures have the best quality of function. Those with incomplete structures have a greater tendency to develop bladder and pelvic floor problems including urinary incontinence, pelvic organ prolapse, and bowel dysfunction. This wide range of structures is evident in children as well as in adults. Children with the best of structures are quicker to acquire bladder control by day and to become reliably dry at night. Children with the best of structures will never have had a urinary tract infection or constipation problems. Structures are inherited according to genetic characteristics, and there is a strong tendency for bladder and bowel and pelvic floor problems to â€œrun in the family.â€•

This chapter will include some observations and describe a pattern of sacral neurogenic deficit that exists in patients. The deficit is evident in a spectrum of severity. Severe deficits are rare, but minor deficits are commonly found in patients and are important in the pathogenesis of significant symptoms, dysfunction, and disease.

Human Caudel Structures

Humans possess caudal structures. Although no external tail is to be found at birth, the human embryo has a large and distinct tail. The form of all mammalian embryos is similar in the first weeks after conception. Nature has one pathway for building an embryo from a single fertilized egg cell to a ball of cells and then a disc-shaped embryo. As we consider our human structures, the normal human newborn does not possess tail structures, but the perfectly formed early human embryo does have a large and distinct tail. The disc has a dorsal surface and a ventral, head end, and tail. For the human embryo, the tail is most prominent the fifth and sixth week after conception.

The human tail undergoes a process of die back, degeneration, and resorption during the seventh and eighth weeks. This process of apoptosis and tissue loss occurs when the crown to rump length of the developing embryo is no more than 6 mm. The embryo is an incredibly complex and dynamic creation. Nature rolls out tissue, and more is made than is needed so the excess is trimmed away. It is ironic that cell death and tissue destruction are as important as cell growth and proliferation in the course of building the perfect embryo.

In the embryo, chemical signaling defines what tissue will survive and how much will die off. In nature, there is no absolutely constant and perfectly reproducible measure; instead, there is variation. There is always a range of possibilities to be found in biological structures. Nature has no defining line on a perfect blueprint; instead, there are watersheds and transition zones. The process of cell death in the tail of the embryo could be likened to the tide on the beach. The advancing tide of cell death will wash away the unwanted tissue and leave that to be preserved untouched.

Is it reasonable to expect that this process will be accomplished perfectly and be the same for every embryo? Is it reasonable to predict that the precision of this event will be so accurate as to delete only the unwanted excess and preserve the full perfect complement of structures every time? Or is it possible that this advancing tide of cell death might, at times, overshoot the perfect place and cause unwanted erosion of caudal structures that would have been preserved in the perfect individual?

This seemingly trivial event in the first weeks after conception might be expected to lead to measurable consequences in form and function of the caudal segments. The loss would be evident in both sexes, and degrees of loss would result in a spectrum of deficits. The pattern would be such that for each individual, there would be a tapering off of structure and function in the most caudal segments with the greatest loss found in the most distal elements. It would be possible to have losses that might be more marked on one side or the other, and thus for each individual, the loss would not be expected to be perfectly symmetrical. The prevalence of the most distal deficits would be highest, and

the more proximal deficits would be rare. Patterns of deficit would be expected with multiple anomalies occurring in the most severe forms and fewer and lesser deficits in the more common forms.

The most extreme deficit, compatible with survival, is the so-called â€œmermaid syndrome,â€• or sirenomelia, in which the newborn lacks the sacrum and pelvic musculature including the external rotators, flexors, and extensors of the hips and all of the more distal muscles. The lower extremities are fused together by a common sheath of skin. For these rare infants, there are no sacral and few lumbar nerves. Where there are no nerves, there is no muscle, and the lower limbs are left flaccid and fused because there have been no forces at work to separate and pull apart the inert flail extremities.

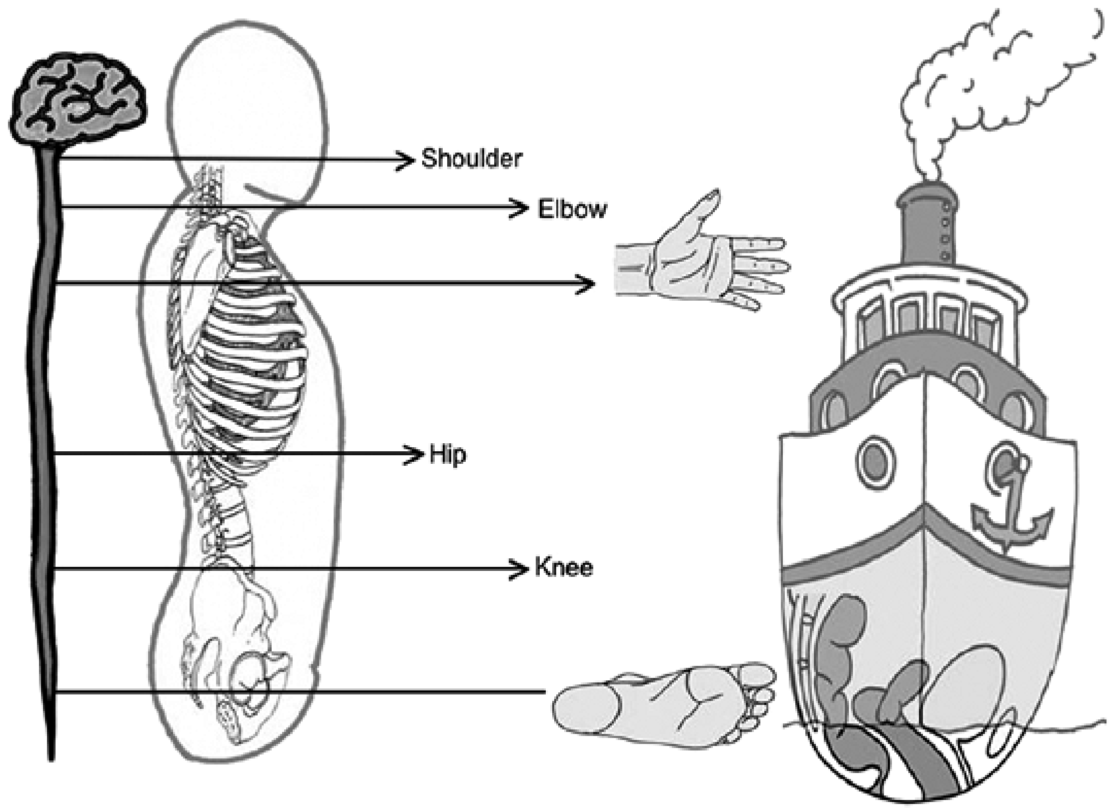

Figure 22.1 Nervous system view of the human body. Note that the sacral segments of the spinal cord responsible for pelvic floor function overlap with and are distal to the segments that innervate the feet and toes.

For these unfortunate newborns, there is no perineum, no pelvic muscles, no anus, and no hindgut. There is no urethra and no bladder, the kidneys are abnormal, and the massively dilated ureters open into a shallow posterior sinus distal to a sacral fovea. This is a rare and extreme form of sacral deficit. Early descriptions suggested that sirenomelia might be the result of a vascular steal phenomenon, but this is no longer acceptable.

Physicians recognize major congenital defects in which there is sacral agenesis and unequivocal neurogenic deficit with signs of cloacal extrophy or bladder extrophy and epispadias. These defects are often associated with vertebral and lower extremity anomalies. Other defects include congenital absence of the uterus or vagina and talipes equino varus (club foot anomalies). Lesser anomalies exist and are more prevalent, but these are not recognized to be associated with sacral neurogenic deficits. These anomalies include posterior urethral valves, imperforate hymen, vaginal septum, and imperforate anus.

It is possible to have losses that might be more marked on one side or the other, so for each individual, the loss would not be expected to be symmetrical. The prevalence of distal deficits would be more common, and the more proximal deficits would be rare. Patterns of deficit would be expected with multiple anomalies occurring in the most severe forms and fewer and lesser deficits in the more common forms.

The impact of these deficits would result in imperfect development and imperfect form and function of the pelvic organ systems and the pelvic floor. The impact of these problems would be felt in the bowels, bladder, and sexual functions. This pattern of incomplete development in animals will result in a perfect animal with an incomplete tail. In those species without a tail structure, incomplete development of the caudal nervous system will result in incomplete innervation of the bowel, bladder, and pelvic floor dysfunction. In more severe cases, it will also impact the form and function of the toes, feet, lower limbs, and gluteal muscle masses (Fig. 22.1).

It may be that these congenital anomalies of the sacral segments represent a range of abnormal forms associated with a corresponding spectrum of caudal regression. Nerves and nerve growth factors play a potent role in directing tissue growth and development in the embryo, and thus a quantitative deficit of sacral nerves might contribute to a wide variety of aberrations of form and function.

Pelvic Floor Structure and Function

The pelvic floor is a dynamic trampoline of resilient muscles and connective tissue structures. The muscles and loose connective tissues are critical for normal pelvic support. They must contract to maintain pelvic support for continence. They must relax to permit voluntary urination and to initiate the act of defecation. In the female, the pelvic floor must relax and lengthen enormously to allow the passage of a full-term fetus during childbirth, yet it must contract again after delivery to permit all of the normal functions to be maintained.

Much of surgical anatomy is taught in the operating room, and this anatomy is distinctly different from normal. The muscles are often sparse, incomplete, or even absent. Surgical patients do not typically present normal anatomy. The patient may have anatomical defects and detachments that the surgical dissection and repairs are directed to correct. In the operating room, surgical landmarks are limited to the structures that remain, such as the bones, ligaments, fascia, and viscera. The ligaments are the fibrous skeleton of the pelvic floor that remains after the muscles have wasted or been lost to atrophy.

Pelvic Floor Muscles

In the developing fetus, the muscle is laid down in the mesoderm, and motor nerve axons grow out from the nerve cell bodies of the neurectoderm (later to become the spinal cord) to reach the muscle. If the full complement of neurons is present in the spinal cord segment, the full number of axons will be available to grow out to the muscle. Each nerve fiber will provide motor end plates to innervate muscle fibers. In essence, the muscle cells are divided up between the nerve fibers so that one muscle fiber receives an innervation from just one axon, but one axon might supply one or more muscle fibers. If the full complement of nerve fibers is present and they are all successful in reaching the primordial muscle, the muscle will be divided into a large number of separate units of function. Each one is capable of contraction or relaxation, independent of the others.

This provides a full and versatile structure that will have a wide range of functions with the possibility of fine regulation of muscle activity with the addition or subtraction of one motor unit. Each motor unit would contribute only a tiny increment of variation. Further, it would be expected that the central regulation and modulation of motor function would be complete. The full number of neurons available for synaptic activity would clearly have an influence. A large number of neurons in the spinal nucleus would support a larger number of synapses for transmission of modulating impulses from the higher centers.

If the development of the sacral segments were imperfect or incomplete, it would be expected that the number of nerve cells in the segments would be less than the complete number. There would be fewer axons to grow out from the spinal cord to the primordial muscle. There would be fewer neurons available to innervate the muscle fibers, and the muscle would be divided into a lesser number of independent units of function. If the muscle mass was the same, and all muscle fibers were innervated, the motor unit would consist of a larger number of muscle fibers supplied by each neuron.

This muscle would have fewer motor units, but the size of each motor unit would be larger. This would provide a range of function that would be less versatile because although there would be a range of activity, the individual increments would be fewer, and the size of the increments would be larger. The smallest increment of change would be the addition or subtraction of a single motor unit. The severity of the deficit would be proportional to the number of neurons that were lost.

The clinical deficit would be determined by the nerve deficit in the spinal cord segments. A deficiency that extended into the lumbar segments of the spinal cord would result in noticeable clinical deficits in the lower extremities, the corresponding body segments. A distal lesion of the sacral segments could spare the lower extremity but would be marked by a deficit in structure and a corresponding deficit in the function of the most caudal body segments-the anorectum, lower urinary tract, and pelvic floor.

A deficit could be symmetrical or asymmetrical. A unilateral deficit would have effects only on the right or on the left. The contralateral structures could be complete or deficient. The spectrum of deficit in nerve structures would determine the range of function that could be expected. A perfect complement would provide the potential for a complete and versatile range of function. Lack of the complete structures would stand as an invisible obstacle that might delay or even prevent the onset of the full and complete range of function.

Structure and Function of the Pelvic Floor Muscles

The innervation of the lower urinary tract is moderately complex and includes both sensory and motor functions as well as somatic and autonomic systems. The urethral sphincter is a midline structure, like the mouth or the larynx, and is innervated by nerves from the left and from the right. Motor neurons and muscle fibers are arranged

in independent functional units called *motor units*. There are limited numbers of motor units that are responsible for striated sphincter muscle control. The greater the number of motor neurons to the urinary sphincter, the greater the number of motor units, and the more versatile the range of possible muscle activity. Conversely, the lesser the number of motor neurons, the less versatile or more clumsy the possible range of sphincter activity.

A muscle can be likened to a piano as each is made up of individual units-motor units or musical notes. Activity in the muscle is equivalent to music. Work in the muscle is shared between motor units that are working and others that are resting. The work is shared just as music is shared between the notes with some notes quiet while others are sounding. Normal sphincter function is versatile and coordinated so that the left and right hemisphincters work intimately one with the other. We should think of the urethral sphincter as being a duet of two concert pianos, one for the right and one for the left.

During normal voiding by volition, the urethral sphincter relaxes completely, which is associated with electrical silence of the electromyogram (EMG). After voiding, low threshold motor units maintain a resting tone, and this resting tone increases slowly as bladder volume increases. A range of activity exists, with low threshold units the first to become active and higher threshold units becoming active only later during muscle activity.

This change in muscle activity is called *recruitment*. The normal pattern of EMG activity is that there is recruitment of units occurring in response to voluntary and involuntary factors. Further recruitment occurs with change in posture and change in activity, and maximal recruitment occurs in association with pelvic floor contractions associated with vigorous efforts such as coughing or sneezing. There is a change with posture from the supine position to sitting to standing, further increase with walking, and a maximal response with vigorous efforts, such as a high-impact aerobic exercise.

The work of the muscle is shared between the motor units. Some are contracting while others are not, passing the load and sharing the work. When the activity of the muscle increases with recruitment, the number of active motor units will become larger, and the number of inactive or resting motor units will become smaller. At any moment, the reserve of available motor units will be the population of resting units.

We can demonstrate this with other muscle groups. For example, hold a book between finger and thumb outstretched at arm's length. At first, it is comfortable, and you feel confident to the task. Soon, the weight of the book seems to increase as muscle strength begins to wane. Efforts to use other muscles to change posture and redistribute the work of the muscle groups are made, but there is a feeling of pressure and then a sense of urgency-urgency that cannot be resisted, you just cannot hold on and must let go. These feelings are not unfamiliar to any of us. The source of the urgency is the striated muscle. The exact physiologic and biochemical basis might be related to fatigue and local tissue events.

Symptoms of Urinary Frequency and Urgency

In the urinary tract, it is possible that the musculature of the urethral sphincter and pelvic floor might have a potent role in provoking symptoms of urgency that would lead to frequency. It is possible that increasing activity in the urethral sphincter might create a sensation of needing to let go-a sensation that one cannot hold on any longer.

For each individual, the range of muscle function will vary according to the number and size of the motor units that are present and available to be recruited. The completeness of nerve and muscle structures in the lower urinary tract and pelvic floor will determine both the number of motor units and whether the sphincter has a full, versatile range of activity or a more limited one.

Urinary urgency and frequency or feelings of â€œpressureâ€• are among the most common lower urinary tract symptoms. Previously, the clinician made a distinction between motor urgency and sensory urgency on the basis of clinical features, cystoscopic findings, and urodynamics. The clinical distinction between motor urgency and sensory urgency had some value and did lead to specifically targeted treatment.

Motor urgency is caused by inappropriate detrusor contractions. Symptoms include urinary frequency and urgency, which may be provoked by change in posture or position from sitting to standing. Motor urgency is associated with urinary incontinence or threatened incontinence. When leakage does occur, it might be with a flood rather than drops. Cystoscopy might reveal fine trabeculation of the bladder, and there might be leakage around the cystoscope with inappropriate contractions of the detrusor muscle. Urodynamics will often confirm the presence of uninhibited detrusor contractions. For motor urgency, effective treatments include fluid regulation, bladder drill, and anticholinergic medication. If detrusor overactivity cannot be demonstrated, urgency is likely to be considered sensory.

Sensory urgency is due to inflammatory or irritative bladder problems. The symptoms are similar and include urinary frequency and urgency. Urinary incontinence is less common but may occur. Urgency is not usually provoked by posture unless there is an irritative focus such as a stone present in the bladder. Urgency does not lead to incontinence but may go on to become a sensation of pressure or pain as the bladder fills. There might by cystoscopic features of inflammatory changes, and occasionally a bladder tumor or carcinoma-in-situ might be found. Trabeculation is uncommon. Cystometry reveals a stable detrusor but a

small functional capacity, with first sensation and urgency occurring early in the filling.

Simple classification of motor and sensory urgency failed to distinguish all patients and all clinical situations. This classification considered the bladder, and only the bladder, as the source of symptoms and ignored the possible contribution of the urethra or pelvic floor. During cystometry, urethral sphincter activity usually increases with increasing volume. Urgency is felt at or near full capacity, and this is coincident with maximal EMG activity. When inappropriate detrusor contractions occur, there is often voluntary recruitment of sphincter activity to stop leakage and to inhibit the detrusor contraction. These changes are well known to those who are familiar with urodynamics. Inappropriate detrusor contractions may be preceded by a relative fall in sphincter EMG activity.

The voluntary act of voiding is regulated, inhibited, sustained, or abolished by control of higher centers in the cerebral cortex, which in turn coordinate and modulate centers in the midbrain. Volitional activity is brought about by the effector motor neurons in the spinal cord segments at the level of the conus. Function of the sphincter and detrusor are coordinated in the healthy individual. The striated muscle of the sphincter is controlled directly by volition. The sphincter is the first to act. In voiding by volition, the first event is urethral relaxation followed by detrusor contraction.

Striated muscle contraction and relaxation occurs in response to electrical stimulation by neurons. Coordinated muscle activity will be the result of coordinated nerve activity. Coordination of the right and the left requires neural interaction between the right and the left. This coordination might be effected by simultaneous generation of a stimulus to excite or inhibit, by coordination of bilateral tracts by crossover or internuncial neurons, or by other mechanisms such as modulation by Renshaw cells.

The final part of the motor pathway is the motor efferent nerve, and each motor nerve contributes all or nothing. The motor response to stimulation is contraction of all muscle fibers in the motor unit or none (except with reinnervation changes when the immature terminal fibers will be unable to depolarize with every impulse resulting in jitter). The contraction of the muscle fibers will be sustained according to the biochemistry of the muscle fiber, to the frequency and duration of the stimulation, and the magnitude of the stimulus.

There are two types of striated muscle fibers in the sphincter-slow twitch and fast twitch. A fast-twitch contraction is very short lived, approximately 30 to 80 ms, and a slow-twitch contraction will be less short, about 70 to 300 ms in duration. After contraction, there will be a latent interval before contraction can occur again in those muscle fibers.

In humans, most muscles are a mixture of fiber types, but some muscles are exclusively slow twitch. The intrinsic muscles of the larynx are comprised exclusively of slow-twitch fibers. These muscles must have special resistance to fatigue because of their critical function to hold open the vocal cords and to maintain an open airway for breathing. The intrinsic striated muscle of the urethral sphincter is also comprised exclusively of slow-twitch muscle fibers.

Coordination

The motor neuron has a threshold for activity that may vary, and depolarization of the axon will occur only when the threshold for excitation is reached. Each motor neuron has thousands of nerve terminal boutons on the dendrites and cell body, each of which contributes an â€œall or nothingâ€• signal to stimulate or to inhibit. Activity in the motor neuron depends on the magnitude of the stimuli that are excitatory added to those inhibitory stimuli. The total activity for inhibition depends on the number of synapses and the frequency and magnitude of the inhibitory stimuli.

There will be a threshold for excitation and a threshold for inhibition. One motor neuron will excite only those muscle fibers to which it has motor end plates. Depolarization of the muscle and contraction occur only if stimulation exceeds the threshold for excitation and if motor end plates and muscle fibers are susceptible to depolarization. If the muscle has been active, there might be postexcitatory resistance to excitation or a latent period during which the muscle fiber is unable to contract despite excitatory stimulation.

A sustained contraction depends on multiple motor units, each with phases of contraction and relaxation so that at any moment, some are contracting while others are relaxed. Thus, a tonic contraction may be maintained for a long, or possibly indefinite, period by the contribution of one population of fibers and then another. Contraction will be sustained by excitatory stimulation and will be arrested by inhibitory stimulation or by the lack of excitatory stimulation.

To sustain a contraction, there has to be stimulation, with further stimulation acting as a resistance to inhibition that might otherwise interrupt the contraction. This must be true of all coordinated sustained muscle contractions. In the same way, inhibition or relaxation of muscle contraction in order to be sustained must have resistance to excitation that would cause unwanted muscle contraction.

For coordination of muscle contraction, the structures must have a capacity to stimulate and overstimulate, to provide a resistance against unwanted relaxation that will interfere with the performance of sustained contraction. If less than maximal contraction is required for an action or task, the population of motor units to be recruited will be fewer, yet the requirements still exist to stimulate and sustain the resistance to inhibition of the contracting motor units.

For a particular muscle, there are motor units of lower, intermediate, and higher thresholds. With contraction, it is the low threshold motor units that are first to be recruited

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and the high threshold that are the last. In general, the low threshold motor units are smaller than the higher threshold units. There might be a hierarchy of motor neurons, rather than of muscle fibers among motor units, in that the activity must begin first with the nerve cell body and then propagation of an impulse to the axon, motor end plates, and muscle fibers. The anatomical distribution of the motor neurons in the spinal nucleus would be one factor in determining the order of firing during recruitment.

There is a pattern to muscle activity and regulation. For the urethral sphincter, a clear pattern of recruitment occurs in response to bladder filling. There is an order of activation of the motor units according to the thresholds. The number of active motor units increases as bladder filling proceeds and will further increase in increments according to posture. There will be further recruitment according to physical activities such as walking or coughing. There are sphincter changes related to respiration and movement, and there are interactions between the activity of the urethral sphincter and the anal sphincter.

Normal urethral sphincter function includes a wide range of activity. Versatile muscle function is dependent on the number and range of motor units that are capable of maintaining tone and increasing activity for continence as the bladder fills. Further recruitment will be required for changes in position and as there is a need to resist leakage during physical exertion or violent activity such as sneezing. Coordination depends on an even wider range of possible motor neuron activity to relax for voiding-not only to inhibit but also to further inhibit to provide resistance to unwanted stimulation that might interrupt the flow.

Assuming that there is a similar ability or potential for function for each motor neuron, then the versatility for function, the ability to contract or relax with ease, and to perform sustained coordinated activity will be determined by the number of motor neurons. In the same way, the versatile function of a computer might depend on the number of bits/bytes available for data storage and manipulation. The larger the number of units, the greater the opportunity for a full, coordinated range of function and for the execution of sustained tasks and the less susceptible the muscle will be to involuntary or unwanted activity.

Early Life

It would seem reasonable to suggest that if there is a congenital neurogenic deficit, there will be some indication of it in early life. One might predict that urinary milestones might be delayed or that voiding by volition will be difficult for these patients. Problems of urinary infection in early life or difficulty with constipation, fecal impaction, or encopresis might be more common in patients with a deficit. Further, the greater the deficit, the greater the susceptibility to develop symptoms. The problems for the infant and child might be carried on through adolescence and into adult life.

The human infant has an immature nervous system at birth and will only complete the full processes of myelination and maturation in the first years of life. Learned bladder and bowel functions are personal and private. There is great variation in performance and ability between individuals. Some have remarkable ease and facility in voiding, others are much slower to achieve urinary and bowel control, while some others will never gain the full ability to void easily by volition.

How do we learn what to do and how to do it? We give credit to the parent when the child first becomes able to control bowel and bladder function. We might say that the child learned how to do it. We imply or seem to imply that the function has been taught and that the child learned. Success reflects the efforts of the parent and the application of the child. Parents are generally ready to accept the credit for a job well done and at the same time gain the benefit of giving up the duties of diaper attendant as the child assumes responsibility for bowel and bladder function.

The majority of children have an easy transition, but some do not. Just as we give credit to the successful parent, there is a burden of disappointment or guilt when the child is slower or fails to achieve the goal. There might be a feeling that the parent's teaching is at fault, that the child has not been trying, or that there is an unwillingness to learn. There is often a feeling that more efforts must be made to constrain the child to focus on the project. Parents might assume that all children have a similar potential for full function and that the fundamental structures required for full function are available to all.

Consider other natural and spontaneous functions and behaviors. A newborn lamb in the field will stand up within moments of birth and walk around the mother to suckle. This is common in nature. These functions and movement patterns are not learned, they are acquired. When the structures are complete, the function is also complete. The lamb that fails to stand, fails because there is a problem. Imperfect function will usually imply imperfect structure.

In the same way, bladder emptying is not learned but acquired, and when the structures are complete enough, the ability is there. The mother can teach â€œThis is the kitchen, this is not a good place to move your bowelsâ€• or â€œThe school bus will be here in 10 minutes, this would be a good time to empty your bladder.â€• The parent cannot teach â€œThis is how you empty your bladder.â€•

Changes with Aging

Nerve cells are generally not capable of cell division, and the complement of neurons that is laid down in the developing fetus will not increase after birth. Indeed, after the second decade of life, there begins a slow but measurable loss of nerve cells. This process of attrition is one factor that

contributes to slow erosion of structure and a corresponding loss of full function potential. This may have a part to play in determining the age of onset of lower urinary tract symptoms.

It would be reasonable to suggest that a lesser deficit might not be recognizable until the impact of another insult or injury has been added to it. The deficit itself does not provide sufficient signs or symptoms to be recognized until a further burden is added. Consider two small boats afloat, one afloat in deep and one in shallow water. The performance would be virtually the same. However, adding the same burden to both boats would put one aground while not upsetting the functions of the other. The lack of a full complement of neuromuscular structures might have a role in making these individuals disproportionately susceptible to problems after pelvic surgery. For some patients, the full range of versatile function was already lacking before the impact of surgery was felt.

Gender

It is to be expected that a sacral neurogenic deficit associated with a spectrum of caudal regression would be evident in both males and females. Clinical symptoms and patterns of dysfunction will be influenced by the combination of the severity of the neurogenic deficit and by the anatomy of the lower urinary tract. One would predict that symptoms of frequency, urgency, and nocturia might be features of this disorder that are common to both men and women.

The susceptibility to infection and cystitis is much greater for the female. Anatomic factors contribute, including the short female urethra. Urethral colonization with gut organisms is promoted by the close proximity of the urethra and anus. The scrotum is a physical barrier to contamination between the anus and the penile urethral meatus.

The impact of sexual activity would help to favor a greater incidence of urinary infection in adult females.

Similar sphincter dysfunction in men might be associated with voiding difficulty and slow flow. Symptoms may not necessarily be constant but might be intermittent or variable. If urethral relaxation is not sustained at all times throughout voiding, this would provide an opportunity for urine-at high pressure and unable to escape through the sphincter and the urethra-to reflux into the ejaculatory and prostatic ducts. This could be a mechanism that would predispose to prostatitis or prostatodynia.

Anorectal and Bowel Problems

There might be a similar incidence of anorectal problems in men and women. The neurological deficit is not expected to spare the anal sphincter. The impact would be expected to fall on the appreciation of sensation and the act of defecation. The sophisticated active mechanism of puborectalis would be impaired.

The normal act of defecation is easy and complete. Like a train leaving the railway station, the bowel should function with the effortless displacement of the stool from the lower bowel. After normal defecation, the sigmoid colon and rectum are empty and the stool is gone. If the complete structures are lacking, the function is more likely to be incomplete, and instead of the train leaving the station, one or two cars might leave the train, but the train continues to stand. The rectum and sigmoid colon remain loaded with stool most of the time.

Constipation, diarrhea, or irritable bowel symptoms could be associated with the loss of versatile sphincter and pelvic floor function. Alternative mechanisms for defecation would evolve if the spontaneous, easy, coordinated mechanism were lost or deficient. Alternative patterns would include chronic straining, digital manipulation, or reliance on laxatives and enemas. Chronic straining might provoke secondary problems, which might include the development of pelvic prolapse, hemorrhoids, anal fissure, hernias, and varicose veins.

Urological Disorders

The suggestion that there might be a spectrum of organic neurological deficits helps to explain the insidious onset and chronic course of some urological diseases. Patients who lack both full structures and versatile range of sphincter function might be more susceptible to irritative symptoms because of involuntary unwanted sphincter activity during voiding. This would produce variable degrees of voiding difficulty and dysfunction, including hesitancy to initiate the flow.

In this spectrum of subtle neurogenic deficit, it is possible that asymmetric or unilateral neurological deficit would create enough of an obstacle to normal sphincter function. A unilateral deficit might be enough of an impediment to hold back the potential for full function and block the advance to perfect and versatile sphincter function. Such a deficit would not only dull the potential for full function but also promote lower urinary tract symptoms without more remarkable outward signs of a neurogenic deficit.

Sensory Deficits

If it is proposed that there might be a spectrum of motor deficit associated with caudal regression, it is most likely that the sensory structures will not be spared altogether. Rather, it would be expected that there could be a corresponding deficit of sensory perception. It is expected that the individual might lack the subtle ability to discern the full appreciation of perineal and visceral sensations

because the full array of peripheral sensory afferents and central connections might be lacking.

A sensory deficit will cause problems in making a confident distinction between flatus and what might be more than flatus in the lower bowel at all times. There might be difficulty with the appreciation of bladder filling and the state of readiness to void. A lack of the full delicacy of perception will allow an opportunity for unwanted leakage and would dull the appreciation of early signs of irritation, inflammation, or infection in the lower urinary tract and pelvic viscera. For some patients, a sensory deficit in the caudal segments might have an impact on sexual function or on the quality of genital sensations, including the appreciation of orgasm.

Congenital and Acquired Deficits

If there is a deficit of neuromuscular structure in the caudal segments, there will be an impact in the pelvic floor. Problems of pelvic prolapse are considered the result of the erect posture and acquired insults that include pregnancy and childbirth. The role of a congenital neurogenic deficit has not been given much attention. Congenital uterine prolapse is rare but does occur in female neonates with major neurogenic deficits, including spina bifida and sacral agenesis.

The levator ani muscles close the urogenital hiatus in women and provide support for all the organ systems of the pelvis. The origin along the pubic bones, arcus tendinous fascia pelvis, pelvic girdle, attachments to the lateral vagina, and insertion around the anorectum provide support and closure for the anorectum. Through the attachments to the pubic symphysis and endopelvic fascia, they provide important support for the bladder neck and help to maintain closure during periods of increased intra-abdominal pressure. By providing vaginal closure, the levator ani muscles help to prevent genital prolapse.

The pelvic floor is a dynamic trampoline of resilient muscle structures. Constant adjustment of muscle activity maintains closure under many different circumstances. It is the muscles of the pelvic floor that are critical for normal support. It is the muscles that contract to maintain pelvic support for continence. It is the muscle that must relax to allow for voluntary urination or the initiation of defecation. It is the muscles that must relax and lengthen enormously to allow the passage of a full-term fetus during childbirth yet contract again postpartum to permit all of these normal functions to be maintained and to hold the organs in their normal positions.

Surgical anatomy of the pelvic floor is often taught in the operating room, and it is quite different from the normal anatomy. The surgical dissection is directed to correct a problem of incontinence or prolapse. Surgical landmarks are limited to the structures that are left-the bones, ligaments, fascia, and viscera. The muscles are often sparse, incomplete, or even absent. It has been suggested that the ligaments are the primary support structures of the pelvic floor, but this is nonsense. The ligaments and fascia represent the fibrous skeleton of the pelvic floor that remains after the muscles have been depleted or lost to atrophy.

There is a pattern of neurogenic deficit in humans. Complete and perfect structures will support full and versatile function, but neuromuscular structures are not just complete or deficient; rather, there is a broad spectrum of deficit from trivial, through a wide range of moderate deficits, to profound and clinically obvious neurogenic deficits. Deficits are not exclusively acquired but are often congenital and most commonly are the result of the sum of both congenital factors and acquired insults.

The process of programmed cell death and resorption of the distal spinal cord segments, which is a normal part of the development of the human embryo, does not always spare the critical nerve cell populations of the caudal segments. For many, this process will overshoot the mark, and this initial tiny change for the embryo will become exaggerated and produce a spectrum of deficits in human form and function. The lack of a more developed tail structure renders humans, and some other species, peculiarly susceptible to caudal neurogenic deficit because there is no mechanism to extend the nervous system beyond the body segments.

The presence of a tail provides such a mechanism. The tail extends the nervous system distally, beyond the body segments, and this must confer at least some resistance against incomplete development of the caudal nervous system. A lack of complete distal spinal structures for a tailed creature will result in a perfectly spared body with normal bladder and bowel but a shortened tail.

The role of the nervous system in tissue growth and development is important, and it would be predicted that a congenital sacral neurogenic deficit could be reflected in abnormalities of form as well as function. It is suggested the spectrum of neurogenic deficit might be an important factor in determining the incidence and severity of congenital abnormalities of the urinary tract, urogenital sinus, and anorectum. The lack of a perfect innervation will stand as an invisible obstacle that will obstruct the normal effortless acquisition of full function of the child. The lack of perfect innervation will persist as a disadvantage for both the adolescent and the adult, and will become more obvious with the impact of the accelerated neurological losses associated with aging.

A lack of complete structures will serve to amplify the impact of acquired loss by injury or disease and will limit the reserves of structure that are available. The slow loss of neurons that occurs with aging will be felt as a change in function at a younger age for the individual who has started life's journey with less than the full complement of neurons in the sacral spinal segments.

Clinicians are taught to look for major neural tube defects and to recognize the neurogenic deficit associated with the common anomalies such as spina bifida (meningomyelocele). More severe neural tube defects do occur in humans, including anencephaly. However, these most severe deficits are not compatible with survival. There is a spectrum of lesser deficits associated with spinal dysraphism and tethered spinal cord syndromes.

Nerve deficit is recognized typically by the presence of spinal stigmata and deformity or locomotor dysfunction in the lower extremities. Major deficits may be obvious at birth. Lesser deficits may not be recognized in the early years, only to present with a changing deficit and new symptoms in adolescence or in adult life. Some patients with major neurological deficits may go unnoticed, particularly if the lower limbs are relatively spared.

The Traditional View of the Pysician

The traditional view of the physician conducting a clinical neurological examination proceeds from the cranial nerves above and extends in an orderly way down the spinal segments and finally to the feet and toes. The physician's view of the body is not at all the same as the nervous system's view. When the physician stops at the feet, the most caudal segments of the patient are excluded. This traditional perspective of the physician fails to include the whole patient. Unfortunately, many physicians fail to recognize the design of the sacral segments.

The innervation of the pelvic organs that are contained within and supported by the pelvic floor is moderately complex and includes both sensory and motor and somatic and autonomic systems. When deficits occur, we should expect that there might be sensory impairments as well as motor effects. The sphincters are in the midline, like the mouth, pharynx, or larynx, and are innervated by nerves from the left and from the right. A perfect complement would provide the potential for a complete and versatile range of function. Lack of the complete structures would stand as an invisible obstacle that might delay or even prevent the onset of the full and complete range of function. A deficit could be symmetrical or asymmetrical and could have a clinical effect that was only on the right or the left. The contralateral structures could be complete or deficient. The spectrum of deficit in nerve structures would determine the range of function that could be expected.

In clinical examinations, there is great emphasis on comparing the right side with the left. In health, there should be broad symmetry between the two sides. One should not expect to find perfect symmetry, but there should be similar balanced function on both sides, and abnormalities are most easy to distinguish as we compare one side with the other and find significant differences. In the face, compare the right and the left to look for signs of a unilateral weakness that might reflect a significant neurological deficit such as might be present after a stroke. The pelvic floor has right-sided and left-sided structures just as the face. The principles of clinical examination are the same, whether examining the face, hands, or pelvic floor.

Figure 22.2 Feet of 60 year old lady with lifelong symptoms of stress urinary incontinence. Note that the lateral metatarsals and toes are hypoplastic consistent with a congenital etiology.

Each person is born with his or her own spectrum of structures in the sacral segments. The structures mature to their optimal state in young life, and there is some degree of loss as aging occurs. Rather like the hairs on the head, a person starts with all that he or she will ever have and throughout life will lose some. The rate of loss may vary from one individual to another, and the impact of a given increment of loss may be felt quite differently from one individual to another because each person begins with a unique complement of structure.

In the usual course of life, and particularly with aging, there is an expected pattern of loss that affects all of our structures. There may be loss of hair on the surface of the body. There may be some loss of muscle mass and strength in the limbs. In the nervous system, that loss might occur in the populations of neurons in the spinal cord, and these losses might occur in the most distal segments. Indeed, the most distal segments might be at special risk because it is here that there was a pattern of cell death even in the embryo. With aging, neuronal losses might be greater in the caudal segments than in the more proximal segments of the spinal cord.

It is interesting that the familiar features associated with aging include changes in the feet. There are obvious acquired causes that influence the shape of the feet, such as lifelong preference for particular types of footwear, but it is the older patients who suffer more with hallux valgus, bunions, hammertoes, and corns (Figs. 22.2 and 22.3A, B). The intrinsic muscles of the feet flex the metatarsophalangeal joints and extend the interphalangeal joints. The

intrinsics are responsible for maintaining the alignment of the toes and for spreading the toes apart in the line of the toes-abduction. The muscles act on the bones and joints to shape the feet and conserve the normal arch. As we age, the foot tends to become longer, and the arch becomes flatter. These features might reflect a pattern of erosion of the caudal structures in the nervous system that occurs with aging. This pattern of loss is an important factor in the pathogenesis of significant symptoms, dysfunction, and disease in the elderly.

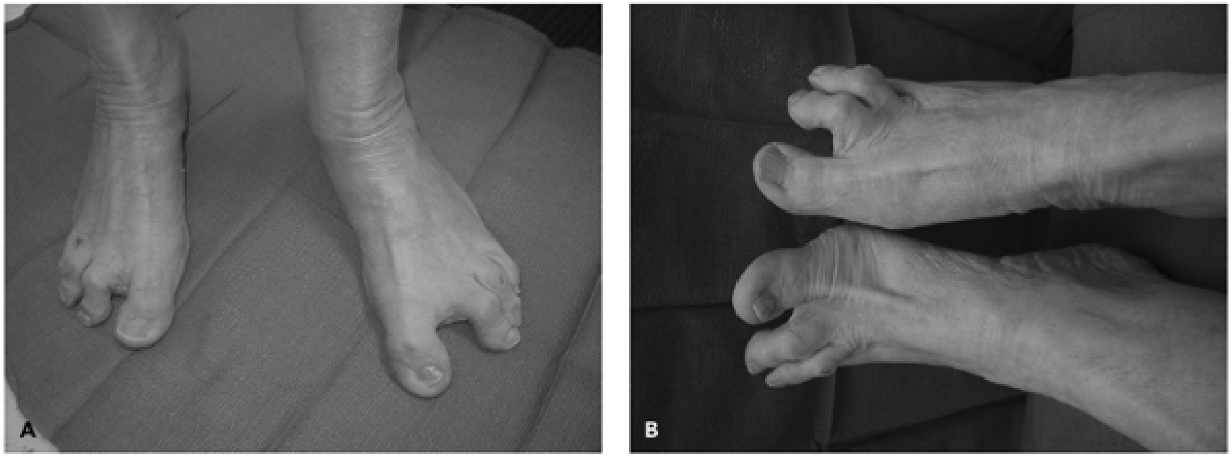

Figure 22.3 A-B: Feet of 74 year old lady with lifelong symptoms of stress urinary incontinence. Note that one fifth metatarsal and toe is absent, there is hypoplasia and syndactyly of fourth and fifth toes.

In the nervous system, the brain and spinal cord contain all the nerves that sense environment and direct actions of the muscles to move and act in effective and coordinated ways. There is an organization of nerves at each level such that the nerves in the neck move the upper limbs and the nerves of the lumbar region move the lower limbs. The spinal cord is highly organized in segments like steps on a ladder, with each segment containing specific motoneurons for specific muscle groups that act on particular joints to generate specific movement patterns. An injury to the spinal cord in the neck will often occur at C6-7 level. Typically, this injury will result in damage to the nerves of the hands (C7-8) and fingers (T1) and effect changes in all of the lower body but will tend to spare the nerves that move the muscles of the shoulder (C5), elbow (C6), and wrist (C6-7). These patients can still move a wheelchair with actions of the shoulders, elbows, and wrists, but they can no longer move their fingers effectively for writing or feeding.

The lower spinal cord is arranged in the same stepwise pattern. The more proximal segments (L2-3) contain the nerves that move the most proximal muscles that move the hip. Below this, there are the nerves that move the knee (L4-5) and below that, there are nerves that move and control the ankle joint (S1). The nerves to the muscles of the pelvic floor are at the lowest levels in the human spinal conus (S3-5). For humans, this is the level at which the nervous tissue of the spinal cord ends. There are no more nerves distal to this level, only a fibrous remnant of connective tissue called the *filum terminale*. Nerves and nerve growth factors play a potent role in directing tissue growth and development in the embryo, and thus a quantitative deficit of sacral nerves might contribute to a variety of aberrations of form and function.

The nerves that are responsible for the activity of the pelvic floor muscles (S3-5) are more caudal in the spinal cord than the nerves of the feet and toes muscles (S2-3). The ascending and descending fibers from the motor and sensory cortex are located on the periphery of the spinal cord, and they are vulnerable at all levels, including the proximal cervical spine segments. Back or neck problems that include disc disease or spinal stenosis will cause radiculopathy with radiating pain in the segmental distribution if there is compression of a nerve root, but if the extruded disc material or bone spur is in direct contact with the spinal cord, the impact will be on the peripheral spinal bundles, and the effects will be felt in the sacral segments.

Clinical signs and physical features are commonly found in patients with incontinence or vaginal prolapse. Physical signs are of great importance because they allow the physician to identify predisposing problems and the patient to understand why these problems affect her and not others. Patients will be able to use some of the findings to compare with friends or family, and as structural features are found to be different, the cause of problems will be more clearly recognized as organic rather than behavioral. As the patient becomes able to recognize the organic differences that distinguish her own structures from those of asymptomatic friends, it serves to lessen the personal stigma. It is no longer about â€œwhat did I doâ€• or â€œwhat did I not do,â€• it is more about â€œwhat do I have in the way of structures, and how can we enhance and maximize the full potential of those.â€•

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Physical Examination

It is not appropriate here to include all aspects of the complete physical examination. The focus will be on those elements that might be beyond the scope of a standard gynecological examination. Take time to observe the face. Look for symmetry in muscle function during speech and facial expressions. Do not expect to find perfect symmetry, but there should be similar balanced movements on the right and the left. Direct the patient to open the eyes wide and then to close the eyes tightly. Observe the form of these expressions. Subtle asymmetries will become obvious. When you ask the patient to show her teeth, the form of the mouth and lips will be evident. Ask her to put out the tongue, then observe the movement of the soft palate. Unilateral weakness might suggest past history of stroke. If there is a lack of facial expression, tap the patient on the brow to elicit a glabellar tap reflex that might suggest parkinsonism.

Stature, posture, and gait give the first clues of congenital and acquired neurospinal deficits. Short stature might imply incomplete growth or development. The form of the neck and asymmetry of shoulders is important. Note the short, wide neck with one shoulder held higher such that the tip of the shoulder is closer to the ear than the other. These signs are typical for patients with Klippel-Feil syndrome that includes vertebral anomalies of the cervical spine and lumbosacral abnormalities. Range of movement of the neck might be limited, and there might be paresthesia or weakness in one or both upper extremities. Bowel, bladder, and sleep apnea problems are common in these patients, and anesthesia problems might include difficulties with intubation and airway management.

Spinal alignment should be symmetrical without excessive curvature such as kyphosis, lordosis, or scoliosis. If scoliosis is suspected but not clinically obvious, direct the patient to stand with feet together facing away and to bend forward so that the hands slide down anterior thigh toward the knees. If there is significant scoliosis, one shoulder will be higher than the other. Limited range of movement might suggest arthritis or spondylitis. In younger patients, palpate the dorsal spines of the lumbar vertebrae to reveal a palpable step at L5/S1, which might suggest spondylolisthesis. Any of these problems might be associated with sacral neurogenic deficits.

After examination in the supine position, turn the patient to lie in a left lateral position with the knees and hips flexed. Examine the posterior aspect of neck and all the length of the spine to sacrum and natal cleft. Look for skin changes, pigmented areas or pigment loss, hair patches, skin pits, lipoma, or other anomalies. Midline findings might be associated with spinal dysraphism. The most common vascular nevi are red markings on the posterior aspect of the neck, often within the hairline. In infants, these are sometimes referred to as â€œstork bites.â€• These findings are commonly present in patients with sacral neurogenic deficits.

Sensory deficits may be recognized by simple clinical examination of the sacral dermatomes. Examine the patient in a lateral position with the knees drawn up. Use two orange sticks held with the tips 4 cm apart to assess two-point discrimination in the posterior thigh (S2), perianal (S3-4), and postanal dermatomes (S5). Note the patterns of asymmetry, if present. The sensory deficits are typically less marked than the motor deficits. This would be expected because adjacent sensory nerves can extend their territories to some degree to minimize the area of sensory loss.

Limb and digit anomalies are often evident-in particular, a short fifth finger and short lateral toes. These signs are most marked in meningomyelocele patients in whom the upper limbs might be of normal length but the lower limbs are short and might be asymmetrical. Inspection of the feet is important because they offer a mirror that will reflect the condition of the muscles of the pelvic floor. The patient who has severe urinary incontinence because of muscle weakness will often have a corresponding pattern of weakness in the intrinsic muscles of the feet. Look at the choice of footwear and whether orthotics are used. A typical pattern of deficit would include flat feet with loss of the normal arch and loss of intrinsic muscles. An exaggerated high arch with inert immobile toes is also part of the spectrum of deficits. The perfect feet are symmetrical with normal shape and form and full function of the muscles that not only flex and extend the toes but also abduct the toes. The most sensitive feature of motor deficit in the feet is the inability to abduct the fifth toes. Some patients will be able to flex the toes, but not spread them apart in the line of the toes.

The features of the skin will reflect neurological integrity. Nerves regulate blood flow in the skin just as traffic lights control the distribution and volume of traffic in the streets. In the presence of a nerve deficit, vasomotor regulation is often impaired, and the feet are pale and cold to touch. Cyanosis might be evident, and blanching of the skin reveals slow vascular return. Warming the feet in a hot bath will provoke hyperemia that might persist not for minutes but for more than an hour. Changes in pigmentation, hair loss, and dystrophic changes in the nails might be evident. Like other features, these vascular and skin changes may be asymmetrical in patients who have significant difference in the size of the feet. The less well-formed foot will have more obvious anomalies of the skin nails and vasomotor features.

In health, when we examine the patient standing barefoot, the toes should lie flat on the floor, like the fingers of a hand palm down on a tabletop. The toenails, like the fingernails, should be horizontal. The patient with intrinsic muscle weakness of the sacral segments may have clawing of the toes-hyperextension of the M-P joints and flexion of the I-P joints-so that the toenails are pointing downward in a vertical direction instead of horizontal. Lateral deviation of the great toe (hallux valgus) is often present, and the lateral toes may be hypoplastic. Hypoplastic toes

or syndactyly would imply a congenital sacral neurogenic deficit rather than an acquired cause.

When examining the perineum, observe the features of the skin. Look at the size and contour of the labial folds. Perineal and vulvar skin will often demonstrate features of pigmentation loss and other changes. Typical abnormalities include vitiligo, lichen sclerosus, and lichen planus. These are descriptive terms of classical conditions that are generally of unknown etiology. In the male, the same abnormalities occur in the genital skin and are usually called *balanitis xerotica obliterans* (BXO). The clinical and histological features of BXO are identical to lichen sclerosus including agglutination of tissue folds. Just as lichen planus can extend to involve vaginal mucosa, BXO will often extend into the urethra and cause severe chronic urethral strictures. It is likely that these conditions include neurodystrophic features that reflect sacral neurogenic deficits.

In the perineum, we should compare muscle function on the right side and the left, just as you would compare the muscles of the face. Include resting tone, muscle strength, and duration of contraction of the circumvaginal muscles, levator ani muscles, and the right and left sides of the anal sphincter. Examine the patient standing to provoke leakage, but include inspection of the back and buttocks. The gluteal form and folds will also reflect the relative strength of the pelvic floor structures. Compare right and left gluteal muscle masses and gluteal folds, and inspect the natal cleft. Ask the patient to stand on one leg. Typically, the patient will not hesitate and will stand immediately on the stronger limb. The favored limb will be the side of the greater gluteal muscle mass and the larger more versatile foot. Some patients will have such weakness that they cannot stand on only one leg or when standing on the weaker side the pelvis cannot be maintained in a level position and instead will tilt downward (Trendelenberg sign).

Conclusion

Sacral neurogenic deficits are common and are both congenital and acquired. Each patient has a given set of structures, and each is subtly different from another. Many acquired diseases may have a part to play in exacerbating pre-existing sacral neurological deficits. Common examples include diabetes and lumbar or cervical disc disease with spinal stenosis and pelvic floor insults such as vaginal delivery. Surgical procedures in the pelvis or retroperitoneum may disturb function, and radiation therapy in the field of the neurospinal axis or pelvis may be important factors. The impact of these acquired insults will be felt differently from one patient to another according to the initial conditions. Physicians are familiar with these differences-one patient might have been diabetic for years and have no voiding problems, and another might be newly diagnosed and already requiring intermittent catheterization. If patients have different complements of structure at the beginning of life, the impact of acquired losses will be felt differently.

Pelvic surgeons should include a more careful examination of the sacral neurological dermatomes to recognize the patterns of deficit, which have a part to play in determining the results of surgical treatments. It takes almost no time to include observations of the back, buttocks, legs, and feet. Patients find it easy to understand that everyone is different and that certain features carry an increased risk of symptoms or dysfunction. For example, patients will compare their own feet with other family members and friends. It is an opportunity to recognize simple structural differences that help to explain why symptoms might occur. Appreciating these differences will also include the patient in a new understanding of the nature of the challenge that faces her surgical team as they work together with her for the best possible outcomes.

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The Use of Urethral Bulking Agents and Artificial Urinary Sphincter

Niall T. M. Galloway

Stress urinary incontinence (SUI) is often the indication for surgery, but typically, surgery is directed to correct anatomical defects that may be related to incontinence. These are not the same. As physicians treat patients, they must be clear about the relationships between the presenting complaints, indications for surgery, and probable outcomes. Correcting the anatomical support defects of the vaginal attachment might be enough to correct prolapse and incontinence for some patients. For others, there are also intrinsic deficiencies of the urethral closure mechanism. For these individuals, it is not sufficient to replace the urethra into the perfect anatomical position. It is necessary to correct the intrinsic deficiency as well as the pelvic support defects. For this group of patients, we must add an element that will restore coadaptation of the urethra. Popular procedural choices are the use of a sling procedure, a periurethral bulking agent, or placement of an artificial urinary sphincter.

SUI is a common presenting complaint and is the most common indication for surgical treatment. Obtaining a thorough clinical history will give some indications of the onset, severity, and duration of symptoms. Physical examination will reveal associated physical signs and might reveal reversible factors that can be treated, and this might improve or resolve urinary leakage. Such factors include active urinary tract infection, severe estrogen deficiency, or fecal impaction. Candidates for surgery should have failed behavioral methods including fluid management, diet, and bowel management to resolve abdominal distention and should understand the principles of appropriate voiding intervals and strategies to avoid leakage.

In general, surgery should be directed to restore normal nulliparous pelvic support anatomy. The choice of procedure should be influenced by the severity of symptoms, the general condition of the patient, and patient preference. Surgery can only change anatomy. If surgery is to be effective, the cause of incontinence must be a correctable anatomical abnormality. Surgery will not change patient behavior, and if leakage is the result of disorders of patient behavior, surgery will not be effective.

To better define the anatomical factors, it is appropriate to evaluate the surgical candidate with urodynamics and urethrocystoscopy. Urodynamics may reveal bladder dysfunction such as detrusor overactivity or low compliance. Loss of awareness of bladder filling, incomplete emptying, and lack of volitional voiding may be associated with a poor surgical outcome. Fluoroscopy might demonstrate an open bladder neck, bladder diverticulum, or vesicoureteric reflux that could influence surgical outcomes. The patient who has an areflexic bladder and is voiding by abdominal straining is more likely to be unable to empty after a sling procedure.

Provocative maneuvers should be used at the time of urodynamics to demonstrate urinary leakage with coughing or straining. Leakage might confirm severe intrinsic weakness of the urethral closure mechanism, but at times, no leakage can be demonstrated despite repeated testing. It is not appropriate to use surgical methods to

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complement outflow resistance if preoperative testing fails to demonstrate evidence of intrinsic urethral weakness or incompetence.

Resting urethral pressure profilometry and stress profilometry will help to define intrinsic weakness in addition to Valsalva leak point pressure (VLPP) measurement. There is no absolute agreement on threshold values, but most authors consider VLPP of less than 100 cm/H_2O as consistent with some degree of intrinsic urethral weakness. Less than 60 cm/H_2O is consistent with more severe intrinsic urethral weakness. A maximum urethral pressure profile of less than 20 cm/H_2O and a small area under the curve is consistent with severe intrinsic urethral weakness.

Incomplete bladder emptying is a common finding, particularly in elderly patients with moderate or severe cognitive impairment. Urethral bulking agents are not appropriate to use in patients who have incomplete bladder emptying unless there is a willingness to use intermittent catheterization as a long-term management plan after treatment.

Urethrocystoscopy

Urethrocystoscopy should be done in the clinic before committing to a surgical plan. It is not uncommon to find evidence of bladder stone, bladder tumor, or urethral diverticulum. Less commonly, ectopic ureter, urethral duplication anomalies, or variants of epispadiac urethra may be found. In patients with a prior history of continence surgery, it is not uncommon to find erosion of suture material or mesh into the lower urinary tract even in the face of a normal urinalysis. It is helpful to visualize the ureteric orifices and to document the efflux of urine. Much time can be saved at surgery if the surgeon knows in advance that one kidney is absent or nonfunctioning.

The urethra and bladder neck should be examined carefully using a urethroscope or visual obturator. The choice of instrument is important because a standard cystoscope has a beak, and the irrigating fluid flows out from the underside of the sheath rather than at the tip of the instrument (at the lens). As the scope is brought back into the urethra from the bladder as soon as the open segment of the cystoscope reaches the urethral meatus, the urethra will collapse around the lens and obscure the view. Commercially available vaginal tape and sling material is often colorless and can be difficult to see when there is erosion of mesh within the urethra.

It is helpful to measure the urethral length in all patients when planning surgical treatment for incontinence and particularly important when considering the use of periurethral bulking agents. There is a great variation in urethral length. In patients with SUI, it is unusual to find a length of 3.5 or 4 cm, as is described in anatomy textbooks. It is common to find a length of less than 2 cm and occasionally less than 1 cm. This is critical information, and it is key to successful patient selection.

To measure urethral length, bring the lens of the scope to the internal meatus so that a thin rim of bladder neck is just visible at the periphery of the image. Place the tip of the index finger against the external urethral meatus in the 6 o'clock position, and hold it steady against the sheath as the instrument is gently withdrawn with the water running. When the instrument is removed, the distance between the tip of the finger and the tip of the lens is the urethral length. It is better to measure this distance several times to be sure of an accurate repeatable value.

It is also helpful to feel the thickness of the urethral wall when the cystoscope is in place. Knowing the normal thickness of the tissue will allow recognition of thickening that might be associated with urethral diverticulum or thinning that may be found in association with a fascial defect or in the elderly with severe estrogen deficiency.

Mechanism of continence

The mechanism of continence is complex and incompletely defined. Intrinsic urethral sphincter function is an important element, but other factors such as the transmission of abdominal pressure to the proximal urethra have been shown to be of great consequence (1). In women with anterior vaginal prolapse and bladder neck hypermobility, pressure transmission to the proximal urethra is compromised, and the intrinsic sphincter mechanism becomes of greater importance (2). The outcome of surgical treatments for urethral hypermobility is less predictable when intrinsic sphincter deficiency is present. In women with moderate or severe SUI without significant bladder neck hypermobility, it can be assumed that significant intrinsic sphincter weakness must be present. Treatments that augment urethral sphincter function are attractive therapeutic options for these patients.

There are at least four anatomical parameters that contribute to the continence mechanism: displacement, urethral muscle weakness, loss of urethral length, and open bladder neck. These factors are related and act together as causes of SUI. Bulking agents are most effective when used in the proximal urethra. Bulking agents effectively treat bladder neck incompetence and function to close the open or beaking bladder neck. At the same time, closure of the proximal urethra will increase the functional urethral length and modify the urethral pressure profile.

Symptomatic improvement is noted by reduction in severity and frequency of urinary leakage, and objective measures include changes in urodynamic parameters such as functional urethral length, urethral closure pressure, stress urethral closure pressure profile, and some increase in VLPP.

It is important that a bulking agent is used not only in the right position within the urethra but also the right depths beneath the urethral submucosa. Injection should raise a cushion of mucosa at the level of the proximal urethra but not within the bladder itself. The optimal injection will not appear as a white and blanched color; rather, the vascular

markings of the overlying mucosa will be preserved. The injectible bulking agent must not be placed in the muscle tissue. Muscle action can only occur when the architecture of the muscle is intact. If inert bulking agent is introduced into the planes of the muscle fibers, they will be locked and effectively inert. This is a cause of worsening incontinence after use of an injectible bulking agent.

Patient selection

Patient selection is important when planning for success in using urethral bulking agents. Typically, older patients are good candidates because these patients may have more comorbidities that make them unsuitable for major surgery. Older patients must be cognitively intact, and urinary leakage should be moderate rather than severe. The patient should be able to empty the bladder to completion and have little or no hypermobility. The author prefers to select patients who are already compliant with behavioral therapies. Urodynamic study should reveal no adverse bladder features such as severe detrusor instability or reduced bladder compliance. Cystoscopy should confirm an adequate urethral length of more than 1.5 cm. The author's experience with using bulking agents in patients with a very short urethra has been disappointing.

Periurethral collagen is easy to use and is readily available. Patients should have a skin test performed 6 weeks prior to injection to document the absence of an antigenic effect. The patient is typically prepared by the use of local estrogen cream (unconjugated) applied daily for 2 weeks and then 3 times weekly until the periurethral injection. Typically, patients will use this for at least 6 weeks prior to treatment. The estrogen cream is applied with the fingertip to the urethra and is best done before bed. Only a small volume of cream is necessary, and patients are usually instructed to use a lentil-sized dose of cream.

The bulking agent may be used in the office setting or in the operating room. Accurate placement is the key to technical success. Many authors favor use in the office because of convenience, but effective analgesia and local anesthesia is important if the patient is to be still and cooperative. It is this author's preference to do these procedures in the operating room as an outpatient using monitored anesthesia care and local anesthetic (1% plain lidocaine). All patients will have normal urinalysis and sterile urine culture immediately prior to injection therapy.

Choice of Operative Technique

Some surgeons favor transurethral injection because it is convenient and familiar for the urologist who routinely works through a cystoscope. A long needle is passed through the working channel, and injection is made under direct vision. It is technically easy to guide the placement of the needle tip and to make the injections close to the bladder neck, but the needle puncture site is always very close to the raised cushion of injectible. When using the transurethral technique, it is typical to see some of the bulking agent leak out of the track when the needle is withdrawn.

The principle of successful treatment is to create cushions of injectible material to cause coadaptation of the proximal urethra. The volume of the cushions will be important for success, and the length of the needle track will offer resistance to loss of the bulking agent. If the needle track is very short because the injection site is close to the site of the enlarging cushion, leakage of the bulking agent through the needle track is to be expected.

It is more attractive to use a periurethral approach. The needle tip is placed at the external urethral meatus and is advanced parallel to the urethral lumen. To facilitate accurate needle placement, it is essential to measure the urethral length as previously described using the cystoscopic method. This measurement should be repeated three times to ensure accuracy. A straight female urethral sound is selected that can be placed into the urethra. This serves to straighten the urethra and will also offer resistance to movement of the tissues in front of the advancing needle tip. The author uses a sound of 28 or 30 French, and a marker of tape is applied around the sound to act as an external guide for judging the distance to advance the needle tip.

With the bladder empty and the large, straight female urethral sound in place, the first collagen injection is made typically at the 4 o'clock position, and the needle tip is positioned 3 or 4 mm lateral to the urethral meatus where the 1% lidocaine has been applied. With the needle tip only just puncturing the skin, the position of the sound is then adjusted so that the marker on the sound is at the level of the hub of the needle. The bevel of the needle is directed toward the urethral lumen so that any tendency of migration of the needle tip will be away from the urethral lumen rather than toward it.

Holding the needle and syringe against the urethral sound and holding the sound in a constant position, the needle is advanced only parallel to the sound. The forward movement of the needle tip is gentle, slow, and steady. Advance the tip always parallel to the sound until the length of the needle traveled is just 3 mm less than the measured length of the urethra. The optimal distance is judged by movement of the hub from the marker on the sound.

Resting the back of the hand against the patient carefully steadies the surgeon's hand that is holding the needle, and the sound is removed. Then, holding the needle quite still, the urethroscope is introduced into the urethra and is positioned in the midurethra. With the 0-degree lens, an excellent view of the urethra is obtained on the endoscopy screen. Use of the camera allows the operator and assistant to view the proximal urethra. The magnification of the instrument also favors the best visualization. It is often necessary to turn the amplitude of the light source down to gain the best view.

The assistant holds the urethroscope steady in a constant position as the needle tip is gently moved in the line of the urethra. If the needle tip is in an appropriate position, the movement of the tip will be visible. If there is a need to advance the needle tip, the urethroscope should be advanced completely into the bladder, and a small movement of not more than 2 or 3 mm should be used to reposition the needle. It is often helpful to make a small collagen injection of 0.2 mL to lift the tissues away from the needle tip before advancing the needle. If you try to advance the tip while observing, there is a greater tendency to overshoot and perforate at the bladder neck.

The urethroscope should be positioned in the midurethra so that the injection is made between the lens and bladder neck. As the injectible is gently placed, the mucosa will appear to become raised. Often, the raised cushion will bulge forward into the urethral lumen. Each preloaded syringe of Contigen has a single dose of 3 mL. It is typical to use one full syringe at each injection site.

For the next injection at the 8 o'clock position, the same technique is used, but a smaller sound, usually a 24 or 22 CharriÃ¨re, will be used so as not to place too much force on the new cushion. It is helpful to introduce this sound with the tip traveling along the lateral wall away from the site of the last injection.

When the second injection is complete, the urethroscope is used to evaluate the bladder neck closure. The shape of the cushions will have significantly changed the appearance of the bladder neck, and commonly, an area in the 1 or 11 o'clock position is relatively open.

For the third collagen injection, an anterior site that corresponds to the somewhat open area between the two cushions is chosen. In this position, it is typical to leave the urethroscope in the bladder rather than to use a sound. The needle is passed in a similar way but with a little more distance, 5 mm rather than 3 mm, from the urethral meatus. The length of the anterior urethra is somewhat shorter, and a lesser distance should be used when placing the needle such that the excursion of the needle tip is 3 or 4 mm less than that used for the first injection. When the needle position is optimal, the urethroscope is brought gently back into the urethra, and the injection is slowly made in the third position. It is not essential to leave the urethroscope in place during the third injection.

In a technically perfect injection, there will be no extravasation of injectible, and the appearance of the cushions will resemble the view of an inverted male prostate with three bulging lobes. In an effort to leave the cushions of injectible material undisturbed, the author does not pass the cystoscope into the bladder after placement of the third collagen. Palpation of the proximal urethra and the bladder neck is to be discouraged immediately after injection because of the possibility of disturbing one of the new cushions.

There might be some bleeding from the needle sites at the external meatus. Gentle pressure with a sponge over the urethral meatus may be necessary to control bleeding, but this will usually resolve quickly within just a few minutes. After the third injection, the bladder is drained with a 10 French red rubber catheter so that the patient returns to the recovery room with an empty bladder. As the urine and water are drained from the bladder, the author directs the fluid to drain on a colored towel so that any white collagen that has extravasated into the bladder can be documented. In the absence of extravasation, a good long-term result can be predicted.

Approximately 10% of cases will be unable to empty the bladder immediately after the procedure, and these patients are most often managed by intermittent catheterization using a small 10 or 12 French lubricated catheter. Some of the injectible volume is the saline transport, and this fluid will be dissipated in the first 24 to 48 hours. It is unusual to have patients with persistent retention after 48 hours.

In addition to a single-dose, intravenous perioperative antibiotic, patients are encouraged to take an oral antibiotic for 3 to 5 days following surgery and are encouraged to void every 2 hours by day. Some patients will experience some dysuria, but this rarely persists for more than 3 days. The first postoperative visit is typically at 2 or 3 weeks, and at that time, the patient is evaluated with a bladder scan and void to determine whether the bladder is emptying to completion and to repeat the urinalysis.

Results

There are numerous reports in the literature of the efficacy, safety, and lack of complications. Commonly, early results reflect cured and improved rates in the order of 60% to 90% at 6 or 12 months. In most series, longer follow-up will reveal a significant decrease over time. At 2 years, the continence rate is reported in the order of 50% (3,4). Authors have applied this treatment to patients with urethral hypermobility and have reported similar cure rates. This has not been reflected in the author's experience, so bulking agents are not used for patients who have significant urethral hypermobility.

Complications of periurethral collagen have been reported but are typically minor.

Urinary retention ranges from 1% to 21% (5). Transient hematuria can occur in 2% of patients, and irritative voiding symptoms may occur in 10% to 40% of patients. These symptoms may be related to detrusor overactivity, which was found to be present in 39% of patients treated by Khullar et al. (6). Stothers et al. reported urgency and urge incontinence in 12.9% of a group of 337 patients after collagen injection (7).

Allergic reaction to collagen injection after a negative skin test has been reported, but this is exceedingly rare and was associated with a clinical picture of low-grade fever and joint pains. There is a potential risk of hypersensitivity reaction, because antibody production is stimulated by collagen injection (8,9,10).

Other agents have been used for periurethral bulking, including Teflon. Teflon particles have been shown to migrate to distant sites in the body, including the lung and brain. No adverse event has been demonstrated, but concerns about possible long-term complications have led to newer agents. Silicone microimplants offer a theoretical advantage because the particle size is larger, between 100 and 150 Âµm in diameter (11). The risk of migration is related to particle size, and the larger particle size is associated with lesser risk. The disadvantage is that large particle materials are more viscous and harder to inject when using a small-bore needle. Silicone microimplants must be injected with an injection gun and large-bore needle.

Similarly, pyrolytic zirconium oxide beads (Durasphere) are a nonreactive carbon material of large particle size. A randomized trial between GAX-collagen (Contigen) and the Durasphere product revealed similar outcomes at 1 year. Forty-nine of 61 patients treated with Durasphere had an improvement compared with 47 of 68 patients in the collagen group. The difference was not statistically significant (12).

Biological materials have been used as well as synthetic ones. Blood and fat are easy to harvest but have not been shown to have more than a transient benefit. Recently, interest has turned to cell culture to grow the patient's own muscle tissue and then to reinject the material as a bulking agent that might grow and persist in the tissues. It is not clear whether injected muscle cells will be able to attract reinnervation and function as an effective sphincter muscle. The clinical application of this technology is in the elderly population, who might be more likely to have significant neurological deficits in the pelvic floor and urethral sphincter (13).

Current research interest in periurethral bulking for the treatment of SUI is focused on the use of implantable balloon technology or Adjustable Continence Therapy (ACT). This technology has been used in Europe for more than 5 years and is currently under study by the U.S. Food and Drug Administration. The treatment is performed under general or regional anesthetic and involves percutaneous placement of two small balloons at the level of the bladder neck. The surgeon performs urethrocystoscopy as described and then places a urethral catheter to partially fill the bladder with dilute contrast. Using an examining finger in the vagina, a trocar is inserted close to the proximal urethra, and fluoroscopy is used to guide optimal placement.

A tissue-expanding device is used to create a pocket close to the bladder neck, and the trocar sheath is used as a guide to slide the balloon into place. Each balloon has a short length of tubing that is closed by a small valve positioned under the labial skin. Radiological contrast is used to fill the balloon with an initial volume, and more can be added at intervals to improve coadaptation of the bladder neck until optimal benefit is obtained. The adjustments can be done in the clinic setting and are well tolerated. Initial experience with this therapy is very encouraging.

Artificial Urinary Sphincter

The artificial urinary sphincter (AMS 800) is a prosthetic device that consists of three fluid-filled components. The cuff is placed to encircle the urethra, the pressure-regulating balloon is an intra-abdominal fluid-filled reservoir, and the control mechanism is placed in the labia majora. The components are connected by special kink-resistant tubing and connectors. In the closed state, the cuff is filled with fluid from the pressure-regulating balloon, and the urethra is closed to maintain continence. For emptying, the patient uses the pump of the control mechanism in the labia and squeezes three to five times. This drives fluid out of the cuff and back to the reservoir, and in so doing opens the urethra for voiding. Fluid slowly refills the system in 1 or 2 minutes, and the cuff refills to restore urethral coaptation and continence. The device can be placed by using an abdominal or vaginal approach.

The AMS 800 (American Medical Systems, Minnetonka, MN) is a unique implantable device that is distributed throughout the world. There is a role for the artificial urinary sphincter in treating women with SUI, but the device is expensive, and the technique is more complex than other continence procedures. As well, there is risk of significant long-term complications. The artificial urinary sphincter is not appropriate for mild to moderate SUI. It is typically reserved for use as a salvage procedure for complicated patients with severe stress incontinence.

The clinical evaluation and diagnostic studies for bulking agents and artificial urinary sphincter are the same, but the selection criteria are different. Patients selected for an artificial sphincter usually have congenital or acquired causes for severe intrinsic urethral weakness. Neurological deficits include meningomyelocele (spina bifida), sacral dysgenesis, or other forms of spinal dysraphism. Spinal cord injury, spinal tumor, or neuropathy can also result in severe intrinsic urethral weakness. History of radical pelvic surgery for rectal cancer or cervical cancer might result in denervation, and multiple failed continence surgeries might result in scarring and urethral insufficiency.

Congenital anomalies of development, including epispadiac urethra, might require the use of an artificial urinary sphincter to restore continence. Some patients require augmentation cystoplasty, and these patients can be successfully managed by placement of an artificial sphincter at the time of lower urinary tract reconstruction. There are relative contraindications-a history of pelvic radiation is associated with an increased risk of cuff erosion. Similarly, patients with chronic urinary tract infections, genital ulcerations, or severe diabetic neuropathy might be at greater risk of complications.

To use the artificial sphincter, the patient must have adequate manual dexterity. Two hands are usually required, one to hold the control mechanism steady and one to squeeze the pump. Elderly patients with neurological deficits associated with stroke or Parkinson disease

are not appropriate candidates for the artificial urinary sphincter.

Urodynamic parameters should also be considered. The patient with severe stress incontinence and an areflexic bladder offers a challenging problem. If voiding occurs only with abdominal straining, the use of a sling might result in retention.

The artificial sphincter would be a reasonable choice if the patient were anxious to avoid the need for long-term management with clean intermittent catheterization.

Surgical Technique

The surgical techniques for placement of the artificial urinary sphincter have been well described (14,15,16). Some authors favor a vaginal approach because access to the urethral dissection is more straightforward. This is reasonable for many patients. For others, who have had multiple prior continence procedures, it can be difficult to work through the scarring of tapes and retained sutures in the retropubic space. The surgeon should not be reluctant to use simultaneous abdominal and vaginal access if the planes of dissection are obliterated.

To place the artificial urinary sphincter using a vaginal approach, a vertical incision is made in the anterior vaginal wall. It is helpful to infiltrate the tissues with 1% lidocaine to elevate the tissues and ease the dissection. A large Foley catheter (20 French) should be in place as the dissection proceeds. The incision should extend from the midurethra to the proximal bladder neck, and angled scissors can be used to develop thick vaginal flaps on each side. The dissecting scissors should be directed laterally to the pubic ramus and then toward the ipsilateral shoulder to penetrate the endopelvic fascia. Blunt dissection may be used to develop this space and to sweep the tissues from lateral to medial to create a space toward the midline in the retropubic space.

If there is scarring due to previous surgery, a sharp dissection may be needed to enter the retropubic space. It can be helpful to remove the Foley catheter and to place a large metal sound (28 French) in the urethra to minimize the risk of urethral injury. Dissection is continued on the right and the left until the space is completely developed. It is also necessary to dissect the posterior aspect of the bladder free from the underlying anterior vaginal wall. The plane of dissection should be between the pubocervical fascia and the bladder base, leaving the intact vaginal wall beneath the bladder base and bladder neck. This will reduce the risk of erosion of the cuff into the vagina.

When the proximal urethra has been mobilized, a curved vascular clap is passed around the urethra from left to right, and the measuring tape is grasped and passed around the urethra. This is used to measure the appropriate cuff size, which is then selected, prepared, and passed around the proximal urethra until it is in optimal position, and the tubing is passed through the window in the cuff and secured. The cuff should be rotated 180 degrees so that the locking button is brought to rest on the superior aspect of the urethra away from the vaginal wall.

A 5-cm transverse suprapubic incision is made over the belly of the rectus abdominus muscle, and the dissection is carried down to the anterior rectus sheath, which is opened transversely to reveal the muscle bellies. Using scissors, the line of the muscle fibers is split in the medical third to open into the preperitoneal space. An examining finger can be introduced into the wound and a space developed away from the inferior epigastric vessels. It is helpful to use a long nasal speculum to pass the pressure-regulating balloon, which is typically 51 to 60 cm or 61 to 70 cm of water pressure. The reservoir is filled with 22 mL of isotonic contrast.

Working from the suprapubic incision, a tunnel is created toward the pubic tubercle and then downward to the labia majora to create a superficial pouch into which the pump can be placed. The tunnel is developed with long blunt-tip scissors, and the long nasal speculum is used to facilitate placement of the device. It is important to place the pump in a posterior position so that it can readily be manipulated. When the control mechanism is in place, the tubing is trimmed, and quick connectors are used to secure the tubing. Great care must be taken to ensure that all elements of the device are free of air bubbles and are irrigated to remove any air or blood cells from the tubing prior to securing the connections.

The suprapubic and vaginal wounds are thoroughly irrigated with copious warm antibiotic irrigation (gentamicin and bacitracin). The wounds are then closed in layers with absorbable suture. It is critical to inspect the vaginal flaps before closure and before any ischemic edge is excised. If there is any question about the vitality of the vaginal flaps, a vascularized labial flap (Martius) should be used from the contralateral labia to cover the tissues between the cuff and the vaginal closure. Most often, the device is cycled to ensure that it empties and fills in the appropriate way, a small-bore catheter (12 French) is left in place for the first 24 hours, and the device is typically left in the deactivated state for 4 to 6 weeks.

Results

Results of placement of an artificial urinary sphincter are generally satisfactory.

Successful resolution of incontinence at 1 to 5 years is usually greater than 90% (17). There are few reports in the literature of long-term follow-up of the artificial urinary sphincter. Revision of the artificial sphincter is often needed because of thinning of the urethra under the cuff or because of late complications such as vaginal or urethral erosion. The literature would suggest that approximately 50% of patients will require some form

of revision at 5 years, and more than 90% will require revision within 10 years (18).

In counseling patients about the use of the artificial urinary sphincter, it should be clear that although this device offers an excellent possibility of satisfactory continence, there is always a prevailing concern. The device will tend to cause atrophy of the underlying tissues particularly adjacent to the cuff, and it can be expected that some surgical revision will be likely in due course. The artificial urinary sphincter remains a suitable choice for some patients, but the risk of long-term complications is real, and this needs to be considered when counseling patients about the choice of surgical treatments for severe SUI.

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23

Pubovaginal Slings

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The popularity of pubovaginal sling surgery has waxed and waned since its inception nearly a century ago. The procedures used have historically been associated with high complication rates and were reserved for treatment of refractory stress urinary incontinence (SUI). However, the sling procedure has experienced a renaissance in the past 30 years, in part due to better understanding of the pathophysiology of SUI. Technological advances such as novel sling materials and methods of attachment have further contributed to decreased operative time and shorter postoperative convalescence. The goals of this chapter are to define the sling's mechanism of action, describe the authors' technique of sling surgery, and review the results of sling procedures utilizing various materials.

History

At the beginning of the 20th century, the first slings were performed entirely from an abdominal approach and utilized autologous tissues. Initial attempts to increase outlet resistance by using detached or tunneled muscle flaps frequently met with severe complications, such as urethral sloughing, fistula formation, and bladder outlet obstruction. It was after the first abdominovaginal sling was performed in 1942 that Aldridge made some important observations (1). First, detached and excessively mobilized muscle flaps inevitably become devascularized and denervated, achieving continence solely by obstruction. Second, careful anatomic dissection revealed an â€œalmost bloodless planeâ€• on either side of the urethra, permitting minimally traumatic entry into the space of Retzius. Despite these advancements in understanding and reports of sustained long-term cures, complications unfortunately continued to be common (2). Inevitably, the popularity of the procedure waned over the next several decades.

As long-term efficacy of needle suspensions began to be questioned, there was a renewed interest in slings in the late 1970s. Improving on the Aldridge technique, McGuire and Lytton isolated a strip of rectus fascia and left it attached laterally on one side (3). The free end of the strip was passed through the body of the rectus muscle, positioned under the urethra, and reattached to the other side of the rectus fascia. Blaivas and Jacobs further modified the McGuire technique by completely detaching the rectus fascial strip at both ends and perforating the endopelvic fascia from below (4). Although the pubovaginal sling has undergone several modifications over the ensuing years, it remains very much the procedure championed by McGuire and Blaivas.

Pathophysiology of Stress Incontinence

Continence depends on the interaction of urethral and bladder neck support, intrinsic urethral properties, urethral sphincter mechanism, and pelvic floor musculature. While this interaction is complex and not completely understood, several factors are known to assist in maintaining continence in the neurologically intact female. At rest, a seal composed of richly vascularized submucosal connective tissue compresses mucosal urethral folds to create a watertight closure (5). This â€œmucosal sealâ€• is augmented by heightened wall tension created by luminal secretions from the periurethral glands. In addition, slow-twitch muscle fibers in the paraurethral layer of the external sphincter maintain passive continence by tonic contraction of the urethra (6,7).

The mechanism undergoes several adaptations during periods of increased intra-abdominal stress. First, a reflex contraction of the levator ani musculature and urogenital diaphragm elevates suburethral supporting tissue and compresses the proximal urethra. This is eloquently described in DeLancey's â€œhammock hypothesisâ€• (8). Second, the urethropelvic ligaments augment the muscular closure of the pelvic floor. These structures envelop the proximal urethra and bladder neck medially and insert laterally onto

the arcus tendineus fascia pelvis. Third, striated muscle in the urethrovaginal sphincter and compressor urethras aid in compressing the urethra during stress maneuvers. The net effect of these changes is increased outlet resistance. In the setting of intact urethral support, the increased intra-abdominal pressure is transmitted equally to the bladder and urethra, and continence results.

Conversely, in women with loss of anatomic support, the proximal urethra descends during stress maneuvers and rotates out of the pelvis. In addition, some authors have noted posterior wall descent and bladder neck funneling resulting in unexpected bladder neck opening. The bladder receives greater intra-abdominal pressure relative to the urethra, and involuntary urinary incontinence results (9). Intuitively, the sling not only replaces and augments the normal urethral support structures but also buttresses the bladder neck to prevent descent and funneling during stress maneuvers.

Recently, much attention has been given to a new class of sling procedures placed at the midurethra rather than the bladder neck. The midurethra has previously been found to be the site of maximal intraurethral pressure (10). With this in mind, Petros and Ulmsten proposed in their â€œintegral theoryâ€• that the midurethra, rather than the bladder neck, may be the key mechanism for urinary continence (11). The authors described three opposing muscle forces (vectors) that influence the micturition mechanism: (i) a forward force activated by the pubococcygeus muscle, (ii) a backward force activated by the levator ani musculature, and (iii) an inferior force controlled by the longitudinal muscle of the anus. During an increase in intra-abdominal pressure, contraction of the pubococcygeus pulls the anterior vaginal wall forward and closes off the urethra. This response is contingent on an intact attachment between the anterior vaginal wall and the pubourethral ligaments (PUL), which act as a fulcrum at the midurethra. Laxity in the PUL contributes to funneling of the bladder neck and incontinence during increases in intra-abdominal pressure. Midurethral slings, in turn, support the midurethra in a tensionfree fashion to prevent SUI.

Pubovaginal Sling Surgery

Preoperative Considerations

A comprehensive history, physical examination, and urodynamic assessment is performed on all patients. It is vital to not only properly characterize the nature of incontinence but also to identify all aspects of vaginal prolapse. All prolapse defects should be repaired in a site-specific fashion at time of sling surgery to minimize the possibility of SUI recurrence, urinary retention, or worsening prolapse. A discussion of the risks, benefits, and options to sling surgery is germane in obtaining informed consent. Risks include but are not limited to bleeding, infection, injury to the bladder or urethra with subsequent fistula formation, dyspareunia, formation of anterior or apical vaginal wall prolapse, and de novo or worsening storage symptoms. Unless a concomitant hysterectomy, vaginal vault suspension, or posterior compartment surgery is planned, no special preoperative bowel regimen is ordered.

An hour prior to surgery, intravenous antibiotics are given (ampicillin and gentamicin or a fluoroquinolone). Antithromboembolic hose and sequential compression devices are applied prior to induction of anesthesia. Either regional or general anesthesia may be used. The patient is positioned in slightly exaggerated dorsal lithotomy position in Allen stirrups. Betadine or Hibiclens preparation is performed from the umbilicus to the midthigh, including the vaginal canal. After draping, an indwelling urethral catheter is placed to continuous drainage. The authors typically use a Scott retractor and a weighted vaginal speculum for retraction.

Harvest of Rectus Fascia/Abdominal Incision

It is the authors' preference to use a skin incision from prior surgery; however, if no previous scar exists, then a Pfannenstiel incision is more than adequate. After incising the skin sharply, cautery is used to dissect the subcutaneous fat and Scarpa's fascia, thereby exposing the rectus fascia. It is important not to excessively undermine the areolar tissue overlying the rectus fascia, as this may increase the possibility of postoperative seroma formation. A strip of rectus fascia measuring approximately 1.5 cm Ã— 7 cm is excised, and 0-0 polypropylene sutures are attached to each end. The sling is then soaked in normal saline until the vaginal incision is prepared. The rent in the rectus fascia is closed with continuous or interrupted no. 1 delayed absorbable suture. The skin is left open to aid in the passage of sling sutures later in the procedure.

The abdominal dissection is typically minimal if a graft material is used for the sling. Two common options are a short horizontal incision or two separate lateral incisions just cranial to the pubic symphysis. The graft may be placed in antibiotic solution at this time.

*Authors' Note: Irrespective of the chosen material, we feel that the length of the sling should be such that it spans the interarcuate distance. In effect, the sling is able to serve the dual purpose of providing suburethral support and paraurethral suspension. In addition, it has previously been demonstrated that longer slings have a greater tensile strength and decreased rates of suture pull-through when compared with patch slings of the same material (*12*).*

Vaginal Dissection

Using the urethral catheter balloon as a landmark, the vaginal incision is mapped out. If a sling is the only surgery being planned, an inverted U incision provides excellent access to the bladder neck. The apex of the U is based at

the midurethra, and the widely spaced legs of the U extend just proximal to the bladder neck (Fig. 23.1). Alternatively, a vertical midline incision may be used if any concomitant anterior or apical compartment surgery is planned. The anterior vaginal wall is infiltrated with normal saline, and the vagina is incised sharply. The vaginal mucosa is then dissected sharply off the underlying surface of the pubocervical and periurethral fascia. Lateral dissection should proceed up to the inferior edge of the pubic symphysis.

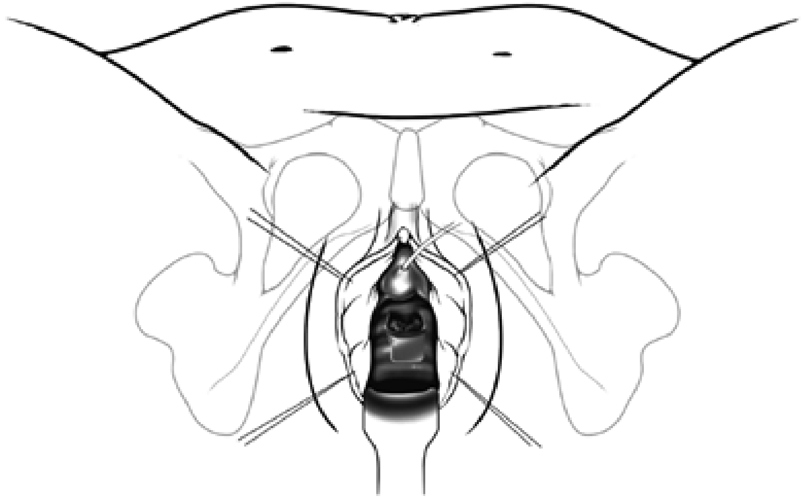

Figure 23-1 A wide-based inverted U incision has been made in the anterior vaginal wall. The apex of the U is based at the midurethra, and the legs of the U extend beyond the bladder neck.

An ampule of indigo carmine dye is administered intravenously at this time. Using the index finger of the nondominant hand as a guide, the endopelvic fascia is perforated with Metzenbaum scissors on each side, and the space of Retzius is entered. The scissors should be aimed at the ipsilateral shoulder and remain just inferior to the pubic symphysis. Once the endopelvic fascia is perforated, the scissors should be fully opened in a vertical direction and withdrawn in an open position. At this point, an index finger may be inserted into the retropubic space, and paraurethral adhesions should be released manually.

Suture Passage

If any surgery is planned to address anterior or apical compartment prolapse, it should be completed prior to passage of sutures. Double-pronged needles are placed into the abdominal incision just cephalad to the symphysis (Fig. 23.2). The needles should pierce the rectus fascia approximately 2 cm lateral to the midline and remain immediately posterior to the pubis. A finger in the retropubic space is used to guide the needle out of the vaginal incision. A similar pass is performed on the contralateral side. Cystoscopy should now be performed.

Cystoscopy

Ureteral integrity is confirmed when blue urine is seen effluxing from each ureteral orifice. A 70-degree lens may be helpful to visualize the dome and superolateral aspects of the bladder where penetration with needles is more likely to occur. It is vital to inspect carefully around the air bubble, as it may occasionally obscure the metal passer. It is also imperative to adequately visualize the entire path of the passer from the dome to the bladder neck and proximal urethra, as bladder integrity may be compromised anywhere along this path. If the bladder has been penetrated, the offending suture passer should be removed under direct vision, the bladder drained, and the needle should be passed again. Cystoscopy should be performed after each pass to confirm bladder integrity.

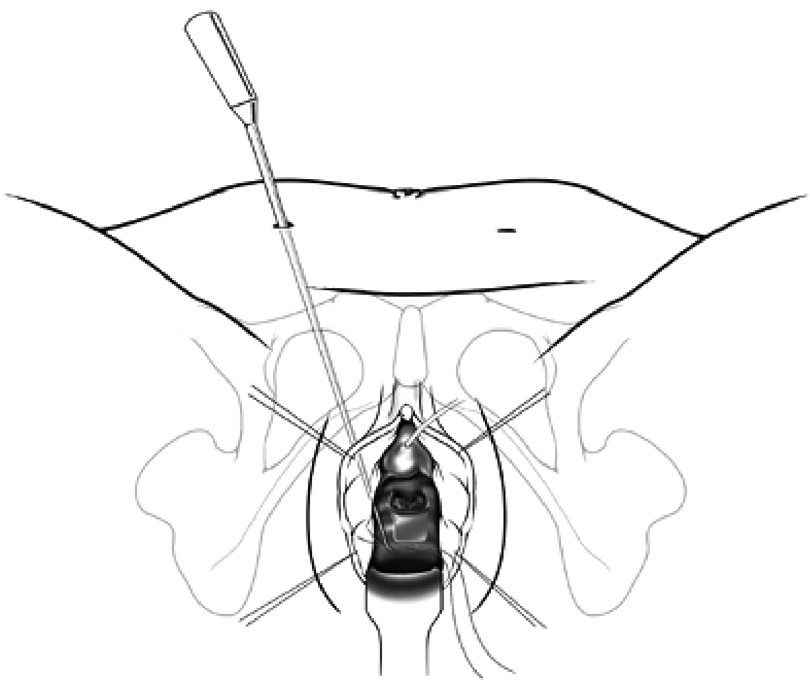

Figure 23-2 A suture passer is advanced from the suprapubic incision into the vaginal incision. Care is taken to stay just posterior to the pubic symphysis. Typically, digital guidance from below aids in identifying the correct tissue plane for suture passage.

Adjusting Sling Tension

The sling sutures are loaded onto the double-pronged needles and are transferred into the abdominal incision (Fig. 23.3). The sling is then positioned over the bladder neck, and the distal/superior edge of the sling is anchored to the periurethral fascia with 0-0-0-0 delayed absorbable suture (Fig. 23.4). After irrigating with antibiotic solution, the vaginal incision is closed with 0-0 delayed absorbable suture.

Suture tension is set from the abdominal incision. Prior to this, the patient's legs are lowered to a comfortable lithotomy position, and all retractors and speculums are removed. The pair of sutures is tied to the contralateral pair over the rectus fascia under no tension. The authors typically have an assistant use his or her index and middle fingers as a spacer between the suture knot and the rectus fascia. After two knots, the sutures are gently clamped with a rubber shod, and tension is tested by removing the urethral catheter and inserting a cystoscope sheath into the

bladder. If there is no hitch in passing the sheath into the bladder, then the sling tension is adequate, and additional knots may be now added to the sutures. If there is a hitch, then the knot should be undone and more laxity given to the sling. This is repeated until the cystoscope sheath is passed into the bladder without a hitch.

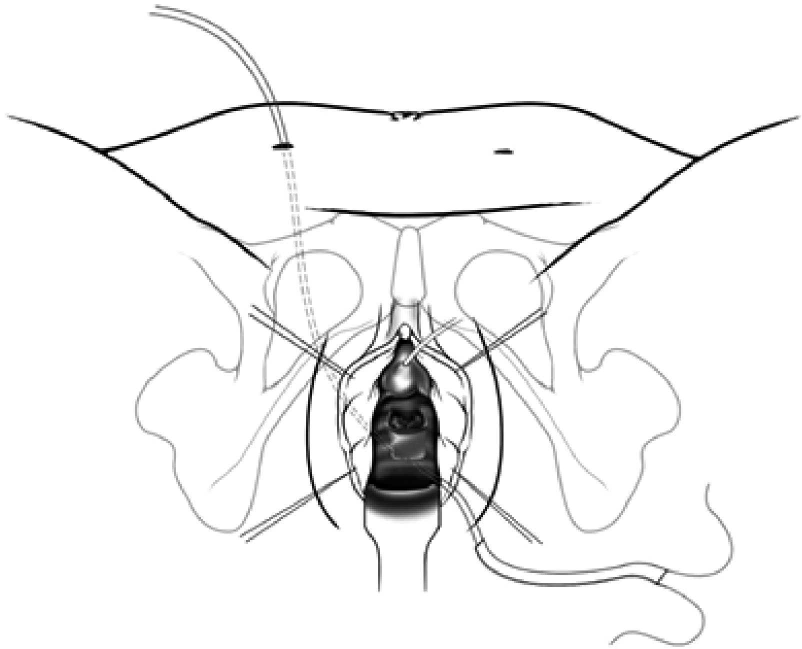

Figure 23-3 Sutures are transferred out of the suprapubic incision(s). A similar passage is performed on the contralateral side. Cystoscopy should be performed to ensure that bladder integrity has not been compromised.

The abdominal wound is irrigated with antibiotic solution, and Scarpa's fascia and skin are closed. The vagina is carefully packed with gauze soaked in estrogen cream. Alternatively, saline-soaked or betadine-soaked gauze may be used for premenopausal women.

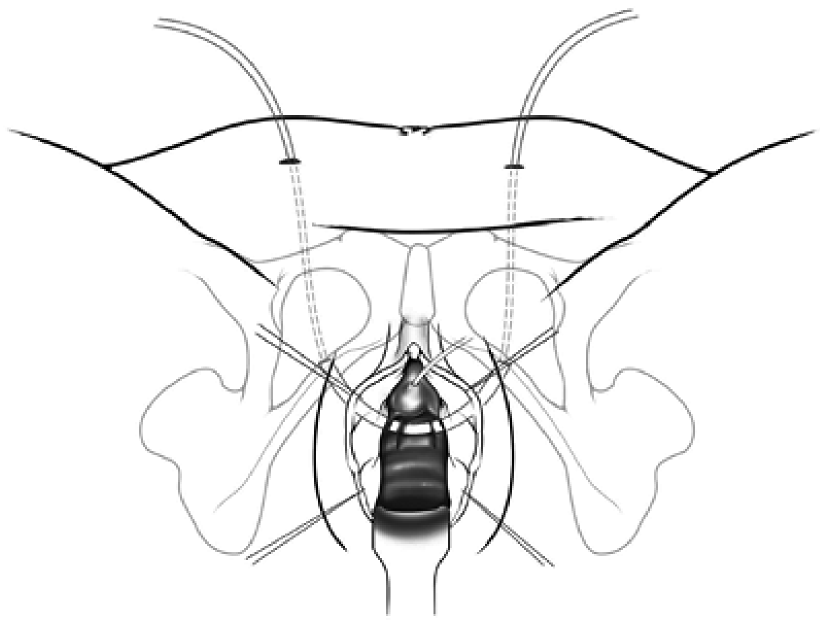

Figure 23-4 The sling is positioned under the bladder neck and is anchored to the periurethral fascia. The vaginal wall is then closed and the sling tension is adjusted from above.

Postoperative Course

Patients are typically admitted for overnight observation. The vaginal packing is removed the following morning, and a voiding trial may be performed. The patient is discharged home without a urethral catheter unless postvoid residuals persistently exceed 150 cc. In that case, an indwelling catheter is replaced, and an outpatient voiding trial is performed in the next few days. Alternatively, the patient may be instructed in clean intermittent catheterization to begin at home. If the bladder was penetrated with a suture passer at any time during the procedure, the patient is discharged with the urethral catheter to continuous drainage. An outpatient voiding trial is performed 48 to 72 hours later. All patients are discharged with antibiotics, analgesics, and a stool softener.

Patients are instructed not to lift objects in excess of 5 pounds for six weeks. Once the vaginal incision is healed at 6 weeks, the patient may attempt intercourse as tolerated. Early ambulation is encouraged, but strenuous exercise should be avoided. Follow-up visits are typically at 2 weeks, 6 weeks, 6 months, and annually thereafter. Patients may be released to full activity at 6 weeks. They should be counseled to avoid smoking, to control conditions contributing to increased intra-abdominal pressure (i.e., asthma, chronic allergies), and to maintain a normal weight for their height.

Results

The American Urology Association's (AUA) Female Stress Incontinence Clinical Guidelines Panel investigated the efficacy of different surgical procedures for SUI by conducting a comprehensive review of published outcome data. The panel concluded that suburethral slings, along with retropubic bladder suspensions, are the most efficacious procedures for long-term success in the treatment of SUI (13). There was a greater than 80% probability of improvement or cure of SUI at 48 months or longer after a suburethral sling. It should also be noted that at the time of the panel's report, slings were not yet the standard of care for surgical correction of SUI and were typically reserved for patients who failed previous surgical therapy. The data suggests that if patients with primary SUI are included in study populations, the success rates of sling surgery may be potentially even higher.

Technological advances such as novel sling materials and methods of suspension have further contributed to decreased operative time and shorter postoperative convalescence. Not unexpectedly, the nearly exponential increase in the number of sling-related products on the market has been accompanied by an influx of short-term results. In addition, few claims of efficacy have adequately addressed tissue acceptance after sling implantation. Biocompatibility refers to the interaction between an implantable

device and the physiological systems of the patient being treated with the implant. The ideal â€œbiocompatibleâ€• sling material would have certain qualities. It should be minimally deformed by its environment in vivo and retain its strength and elasticity over the life of the patient. It should be noncarcinogenic, nonallergenic, and nonimmunogenic. It should also be easy to use, inexpensive, and easy to sterilize. While no current sling material effectively balances efficacy, biocompatibility, and patient morbidity, some are better than others. The currently available sling materials are autografts, heterografts, xenografts, and synthetic meshes.

Autologous Materials

While many autologous tissues have been used as sling materials, only rectus fascia and fascia lata have stood the test of time. The harvest of both tissues requires a separate incision, a practice typically associated with longer operative and anesthesia times. The harvest of fascia lata may further require a change in patient positioning and additional instrumentation to strip the muscle. The advantage of either autograft is its noncarcinogenic and nonallergenic nature. Both are strong and durable, with consistent long-term efficacy (Table 23.1).

The major postoperative complications have been associated with harvest site healing, rare abdominal hernia formation after harvesting rectus fascia, and leg pain after harvest of fascia lata (Table 23.2) (58). No cases of rejection have been reported, and the several cases of urethral erosion were more likely due to aggressive periurethral dissection or placing the sling under undue tension (31,59,60,61,62). Urinary retention appears to be slightly more common in fascia lata slings as compared with rectus fascia. In summary, long-term cure rates using autologous rectus fascia and fascia lata have consistently exceeded 80%. Both materials are associated with excellent tissue acceptance and should be considered the â€œgold standardâ€• against which all other sling materials are measured. Fascia lata may be preferable in cases of previous abdominal surgery or when the status of rectus fascia is tenuous.

Several other autologous sling materials have been described sporadically (Table 23.3). An evaluation of the efficacy and side effect profiles of these materials is challenging due to the low number of patients in most studies and short follow-up periods.

Cadaveric Allografts

Ophthalmic and orthopedic surgeons have been using cadaveric allografts for over 20 years, thereby paving the way for the use of these materials in sling surgery. Cadaveric tissue is attractive for several reasons. As with any nonautologous tissue, allograft use eliminates the time and morbidity of harvesting autologous fascia. Another advantage is theoretically greater biocompatibility and lower risk of erosion over synthetic materials. A unique theoretical concern with using these tissues, however, is the potential for disease transmission. Although all cadaveric tissues undergo serologic screening for human immunodeficiency virus (HIV) and hepatitis B, false negative results are possible. The risk of HIV transmission from a frozen allograft has been estimated to be 1 in 8 million, while the risk of developing Creutzfeldt-Jacob disease (CJD) is approximately 1 in 3.5 million (71,72). Several materials have been described in sling surgery, including lyophilized dura, several preparations of fascia lata, and acellular dermis.

Lyophilized dura mater has been used in urologic surgery in Europe for many years. Its applications have included coverage of tissue defects after Peyronie's plaque incision or urethroplasty, bladder augmentation, calyceal fistula repair, and interposition in repairs of vesicovaginal fistulas (73,74,75,76,77,78,79,80). There have only been a few reports documenting efficacy in treatment of SUI. Rottenberg et al. reported an 89% objective success rate at over 6 months of follow-up, and Enzelsberger et al. reported a 92% cure rate in 36 patients at 32 to 48 months of follow-up (81,82). No complications relating to graft use were reported in either study. Incidentally, one case of CJD has been diagnosed in a Croatian male who had received a cadaveric dura mater graft 12 years earlier during a nonurological procedure (83).

Cadaveric fascia lata (CFL) has also been used extensively for repair of various tissue defects but has been used in sling surgery only since 1996 (84). There are two main techniques of processing CFL, solvent dehydration and freeze-drying. Studies regarding the strength of the two preparations present conflicting results. Sutaria and Staskin found no statistical difference in maximum load or thickness between freeze-dried CFL, solvent-dehydrated CFL, and acellular cadaveric dermis (85). Conversely, Lemer et al. found that solvent-dehydrated CFL and acellular dermis had a similar load to failure as autologous rectus fascia, while freeze-dried CFL was significantly less stiff and had a significantly lower maximum load to failure (86). Both preparations of CFL require 15 to 30 minutes to rehydrate in saline prior to implantation. The results and incidence of complications and voiding dysfunction associated with CFL slings are presented in Tables 23.4 and 23.5.

Since a report of early allograft failure, much attention has been focused on the durability of CFL (98). Literature suggests that early failure of allograft slings (within 3 months of surgery) may approach 20%, especially after using slings that were frozen in processing (99,100,101). In addition, recent reports suggest that intermediate-term failure rates (4 to 13 months following surgery) may approach 7% (89). One group, in particular, observed a 38% failure rate at less than 12 months of follow-up in their 154 patients (102). When 26 of these failures underwent reoperation, sling material was found to be fragmented, attenuated, or completely absent. Animal data has further cast doubt on these materials, as an approximately 90% decrease in tensile strength and stiffness of both preparations of CFL has

been observed in rabbit studies (103,104). While it is not clear what factors are responsible for the variations in sling durability, several mechanisms of allograft loss have been proposed (host-versus-graft reaction, potentially accelerated immunity, autolysis). The long-term challenge lies in standardizing the processing of allografts, as preparatory techniques currently differ between companies and tissue banks. To date, there have been no published trials that have compared outcomes of solvent-dehydrated and freeze-dried allografts in vivo.

Table 23.1 Results of Rectus Fascia and Fascia Lata Slings

Author(s)	Material	N	L (cm)	Mean F/U (mo)	Cure (%)
Kaufman (14)	Rectus	15	15	<48.0	93.3
Schultz-Lampel et al. (15)	Rectus	11	â€”	240	63.6

Loughlin (16)	Rectus	22	5	15.0	72.7
Mason & Roach (17)	Rectus	63	4	12.0	93.7
Zaragoza (18)	Rectus	60	6â€“8	25.0	100.0
Siegel et al. (19)	Rectus	20[a]	â€”	185.0	80.0
Carr et al. (20)	Rectus	96	11â€“13	22.0	97.9
Barbalias et al. (21)	Rectus	32	12	>30.0	65.6
Chaikin et al. (22)	Rectus	251	15	37.0	72.9
Maheshkumar et al. (23)	Rectus	43[b]	â€”	17.4	95.3
Hassouna & Ghoniem (24)	Rectus	82	7	41.0	89.1[c]
Kane et al. (25)	Rectus	13	5[d]	26.0	100.0
Yoong & Emens (26)	Rectus	50	[e]	24.0	94.0

Morgan et al. (27)	Rectus	247	6â€“8	51.0	82.2
Kochakarn et al. (28)	Rectus	100	â€”	12.1	94.0
Groutz et al. (29)	Rectus	67	15	34.0	67.2
Kuo (30)	Rectus	24	20	24.0	95.8
Borup & Nielsen (31)	Rectus	31	12	60.0	96.8
Gormley et al. (32)	Rectus	41	â€”	>74.0	95.1
de Rossi (33)	Rectus	27	8	20.0	100.0
Lucas et al. (34)	Rectus	156	[f]	>30.0	76.0
Chou et al. (35)	Rectus	98	12	36.0	95.0[c]
Pfitzenmaier et al. (36)	Rectus	50	â€”	60.0[g]	63.9
Guatelli et al. (37)	Rectus	35[h]	>20[i]	26.0	74.2

Almeida et al. (38)	Rectus	30	â€”	33.0	70.0
Rodrigues et al. (39)	Rectus	126	â€”	70.3	74.4
Kreder & Austin (40)	Rectus/FL	27	â€”	22.0	96.3
Golomb et al. (41)	Rectus/FL	18	15	30.7	88.9
Haab et al. (42)	Rectus/FL	37	12â€“15	48.2	73.0
Wright et al. (43)	Rectus/FL	33	13â€“15	16.0	93.9
Petrou & Frank (44)	Rectus/FL	14	10	17.0	50.0
Richter et al. (45)	Rectus/FL	57[j]	24	42.0.	84.0
Flynn & Yap (46)	Rectus/FL	71	12	44.0	90.1
Chien et al. (47)	Rectus/FL	23	10	30.5	94.1[c]
Low (48)	FL	36	>24	>24.0	94.4

Addison et al. (49)	FL	97	â€”	12.0	86.6
Beck et al. (50)	FL	170	>17	>24.0	98.2
Karram & Bhatia (51)	FL	10	5Ã—7	>12.0	90.0
Govier et al. (52)	FL	30	>24	14.0	69.7
Berman & Kreder (53)	FL	14	>17	14.9	71.4
Phelps et al. (54)	FL	27	>20[i]	20.0	77.8
Latini et al. (55)	FL	63	18â€“22	53.0	85.0[c]
Ellerkmann et al. (56)	FL	39	>24	>24.0	92.3

N, number of patients; L (cm), sling length in centimeters; Mean F/U (mo), follow-up period in months; Cure (%), percentage of patients cured; FL, fascia lata.

[a]includes one nonrectus sling;

[b]attachment point is Cooper's ligament in 18 patients;

[c]includes cured and improved patients;

[d]suprapubic bone anchors;

[e]Aldridge-style slings;

[f]includes full-length slings and short â€œsling on a stringâ€•;
[g]median follow-up;
[h]includes seven porcine dermis slings;
[i]attachment point is Cooper's ligament;
[j]includes Aldridge-style rectus slings.

As with any nonautologous material, tissue acceptance is another potential concern. While frank rejection has not

been described, Kammerer-Doak et al. reported a 23% vaginal extrusion rate in their series of 22 slings, and another study described the excision of two infected slings (47,105). Since inflammation is virtually indistinguishable from rejection without the use of specific tissue staining, it is not yet clear whether true rejection occurs after allograft implantation. Urethral erosion has been reported in five patients (61). Disease transmission from a cadaveric sling, another theoretical concern, has not been reported to date. However, recent reports of DNA detected in both freeze-dried and solvent-dehydrated CFL have raised further questions about the safety of these materials (106,107). While it is not yet known whether the genetic material found in these slings is transmissible or associated with an increased health risk in the long term, the findings should be taken into account when considering these tissues for sling surgery.

Table 23.2 Complications of Autologous Slings

Author(s)	De novo Storage Symptoms (%)	Voiding Dysfunction	Other Complications
Kaufman (14)	â€”	Obstruction (33%); Dilation/VIU (27%); Excision (7%)	â€”

Schultz-Lampel et al. (15)	0	â€”	â€”
Loughlin (16)	6	Short-term retention/dilation (23%)	â€”
Mason & Roach (17)	â€”	CIC at 3 mo (19%); CIC at 6 mo (6%); Long-term CIC (3%); Revision (2%)	DVT (2%)
Zaragoza (18)	12	â€”	â€”
Siegel et al. (19)	â€”	Incision (30%)	â€”
Carr et al. (20)	â€”	Refractory UI (6%); CIC at 3 mo (7%); Permanent CIC (3%); Early revision (1%)	â€”
Barbalias et al. (21)	0	â€”	Bladder perforation (1%)
Chaikin et al. (22)	8	CIC >1 mo (2%)	â€”

Maheshkumar et al. (23)	â€”	CIC (42%); Incision (5%)	Pain from procedure (25%)
Hassouna & Ghoniem (24)	21	Strain to void (1%)	Wound (15%)
Kane et al. (25)	8	Dilation/VIU (8%)	Bladder perforation (6%); Wound (10%); DVT (2%),
Yoong & Emens (26)	0	0%	Pelvic hematoma (1%); Incisional hernia (1%); DVT (<1%); PE (<1%)
Morgan et al. (27)	7	Urethrolysis (2%)	Wound (1%)
Kochakarn et al. (28)	5	Mean time of CIC, 8.9 wk (39%)	â€”
Groutz et al. (29)	10	Weak stream at 3 wk (22%)	Subcutaneous hematoma (8%); Persistent dysuria (4%)

Kuo (30)	8	Urethrolysis (4%)	Sling erosion (8%)
Borup & Nielsen (31)	13	CIC at 6 mo (39%); CIC at 1 y (16%); Revision at 1 y (3%)	â€”
Gormley et al. (32)	â€”	â€”	Bladder perforation (14%)
de Rossi (33)	7	Weak stream (7%)	â€”
Giannitsas et al. (57)	43	CIC (8%); De novo voiding problems (33%)	â€”
Chou et al. (35)	4	Revision (1%)	â€”
Pfitzenmaier et al. (36)	â€”	â€”	â€”
Guatelli et al. (37)	6	Obstruction (6%); Incision (3%)	â€”
Almeida et al. (38)	â€”	â€”	â€”
Rodrigues et al. (39)	â€”	Obstruction (11%)	Thigh hematoma

			(4%); Death from MI
Kreder & Austin (40)	12	Long-term CIC (7%)	(4%)
Golomb et al. (41)	5	Refractory urge (6%)	â€”
Haab et al. (42)	27	Refractory urge (24%); CIC (3%)	â€”
Wright et al. (43)	10	Urethrolysis (3%)	â€”
Petrou & Frank (44)	0	Long-term CIC (7%)	â€”
Richter et al. (45)	â€”	High PVR (16%); Posture (4%); CIC (7%)	â€”
Flynn & Yap (46)	5	Retention >45 d (3%); Urethrolysis (1%)	â€”
Chien et al. (47)	â€”	â€”	â€”
Low (48)	â€”	â€”	UVF (8%)

Addison et al. (49)	â€”	Long-term retention (6%)	Bladder perforation (8%); Wound (2%); PE (1%)
Beck et al. (50)	â€”	Mean period of voiding dysfunction, 2 mo; Incision (3%)	Wound (5%); FL hematoma (1%); Seroma (4%); PE (1%); DVT (1%)
Karram & Bhatia (51)	â€”	Mean time to spontaneous void, 20 d; Maximum, 39 d	â€”
Govier et al. (52)	14	Mean CIC, 3.3 wk; CIC at 4 mo (3%); Incision (3%)	Leg pain (3%)
Berman & Kreder (53)	â€”	â€”	Leg hematoma (14%)
Phelps et al. (54)	â€”	Retention/Incision (3%); CIC (2%)[a]	â€”
Latini et al. (55)	â€”	â€”	â€”
Ellerkmann et al. (56)	â€”	â€”	â€”

De novo storage symptoms (%), percentage of patients with de novo storage symptoms (i.e., urgency, frequency, urge incontinence); FL, fascia lata; Dilation, urethral dilation; VIU, visual internal urethrotomy; Incision, sling incision; CIC, clean intermittent catheterization; Revision, sling revision; DVT, deep vein thrombosis; Wound, wound infection or complication; PVR, postvoid residual; MI, myocardial infarction; UVF, urethrovaginal fistula; PE, pulmonary embolism; mo, months; wk, weeks; d, days; y, years.

[a]Percentages include totals for 27 FL slings and 36 CFL slings.

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Table 23.3 Results of Miscellaneous Autologous Slings

Author(s)	Year	Material	N	F/U (mo)	Cure (%)
Pelosi et al. (63)	1976	Dermis	2	>5	100.0
Gierup & Hakelius (64)	1978	Extensor brevis	2	â€”	â€”
Poliak et al. (65)	1983	Palmaris longus	6	12â€“36	100.0
Schonauer (66)	1988	Pubocervical fascia	21	3	95.2

Muller et al. (67)	1993	External oblique aponeurosis	108	60	66.7
Wall et al. (68)	1996	Rectus abdominis flap	32	2â€“13 (6)	87.5
Loran & Pushkar (69)	1997	Skin	281	68	>70.0
Neal & Foster (70)	2001	Semitendinosus	4	12â€“28	100.0

N, number of patients; F/U (mo), follow-up period in months; Cure (%), percentage of patients cured.

Cadaveric acellular dermis is another allograft available for use in sling surgery. After dermal cellular elements and the epidermis have been removed, the remaining basement membrane acts as a scaffold to allow ingrowth of the patient's own cells and vasculature. Cadaveric dermis is reported to be more elastic than CFL, and studies suggest that it has similar strength to autologous tissues (85,86). Three reports of dermal allografts in sling surgery have revealed mixed results. At a mean of 18 months, Crivellaro et al. reported that approximately 80% of 234 patients treated with a dermal allograft patch sling and bone anchor fixation were cured or improved (108). De novo urgency occurred in just over 5%, and SUI recurred in 15% of

patients. Unexpected long-term urinary retention and delayed wound healing were rare complications. Likewise, Wang et al. observed a 95% cured and improved rate in 111 patients treated with a Repliform sling (109). At a minimum follow-up of 36 months, de novo urgency developed in 1% and retention in 3% of their patients. Conversely, at a mean of 14.6 months, Owens and Winters found that only 32% of their 25 patients were dry after a Duraderm sling, and 32% failed (110). Twenty-four percent of these failures occurred between 6 and 14 months after surgery. These results are similar to the outcomes observed in some reports of cadaveric fascia. While it appears to integrate consistently into tissue, dermal allograft does carry the theoretical potential for ingrowth of hair follicles and sebaceous glands. Like CFL, DNA of unknown transmissibility has been isolated in this tissue as well (106).

Table 23.4 Results of Cadaveric Fascia Lata Slings

Author(s)	Processing	N	L (cm)	Mean F/U (mo)	Cure (%)
Elliott & Boone (87)	Solvent-dehydrated	26	12	15.0.	76.9
Amundsen et al. (72)	Freeze-dried	91	15	19.4	62.6
Brown & Govier (88); O'Reilly & Govier (89)	Freeze-dried	104	24	12.0	66.3[a]
Vereecken & Lechat (90)	Freeze-dried	8	>20	24.0	100.0
Walsh et al. (91)	Freeze-dried	31	10	13.5	93.5
Flynn & Yap (46)	Freeze-dried	63	12	29.0	87.3

Chien et al. (47)	â€”	83	10	27.4	90.1[b]
Bodell & Leach (92)	Solvent-dehydrated	186	7[c]	16.4	75.8[d]
Richter et al. (93)	Freeze-dried	102	25	35.0	75.0[b]
Phelps & Liu (54)	â€”	36	>20	20.0	83.3
Hartanto et al. (94)	â€”	34	7[c]	12.5	83.3
Almeida et al. (38)	Freeze-dried	30	6â€“8	36.0	40.0
Gurdal et al. (95)	Solvent-dehydrated	42	4	16.0	88.0
Park et al. (96)	Freeze-dried	60	20	>36.0	85.0
FitzGerald et al. (97)	Freeze-dried	27	â€”	12.0	59.0
Ellerkmann et al. (56)	Solvent-dehydrated	32	>24	>24.0	90.5

N, number of patients; L (cm), sling length in centimeters; Mean F/U (mo), follow-up period in months; Cure (%), Percentage of patients cured.

[a]updated cure rate with eight additional failures between 4 and 13 months postoperatively (89);
[b]includes cured and improved patients; [c]transvaginal bone anchors;
[d]patients reporting >50% improvement and no subjective SUI.

Table 23.5 Complications of Cadaveric Fascia Lata Slings

Author(s)	De novo Storage Symptoms (%)	Voiding Dysfunction	Other Complications
Elliott & Boone (87)	13	â€"	â€"
Amundsen (72)	44	Urethrolysis (1%)	â€"
Brown & Glovier (88); O'Reilly & Glovier (89)	â€"	Long-term retention (2%)	â€"
Vereecken & Lechat (90)	13	Incision (13%)	â€"
Walsh et al. (91)	â€"	Posture to void (77%); CIC at 4 mo (35%); CIC at 1 y (3%)	â€"

Flynn & Yap (46)	28	Retention at 56 d (2%)	â€”
Chien et al. (47)	â€”	â€”	â€”
Bodell & Leach (92)	â€”	â€”	Osteitis (1%)
Richter et al. (93)	â€”	Difficulty emptying bladder (58%)	â€”
Phelps et al. (54)	â€”	Retention/Incision (3%); CIC (2%)[a]	â€”
Hartanto et al. (94)	â€”	â€”	â€”
Almeida et al. (38)	â€”	â€”	â€”
Gurdal et al. (95)	â€”	CIC for mean of 20 d (12%)	â€”
Park et al. (96)	5	High PVR at 30 d (5%); Suprapubic suture removal (3%); CIC for 1 mo (2%)	Bladder perforation (2%); Blood transfusion (7%)

FitzGerald et al. (97)	â€”	â€”	â€”
Ellerkmann et al. (56)	â€”	â€”	â€”

De novo storage symptoms (%), Percentage of patients with de novo storage symptoms (i.e., urgency, frequency, urge incontinence); CIC, clean intermittent catheterization; PVR, postvoid residual; mo, months; y, years; d, days.
[a]Percentages include totals for 27 FL slings and 36 CFL slings.

In summary, the use of cadaveric allografts in sling surgery has decreased operative time, minimized the morbidity of harvesting autologous fascia, and shortened postoperative convalescence. Due to small amounts of outcome data, conclusions can only be drawn about CFL. Short-term cure rates approach those of autologous tissues, but reports of allograft use in sling surgery typically lack long-term results. In the immediate postoperative period, rates of voiding dysfunction are similar to autologous slings. However, since the preparation of CFL currently varies by company and tissue bank, the durability of these tissues may be unpredictable. The data suggests that solvent-dehydrated CFL may be more durable than its freeze-dried counterparts. Sparse results of cadaveric dermis slings indicate that this product may have short-term and medium-term failure rates similar to cadaveric fascia. Also, while there has been no reported disease transmission from CFL and acellular dermis, the detection of DNA in both materials may be a theoretical concern in the long term.

Xenografts

Like cadaveric allografts, animal tissues have been utilized for cutaneous and soft-tissue reconstruction for many years. The first sling implant, Zenoderm, was derived from porcine corium that was first treated with proteolytic enzymes to remove noncollagenous material. The strips were subsequently immersed in glutaraldehyde to cross link the collagen molecules and reduce antigenicity. Finally, the matrix was lyophilized (freeze-dried) and sterilized with gamma radiation. Short-term results with this product revealed cure rates that were similar to autologous fascia as well as comparable rates of urinary retention (111,112).

Porcine dermis is currently available under several trade names: DermMatrix, Pelvicol, and InteXen. These new materials are cross linked with diisocyanate, which is nontoxic and is not associated with graft mineralization that may be frequently seen after glutaraldehyde cross linking. In one study, Nicholson and Brown cured 79% of 24 patients with a porcine dermis sling at a mean follow-up of over

48 months (113). Thirteen percent of their patients developed urinary retention more than 1 year postoperatively. In another study with 12 months of mean follow-up, cure rates with a porcine sling placed at the midurethra approached 89% (114). Six percent of patients developed de novo storage symptoms, and 7% went on to have a sling release. No cases of sling extrusion or erosion were reported in either study. An additional application for porcine dermis has been suggested as an interposition material between synthetic sling ends in a minimally invasive midurethral sling. Theoretically, a biologic material may be able to provide increased suburethral support while minimizing the possibility of erosion seen with synthetics. Early results of the BioArc have been promising, with low rates of postoperative retention and sling extrusion (115).

Frank rejection has not been reported with porcine dermis; however, there have recently been two reports suggesting that this material may have an unpredictable tissue response. Cole et al. encountered an encapsulated porcine sling in an obstructed patient undergoing urethrolysis 6 months after implantation (116). Grossly, the sling was completely intact and was histologically acellular. In another study, Gandhi et al. observed a trend toward porcine graft preservation in eight women with persistent urinary retention up to 42 weeks after surgery (117). As in the previous report, slings were easily identified and removed. Histologically, there was minimal tissue remodeling, and collagen deposition was present only on the periphery of the sling. In addition, the authors observed inflammation and foreign body reaction in half of these patients. Interestingly, porcine slings in women undergoing reoperation for recurrent SUI were difficult to identify, and histologically, no graft material could be identified. These observations suggest that porcine dermis may in fact be immunogenic, and this response may be associated with persistent postoperative urinary retention. As with cadaveric allografts, specific tissue staining may be needed in the future to distinguish inflammation from rejection.

Small intestinal submucosa (SIS) is harvested from porcine jejunum, and the extracellular collagen matrix remains intact. Subsequently, collagen, growth factors, glycosaminoglycans, proteoglycans, and glycoproteins promote host cell proliferation through SIS layers. Theoretically, the SIS scaffold should be entirely remodeled and replaced by the host's connective tissue in 90 days. Previous uses for SIS in urological surgery have included urethroplasty, repair of Peyronie's plaques, and ureteral interposition (118,119,120). SIS for pelvic surgery is currently available in 1-ply and 4-ply sheets for prolapse repairs (Surgisis, Surgisis ES), 4-ply slings (Stratasis), and an 8-ply tension-free sling (Stratasis TF). Initial results in pediatric patients with neurogenic incontinence revealed encouraging cure rates and no significant delays in healing (121). Currently, there are two reports of 4-ply SIS in non-neurogenic SUI. Palma et al. cured 93% of their 28 patients at a mean of 8 months (122). There were no wound infections or de novo urinary storage symptoms. Rutner et al. cured 94% of 115 patients using a transvaginal approach with bone anchors at a mean follow-up of 36 months (123). Only 1% of their patient population required urethrolysis.

As with other xenografts and allografts, immunogenicity is a potential concern with SIS. Wiedemann and Otto performed biopsies of 4-ply SIS slings at reoperation for recurrent SUI and found no evidence of inflammatory or foreign body reaction at 17, 12, and 9 months (124). Recently, however, there have been several reports of significant inflammatory reactions after implantation of 8-ply SIS tension-free slings (125). Ho et al. reported that 6 out of their 10 patients developed erythema and inflammation at the abdominal wound site (126). One sterile abscess required operative drainage, while another drained spontaneously. In another study, 33% out of 18 women developed suprapubic inflammatory reactions (127). While three women responded to antibiotics only, three others required four drainage procedures to definitively resolve abscesses. In both studies, continence was maintained, and no slings required revision or excision.

Bovine pericardium is currently available in several preparations. The UroPatch is composed of purified and detoxified bovine pericardium that has been cross linked with glutaraldehyde. Pelosi et al. reported a 95% cure rate at a mean follow-up of 20 months in 22 patients who underwent a UroPatch sling suspended with infrapubic bone anchors (128). Another preparation is a noncross-linked, propylene oxide-treated, acellular collagen matrix derived from bovine pericardium. Marketed as Veritas Collagen Matrix, this tissue is reportedly thinner than freeze-dried or solvent-dehydrated CFL but may possess greater tensile strength (129). DNA has been extracted from this preparation of bovine pericardium, but the amount may be much less than that isolated in either CFL or cadaveric dermis (130). As with other tissues, it is not clear whether this DNA is transmissible. The biocompatibility of bovine pericardium has also recently come into question as two Brazilian studies have reported frequent rejections by human tissue (131,132). Out of a combined 15 patients, 11 experienced vaginal extrusion and wound dehiscence that necessitated sling removal.

In summary, the manufacturers of all three xenografts claim that each is biocompatible, has excellent tensile strength, is nonimmunogenic, and is devoid of viruses or prions. While all may have comparable tensile strength, claims of biocompatibility and immunogenicity must be strongly scrutinized when considering a xenograft as a sling material. To date, only porcine dermis and 4-ply SIS have been largely nonimmunogenic. Porcine dermis is also the only product to have sufficient reports of long-term efficacy. Like cadaveric allografts, these products may also contain DNA, which may pose an unknown long-term health risk to the patient. Despite these questions, the appeal of xenograft tissues is unmistakable. Consistent human tissue ingrowth into an acellular biologic matrix may eventually

offer the best combination of tensile strength and acceptance by the human body. At the recent European Association of Urology Congress, Eberli et al. presented their research of a novel acellular collagen matrix derived from porcine bladder submucosa (133). The matrix was placed under the bladder neck in rabbits and then examined at 1, 2, and 3 months. The authors found that the matrices retained tensile strength similar to native fascia, and histochemical analysis revealed a minimal inflammatory response that diminished over time. Such studies underscore the potential of developing the ideal sling material in the near future.

Synthetic Materials in Bladder Neck Slings

In situations where no suitable native fascia was available, several authors experimented with synthetic materials as suburethral slings. In the 1950s, nylon and Perlon were used for sling construction, and in 1961, Zoedler first reported the use of nylon strips in a suburethral sling (134,135). A high rate of urethral obstruction and transection was seen because of the narrow nature of these slings and the tendency to â€œstrangleâ€• the bladder neck. After experiencing high rates of postoperative suprapubic abscess and urethral fistula, several authors deemed Mersilene ribbon unsatisfactory for use in sling surgery (136,137). While the implementation of wider pieces of Mersilene gauze led to fewer complications, the interest in synthetic materials ebbed (138). It would be several years until synthetic materials would again be popular.

While all synthetic materials are strong, they differ in several ways. Most are constructed from permanent materials, but absorbable slings have been introduced. Slings can also differ in composition (monofilament vs. multifilament), pore size, and flexibility. In addition, multifilament meshes contain interstices that may be much smaller than standard pores. The small pore size may allow bacteria (1 Âµm) to enter the mesh but keep out mediators of the body's immune response such as macrophages and lymphocytes (50 Âµm) (139). These small pores may also deter the ingrowth of fibrocollagenous tissue and prevent proper sling integration into the surrounding tissue. Finally, synthetic slings may also contain additives and coatings that impact on their acceptance by human tissues. Results and complications of synthetic materials in sling surgery are summarized in Tables 23.6 and 23.7.

Table 23.6 Results of Synthetic Slings

Author(s)	Material	N	L (cm)	Mean F/U (mo)	Cure (%)

Korda et al. (140)	Silastic	66	19.0	14.0	81.8
Chin & Stanton (141)	Silastic	88	>20.0[a,b]	3.0â€“60.0	80.7
Debodinance et al. (142)	Gore-Tex	72	â€”	24.0	65.3
Weinberger & Ostergard (143,144)	Gore-Tex	62	200	38.0	72.5
Errando et al. (145)	Gore-Tex	33	30.0	13.0	72.7
Barbalias et al. (146)	Gore-Tex	24	12.0	30.0	83.3
Choe & Staskin (147)	Gore-Tex	90	3.5	51.0	88.9
Yamada et al. (148)	Gore-Tex	72	3.0	67.0	77.8
Choe et al. (149)	Gore-Tex	30	3.5[c]	18.0	93.3
Nichols (150)	Mersilene	22	32.0	<36.0	95.5

Skipper (151)	Mersilene	30	32.0	>12.0	86.7
Iosif (152)	Mersilene	44	30.0	>36.0	72.7
Kersey et al. (153)	Mersilene	100	23.0	6.0â€“60.0	78.0
Guner et al. (154)	Mersilene	24	25.0	24.0	95.8
Young et al. (155)	Mersilene	52	30.0	63.0	90.4
Sousa-Escandon (156)	Mersilene	31	3.0[d,e]	34.0	87.1
Kunhardt Urquiza et al. (157)	Mersilene	25	â€”	24.0	84.0
Bryans (158)	Marlex	69	30[b]	6.0â€“96.0	73.9
Morgan et al. (159)	Marlex	208	30[b]	>60.0	77.4
Morgan et al. (160)	Marlex	88	30[b]	49.7	85.2

Amaye-Obu & Drutz (161)	Marlex	92	30[f]	>12.0	92.4
Rodriguez et al. (162)	Prolene	138	10	15.0	96.0[g]
Kuo (163)	Prolene	50	30	24.0[h]	84.0
Shah et al. (164)	Prolene	49	[e]	59.0	81.6
Kung et al. (165)	Prolene	175	30[b,i]	17.8	91.1

N, number of patients; L (cm), sling length in centimeters; Mean F/U (mo), follow-up period in months; Cure (%), percentage of patients cured. [a]abdominal route only; [b]attached to Cooper's ligament; [c]polytetrafluoroethylene mesh impregnated with silver diacetate and chlorhexidine; [d]Mersilene patch buttressed with vaginal wall sling; [e]suprapubic bone anchors; [f]includes modified suburethral slings; [g]includes dry and patients >50% improved on questionnaire; [h]median follow-up; [i]laparoscope-aided approach.

Table 23.7 Complications of Synthetic Slings

Author(s)	De novo Storage Symptoms	Voiding Dysfunction	Other Complications

	(%)		
Korda et al. (140)	14	Voiding dysfunction (9%); CIC (9%); Incision (24%)	Sinus (5%); Excision (2%)
Chin & Stanton (141)	28	Voiding dysfunction (17%); Obstruction (2%); Excision (14%)	Bladder erosion (5%); UVF (1%); Extrusion (6%); Groin Pain (2%); Wound (15%); VVF (1%)
Debodinance et al. (142)	â€”	â€”	Rejection/Excision (32%)
Weinberger & Ostergard (143,144)	33	Mean SPT drainage, 29 d; Mean CIC, 138 d; Revision/Incision (15%)	Rejection/Excision (35%); Wound (50%)
Errando et al. (145)	â€”	CIC >3 mo (12%)	Excision (6%)
Barbalias et al. (146)	10	â€”	Urethral erosion (8%); Excision (8%) Excision (6%)
Choe & Staskin (147)	12	CIC at 3 mo (8%); Incision (7%)	Urethral erosion (1%); Infection (1%);

Yamada et al. (148)	15	â€”	Excision (3%)
Choe et al. (149)	6	â€”	â€”
Nichols (150)	â€”	â€”	Extrusion (5%)
Skipper (151)	â€”	â€”	UVF (3%); Excision (7%)
Iosif (152)	â€”	Retention >6 wk (34%); Incision (16%)	Abscess (5%)
Kersey et al. (153)	â€”	Voiding dysfunction (15%); Dilation (23%)	Wound (11%); Exposed suture (2%)
Guner et al. (154)	â€”	â€”	Abdominal cellulitis (13%)
Young et al. (155)	17	Voiding dysfunction at 6 wk (23%); Retention >1 y (6%); CIC >3 mo (13%); Incision (6%)	Extrusion (2%); Excision (2%); Groin abscess (10%); Inguinal neuropathy (2%); Partial sling excision (15%)
Sousa-	23	SPT for 3 to 6 wk	â€”

Escandon (156)		(6%)	
Kunhardt Urquiza et al. (157)	â€”	Retention/Revision (4%)	â€”
Bryans (158)	â€”	Posture to void (22%); CIC for 3 to 6 mo (6%)	Extrusion (7%); Sinus (1%); Excision (3%)
Morgan et al. (159)	â€”	Obstruction/TURBN (6%); CIC (1%); Long-term voiding dysfunction (5%)	Urinary diversion (2%); Sinus (1%); Urethral erosion/Revision (6%)
Morgan et al. (160)	7	Retention >2 y (2%)	â€”
Amaye-Obu & Drutz (161)	â€”	Long-term CIC/Suture release (5%)	Excision (2%)
Rodriguez et al. (162)	9	Retention for 2 to 3 mo (1%)	â€”
Kuo (163)	17	Urethrolysis (4%)	Extrusion/Revision (2%)
Shah et al. (164)	4	Urethrolysis (4%)	Pain from dislodged anchor

			(2%)
Kung et al. (165)	â€”	â€”	â€”

De novo storage symptoms (%), percentage of patients with de novo storage symptoms (i.e., urgency, frequency, urge incontinence); UVF, urethrovaginal fistula; VVF, vesicovaginal fistula; SPT, suprapubic tube; CIC, clean intermittent catheterization; Wound, wound-related complications; TURBN, transurethral resection of bladder neck; d, days; mo, months; wk, weeks; y, years.

Silastic slings are constructed from medical grade silicone rubber reinforced with woven polyester. The finished product is a permanent multifilament mesh with submicronic pore size. Despite an 81% subjective cure rate at up to 60 months of follow-up, a large number of complications have been observed (140,141). De novo storage symptoms were seen in up to 28% of patients; 24% of patients underwent sling revision; and 14% of patients underwent sling excision due to erosion, pain, or fistula formation. Recently, silicone-coated mesh has been reintroduced for sling construction. A thin layer of silicone is applied to a multifilament polyester backbone to theoretically render the mesh â€œmonofilamentâ€• and reduce fraying and unraveling. Reports of tissue integration with this product have revealed conflicting results. Carbone et al. described their sling technique utilizing this product with transvaginal bone anchors (166). At a mean of 30 months, 93% of 70 patients were cured, and only 3% required sling excision due to anaerobic infection. Other studies, however, have described less favorable outcomes. Duckett and Constantine excised five of seven Silastic slings due to sinus formation at less than 11 months postoperatively, while Schostak et al. excised half of their 26 slings due to poor vaginal wound healing (167,168). Other authors have described similar complications in case studies (169,170). In addition, at a recent presentation at the AUA, Govier et al. reported a 40% vaginal extrusion rate at a mean of 160 days in their series of silicone-coated mesh (171). Currently, the silicone-coated mesh sling is no longer marketed for sling surgery.

Gore-Tex (expanded polytetrafluoroethylene) is a soft and pliable multifilament mesh with small pores (<10 Âµm). The mean cure rate after Gore-Tex sling implantation is approximately 77%, and rates of de novo storage symptoms range from 10% to 33%. Ironically, the dense nature of Gore-Tex that makes it an ideal material for endovascular reconstruction has been a detriment in sling surgery. In vivo, the mesh tends to become covered with a pseudocapsule that deters tissue integration. Rejection appears to be directly related to sling length. As full-length slings have been associated with excision rates of 30% to 35%, patch slings have been rejected in only 3% to 6% of patients. In one study of pediatric patients with neurogenic incontinence, 14 of 19 slings eroded into the urinary tract and required excision at a median of 7 years (172). Bladder calculi were associated with nearly every case. One case of urethral transection has been reported (173). In an attempt to reduce the incidence of sling rejection, Choe et al. modified the Gore-Tex patch sling by impregnating it with silver diacetate and chlorhexidine, both potent antimicrobials (149,174). At a mean of 22 months, no erosion or rejection was seen with MycroMesh; however, vaginal extrusion requiring sling removal has been reported after a delay of 6 months (175).

Mersilene, composed of braided polyethylene terephthalate (polyester), is another permanent multifilament graft. The mean cure rate is approximately 83%, and rates of de novo storage symptoms typically approach 20%. While exact pore size has been debated, Mersilene is thought to have larger pores than Gore-Tex and is not as dense. These qualities were initially felt to make Mersilene a better synthetic sling material; however, further experience with this fabric has revealed that Mersilene implantation stimulates a dense inflammatory tissue reaction. Erosion and excision rates have ranged from 2% to 17%, and one case of urethral transection has been reported (176). As with Gore-Tex, Mersilene has also been modified in an attempt to improve tissue integration. A woven polyester mesh that was impregnated with collagen was available several years ago under the names ProteGen and Meadox. Short-term results appeared to support the theory that collagen impregnation may improve tissue integration (177). However, several studies reported a large number of sling excisions due to erosion and pain as early as 3 months after surgery, and ProteGen was recalled in 1999 (178,179,180).

Marlex and Prolene slings are both constructed from polypropylene, a monofilament mesh. Both contain large pores and are devoid of interstices, theoretically allowing improved tissue bonding. Marlex is a stiff material and may wrinkle more than other synthetic materials, increasing the potential for mesh distortion and erosion (181). Marlex is associated with a mean cure rate of 81%, and de novo storage symptoms have been seen in up to 7% of patients. Erosion occurs in up to 7% of patients, and the revision rate approaches 6%. Prolene is more flexible than Marlex and also contains larger pores (1500 Âµm vs. 600 Âµm). While long-term experience with standard (bladder neck) sling construction is more limited, a mean cure rate of 91% has been observed (162,163,164,165). Only 2% of patients have experienced sling erosion, and an additional 4% have required urethrolysis at a median of 24 months.

Reports of absorbable materials for sling construction have been sparse. Short-term results with Vicryl multifilament mesh (polyglactin 910) revealed a 95% cure rate and no evidence of erosion (182). A recent study has reported on a composite sling consisting of polypropylene mesh ends with an absorbable polydioxanone suburethral segment (183). At a mean of 30 months, 97.5% of 40 patients were dry and none developed de novo storage symptoms. Another absorbable product that has recently been introduced is SABRE (Self-Anchoring BioResorbable sling), a copolymer of polylactic acid and polycaprolactone. Polylactic acid is a biodegradable polymer derived from lactic acid from starch-rich products, and polycaprolactone is a biodegradable thermoplastic polymer derived from the chemical synthesis of crude oil. The theoretical advantage of SABRE is greater biocompatibility along with decreased incidence of rejection. Initial results are encouraging. At a mean of 18 months, Riccetto et al. reported an 80% cure rate in their 23 patients (184). There were two cases of vaginal extrusion, and three patients reported irritative voiding symptoms in the immediate postoperative period (up to 4 weeks). Further follow-up is necessary before drawing conclusions about this product's long-term efficacy.

Permanent synthetic materials for pubovaginal sling surgery are abundant, strong, and noncarcinogenic. All are associated with similar cure rates that approach those observed with autologous sling materials. Dense synthetic meshes such as Gore-Tex and Silastic may not integrate into host tissue well and frequently lead to a high rate of rejection and subsequent sling excision. Despite larger pore size, high rates of erosion and sinus formation have been seen with other multifilament meshes such as Mersilene. Impregnation with antibacterial substances and collagen has not protected these slings from erosion. Loose monofilament meshes with large pores appear to have fewer rejection-related complications and may be better choices for sling surgery. Due to its large pore size, monofilament construction, and flexibility, Prolene is currently the best synthetic material available for sling construction. It cannot be overemphasized that synthetic meshes have unique characteristics, and effective applications in other body sites may not necessarily make them good materials for the vaginal milieu. Therefore, each material should be evaluated with long-term data. Furthermore, no synthetic material is immune to the potential for erosion and rejection, especially when placed under excessive suburethral tension.

Conclusions

Pubovaginal sling surgery has been a work in progress for nearly 100 years. While the popularity of other surgeries such as bladder suspensions has ebbed, the sling remains

a mainstay in the surgical correction of stress urinary incontinence. As our understanding of pelvic anatomy and physiology has improved, so have surgical outcomes. Several points are important when considering sling surgery. First, the patient must be counseled preoperatively, and informed consent should be obtained. Specific details should include the nature and behavior of the sling material as well as complications of the procedure itself. Even in experienced hands, the sling has potential complications and suboptimal outcomes that the patient needs to understand. Second, careful cystoscopy to ensure bladder integrity and tension-free sling placement cannot be overemphasized. Postoperative voiding dysfunction resulting from excessive sling tension may be a greater cause of concern to the patient than the initial SUI. Finally, patient adherence to postoperative instructions, including lifting limitations and lifestyle modifications, is vital for maintaining the efficacy of the surgery.

It is clear from the data that sling surgery with most materials produces short-term success rates comparable to autologous fascia. Rates of postoperative voiding dysfunction and urinary retention also appear to be similar. Allografts, xenografts, and synthetic materials uniformly shorten operative times and minimize morbidity associated with fascial harvest. The time saved, however, may come at a price in the long-term. Certain preparations of CFL and cadaveric dermis may be associated with a failure rate that exceeds 25% during the first year. Some SIS and bovine pericardium products are associated with significant inflammatory responses and frank rejection. In addition, DNA of unknown transmissibility has been isolated in several sling products, including CFL, cadaveric dermis, and bovine pericardium. The integration of synthetic meshes into human tissue depends on increased flexibility, monofilament construction, and large pore size. Meshes not meeting these characteristics have been associated with high erosion and rejection rates. Certainly, more research is needed to fully evaluate and improve these products.

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24A

Midurethral Slings: Pubic Bone Stabilization Sling and Transobturator Vaginal Tape

S. Robert Kovac

Xiufen Ding

In the 20th century, gynecologists began to rethink the treatment of stress urinary incontinence (SUI). However, controversy continues as to the best surgical approach to treat this condition. It is unlikely that the necessary prospective, randomized studies with matched variables will ever be conducted to help resolve the matter. There are more than 200 surgical procedures for urinary incontinence performed by a variety of methods. When a consensus is lacking or ambiguous, as is the case with the management of SUI, physician decision making is driven by subjective factors referred to as â€œpractice style,â€• which incorporates physician attitudes, tastes, and habits. The influence of surgical equipment companies who can actively promote a particular method before long-term studies have been done must be added to this list.

Damage to the muscles, fascia, and nerves of the pelvic floor can result in SUI. Therefore, the key to its successful management is to define the anatomy of continence mechanism, to understand how and what becomes defective, and then to institute specific surgery to correct the defect directly.

For many years, the management of SUI has been complicated by a basic defect in knowledge, namely the anatomical basis of normal continence control. For most of the 20th century, clinicians believed that SUI was associated with loss of urethral support.

What is it about urethral support that is influential in protecting loss of urine with stress provocation?

Surgical attempts to change proximal urethral and bladder neck anatomy were commonplace in the 20th century. Standard empirical operations such as the Marshall-Marchetti-Kranz (MMK) procedure and its derivative operations described by Burch and Pereyra could only affect the stability, position, and mobility of the urethra in relation to the urethrovesicle junction (1,2) (Fig. 24A.1). The fact that these operations are successful does not mean that they have restored an abnormality to normal. Until the anatomy is further understood and is used as a basis for corrective surgery, the problem of deciding which operation to advise will continue. At present, there is no definitive or ideal operation, or definitive test to separate cases on the basis of what operation to perform. In the future, we should be able to select management of SUI based on the abnormality found in individual patients. The current empiric approach is to assign women to treatment because they have SUI. Most often, this approach assigns women to empirical procedures that are stated to be the gold standard rather than selecting operations that correct the abnormality of the continence mechanism.

The anatomic approach to the treatment of SUI must be evaluated to determine if there are any advantages over the empirical operations of the 20th century. The clinical

effectiveness of these 20th century procedures have been well documented, but to consider these procedures the gold standard for the surgical treatment of SUI must be questioned because outcome studies have revealed that these operations are not optimal at restoring normal urinary control (3). In addition, postoperative enterocele, de novo detrusor instability, and significant voiding dysfunction are major problems associated with these empirical and nonanatomic procedures.

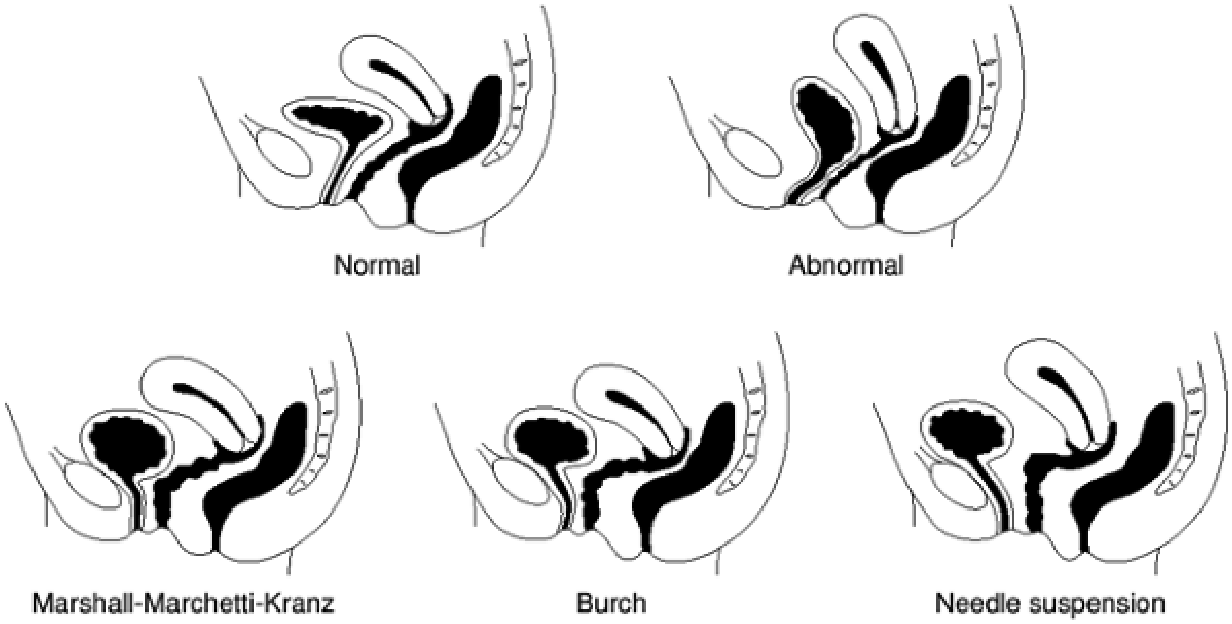

Figure 24A.1 Twentieth-century operations for stress urinary incontinence were designed to change proximal urethral and bladder neck anatomy.

It has been hypothesized that pelvic support and continence require an intact endopelvic fascia from one arcus to the other in order to stabilize the bladder and urethra in their normal retropubic position during coughing, straining, or Valsalva maneuvers (4). Anatomic studies by DeLancey demonstrated a connection between the supportive fascia under the urethra and the levator ani muscle (5). Richardson et al. recognized the separations between the pubocervical fascia and the arcus tendineus fasciae pelvis (ATFP) (4). He suggested that a paravaginal repair was an attractive option for restoring normal anatomy and resolving incontinence. However, if a woman did not have a paravaginal defect, she was not a candidate for a paravaginal repair. Although paravaginal repair is an attractive option for restoring normal anatomy, this procedure is not always effective in providing urethral support and stabilization. Richardson et al's observations caused a paradigm shift from empirical beliefs toward an accurate definition of the defects present in each patient (4) (Chapter 16).

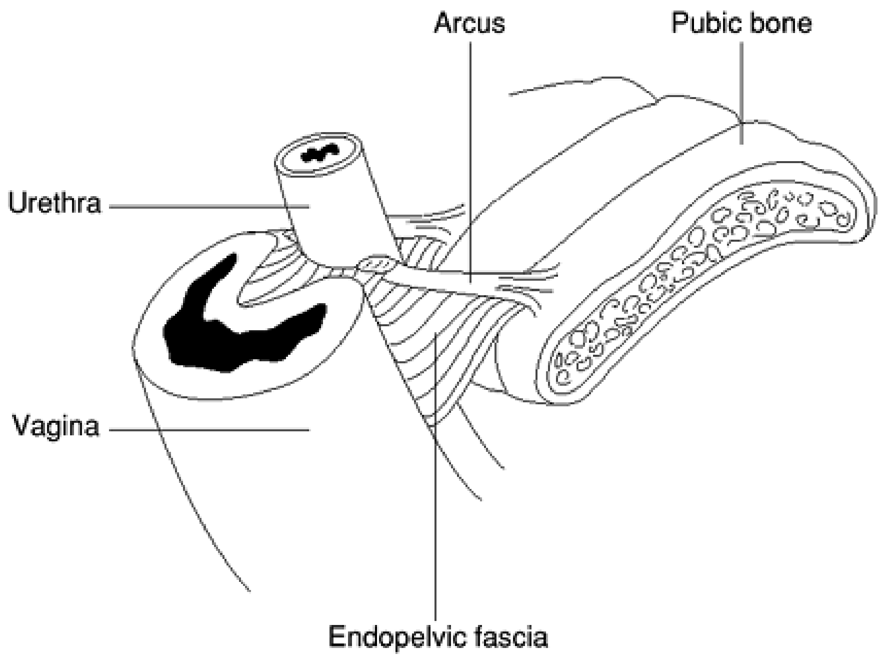

Figure 24A.2 Hammock hypothesis modified from Delancey. (Adapted from DeLancey JO. Structural support of the urethra as it relates to stress urinary incontinence: the hammock hypothesis. *Am J Obstet Gynecol*. 1994;170:1713â€“1720
, with permission.)

DeLancey proposed that continence is maintained because the urethra is compressed against a hammocklike supporting layer rather than lying in an intra-abdominal position (6). He demonstrated that the urethra lies in a position where it can be compressed against the supporting hammock by rises in intra-abdominal pressure (Fig. 24A.2). This theory was a quantum leap from the early beliefs of the 20th century that the urethra must be placed in a high retropubic position, back into the high pressure zone of the abdomen, and back into its supposed intra-abdominal position. These earlier theories resulted in positioning the urethra in an unnatural high position retropubically. DeLancey's theory suggested that weakening of the endopelvic fascia, anterior vaginal wall, and partial or complete detachment of the arcus from its insertion at the posterior-inferior part of the pubic bone may lead to incontinence. Furthermore, he suggested that successful surgical correction of urinary incontinence must restore the normal anatomy and function of the urethra rather than elevating it to an unnaturally high retropubic position (6).

In the future, physicians should be able to determine whether incontinence is the result of fascial, muscular, or neural damage. Treatment of the future will be based on the defects found. Thus, surgery will be useful where there are defects in the endopelvic fascia. Contraction of pelvic floor muscles instead of surgery may benefit patients who have intact fascia but weakened, properly innervated muscles. The most difficult patients to treat will be those

whose muscles are detached from fascia or have marked deinnervation.

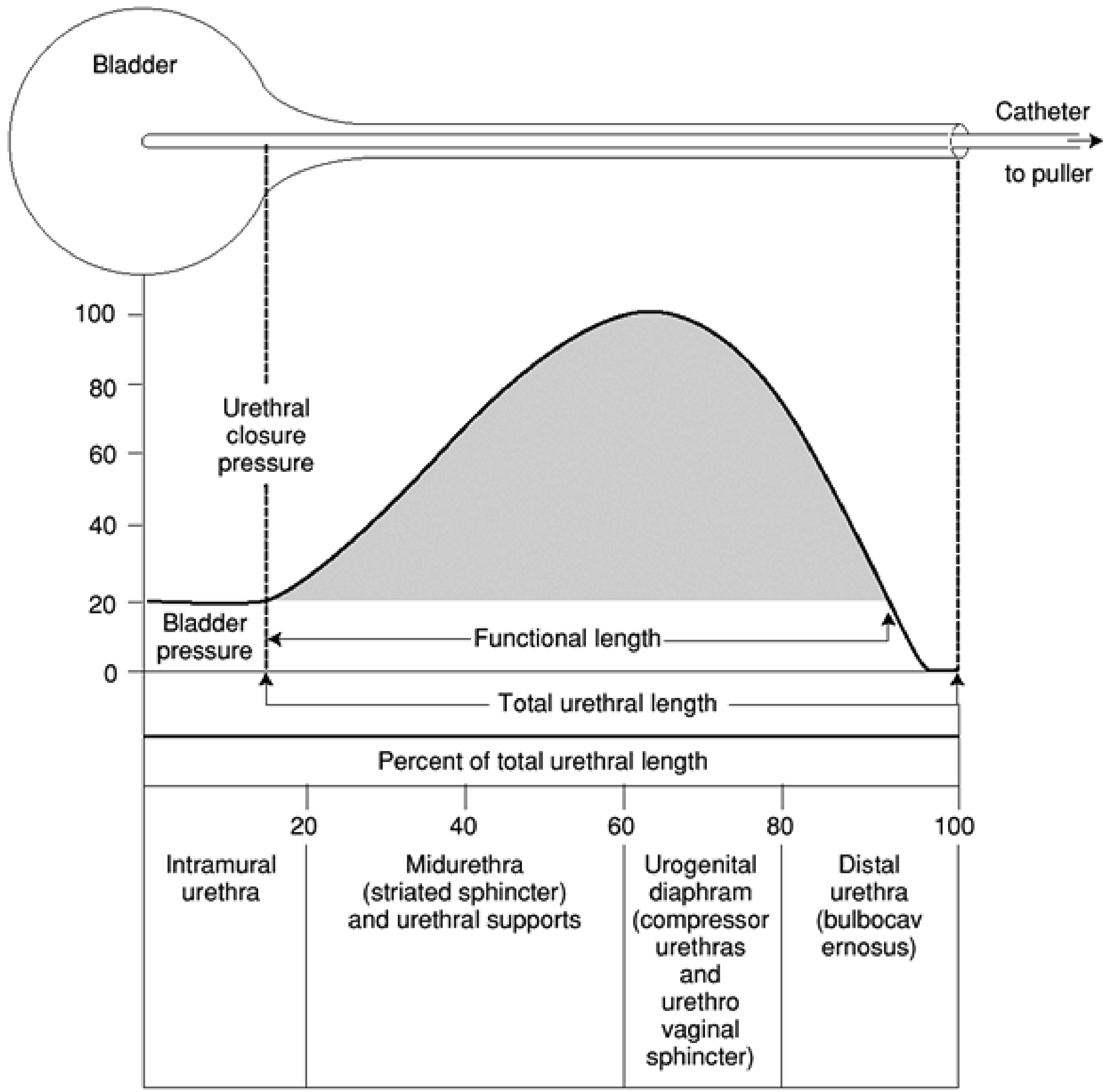

Figure 24A.3 Correlation of mid-urethral anatomy with urodynamic anatomy. (Adapted from
DeLancey JO. Correlative study of paraurethral anatomy. *Obstet Gynecol*. 1986;68:91â€“97
, with permission.)

The recent improvements in understanding of the underlying pathophysiologic mechanisms responsible for SUI have led to the development of innovative new surgical methods. These new techniques are less invasive and appear to offer improved safety and reduced hospital stays, while maintaining the efficacy of open incontinence operations. Delancey's hammock hypothesis and anatomic descriptions of the structures of the urethral support system and observations of a high urethral pressure in the midurethra during urodynamic studies lead to an appreciation of the significance of the midurethra for continence control (6,7) (Fig. 24A.3).

What operations will be used in the present, knowing that the only surgical procedure that has a chance of resolving SUI on a long-term basis will involve repair of fascial defects that support the urethra? The marked success of midurethral slings has distinguished them to be the procedures for SUI in the 21st century. The tensionfree tape (TVT) has been the most successful of these operations and is described in Chapter 24B.

Another tension-free sling-the pubic bone stabilization (PBS) sling-reported by Kovac in 1990 involves the use of transvaginally placed bone screws (Infast, American Medical Systems, Minnetonka, MN) into the back of the pubic bone at the normal insertion point of the ATFP to support a tension-free sling over the midurethra (8) (Fig. 24A.4). Bone anchoring was noted in 1992 by Benederev, who reported on suprapubically placed bone anchors into the pubic bone in patients who underwent bladder neck suspensions (9). Several reports were published in 1997 using the transvaginal approach for bone anchor insertion (10,11). The risk of infection using the transvaginal approach was unknown but was expected by some to be considerable. Some surgeons suggested, despite the lack of clinical evidence, that transvaginal bone anchoring would lead to a high incidence of osteomyelitis. Comments were made by some surgeons that it was dangerous to place a bone anchor into the pubic bone transvaginally because of their experience with abdominally placed bone anchors. When transabdominal bone anchors were used to suspend a suburethral sling of Proegen (Boston Scientific, Boston, MA), the incidence of osteomyelitis was 480 of 60,000 cases (personal communication with Boston Scientific).

In the urologic and urogynecologic literature, osteitis pubis and osteomyelitis have been reported to complicate a variety of surgeries (12). These surgeries included

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endoscopic resection of the prostate, transected prostrate biopsy, abdominoperineal resection, periurethral injection of collagen, Burch operation, needle suspension, and

MMK operations (13,14,15). Previous beliefs suggest that periosteal trauma is the important initiating event causing osteomyelitis. However, it is a far assumption to believe that periosteal trauma is caused by some of the mentioned operations in which the periosteum is not directly involved with the operation. Thus, there appears to be other potential causation for this complication rather than periosteal trauma.

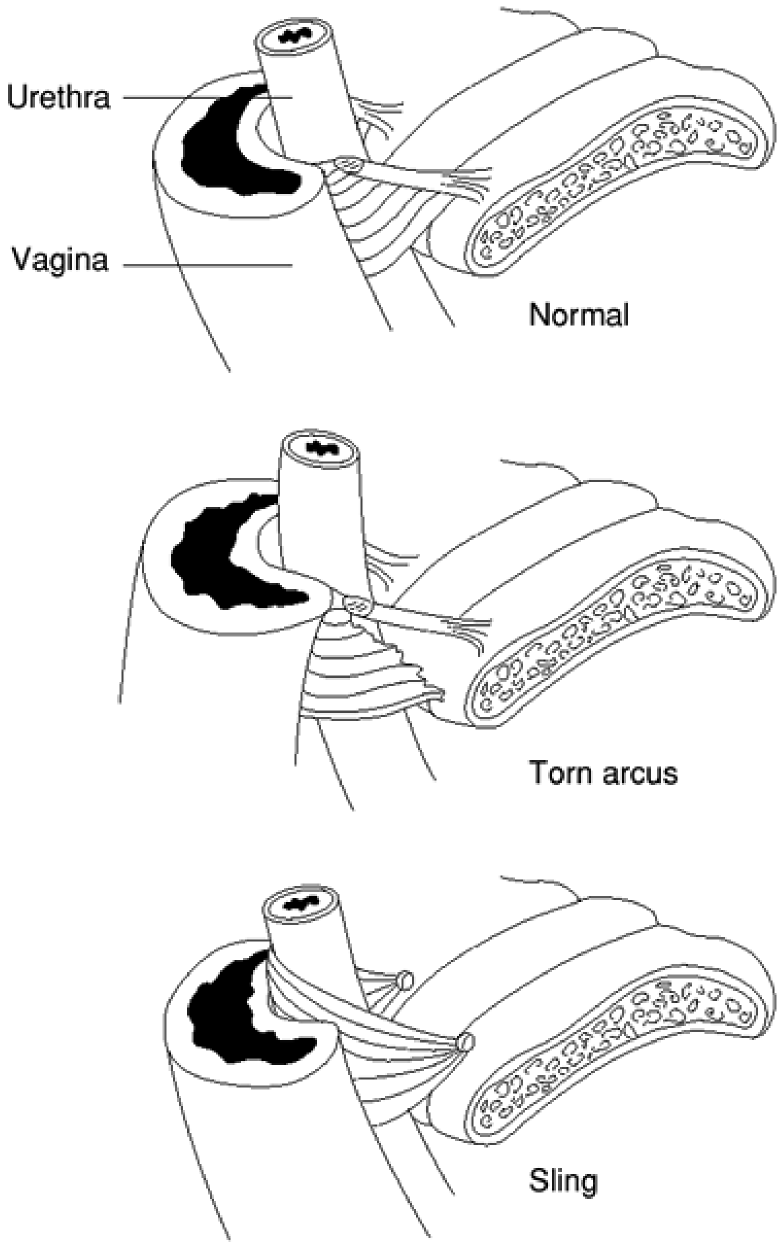


Figure 24A.4 The PBS sling was designed to correct the anatomic derangement of the midurethra by placing a midurethral sling attached to bone anchors at the anatomic site where ATFP inserts into the pubic bone.

Frederick et al. have published the largest series to date on osteitis pubis and osteomyelitis following transvaginal bone anchor fixation. In their combined experience and results from published studies of 1,228 cases, there was nearly a 2% (0.16%) incidence of osteitis pubis and almost a 1% (0.16%) incidence of osteomyelitis (16). The senior author developed the method for transvaginal fixation of bone anchors and placement of a midurethral sling in 1990 (17). He performed 2,016 procedures at three different academic institutions and never experienced a case of osteitis pubis or osteomyelitis. Therefore, future remarks by surgeons that this procedure is fraught with danger because of the risk of noninfectious or infectious disease of the pubic bone could be considered questionable.

Personal communication with the company (American Medical Systems, Minnetonka, MN) revealed that over 150,000 of these procedures have been performed since 1997. A 4-year report on the outcomes of the procedure was published before active marketing began, as recommended by the American Urological Panel in 1997. Long-term results (8 years) of the durability of this procedure were subsequently published in a cohort study of 105 patients with cure/dry/improved rates >98% (18).

Technique

Pubic Bone Sling

The anterior wall of the vagina is incised in the midline up to the posterior urethral fold. The vagina is retracted laterally with hooks that are secured to a Scots retractor (Lone Star Medical, Houston, TX). The vesicovaginal space is developed laterally so that the surgeon can palpate the arcus tendineus fascia as it courses from the ischial spine to its insertion into the posterior-inferior aspect of the pubic bone. A soft-tissue, 3-mm titanium screw attached to a no. 0 braided polyester suture is connected to an Infast device (American Medical Systems, Minnetonka, MN). The titanium screw is driven into the back of the pubic bone approximately 1 cm laterally to the lateral edge of the pubic symphysis pubis and approximately 1 cm posteriorly and superiorly from the inferior edge of the body of the pubis (Fig. 24A.5).

Figure 24A.5 Infast device for placing a 3-mm titanium screw into the back of the pubic bone.

A patch of Gynecare mesh (Gynecare, Summerville, NJ) or small intestinal submucosa (SIS) (Cook, Spencer, IN) approximately 2 Ã— 6 cm is sutured over the middle urethra. The sling is transfixed with no. 2-0 braided polyester Ethibond (Ethicon, Sommerville, NJ) sutures at its upper and lower borders to the paraurethral tissues, leaving a

troughlike space between the urethra and the mesh (Fig. 24A.6). These sutures prevent migration of the mesh from its midurethral position and also prevent elevation or overcorrection. The sutures of the bone screw are then attached to mesh by weaving the suture to the mesh (Fig. 24A.7). Then, the sutures are tied securely to the pubic bone. Tension to the sling does not need to be adjusted as the four transfixation sutures (Fig. 24A.8) provide a tension-free space between the mesh and the urethra, and prevent overcorrection by the mesh. Any anterior wall defects present are repaired as necessary. The vaginal wall is then closed. A Foley catheter is placed for overnight bladder drainage that is removed the following morning, and then the patient is encouraged to void spontaneously. The patient is taught self-catheterization to check for postvoid residuals and is discharged. Self-catheterization for postvoid residuals continues until residual volumes are less than 100 cc, which usually occurs by the second postoperative day.

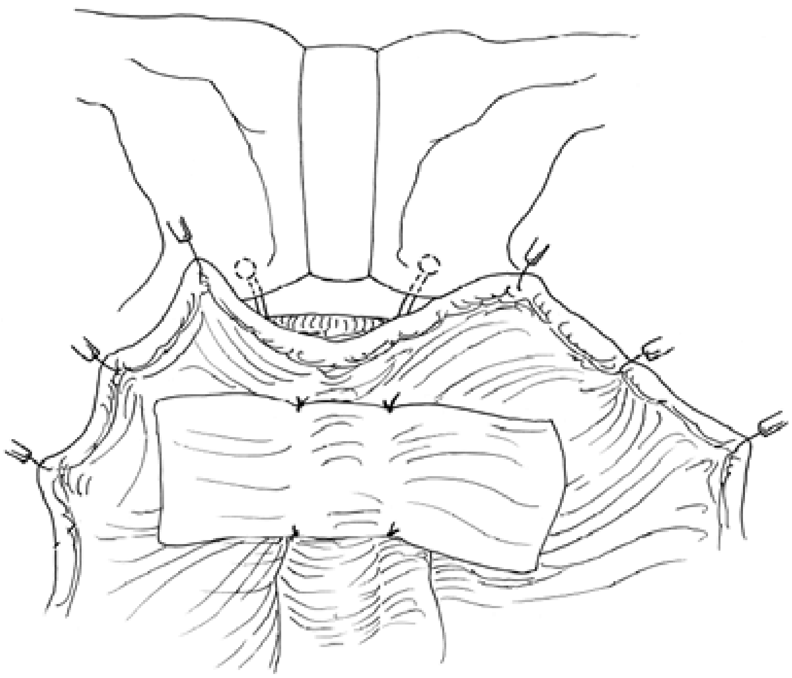


Figure 24A.6 Midurethral sling is positioned over midurethra and is transfixed with no. 2-0 Ethibond sutures to prevent migration of the sling.

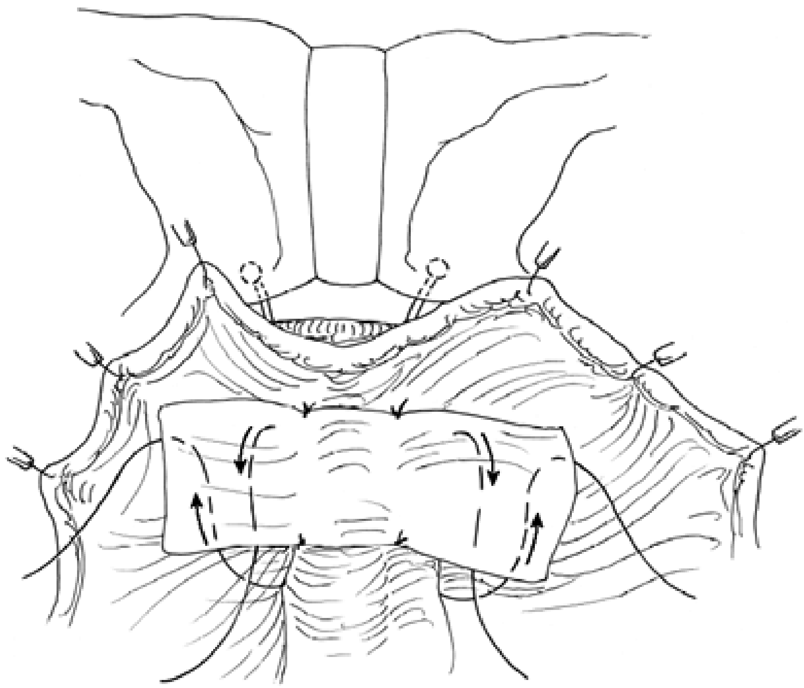


Figure 24A.7 Sutures attached to the bone screws are connected to the sling by weaving them into the sling in opposite directions. The sutures are tied securely to the pubic bone.

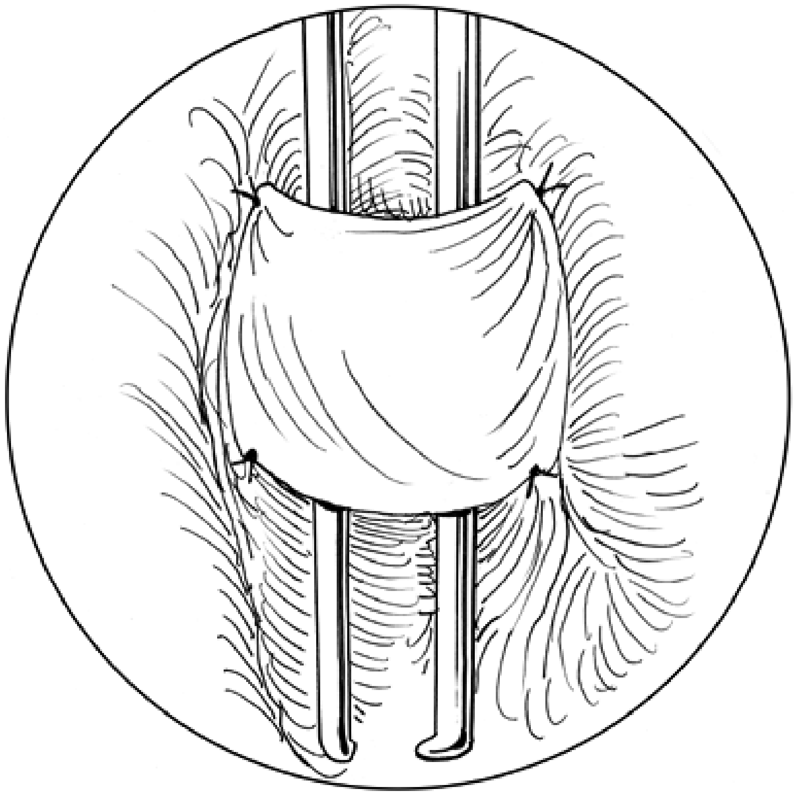


Figure 24A.8 Sling tension adjustment is unnecessary, as the four transfixation sutures prevent overcorrection or abnormal compression to the urethra. Placement of tissue forceps between the urethra and the sling is demonstrated after the sling as been tied to the bone screws. This is truly a tension-free sling, as the tissue forceps demonstrates. Other midurethral slings require the surgeon to place an instrument between the urethra and sling to prevent excess tension on the sling and prevent postoperative voiding dysfunction. The biomechanics of this sling prevent this concern.

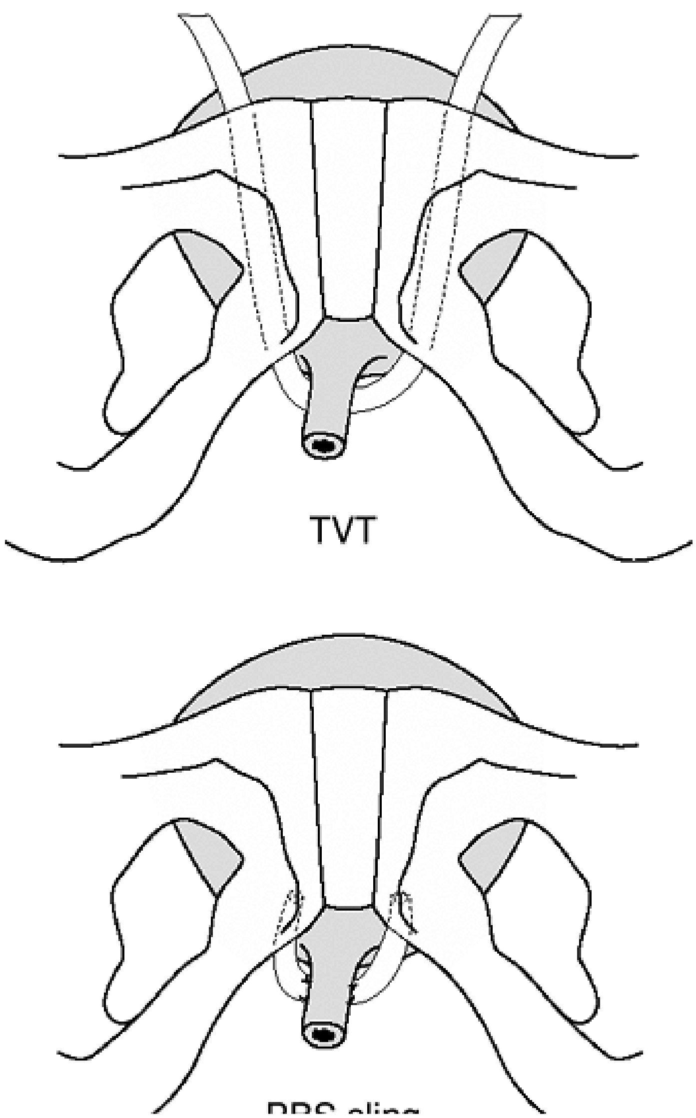
The senior author continues to teach and recommend the pubic bone sling with excellent results. In addition to the absence of osseous complications, there have been no deaths or bladder, bowel, or vascular injuries. There have also been no reports of urethral injuries or erosions of the sling material. Resumption of normal voiding usually occurs by the second postoperative day. The use of self-catheterization to check for postvoid residuals has resulted in a rapid return to normal voiding without urinary incontinence or voiding dysfunction. The durability of this procedure appears to be excellent, as over 90% of patients who underwent this operation 15 years ago are still continent and do not complain of voiding dysfunction.

To avoid the potential for osseous complications from any suburethral sling procedure, the following is used. The pH of the vagina is obtained in the operating room prior to prepping the patient. Vaginal pH has been reported to be the most sensitive of all the criteria for diagnosing bacterial vaginosis (BV) (19). Alkaline pH above 5.0 suggests an abnormal vaginal ecosystem. The syndrome BV is characterized by a disturbed vaginal microflora, in which the

normally occurring lactobacilli yield quantitatively to an overgrowth of anaerobic bacteria. This further suggests that the concentration of anaerobic bacteria in the vagina has reached levels of $>10^8$. Vaginal cuff and wound infections occurred more often when BV was present than when it was absent (20,21). Because prophylactic antibiotics are successful when the vaginal ecosystem is normal, it is necessary to employ therapeutic antibiotic coverage postoperatively in cases where the concentration of bacteria in the vagina is 10^8 or greater. The authors have used metronidazole (Watson) 500 mg orally twice daily starting on the second postoperative day for 5 to 7 days.

The use of bone anchors with suburethral slings placed through a perineal incision to treat men who have become incontinent following radical prostatectomy has been reported to be successful (22,23). The pubic bone sling is the only anti-incontinence operation currently available for both men and women. It is also an effective procedure to treat urethral intrinsic sphincter deficiency.

The wide use of retropubic TVT has been associated with various complications. To avoid these complications, alternative procedures have been developed and continence rates obtained with these new routes in order to compare with the TVT procedure. These slings use the obturator space for the passage of a midurethral sling from one obturator space to the other. The passage of tape is inserted through the obturator foramens from outside to inside or inside to outside while preserving an intact retropubic space. Overcorrection with the transobturator method is less likely than with the TVT procedure, and there appears to be a lower risk of bladder injury (24). Potential complications associated with tension-free procedures that employ needle-carrier placement through the retropubic space are eliminated, and routine cystoscopy is left to the discretion of the surgeon. However, operative cystotomy has been reported that questions this recommendation (25). This novel approach is rapidly performed, and recovery time is short. Short-term studies that appear to be as successful as the TVT are now available. Physicians performing newer techniques of midurethral sling placement, such as the PBS sling and the transobturator tape (TOT), have not reported on the severe complications, such as bowel and vascular injuries or death (26). However, the unique infectious complication of an abscess of the thigh has been reported after placement of the transobturator sling (27). Long-term studies of this new method are needed to determine the efficacy, potential complications, and application to a more complicated scenario, such as urethral intrinsic sphincter deficiency.



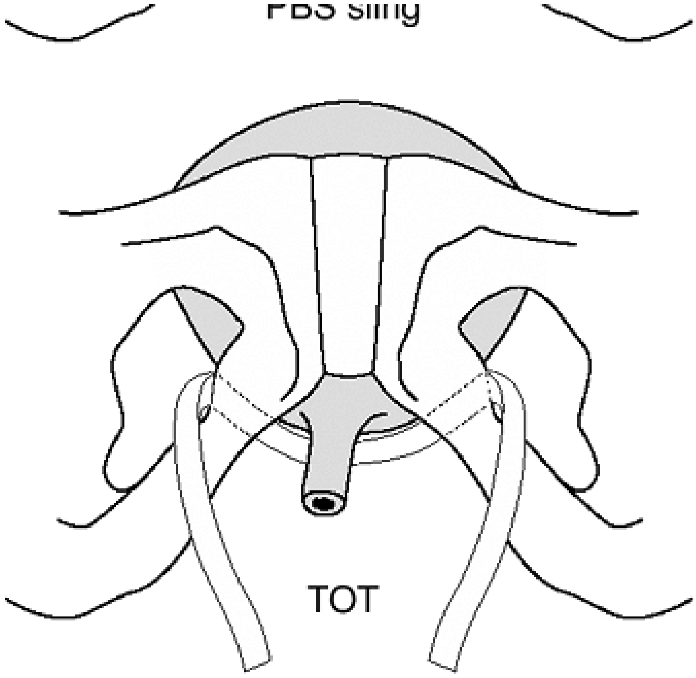


Figure 24A.9 *Differences of mid-urethral slings*. The TVT starts from an incision in the vagina, passes a large bore trochar from a retroperitoneal position into the intraperitoneal cavity, then moves out through the abdominal skin. The PBS sling starts and stays as a totally vaginal procedure and remains vaginal and retroperitoneal throughout the entire course of the operation. The TOT, depending on whether is begun as an outside-in or inside-out technique, requires a vaginal and skin incision and remains retroperitoneal throughout the procedure.

Transobturator Tape

After the vagina is prepared, a Foley catheter is inserted to empty the bladder completely. A 1.5-cm incision is made on the anterior vaginal wall at the junction of the middle and lower third of the urethra. Blunt dissection is performed between the anterior vaginal mucosa and vesicovaginal septum to the level of the ischiopubic ramus. A 5-mm vertical skin incision is made on the internal surface of the thigh by the level of clitoris and 1 cm beyond the ischiopubic ramus. Either a straight or curved tunneling introducer is inserted through the skin incision until it perforates the obturator membrane. The introducer is rotated medially, the index finger of the contralateral hand is placed into the vaginal incision for guidance, and the

tip of the introducer is brought out of the vaginal incision. The sling is attached to the introducer, then it is withdrawn and passed backward through the obturator foramen. The same operation is performed on the contralateral side. The sling tape is placed flat under the urethra, and the tension is adjusted to prevent overtensioning. No cystoscopy is required for this procedure; however, it is recommended to perform cystoscopy if a cystocele is associated. The patients are taught self-catheterization to measure postvoid residues. They usually are discharged on the same day or the day after surgery.

Conclusions

Female incontinence surgery for the 21st century appears to be headed toward the most minimally invasive surgical route for the treatment of SUI. This is the transvaginal route. Currently, the three transvaginal suburethral slings-TVT, PBS sling, and TOT-appear to offer the best methods to treat female stress urinary incontinence (Fig. 24A.9). The PBS sling and the TOT can be readily identified as the least invasive. The other approaches remain retroperitoneal, thus avoiding potential injury to intraperitoneal structures, while the TVT relies on perforation of the peritoneal cavity, which risks contact with other intraperitoneal structures.

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24B

Midurethral Slings: Tension-free Tape

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Mickey M. Karram

The first synthetic midurethral sling was introduced by Ulmsten in 1996 as the tension-free tape (TVT) (Gynecare, Johnson & Johnson, Somerville, NJ) (1). Prior to TVT, all treatments incontinence involved addressing the proximal urethra and bladder neck. In contrast, the T polypropylene mesh at the level of the midurethra. The sling is not sutured or fixed to any but remains in place because of an immediate reaction with the tissue at the level of the u diaphragm and anterior abdominal wall. The procedure has several advantages including a approach, outpatient treatment, local anesthesia, and short operating time. As of Septemb over 600,000 procedures have been performed worldwide (Gynecare, personal communicati

Development of Tensionfree Vaginal Tape and the Integral

DeLancey recently proposed the â€œhammock hypothesisâ€• to characterize the pathophys stress urinary incontinence (SUI). He described a supportive layer composed of endopelvic f anterior vaginal wall that the urethra lies upon. This layer is stabilized by the lateral attach the arcus tendineus fascia pelvis and levator ani muscle. Increases in urethral closure press cough result from compression against this â€œhammock-likeâ€• layer (2). Ulmsten suggest defects in pubourethral ligaments, the suburethral vaginal wall, pubococcygeus muscles, or paraurethral connective tissue are responsible for stress incontinence. The â€œurethral kn to the high-pressure zone of the urethra, is the main position of the pubourethral ligaments site of TVT positioning (3). The integral theory of TVT function states that the TVT improve strengthens the vaginal hammock, improves the function of the pubourethral ligaments, an the function of the levator ani muscles. (4).

Prudent selection of artificial graft materials is fundamental in ensuring proper incorporatio graft without erosion or infection. Mesh integration is based on inflammation, weave charac and implantation site. Pore size greater than 50 Âµm encourages incorporation, allows for angiogenesis, and permits infiltration by both bacteria and inflammatory cells, thus decreas infection (5). TVT mesh is composed of loosely woven, monofilament polypropylene that ma tissue ingrowth. The sling is initially encapsulated by a plastic sheath to reduce mechanical contamination. The material is placed under minimal tension, allowing for mobility of the b neck. Finally, the sling is not sutured but rather is held in place by friction around the tissue These factors contribute to the acceptability and function of TVT.

Anatomy

Unlike traditional sling procedures, the method of TVT placement involves minimal dissectic blind passage of a trocar through the retropubic space. Therefore, constant attention to the of the tip of the needle during passage and a thorough knowledge of the anatomy of the ret space, anterior abdominal wall, and periurethral area is necessary to avoid vascular or neur injury (Fig. 24B.1).

Studies have been performed to document proximity of TVT needles to the major vessels th encountered. Muir et al. examined 10 cadavers to report mean distances from the lateral m the TVT needle to the

medial edge of vessels in the anterior abdominal wall and retropubic space. The distance fr superficial epigastric was noted to be 3.9 cm, the inferior epigastric 3.9 cm, external iliac 4 obturator 3.2 cm. However, the range of distances included 0.9 to 6.7 cm (6). Similarly, Ab in a second cadaver study reported a mean distance of 4 cm from the obturator artery and v from the external iliac, and 4 cm from the internal iliac (7). Finally, a recent magnetic reso imaging (MRI) study reported mean distances from the left iliofemoral vessels to the midline and right at 5.7 cm. (8). From these studies, it is clear that if the needle is deviated lateral rotated, major vascular injury can easily occur.

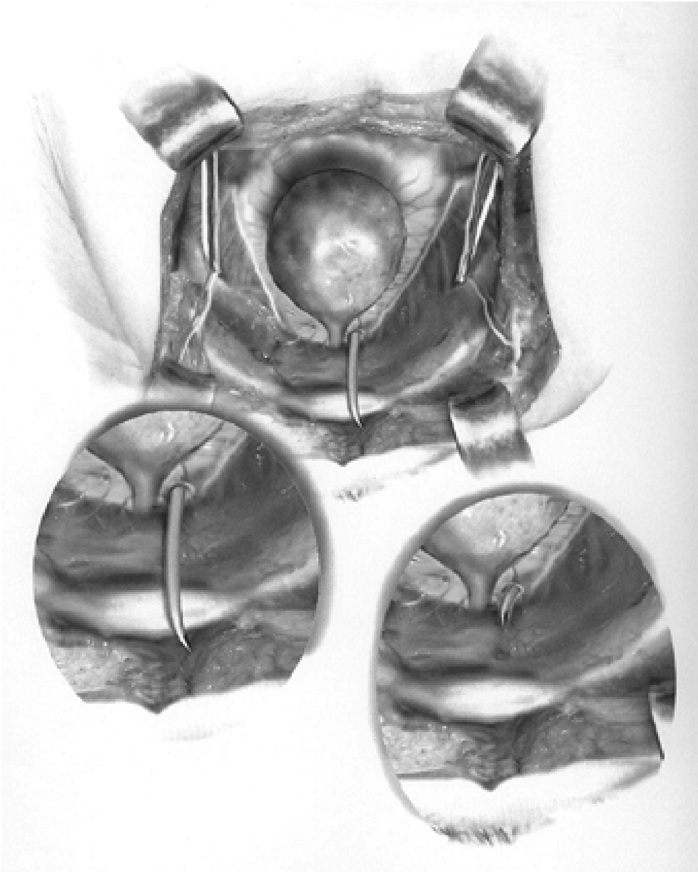

Figure 24B-1 *Passage of the TVT needle through the retropubic space* . Constant attention location of the needle tip during passage is necessary to avoid neurologic or vascular injury.

Technique

Patient Selection

Female patients with urodynamic stress incontinence who desire surgical correction are can the TVT procedure. All patients should undergo a thorough preoperative history and physica Important elements of the history include description of the severity of stress incontinence, anti-incontinence procedures, history of urgency or anticholinergic therapy, and other comc conditions. Examination should evaluate for atrophy, urethral hypermobility, and associatec The incontinence should be documented with use of a voiding diary, urodynamics, and pad t where appropriate. Contraindications to the procedure include an active urinary tract infec or anticoagulation (9).

As will be discussed in the results section of this chapter, patients with stress urinary incont

(SUI), intrinsic sphincter deficiency (ISD), mixed urinary incontinence, recurrent incontinenc incontinence associated with prolapse may be successfully treated with TVT (4 ,10 ,11 ,12 ,). However, because continence is provided by midurethral kinking with Valsalva, a hypermo urethra is more likely to be associated with a successful outcome (16). While initially descr technique under local anesthesia, the need for general anesthesia to perform concurrent va repairs is not a contraindication for TVT (17). Finally, a recent study showed no differences objective or subjective cure rates in women with body mass indexes (BMI) exceeding 30 com those with BMIs of 30 or less (18).

Surgery

Vaginal Approach

The patient is brought to the operating room, and either general, regional, or local anesthe sedation is administered. Broad-spectrum preoperative antibiotics such as cefazolin and ger should be utilized. The patient is positioned in the dorsal lithotomy position. The authors pr candy-cane stirrups for this. Patients should be in the horizontal or in slight Trendelenburg p displace bowel away from the pelvis.

The instrumentation required for the procedure includes 30 cc of local anesthetic such as li bupivacaine HCL, a 22-gauge needle for infiltration, a TVT kit that includes two 5-mm stainl needles connected by a 1.2-cm wide piece of polypropylene mesh, a nondisposable handle o introducer, an 18F Foley catheter, a catheter guide, and absorbable sutures to close the inc 24B.2).

Using a marking pen, the sites of the suprapubic stab incisions are outlined. The sites are lo the superior rim of the pubic bone, two finger-breadths lateral to the midline, and are appr 0.5- to 1-cm long. These should be well inside the pubic tubercle to avoid injury to the ilioir nerve (Fig. 24B.3). The two suprapubic puncture sites should be anesthetized with local an The authors prefer to use 1% lidocaine with epinephrine for this, 10 cc on each side. The inj should be taken down to the pubic bone to infiltrate the rectus fascia and muscle. Some sur inject into the retropubic space.

An 18F Foley catheter is placed and the bladder drained. A Sims or weighted speculum is pla vagina. Local anesthesia, 8 to 10 cc, should be infiltrated in the anterior vaginal wall to ach hydrodissection and

vasoconstriction. A 1.5-cm midline incision is then made at the midurethra. It may be helpfu
palpate the Foley bulb at the bladder neck to ensure the incision is appropriately placed. Ur
bladder neck, the anterior vaginal wall and posterior urethra are fused at the midurethra, a
no natural plane of dissection. Using Allis clamps to stabilize the vaginal mucosa, the tips of
Metzenbaum scissors are used to dissect the vaginal epithelium laterally in the direction of
ipsilateral shoulder to create a tunnel to the level of the inferior pubic ramus (Fig. 24B.4).
authors also prefer to mobilize the urethra off the posterior aspect of the vaginal incision us
dissection.

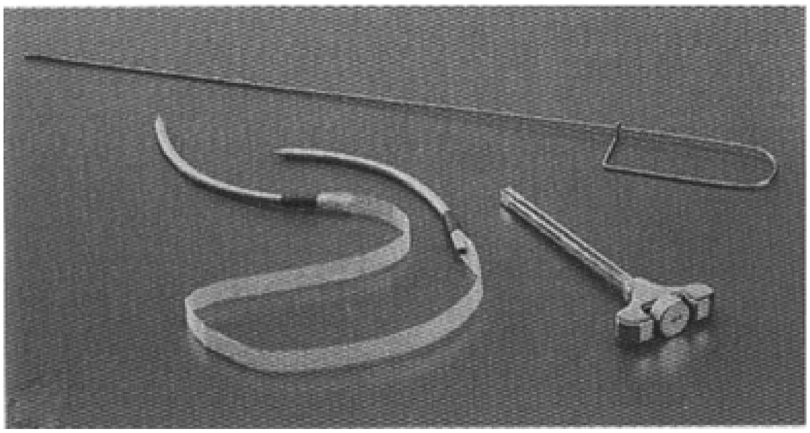

Figure 24B-2 Instrumentation for the TVT procedure. (From, Baggish MS, Karram MM. *Atlas of Pelvic Anatomy and Gynecologic Surgery* . Philadelphia: WB 2001 , with permission.)

Two stab incisions are made in the suprapubic region over the marked areas. The catheter g
passed down the 18F Foley catheter. The catheter guide is directed to the ipsilateral side of
placement to displace the urethra and bladder neck in the contralateral direction.

The TVT sling is made of a polypropylene mesh of approximately 40 Ã— 1.1 cm (19). The me
encased in a plastic sheath that overlaps at the midpoint, allowing for easy removal once th
place. The authors prefer to place a hemostat at the region of overlap to reduce slippage of
during placement. The TVT sling is attached to a 5-mm stainless steel needle that is then sc
the introducer or handle. The needle tip is placed in the vaginal tunnel that has been create
level of the inferior pubic ramus. The introducer should be held in the dominant hand while
of the nondominant hand stabilizes the needle and the index finger of the nondominant han
in the anterior vaginal fornix to ensure the vaginal mucosa is not perforated. While moving

catheter to the ipsilateral side, the needle is initially directed laterally toward the ipsilater shoulder, maintaining constant contact with the inferior pubic ramus. Once the needle pier the urogenital diaphragm, it is then redirected medially and vertically through the space of along the back of the symphysis. It then penetrates the rectus muscle and fascia and exits t suprapubic stab incision. While the needle is in place, the guide wire and catheter are remc cystoscopy performed to ensure no inadvertent bladder injury. Examination with a 70-degre cystoscope is performed in a standardized fashion. The bladder must be distended so that a penetration of the needle will be seen. When bladder integrity is confirmed, the introducer removed, and the needle is brought out through the abdominal incision. If a bladder perfora noted, the introducer and needle are backed out, the bladder drained, and the procedure r When perforations occur, they usually do so in a high, nondependent portion of the bladder reason, the authors do not routinely leave a catheter in place postoperatively if a single per noted; however, some surgeons may prefer to drain the bladder for 24 to 48 hours. The proc then repeated on the opposite side. Care is taken to ensure that the sling does not become prior to placement.

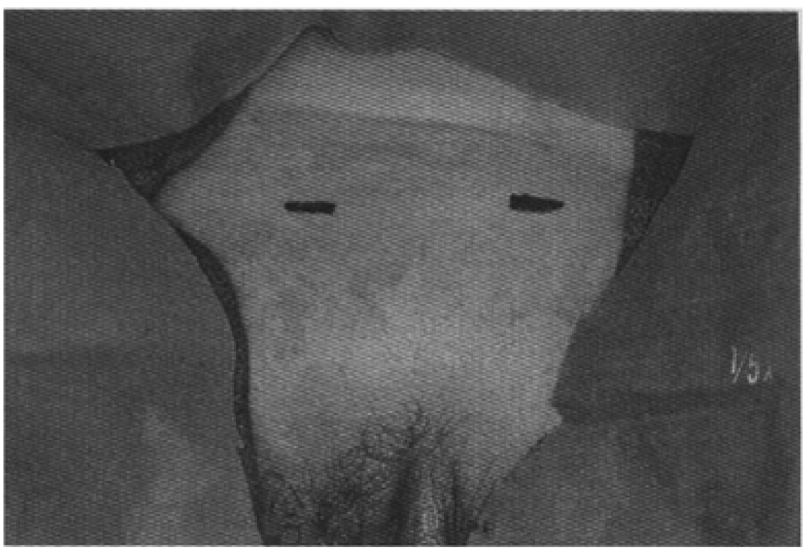

Figure 24B-3 Sites for the suprapubic incisions. (From,
Baggish MS, Karram MM. *Atlas of Pelvic Anatomy and Gynecologic Surgery* . Philadelphia: WE
2001
, with permission.)

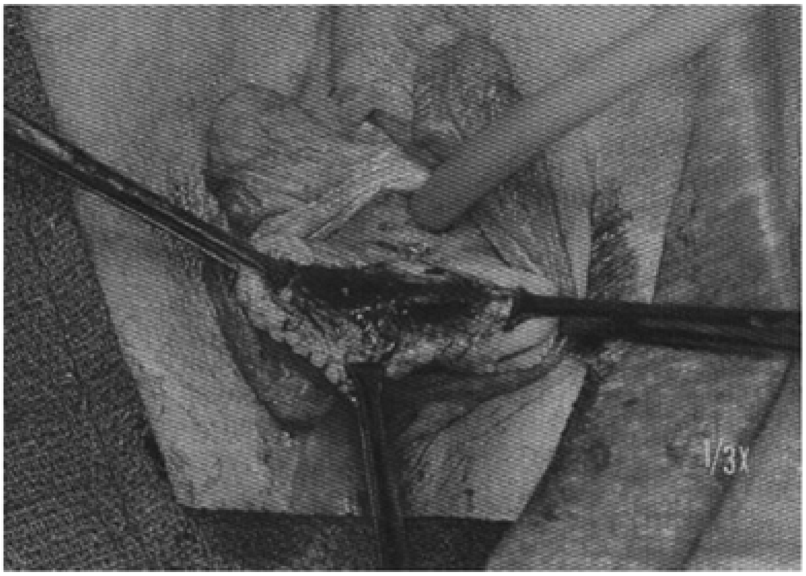

Figure 24B-4 A small midline incision is made at the midurethra. Mayo or Metzenbaum sciss utilized to create a tunnel to the level of the inferior pubic ramus. (From, Baggish MS, Karram MM. *Atlas of Pelvic Anatomy and Gynecologic Surgery* . Philadelphia: WE 2001 , with permission.)

The next step is to properly tension the sling to stabilize but not obstruct the urethra. The F tape and needles

on both sides have now passed through the suprapubic incisions (Fig. 24B.5). The needles a the tape, and Kelly clamps are placed at the sling ends. The sling is pulled to the urethra wi overlapping area at the midline. A Mayo scissors or right angle clamp is initially placed betw posterior urethra and the mesh. If the patient is under local or regional anesthesia, she may to cough or Valsalva. With the bladder full of 250 to 300 cc of fluid, the sling should be tigh that only a few drops of urinary leakage are seen. If the patient is under general anesthesia maneuver can be performed to simulate Valsalva (Fig. 24B.6). In general, the sling is left lo to easily allow the passage of a right angle clamp or scissors between the tape and the post urethra.

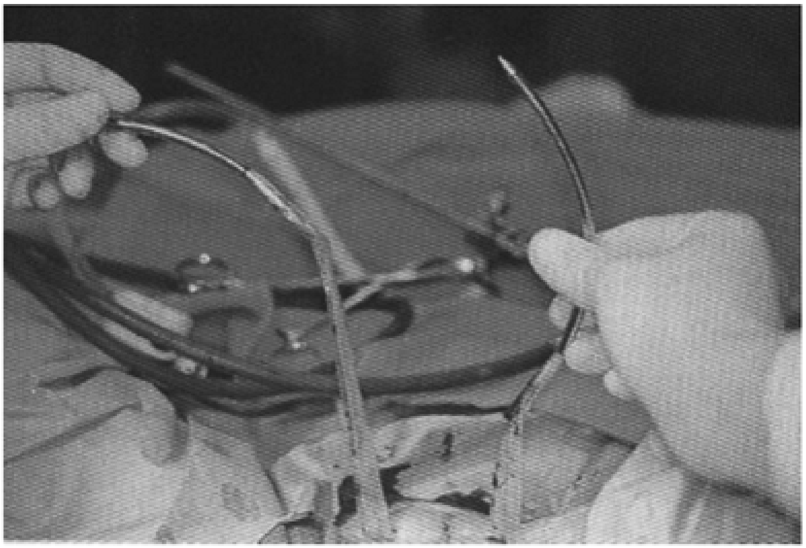

Figure 24B-5 TVT needles and the plastic sheath containing the Prolene tape have been pas
through the suprapubic incisions. (From,
Baggish MS, Karram MM. *Atlas of Pelvic Anatomy and Gynecologic Surgery* . Philadelphia: WE
2001
, with permission.)

Once the tensioning is secure, the sling sheath should be removed while stabilizing the tape
urethra. The tape is cut at the level of the skin, and the vaginal incision is closed using 3-0 (
absorbable sutures in a running fashion. The skin incisions are closed using 4-0 delayed abso
sutures, sterile strips, or a skin adhesive. The Foley catheter is then replaced in the bladder
patient taken to the recovery room.

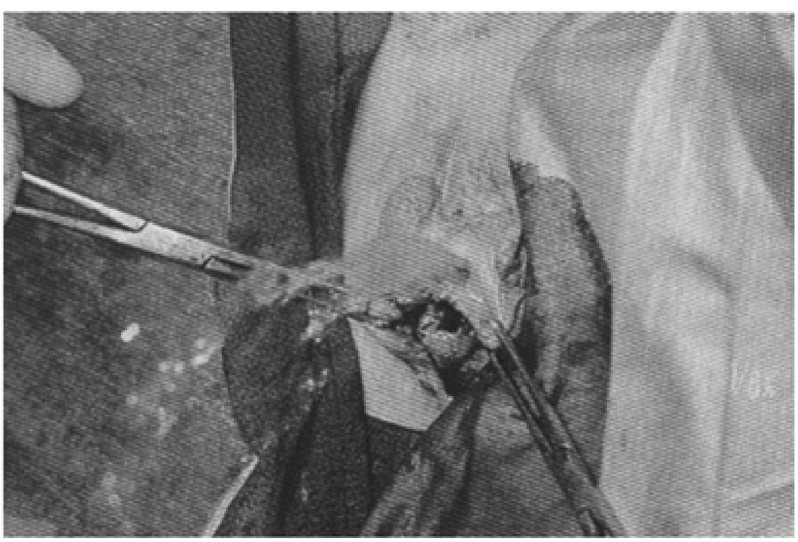

Figure 24B-6 The tape has been passed suprapubically on both sides. The demonstration of during a cough-stress test indicates the need to adjust the sling material. (From, Baggish MS, Karram MM. *Atlas of Pelvic Anatomy and Gynecologic Surgery* . Philadelphia: WE Saunders;2001
, with permission.)

Suprapubic Approach

The first suprapubic-approach sling was the SPARC system (American Medical Systems, Minn MN). This system involves passage of needles from the suprapubic incisions to the vaginal lo order to place a Prolene mesh at the midurethra. The purported benefit is that there is less passage of the needles, and the technique requires only one cystoscopic examination. A sim is available with the TVT-abdominal guide.

The positioning, infiltration, and dissection are performed as for the vaginal approach with of the vaginal tunnels, which must be large enough to permit the tip of an index finger to e level of the inferior pubic ramus.

The bladder is drained completely with the Foley catheter. The abdominal guide needle har grasped in the surgeon's dominant hand with the nondominant hand stabilizing the base of t The tip is placed in the suprapubic incision and advanced off the back of the pubic symphysi â€œpopâ€• is usually felt as the needle pierces the rectus fascia. After penetration of the r fascia, the nondominant hand is placed in the vaginal tunnel on the ipsilateral side of the n handle is then laid on the abdomen of the patient in a cephalad direction and the needle a while maintaining contact with the back of the symphysis. When the tip of the needle is felt index finger of the nondominant hand, the needle is passed through the urogenital diaphrag vaginal incision. The procedure is repeated on the opposite side, and with both needles in p cystoscopy is performed to confirm no evidence of bladder injury. Once this is determined, mechanism is used to connect the ends of the sling to the needle, which is withdrawn thus t the sling into the suprapubic incision. Tensioning is performed as previously described.

Postoperative Care

Patients who undergo the TVT procedure alone may be discharged on the day of surgery. Th protocol is to have the patient leave the operating room with a Foley catheter and have a v performed in the recovery area once the patient is awake. If the patient is able to successfu

two thirds of 300 cc sterile water, she is discharged without a catheter (20). Otherwise, th
is replaced, and the patient returns to the office within a few days for removal. All patients
oral pain medications, and patients who are sent home with a catheter

receive antibiotic prophylaxis. If patients have concurrent reconstructive surgery, a voiding
similar to the above is performed on the day of discharge.

Complications

Overall, complications with TVT are quite low. Potential complications include vascular inju
perforation, infection, erosion or extrusion, voiding dysfunction and bowel injury. A recent
no significant factors such as preoperative patient characteristics, anesthesia type, and surg
experience to predict complications with TVT other than patient age (21). However, others
reported high rates of bladder perforations (22%) and retention (20%) in the learning phase
patients) of TVT, suggesting reduced rates of complications in more experienced hands (22

Vascular Injury

Major vascular injuries have been reported in 44 (0.009%) of the first 500,000 episodes of T
(Gynecare, personal communication). Studies have reported rates of bleeding in 1.1% to 2.5
patients and hematomas in 1.7% to 1.9% of patients (23 ,24). Early bleeding may arise from
periurethral plexus of veins that drape down from the clitoris, the veins of Santorini that su
bladder, and aberrant veins in the retropubic space. Bleeding from these sites is usually self
with pressure or vaginal packing. More serious bleeding may arise from injury to the obturat
external iliac or inferior epigastric vessels. While uncommon, control of bleeding from these
require a laparotomy and repair. As stated previously, these vessels may be located approxi
5 cm away from the normal path of the needle (6). Postoperative hematomas generally are
conservatively (9).

Bladder Perforation

Most reports document bladder perforations in 4.9% to 5.8% of patients (23 ,24). This comp
more common in patients with a history of previous retropubic procedures. It is of utmost ir
that a perforation be detected at the time of trocar passage. Sites of perforation are comm
1 or 2 o'clock position on the left side of the bladder and in the 10 to 11 o'clock position on
detected, the needle is simply passed again, and the site will heal on its own. Some may pre
drain the bladder for 24 to 48 hours if a perforation occurs.

Infection

Vaginal wound infection is a rare complication of TVT due to properties of the sling. More co suprapubic cellulitis may develop at the site of the abdominal puncture wound. Managemen conservative therapy with oral antibiotics and close follow-up.

Erosion or Extrusion

TVT erosion or extrusion of the sling through the vaginal wall occurs infrequently (0.4% to 0.). This may be managed conservatively with observation or estrogen cream (23 ,25). Occasi excision of the tape and advancement of the vagina over the area is required. However, any involving the urinary tract (urethra, bladder) must be treated by removing the synthetic ma

De Novo Urgency, Obstruction, and Voiding Dysfunction

Voiding dysfunction may occur in 12% to 15% of patients following TVT (23 ,24). Symptoms i urgency and frequency requiring anticholinergics, partial obstruction resulting in a slow stre incomplete emptying, or complete retention. Several studies have been performed to evalu predict voiding function following TVT (26 ,27 ,28 ,29 ,30). Voiding studies postoperatively TVT reduces maximum flow rates and increases pressure transmission ratio but does not alte subjective voiding function (27 ,28 ,29). Voiding function appears to be worsened only by o and history of anti-incontinence or prolapse surgery (26).

Management of voiding dysfunction following TVT is controversial. Urethral dilation may or beneficial in loosening material below the urethra due to the elastic, stretchable nature of). If dilation is performed, it should be done in the immediate postoperative period, that is, first week of the procedure. One report noted a urethral erosion when dilatation was done weeks postoperatively (31). This most likely occurred secondary to the fact that the sling h scarred in place.

Other techniques for managing voiding dysfunction post-TVT involve a vaginal incision and l the sling with a right angle clamp or Metzenbaum scissors, or takedown of the sling (32 ,33) takedown is a simple procedure performed in the operating room with only a local anesthet midline incision is made with a scalpel over the site of the previous vaginal incision. Using t blade, the underlying layers are gently dissected in the midline until a gritty type of texture this is the Prolene mesh. The mesh is then isolated using a right angle clamp and is grasped Kocher clamps. The tape is cut in the middle and freed off the posterior urethra laterally. I

experience, if the lateral aspects of the tape are not mobilized adequately, voiding dysfunc
persist. TVT takedowns generally result in relief of complaints of outlet obstruction. In one
of patients remained stress continent after transection when followed for 6 weeks (33).

1
Ulmsten et al. (1)
1996
75
24
Prospective cohort
84, subjective
None
Initial report on TVT
2
Ulmsten et al. (48)
1998
131
12
Prospective multicenter
91, subjective
91, objective
Uncomplicated hematomas (2) Bladder perforation (1)
To determine the safety and efficacy in a variety of surgeonsâ€™ hands; six centers particip
3
Wang & Lo (45)
1998
70
3-18
Prospective cohort
83, objective
87, subjective
Bladder perforations (3) >200-cc blood loss (16%)
Epidural anesthesia utilized in all
4

Ulmsten et al. (47)

1999

50

36

Prospective open study

86, subjective

86, objective

Indwelling catheter for <12 days (10%)

â€”

5

Olsson & Kroon (34)

1991

51

36

Not stated

90, subjective

90, objective

Bladder perforation (1)

Ten with concurrent prolapse repair

6

Moran et al. (39)

2000

40

6-24

Prospective two-center study

80, subjective

95, objective

DO (15%)

Voiding dysfunction (5%)

7

Haab et al. (46)

2001

62

12
Prospective cohort
87, subjective
87, objective
Bladder perforations (6)
Forty-two with spinal and 20 with local anesthesia; continence results uninfluenced by anes
8
Niemczyk et al. (43)
2001
100
1-2
Prospective open study
85, subjective
Bladder perforations (24 [25%]); those with prior anti-incontinence procedure (12)
High rate of bladder perforation Fifty patients with preoperative urge symptoms: 68% resolv
9
Glavind & Larsen (41)
2001
31
3
Prospective cohort
87, subjective
100, objective
De novo DO (2)
Urethrovaginal fistula (1)
â€”
10
Meschia et al. (10)
2001
404
12-35
Prospective multicenter
92, subjective
90, objective

Bladder perforations (6%) Voiding dysfunction (4%) EBL >500 cc (0.5%)
Eighty-six with concurrent prolapse repair
11
Nilsson et al. (4)
2001
90
48-70
Prospective open study
85, subjective
85, objective
Retropubic hematomas (3)
Blood loss >200 cc (3)
Five-year outcome study Twenty-five patients with preoperative urge symptoms:56% improv
12
Rezapour et al. (13)
2001
49
36-60
Prospective open study
74, subjective
74, objective
Bladder perforation (1)
All patients with preop ISD (MUCP <20 cm H_2O)
13
Jeffry et al. (44)
2001
112
18-34
Retrospective
66, subjective
89, objective
De novo DO (26%)
Bladder injuries (13)
Low subjective cure may be due to high rate of postoperative urge symptoms

14
Rezapour & Ulmsten (12)
2001
80
36-60
Prospective open study
85, subjective
85, objective
Laparotomy for hematoma (1)
Of those cured/improved, urgency without incontinence at follow-up (25%)
All with mixed urinary incontinence
15
Nilsson & Kuuva (36)
2001
161
16
Prospective open study
87, subjective
87, objective
De novo DO (3%)
Bladder perforations (6)
Twenty-eight percent with preop recurrent incontinence, 37% with mixed incontinence, 11%
pressure urethra: No difference in cure for primary, recurrent, or mixed incontinence
16
Rezapour & Ulmsten (14)
2001
14
36-60
Prospective open study
82, subjective
82, objective
â€”
All with preop recurrent incontinence
17

Kunde & Varma (17)
2002
50
2-11
Prospective cohort
72, subjective
Sling removal (1)
All under general anesthesia
18
Moss et al. (42)
2002
320
6+
Retrospective multicenter chart review
92, subjective
Bladder perforations (13)
Operative success not reduced by previous surgery, patient weight >80 kg associated with po
outcome
Two hundred forty-five patients with documentation about postoperative voiding
19
Rardin et al. (37)
2002
245: 157 primary incontinence, 88 recurrent
27
Retrospective multicenter
85, subjective for recurrent
87, subjective for primary
Complication rates similar between groups: Bladder perforation (3%); erosion (1)
Comparison of primary versus recurrent incontinence, n = 88 with preop recurrent incontine
20
Perk et al. (40)
2003
25
24

Prospective cohort

80, subjective

Tape spontaneously dropped from vagina (1)

Small cohort size

21

Rafii et al. (18)

2003

187

6-36

Not stated

72â€“74, subjective

82â€“93, objective

Higher incidence of postoperative urge in those with BMI >30

Compared BMI <30 to >30 Thirty-eight with BMI >30, 149 <30

Sixty-nine with concurrent vaginal surgery

22

Lo et al. (15)

2003

58

12

Prospective cohort

91, objective

De novo DO (1)

All with coexisting prolapse repair

23

Ward & Hilton (53)

2004

344

24

Randomized controlled trial, TVT and Burch

TVT: 63, objective

Burch:51, objective

Strict objective criteria, all losses to follow-up counted as failure

24

Liapis et al. (49)

2004

37

22-30

Prospective cohort

73, subjective

73, objective

Bladder perforations (2)

All with preop MUCP <20 cm H_2O: 87% success in patients with hypermobile urethra, 14% wi
urethra

25

Liapis et al. (38)

2004

33

12â€“29

Prospective cohort

70, objective

Urinary retention (9%)

All with preop recurrent incontinence: 90% success with hypermobile urethra, 33% with fixe

26

Meltomaa et al. (11)

2004

150

36

Prospective two-cohort study, TVT with and without concurrent vaginal surgery

87â€“92, subjective

Complications and transient retention more common with concomitant vaginal surgery

Concomitant vaginal surgery in 75 patients; no difference in cure rates with vaginal surgery

27

Levin et al. (35)

2004

313

12-55

Prospective cohort, 241 patients for long-term follow-up
93, subjective
Bladder perforations (16 [5.1%])
De novo DO (20 [8%])
Concomitant vaginal prolapse surgery in 50%
28
Nilsson et al. (50)
2004
90
78â€“100
Prospective
81, objective
81, subjective
De novo DO (6%)
Recurrent UTI (7.5%)
Seven-year follow-up study; 64 women available for follow-up objective assessment, 16 by t
29
Paraiso et al. (54)
2004
72
12-43
Randomized prospective trial, two centers, TVT and laparoscopic Burch
TVT: 97, objective cure at 1 y Laparoscopic Burch: 81, objective cure at 1 y
TVT: Blood transfusion (1), cystotomy (2), takedowns for voiding dysfunction (2)
Burch: Bowel injury (1), laparotomy (3), postoperative ileus (1), pulmonary embolus (1)
Both groups significantly improved; TVT resulted in greater subjective and objective cure
30
Tseng et al. (52)
2005
62
24-30
Randomized controlled trial, TVT and SPARC
TVT: 87, objective SPARC: 81, objective
Bladder perforation (12% of SPARC, 0% TVT)

Retropubic hematoma on routine postoperative ultrasound (8)

No significant difference in outcome, bladder perforation rate may be related to inexperien

SPARC procedure

DO, detrusor overactivity; EBL, estimated blood loss; ISD, intrinsic sphincter deficiency; MU(maximum urethral closure pressure; TVT, tension-free vaginal tape; d, days; y, years.

Number	Author(s)	Year	Number of Patients	Follow-up (Months)	Study Design	Cure (%), Method	Complications (Number or Percent of Patients Affected)

Table 24B.1 Studies of the Tensionfree Vaginal Tape Proce

Bowel Injury

Bowel injury is a rare complication of TVT that may result from cephalad migration of the n during its passage. Another etiology may be bowel adhesions to the symphysis, which is mor in patients with a history of multiple surgeries or peritonitis. To reduce the risk of bowel pe the authors prefer to perform the TVT in a slight Trendelenburg position. When recognized, complication often involves laparotomy and repair. Of the seven reported deaths from TVT, associated with bowel perforations at the time of the surgery (Gynecare, personal communi

Results

Incontinence cure rates with TVT are high and range from 63% to 92% (Table 24B.1). Good s rates have been found for patients undergoing concurrent vaginal surgery, recurrent inconti mixed incontinence, and SUI (1 ,3 ,4 ,10 ,11 ,12 ,14 ,15 ,34 ,35 ,36 ,37 ,38). Results have b for patients with BMIs >30 or <30 and under local and general anesthesia (17 ,18). Factors a with poorer success rates include a fixed urethra or ISD (13 ,49).

Long-term data is available on the outcomes of TVT. Nilsson et al. reported on their results prospective three-center cohort study of 90 women who underwent TVT for primary stress incontinence at 5 and 7 years postoperatively (4 ,50). After 5 years, they reported objectiv subjective cure rates of 85% (4). These rates decreased slightly by 7 years but still remainec 81% (50). Of those not cured, 16% were improved, and failure was documented in 2.5%. Cor included De novo detrusor overactivity in 6.3% and recurrent UTI in 7.5%. There were no voi difficulties or tape rejection (50). While these two papers comment on a relatively small gr subjects, they nevertheless provide reassurance that effects of TVT may be durable over sev

Randomized Trials

There are few trials comparing TVT or slings in general with other surgical treatments for st incontinence (51). One recent paper reported results of a randomized trial comparing TVT in 62 women (52). In this study, there were no significant differences in cure rates betweer procedures at a median follow-up of 25 months.

Ward and Hilton performed a prospective randomized trial comparing TVT with open colpos for stress incontinence in a large group of women (53). They found that after 2 years of foll TVT was as effective as colposuspension. Another group evaluated TVT compared with lapar Burch colposuspension. After a mean follow-up of 20.6 months, the TVT resulted in greater and subjective cure rates (54).

Based on the above findings, it appears that TVT is a highly effective procedure for treatme However, until longer-term data comparing TVT with Burch is available, many still feel that Burch procedure should be offered as the gold standard therapy for stress incontinence (55

Quality-of-Life Studies

While most studies demonstrate objective improvement in urinary incontinence with TVT, p satisfaction and quality of life are also important variables to be assessed. Vassallo et al. pe prospective study using two validated quality-of-life instruments. One hundred fifty-one pat studied, and significant improvements were noted in both the IIQ-7 and UDI-6 from preopera (56). Another study reported similar improvements in quality of life in women greater than compared with younger age groups (57).

Subjective improvement may be related to surgical technique. Recently, Murphy et al. publ findings of 104 women undergoing the TVT procedure alone with either local or general ane Greater improvements were noted in postoperative Urogenital Distress Inventory (UDI)-Stres scores in the local group compared with the general group (58). They concluded that the cc test may be the factor responsible for these significantly higher scores.

Pain with the TVT procedure is an important contributor to patient satisfaction, especially s procedure may be performed under local anesthesia. Schatz and Henriksson evaluated pain 110 women and found that in virtually all cases, local anesthesia was well tolerated and acc Most patients without prolapse repair may be discharged from the hospital on the day of the (59).

Cost Effectiveness

A recent systematic review was performed comparing cost effectiveness of TVT for treatme incontinence with other surgical procedures. TVT was associated with overall lower mean co colposuspension or traditional slings at 5 years of follow-up and the same or more quality-ad years (QALY) (60).

Conclusion

The TVT midurethral sling is still perceived as a relatively new surgical treatment for SUI. In more data has been published on this procedure than retropubic suspensions or traditional p slings. Due to minimal surgical time, reduced costs, and comparable success rates, syntheti midurethral slings are quickly becoming

the most common surgical intervention for SUI. However, it is important to note that to dat proven synthetic midurethral sling is the TVT procedure as described by Ulmsten (3). As lon data become available on the durability of TVT, it is possible that this procedure may suppla other surgical treatments for SUI.

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26

Hemorrhoids and Incontinence

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Hemorrhoids

Hemorrhoids have been chronicled throughout ages. During the Middle Ages, hemorrhoids were synonymous with St. Fiacre's curse (1). St. Fiacre, known as the patron saint of gardeners (and hemorrhoid sufferers), miraculously cured his own prolapsed hemorrhoids while sitting on a stone during prayer. St. Fiacre's stone, still bearing the imprint from his hemorrhoids, is visited today by those desiring relief from hemorrhoidal symptoms. Other audacious treatment regimens described include the famous red hot poker of Maimonides (2) (Fig. 26.1). Currently, symptoms related to hemorrhoids affect approximately 10 million Americans, which is nearly 5% of the population (3). The incidence of this complaint is increased during pregnancy and puerperium, when nearly 35% of women will have a hemorrhoidal symptom (4). Unfortunately, the etiology and pathophysiology of hemorrhoids are poorly understood by both the general public and health care professionals.

Pathogenesis

The lumen of the anal canal is lined by three connective tissue cushions containing a venous plexus that is fed by arteriovenous communications from the terminal branches of the superior rectal arteries to the superior, inferior, and middle rectal veins. The cushions are suspended in the canal by a fine connective tissue framework derived from the internal anal sphincter and longitudinal muscle. These structures appear consistently in the right anterior, right posterior, and left lateral positions. They engorge selectively with an increase in intra-abdominal pressure to ensure fine continence as they comfortably plug the anal canal. They contribute to approximately 15% to 20% of the resting anal pressure (5).

Engorgement of these vascular cushions beyond that required for closure of the anal canal causes subsequent dilation of the plexus and venous stasis. Friability and fragmentation of the connective tissue supporting these cushions leads to their descent. This can occur with age, pregnancy, or passage of hard stools. None of these has been rigorously proven, although 0.2% of pregnant women require urgent hemorrhoidectomy for incarcerated prolapsed hemorrhoids (6).

Symptoms

For many patients, â€œhemorrhoidsâ€• are the culprits for any anorectal condition or symptom. Although hemorrhoids are usually the cause of bleeding, protrusion, itching, and even pain in the anal canal, their diagnosis should be one of exclusion, because more sinister anorectal conditions can imitate a similar symptom complex. Pain associated with a painful lump is a hallmark of a thrombosed external hemorrhoid but can also be seen with malignancy, abscess, or fissure. Anorectal pain in the absence of a visible lump is not likely to be attributable to hemorrhoids. Prolapsed rectal mucosa often produces mucus, and its deposition on the anoderm may cause itchiness and discomfort. If incarceration or irreducible prolapse occurs, strangulation may follow. These patients present with severe pain and bleeding, and occasionally with signs of systemic illness.

The most common presenting symptom of hemorrhoids is bleeding. The blood is typically bright red due to the high oxygen tension caused by the arteriovenous communications within the anal cushions (7). Blood may be visualized on the tissue paper after wiping or be seen dripping in the toilet bowl. Dark blood and blood mixed with stool are rarely associated with hemorrhoids and suggest a more proximal source of bleeding. Hemorrhoids alone do not

cause occult rectal bleeding and are infrequently associated with anemia (8).

Figure 26.1 Hemorrhoid surgery in the 12th century.

Evaluation

The evaluation of a patient with â€œhemorrhoidsâ€• should begin with an assessment of the severity of symptoms. The quantity and frequency of bleeding as well as the presence, timing, and reducibility of prolapsed tissue should be elicited to help classify the extent of the hemorrhoids and dictate therapeutic options. A thorough anorectal exam is indicated to exclude other pathology, such as pruritis ani, dermatitis, anal fistula, or condyloma acuminata. Anal fissure is best seen with eversion of the anal canal by opposing traction with the thumbs. External thrombosed hemorrhoids, skin tags, and prolapsed internal hemorrhoids also can be seen this way. Internal hemorrhoids and the associated rectal mucosal prolapse are best seen through an anoscope with an adequate light source.

Although rectal bleeding is a common manifestation of hemorrhoidal disease, the clinician assessment of the origin of hematochezia is notoriously inaccurate. For this reason, the Practice Parameters for Management of Hemorrhoids devised by the American Society of Colon and Rectal Surgeons (ASCRS) as well as the Medical Position

Statement from the American Gastroenterological Association (AGA) advocate a minimum of anoscopy and/or flexible sigmoidoscopy for bright red rectal bleeding (2,9). For the patient with a family history of colon cancer, anemia, or guaiac positive stools, an adequate work-up should also include a colonoscopy.

Classification of Hemorrhoids

Hemorrhoidal cushions below the dentate line are covered by modified squamous epithelium, lie outside the anal verge, and are called *external hemorrhoids*. Unless thrombosed, these usually do not cause any symptoms other than those associated with the difficulties of anal hygiene. The hemorrhoidal cushions above the dentate line are internal hemorrhoids. These are covered with mucosa and are classified as to the degree of bleeding and prolapse described by the patient or observed by the physician (Table 26.1). This grading system was published in 1985 by Banov et al. and is used by colorectal surgeons in selecting the optimal treatment for the patient (10).

Table 26.1 Classification of Internal Hemorrhoids

Grade	Physical Exam
I	Prominent hemorrhoidal vessels, no prolapse
II	Prolapse with straining, spontaneous reduction
III	Prolapse with straining, easy manual reduction
IV	Chronic prolapse, ineffective manual reduction

From Banov L Jr, Knoepp LF Jr, Erdman LH, et al. Management of hemorrhoidal disease. *J S C Med Assoc.* 1985;81:398â€“401, with permission.

Grade I internal hemorrhoids are simply prominent hemorrhoidal vessels. Grade II hemorrhoids protrude below the dental line on straining but reduce spontaneously. This is usually associated with mild discomfort and bleeding. Grade III internal hemorrhoids protrude beyond the anal verge with straining and require manual reduction to return to the anal canal. These are the hemorrhoids that are typically treated with surgery because of their associated symptoms of mucus discharge, pruritis, bleeding, and discomfort. Finally, Grade IV internal hemorrhoids lie permanently beyond the anal verge, and manual reduction is ineffective in returning them to their normal anatomical positions. Pain, bleeding, thrombosis, and strangulation are frequent complaints for which surgical referral is mandatory.

Medical Treatment

Dietary management consisting of adequate fluid and fiber intake is the primary noninvasive treatment for symptomatic hemorrhoids. For the patient whose main complaint is bleeding, avoidance of straining is safely managed by fiber supplementation such as psyllium (11,12). Psyllium, in combination with water, adds moisture to stool and helps to improve constipation. One double-blind, placebo-controlled trial in 52 patients with symptomatic hemorrhoidal disease found that fiber (psyllium seed) significantly reduced bleeding when compared with placebo; 92% versus 56%, respectively. In this study, pain with defecation was likewise reduced with fiber supplements, demonstrating response rates of 96% versus 68%. Reduction in pruritis and prolapse was noted but failed to reach statistical significance (13).

Several randomized controlled trials have studied the use of micronized purified flavonoids fraction (MPFF) (Daflon; Servier Laboratories, Neuily-Sur Seine, France) for the control of rectal bleeding in Grades I and II hemorrhoids. Flavonoids are derived from citrus fruits and have been shown to increase venous tone and normalize capillary permeability. Improvement of rectal bleeding has been demonstrated with use of MPFF; however, a study comparing MPFF with fiber alone found equivalent responses at 14 days (14,15). MPFF has not been approved for use by the U.S. Food and Drug Administration (16).

Topical analgesics and anti-inflammatory agents, although poorly studied, have ubiquitously been prescribed for symptomatic relief of local pain and itching secondary to hemorrhoids. In a single prospective study, application of nitroglycerin ointment demonstrated relief of pain due to thrombosed external hemorrhoids, presumably by decreasing anal tone (17). Similarly, a double-blind, placebo-controlled trial of 5-aminosalicylic (5-ASA) suppositories demonstrated significant reduction in hemorrhoidal symptoms among patients treated (18). Analogous to fiber supplements, topical therapy has few side effects and is generally safe. Long-term use of topical steroids should be discouraged, however, because of their potential for chronic perianal dermatitis.

Office Treatment

The office setting is an excellent option for the treatment of hemorrhoids that are refractory to medications alone or have a component of mucosal prolapse. Several available treatments achieve the goal of ablation of bleeding or redundant mucosa by coagulation, thrombosis, sclerosis, or necrosis with an associated fixation of the hemorrhoidal cushion by scarring. Though the choices abound, rubber band ligation is recommended because of its effectiveness and low probability of recurrence.

Rubber Band Ligation

Blaisdell was the first to describe ligation of internal hemorrhoids in 1958. In 1963, Barron modified the procedure using rubber bands, which serves as the basis of present-day ligation. Rubber band ligation is most commonly used for Grade I, II, and III hemorrhoids, and its safety and efficacy has been documented by numerous authors (19,20,21). The origin of the hemorrhoidal tissue is confirmed with anoscopy. A special applicator then allows the clinician to tightly encircle the redundant mucosa, connective tissue, and blood vessels in the hemorrhoidal complex (Fig. 26.2). This encirclement must be well above the dentate line, away from the somatic sensory nerve afferents. The mucosa will eventually necrose and slough, whereas the resulting scar will fix the connective tissue to the rectal wall. Most authorities prefer to limit treatment to one or two columns at a time. The most common complication following rubber band ligation is pain, reported in 5% to 60% of treated patients (19,21). Severe bleeding occasionally requires intervention when the eschar from the band sloughs, but this occurs in less than 5% of patients (22-26).

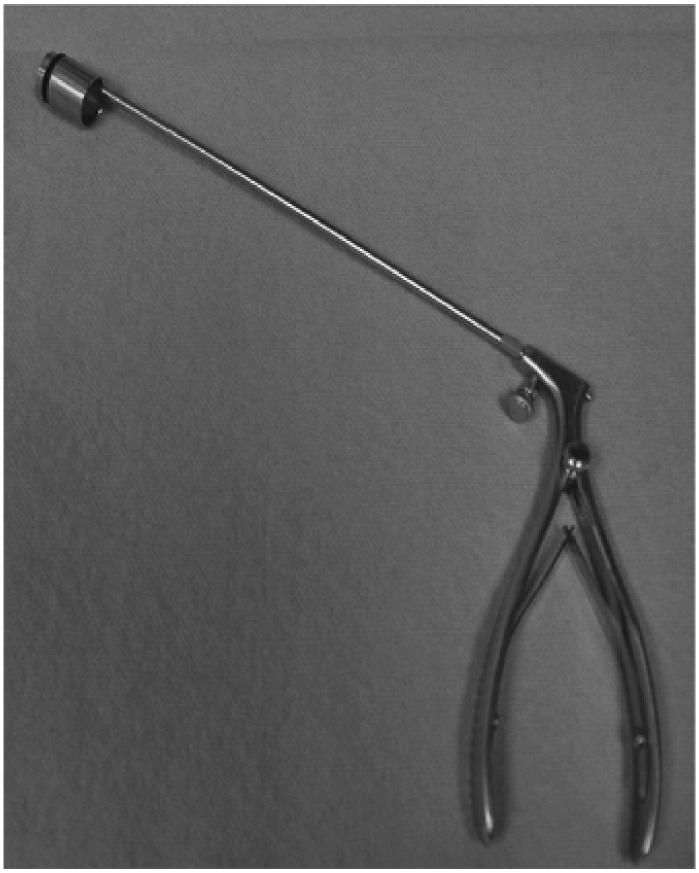

Figure 26.2 Barron Ligator

Infrared Coagulation

In 1979, Neiger described a method for the treatment of hemorrhoids using infrared coagulation (IRC). Infrared light, delivered via a special polymer probe tip connected to a tungsten-halogen light, is applied to the base of the hemorrhoidal tissue, causing protein coagulation and subsequent scarring. According to two randomized studies, hemorrhoidal bleeding was controlled in 67% to 96% of patients with Grade I and Grade II hemorrhoids with minimal complications (20,21).

A randomized controlled trial of 133 consecutive patients comparing rubber band ligation with infrared coagulation found that the patients treated with rubber bands had a 97% improvement in their symptoms versus 92% of the patients treated with IRC.

This study showed no difference in the long-term effects of the two modalities (23). However, a meta-analysis by MacRae and McLeod comparing rubber band ligation with other office procedures concluded that rubber band ligation and IRC were more effective than sclerotherapy in the treatment of hemorrhoids, but patients treated with rubber band ligation had less need for retreatment (24). When compared with rubber band ligation, IRC is more expensive, requires additional equipment, and is likely to require additional therapy due to a higher incidence of hemorrhoid recurrence.

Sclerotherapy

First described in 1869 by Dublin, this oldest form of nonoperative treatment relies on scarring and fixation of mucosa via injection of a variety of caustic solutions such as 5% phenol in almond oil, 5% sodium morrhuate, 5% quinine, and urea into the submucosa of the base of the hemorrhoidal complex. Experience is required to ensure the correct depth of injection, characterized by a typical swelling of the mucosa. The treatment must be reserved for first- and Grade II hemorrhoids that have not responded to fiber supplementation. Sclerotherapy has been found to be effective in 75% to 89% of patients and is associated with slightly less pain than hemorrhoidal banding (25). The recurrence rate after sclerotherapy is approximately 30% at 4 years (26).

Cryotherapy

Cryotherapy was abandoned after Smith et al. performed a trial comparing cryotherapy with closed hemorrhoidectomy on different hemorrhoids in the same patient (27). They found that the cryotherapy site was associated with prolonged pain, foul-smelling discharge, and a significant need for additional therapy.

Surgery

The decision to proceed to surgery must be reached via consensus of the surgeon and the patient, and is based on a variety of factors. It is advised in less than 10% of the patients referred to a specialist for treatment (28). Surgery is usually recommended for symptomatic Grade III hemorrhoids that do not respond to banding and for Grade IV hemorrhoids. Only the symptomatic hemorrhoid cushion is excised, thus conserving anoderm for continence and decreasing the risk of postoperative anal stenosis.

Hemorrhoidectomy can be performed using a variety of techniques, and the choice often depends on the surgeon's preference and training. American-trained surgeons will more frequently offer a Ferguson â€œclosedâ€• hemorrhoidectomy. In this procedure, the hemorrhoidal cushion and the overlying anoderm is excised with care to avoid any injury to the internal sphincter. The pedicle of the hemorrhoidal complex with the feeding blood vessel is ligated, and the anoderm is then closed with a resorbable suture (Fig. 26.3). The technique is believed to be associated with less postoperative pain and a lower rate of anal strictures. In the United Kingdom (UK), a patient is more likely to receive a Milligan-Morgan hemorrhoidectomy. In this operation, after the excision of the hemorrhoidal complex is performed, the anoderm is allowed to heal primarily in 4 to 8 weeks. Advocates of this open technique believe that the procedure decreases the risk of postoperative infections. Interestingly, several randomized controlled studies comparing both of these techniques found no significant difference in the rates of healing or postoperative pain between the two groups (29,30,31).

A new procedure being offered selectively to patients with Grade III and IV internal hemorrhoids is the circular stapled hemorrhoidectomy. Proposed in 1998 by Longo, this procedure only addresses the problem of internal hemorrhoid prolapse and goes by a variety of names: stapled anopexy, prolapsectomy, circumferential mucosectomy, and procedure for prolapsing hemorrhoids (PPH) (32). This technique involves transanal placement of a circular purse-string suture 4 cm above the dentate line (Fig. 26.4). A 33-mm stapler is inserted into the anal canal, and a circumferential excision of the distal rectal mucosa is performed. This repositions the prolapsing hemorrhoidal cushions above the dentate line and accomplishes this goal by avoiding a cutaneous incision. Not surprisingly, the technique has been shown to be associated with decreased postoperative pain and a more rapid return to normal activities (33,34,35,36).

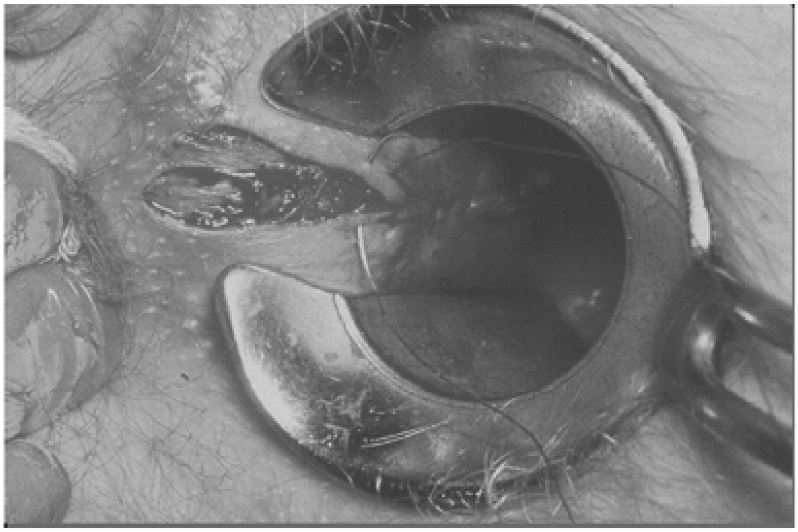

Figure 26.3 Closure of anoderm in a Ferguson â€œclosedâ€• hemorrhoidectomy.

Figure 26.4 Insertion of purse-string suture during stapled hemorrhoidectomy.

Experts have been reluctant to embrace this procedure because of reports of chronic anal pain and fecal urgency (37). Other reported serious complications include rectal perforation and retroperitoneal and pelvic sepsis (38,39,40).

The reoperation rate was found to be 11% in an experienced center. Necessary interventions included excisional hemorrhoidectomy, removal of staples, fissurectomy, and lateral internal sphincterotomy (41). Fragmentation of the internal sphincter has occurred in 14% of the patients in one study, but the rates of anal incontinence remain unknown (42).

Figure 26.5 Thrombosed external hemorrhoids.

Special Considerations

Thrombosed External Hemorrhoids

Acute thrombosis of external hemorrhoids is characterized by severe and persistent pain and swelling in the perianal area. Occasionally, the thrombus ulcerates through the skin, and bleeding ensues (Fig. 26.5).

Nonsurgical treatment, including fiber supplementation or stool softeners, oral analgesics, topical lidocaine ointment, and warm baths, is usually sufficient. Addition of nifedipine ointment to this regimen was associated with a higher likelihood of symptom resolution within 7 days and a more complete resolution of the hemorrhoid itself by 14 days (28). Surgical excision of a symptomatic thrombosed hemorrhoid results in even more rapid symptom resolution, lower incidence of recurrence, and longer remission intervals.

A study of 231 patients with thrombosed external hemorrhoids by Greenspon et al. demonstrated that the time to symptom resolution was 24 days for patients treated conservatively versus 3.9 days for surgical patients (43). Current guidelines recommend local excision of thrombosed hemorrhoids for patients who present within 48 hours after onset of their symptoms. This usually can be accomplished in an office setting. Patients with symptoms over 72 hours can be managed conservatively if pain is abating (2).

Hemorrhoids in Pregnancy and Puerperium

Perianal problems are common in late pregnancy and after delivery. A French study published in 2002 followed 165 pregnant women prospectively. Nine percent had a thrombosed external hemorrhoid or fissure in late pregnancy, and 35% had hemorrhoidal problems after labor and delivery (44). For pregnant women, both internal and thrombosed external hemorrhoids should be managed conservatively until the fetus is viable. Afterward, surgical excision may be safely performed under local anesthesia. Using a stapled hemorrhoidectomy is not recommended for these patients.

Incontinence

Anal incontinence is defined as the inability to control the passage of flatus, liquid, or solid stool, with severity ranging from mild difficulty with gas control to complete loss of control over liquid and formed stools. The true incidence of anal incontinence is unknown, although extreme variations in prevalence rates (1.4% to 18%) have been reported by community-based studies (45,46). Certain subpopulations, including parous women, the elderly, institutionalized patients, and patients with neurological disorders, consistently have higher rates.

Etiology

Normal anal continence is dependent on the interaction of multiple factors, including cognitive function, sphincter mechanism, neurological function, rectal capacity and sensation, colonic transit, and stool consistency. Consequently, thorough knowledge of these integral relationships is necessary for any clinician who prescribes treatment options for incontinence.

The internal sphincter is an involuntary muscle in continuity with the circular fibers of the rectum. It receives sympathetic and parasympathetic innervation by the hypogastric plexus and S1-3, respectively, and is responsible for approximately 80% of the normal resting tone of the anus. When the rectum becomes distended with air or stool, the normal reflex response is a transient relaxation of the internal sphincter, called the *rectoanal inhibitory reflex* (RAIR) or *sampling reflex*. The external anal sphincter responds by voluntary contraction to maintain anal continence. Its primary innervation is by way of the pudendal nerve, and although it contributes to resting anal tone, the external sphincter is predominantly responsible for squeeze pressure.

Direct damage to both sphincters most commonly occurs during childbirth. Most obstetric-related sphincter injuries are occult; whereas, a third of first vaginal deliveries result in sphincter damage, confirmed by endoanal ultrasound. Approximately 33% of these structural defects are associated with new symptoms of incontinence. Direct sphincter injury also occurs after anorectal operations such as fistulotomy and hemorrhoidectomy. Anorectal trauma from impalement or insertion of foreign bodies serves as a third mechanism of injury.

Poor sphincter function may also result indirectly from stretch injury to the pudendal nerve during childbirth, chronic rectal prolapse, or straining with defecation. Central nervous system (CNS) neoplasms, vascular accidents, infections, demyelinating disease of the CNS, and diabetic autonomic neuropathy may also contribute to anal incontinence.

Normal rectal sensation and compliance can be adversely affected by aging, debilitation, and disease states that decrease the elasticity of the rectum. Diarrheal states such as infectious colitis, inflammatory bowel disease, and radiation proctitis also contribute to incontinence. It is important to remember that the presence of diarrhea may be a manifestation of overflow incontinence, secondary to fecal impaction or rectal neoplasms (Table 26.2).

Evaluation

The type, frequency, and duration of symptoms are factors that the clinician should elicit to determine incontinence severity. Equally important in determining the necessity for treatment, patient expectations of treatment, and treatment outcome is the impact on the patient's quality of life. There are many measures of fecal incontinence available, broadly categorized into descriptive, severity, and impact measures (47). Although numerous scoring systems have been reported in the literature, all have their drawbacks and still no universal classification system exists. The system most commonly utilized is the Wexner scoring system, but it combines quality of life and disease severity, which ideally should be measured separately (48). A validated fecal incontinence quality of life instrument does exist (49).

Table 26.2 Etiology of Anal Incontinence

Aging
Trauma
Obstetrical injury
Anorectal surgery (i.e., fistulotomy, hemorrhoidectomy)
Accidental injury (i.e., impalement, foreign body)
Neurological
Congenital

Dementia

CNS neoplasms

Multiple sclerosis

Diabetes

Pelvic floor degeneration

- Chronic straining
- Descending perineum syndrome
- Rectal prolapse
- Vaginal delivery

Alterations in Stool Consistency

Infectious diarrhea

Inflammatory bowel disease

Laxative abuse

Radiation enteritis

Short gut syndrome

Overflow Incontinence

Encopresis

Impaction

Rectal neoplasms

Adapted from Dykes SL, Lowry AC. Fecal incontinence. In: Cameron JL, ed. *Current Surgical Therapy.* 8th ed. Philadelphia: Elsevier Mosby; 2004:267, with permission.

Specific injury to the anal sphincters may be suspected from prior history of anorectal surgery and thorough obstetrical history, including vaginal deliveries, episiotomies, and forceps use. Similarly, congenital abnormalities, diarrheal states, and neurological disorders may suggest other mechanisms for incontinence.

Pertinent findings on simple inspection of the perianal skin include excoriation, scars, and patulous anus. Digital rectal exam may demonstrate poor resting and squeezing tone and can reveal sphincter defects, masses, and impacted stool. Valsalva during examination may disclose mucosal or rectal prolapse. Anoscopy, flexible sigmoidoscopy, or colonoscopy should be performed to exclude the presence of neoplasms or inflammatory conditions.

Anorectal physiology testing, including anal manometry, pudendal nerve terminal motor latency (PNTML), cinedefecography, and endoanal ultrasound, may be helpful in select patients. Manometry can confirm sphincter dysfunction in patients with intact sphincters but correlates poorly with the severity of incontinence. PNTML is thought to reflect neurogenic injury, although its accuracy is controversial. Defecography may reveal rectocele or prolapse not elicited by exam. Endoanal ultrasound detects sphincter defects with 100% sensitivity and specificity when performed by an experienced clinician (50,51). Up to 50% of sphincter defects found by ultrasound are not detected on physical exam. There is considerable debate regarding the utility of anorectal physiology testing. Defecography and ultrasound are the exams most likely to affect treatment plans.

Treatment

Medical Management

The treatment of anal incontinence is dictated by etiology and severity. Obviously, infectious or inflammatory causes and underlying neoplasms should be treated appropriately. For patients with mild symptoms regardless of etiology of their incontinence, initial trials of medical management are appropriate. These include dietary manipulation, bowel management programs, pharmaceutical agents, and biofeedback. Success is highly dependent on patient compliance.

Dietary Manipulation and Bowel Regimens

Possible sources of food intolerance (i.e., lactose, gluten, or dairy products) should be reduced or eliminated from the diet. A daily food diary is recommended to identify those

items that alter stool consistency. Substances commonly linked to diarrhea include alcohol, caffeine, fruits, and leafy vegetables. Patients should strive to gradually increase their daily fiber intake to 30 grams per day through diet or fiber supplements such as psyllium. An effective bowel regimen, when coupled with appropriate dietary manipulation, may provide the incontinent patient with a predictable schedule for stool evacuation. Evacuation using suppositories or enemas may be timed after meals or before outings in order to prevent inadvertent fecal soiling or leakage.

Pharmaceutical Agents

Antidiarrheal medications comprise a major component of medical management of the incontinent patient. The predominant forms are loperamide (Imodium) and opium derivatives, which range from diphenoxylate HCl (Lomotil) to codeine and tincture of opium. Shared mechanisms of actions include decreasing colonic transit and increasing fluid absorption. Loperamide also increases anal sphincter pressure and has a lower potential for abuse. For the constipated patient prone to overflow incontinence, daily use of a polyethelene glycol laxative (Miralax) can be helpful. A recent study by Santoro et al. demonstrated improvement in fecal incontinence symptoms with daily, oral, low-dose amitriptyline (20 mg) (52). Initially introduced as a tricyclic antidepressant, its anticholinergic and serotonin-agonist properties are likely responsible for its effects on colonic transit and rectal contractions.

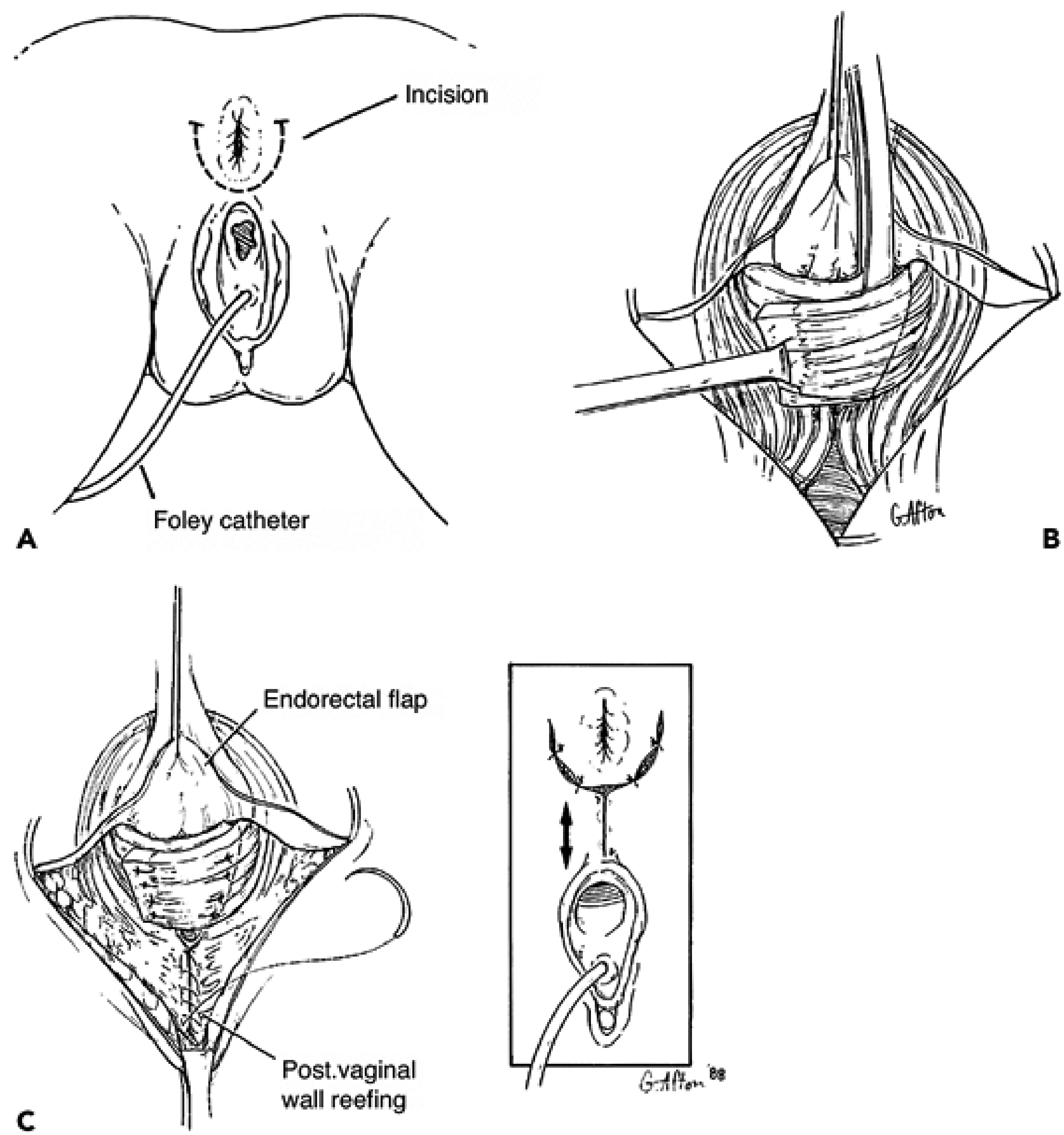

Figure 26.6 *Overlapping sphincteroplasty*. A: The patient is in the prone jack-knife position. A 180-degree curvilinear incision is made in the anoderm about 1.5 cm from the anal verge. Because most sphincteric injuries are obstetric in nature, the incision is usually anterior as shown. B: The external sphincter is mobilized from its bed of scar and surrounding tissues. The entire sphincter mechanism with adjacent scar tissue has now been completely mobilized. An overlapping sphincteroplasty is performed using horizontal mattress sutures. C: The sphincter mechanism has been reconstructed. The posterior vaginal wall can be thickened by reefing the available tissues. The endorectal flap of anoderm, mucosa, and submucosa is sutured over the reconstructed sphincter muscle in four areas to the perianal skin. The vaginal reconstruction is done in a vertical manner to provide skin coverage over the now-thickened perineal body.
(Adapted from
Rothenberger DA. Anal incontinence. In: Cameron JD, ed. *Current Surgical Therapy*. Philadelphia: Decker; 1989:185â€“194.
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Biofeedback

Since its first described use in 1974, biofeedback has proven a safe adjunct in the treatment of the incontinent patient. A candidate for biofeedback must have intact rectal sensation and the ability to voluntarily contract the external anal sphincter. The patient learns basic anatomy and physiology of the rectum and anus, and attempts to improve sphincter strength, rectal compliance, and pelvic floor coordination through exercises taught by a biofeedback therapist in four to eight weekly sessions. Published results of biofeedback demonstrate at least some improvement in 64% to 89% of patients (53,54,55).

Operative Management

For patients with moderate to severe incontinence and an anatomic sphincter defect, primary sphincter repair is the procedure of choice, especially in those

who have failed medical management. The most widely used and accepted method is overlapping sphinctero-plasty (56).

Overlapping Sphincteroplasty

Preoperative preparation includes mechanical bowel prep and antibiotics given before induction of general anesthesia or regional anesthesia. The patient is placed in the prone jack-knife position. A Foley catheter is inserted, and the perineum is prepped and draped. Regardless of the type of anesthesia administered, the perianal space is infiltrated with local anesthetic and epinephrine 1:200,000 for muscle relaxation and hemostasis.

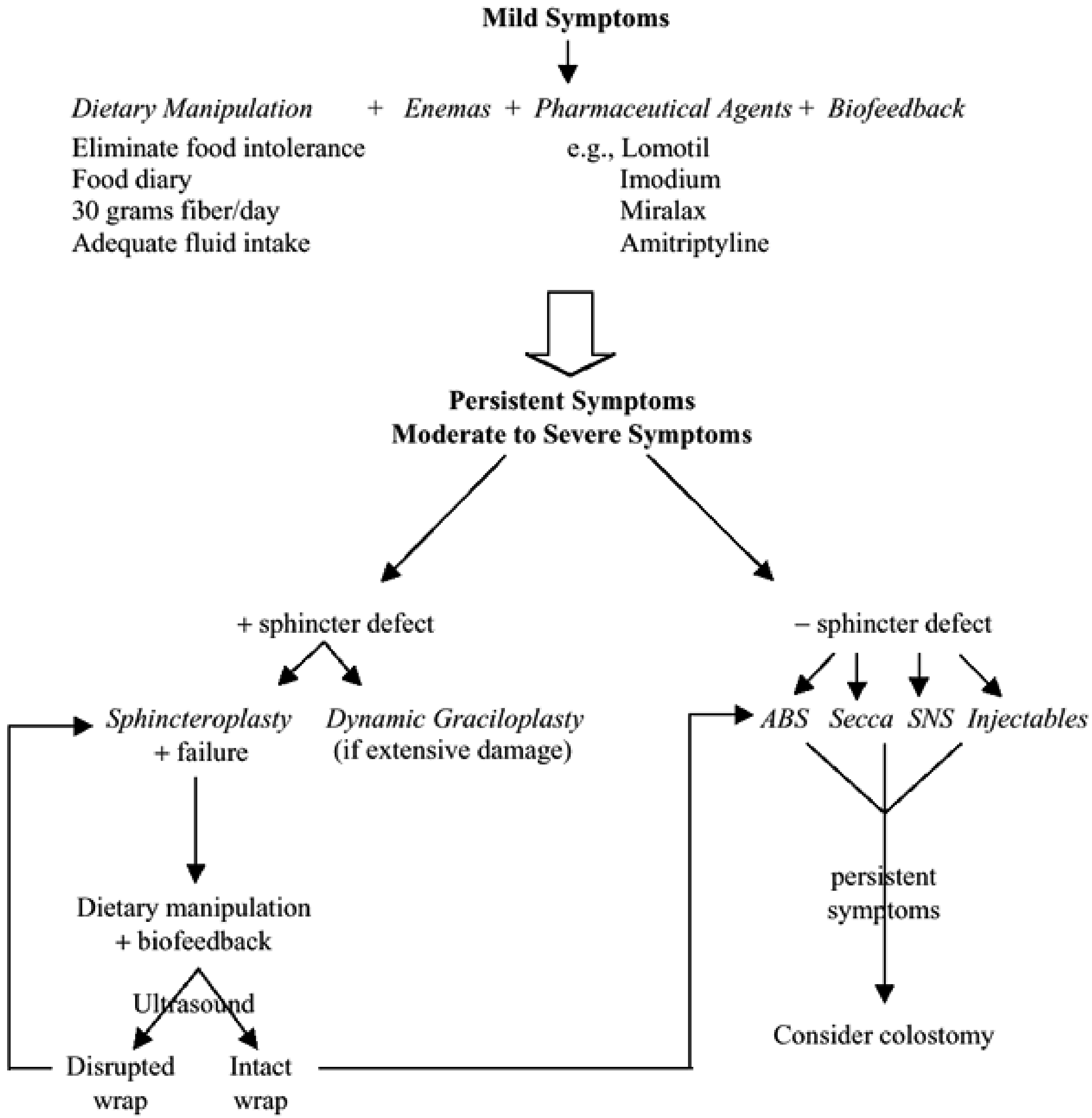

Figure 26.7 Treatment algorithm for fecal incontinence.

A curvilinear incision is made in the perineum, and a flap of anoderm and rectal mucosa is elevated off the internal sphincter and midline scar. The Lone Star retractor (Lone Star Medical Products, Houston, TX) aids exposure. The edges of the sphincter muscle are identified and mobilized from the ischiorectal fossa and posterior vaginal wall. Mobilization needs to be sufficient to overlap the muscle ends without tension. The repair is performed using interrupted, 2-0 absorbable mattress sutures (Fig. 26.6) The internal sphincter may be repaired separately or as part of the overlapping wrap. Proponents of concomitant levatoroplasty argue that it lengthens the anal canal, while opponents cite the risk of dyspareunia. When the repair is complete, a digital rectal exam should reveal a snug anal aperture. The soft tissues, comprised predominantly of scar tissue and transverse perinei muscle, are then reapproximated using interrupted 3-0 absorbable sutures. This maneuver helps to support the perineal body. The skin is closed with interrupted 4-0 absorbable sutures over a Penrose drain or is left partially open. Diversion with a stoma is not necessary.

While overlapping sphincteroplasty is the most commonly utilized technique, a recent study showed no difference in outcome between overlapping repairs and approximation techniques (57). Caution should be exercised if attenuated rather than disrupted muscle is encountered. In that case, imbrication of the sphincter is more appropriate. The drain is usually removed in 24 to 48 hours, and the patient is maintained on a clear liquid diet until the first bowel movement occurs. A regimen of daily tap water enemas is taught to patients for self-administration to avoid impaction caused by pain, narcotic use, and perineal edema.

Success depends on the definition of continence. Continence of solid and liquid stool can be expected in 70% to 90% of patients in most series. A small percentage of patients will have worse function. Preoperative incontinence to solid stool and prior attempts at operative repair are risk factors for failure or poor postoperative continence. Adverse outcomes secondary to pudendal nerve neuropathies are debatable.

For patients with poor function postoperatively, dietary manipulation and biofeedback are the initial treatments. If this fails, anal ultrasound should be repeated to determine if the wrap is intact. Patients found to have disruption of a previous sphincter repair may be candidates for repeat overlapping procedure. Patients with an intact wrap may be considered for one of the new approaches developed for the treatment of fecal incontinence.

Novel Approaches

Patients who are not candidates for sphincteroplasty and have moderate to severe symptoms may be candidates for the recent approaches to incontinence, including dynamic graciloplasty, the artificial bowel sphincter (ABS), sacral nerve stimulation (SNS), and the Secca procedure (58,59,60,61). The Secca procedure delivers temperature-controlled radio frequency energy to the anal sphincter complex under conscious sedation. As the thermal lesions in the submucosa heal, tissue remodeling results in contraction of the anal canal and subsequent increase of anal tone and improved continence. The most recent innovations for the treatment of incontinence include injectable bulking agents, such as carbon-coated beads and silicone, into the sphincter complex (62).

Colostomy

Although new developments are proving useful, there are still patients for whom a stoma is the best option. Patients with severely disrupted anal canal anatomy and significant medical morbidities that may adversely affect healing, such as radiation exposure, are best served by a stoma.

Conclusions

Understanding the etiology of anal incontinence is essential in planning treatment options for this crippling condition. A trial of medical management and biofeedback is beneficial in patients with mild symptoms and does not preclude operative treatment. Overlapping sphincteroplasty has demonstrated improvement in symptoms in patients with anatomic sphincter deficits. Novel approaches such as artificial bowel sphincter, sacral nerve stimulation, and injectable agents are promising for those with significant symptoms and intact sphincter mechanisms. Long-term results of these therapies are eagerly awaited (Fig. 26.7).

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27

Perineal Descent and Rectocele

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Karim Alavi

Pelvic organ prolapse has been described as a hidden epidemic (1). An average of 300,000 women undergo surgery for female organ prolapse each year in the United States (2). One in 10 women will require surgery for female organ prolapse in her lifetime (3). Although more common in elderly women with prior vaginal deliveries, complaints associated with perineal descent can occur in every age group, in nulliparous patients, and in men. The annual cost is over a billion dollars (4). Rectocele, cystocele, enterocele, uterine prolapse, and rectal prolapse represent conditions that gynecologists, urologists, and colon and rectal surgeons will be called on to evaluate and manage. The management of perineal descent will briefly be discussed in this chapter. This will be followed by a more detailed discussion of rectocele and its management.

Perineal Descent

Perineal or *pelvic floor descent* (also known as the syndrome of the descending perineum) represents a generalized term to describe symptomatic weakness, or thinning of the muscles and fascia that support the pelvic floor structures.

Support for the pelvic floor depends on the functional anatomy of two structures. First is the underlying levator muscular support, which includes the pubococcygeus, iliococcygeus, puborectalis, and coccygeus muscles. Second is a continuous framework of connective tissue known as the endopelvic fascia. The endopelvic fascia encompasses the muscle groups and attaches to the bony pelvis. The rectum, vagina, and urethra pass through an opening of this fascial network (5).

Perineal descent is the result of a loss of muscle strength and fascial support. Often, it is the result of birth trauma with physical stress on fascia and muscles as well as possible damage to the pudendal nerves (6). Other factors that may weaken the pelvic floor include chronic constipation, straining, muscle atrophy, and congenital weakness.

Clinically, patients present with complaints of tenesmus, difficult evacuation, and incontinence. Physical exam demonstrates a loss of concavity of the perineum on Valsalva. Radiographic evaluation demonstrates the anal canal descending 3 to 4 cm or more below a line drawn between the pubic bone and the coccyx (7).

Surgical Treatment

Surgical treatment for perineal descent has been limited to only a few institutions. Described approaches include posterior perineal approach, total pelvic Marlex mesh repair (sacral colpoperineopexy), and rectopexy and colpopexy with mesh.

The posterior perineal approach is described by Nichols (8). It includes a posterior sacral approach with anterior mobilization of the rectum. Permanent sutures are placed at 1-cm intervals extending proximally through the posterior mesorectum. The sutures are then fixed to the sacral ligaments. Although initially proposed by Nichols, further studies in the literature are lacking.

Total pelvic Marlex mesh repair (sacral colpoperineopexy) is a combined abdominal and perineal approach (9). From the perineum, perineorrhaphy is performed for patients by separation of the superficial perineal muscles. The posterior vaginal fascia is reapproximated to the perineal body (when identifiable). The abdominal approach requires anterior and posterior mobilization of the vagina. The vagina is dissected away from the bladder sufficient to identify the anterior vaginal fascia, thus permitting sufficient space for mesh placement. The rectovaginal space

is then dissected until the superior aspect of the posterior vaginal fascia contiguous with the perineal body is identified. Mersilene (Ethicon, Somerville, NJ) mesh is sutured to the anterior and posterior vaginal walls. The mesh is then attached to the sacral ligament.

The combination of mesh placement with rectopexy and colpopexy is described by Collopy (10). Patients with a prior hysterectomy and symptoms of rectal and vaginal prolapse were included in this study. The procedure is described as a mesh rectopexy followed by closure of the pelvic cul-de-sac. Finally, a colpopexy is described with attaching the extensions of the mesh to an anatomically corrected vaginal wall.

The majority of theses approaches have been described in single-institution retrospective studies. Randomized controlled clinical trials have been lacking. Surgical correction should be tailored to individual patients with full discussion of potential risks, complications, and realistic expectations of results.

Rectocele

Rectocele is a bulge, prolapse, or herniation of the anterior rectal wall through the posterior vagina. Rectoceles in general are characterized anatomically as low (Level III), middle (Level II), high (Level I), or a combination. A Level I rectocele is a defect proximal to the uterosacral and cardinal ligaments. Level II is described as a weakness in the endopelvic fascia extending into the rectovaginal septum. Level III is a weakness distal to the fascial attaching of the perineal body. Level I rectoceles are often associated with a hysterectomy, whereas perineal trauma is most often associated with a combination of Level II and Level III defects (5).

Etiology

The etiology of rectocele is thought to be multifactorial. Postmenopausal females with other underlying symptoms of vaginal descent (internal prolapse, chronic constipation, cystocele, vaginal prolapse, and rectal prolapse) also may demonstrate a rectocele. Obstetrical trauma to the vagina and pelvis leads to weakness of the rectovaginal septum, perineal nerve damage, and laxity of the entire endopelvic fascia and pelvic floor musculature. Rectocele has also been characterized as the consequence of a high-pressure system (the rectal canal) adjacent to a low-pressure system (the vaginal vault). The lower rectal wall begins to encroach on the posterior vaginal wall. A history of chronic constipation or straining with bowel movements and increased pressure in the rectum hastens the encroachment. Women who have undergone a hysterectomy appear to have a higher risk of rectocele. Although this is a problem that most commonly increases with age, congenital weakness of the rectovaginal septum has been postulated to account for a small subset of young nulliparous women with rectocele (11).

Table 27.1 Symptoms Associated with Rectocele

Gastrointestinal

â€¢ Chronic constipation

â€¢ Incomplete evacuation (recurrent urge for defecation)

â€¢ Assisted evacuation (requiring vaginal or perineal pressure)

â€¢ Fecal soiling or incontinence

â€¢ Rectal prolapse

Genitourinary

â€¢ Urinary incontinence

â€¢ Difficult urination

â€¢ Vaginal bleeding

â€¢ Bulging from vagina

â€¢ Sense of a mass in the vagina

Other

â€¢ Pelvic or perineal pain

â€¢ Dyspareunia

â€¢ Low back pain

Clinical Presentation and Evaluation

Patients with rectocele can present with a multitude of symptoms (Table 27.1). Evaluation includes a thorough medical history. Additional pertinent details include an obstetrical history, history of prior pelvic and abdominal surgery, and a history of previous nonoperative treatments. A thorough description of bowel and urinary function should be obtained, including use of standardized questionnaires for bowel function (continence and constipation) and urinary function. Physical exam confirms the diagnosis. External and speculum exam demonstrates bulging of the posterior vaginal wall with straining. Rectal exam should be performed to assess for rectal tone. Other pathology such as anorectal masses, hemorrhoids, fistula, abscess, rectal-vaginal fistula, and rectal prolapse should be excluded. Rectovaginal exam demonstrating a thin rectovaginal septum supports the diagnosis of rectocele. Other pathology of the pelvic floor including cystocele, uterine prolapse, rectal prolapse, and enterocele should be defined if surgery is required.

Evaluation of pelvic floor physiology may assist in the initial work-up, although its utility has been debated. Defecography assesses the size of rectocele and defines the degree of rectal emptying and retained stool (Fig. 27.1). It can demonstrate an underlying physiologic dysfunction for complaints of constipation such as dyssynergic defecation and paradoxic puborectalis. Defecography can also help visualize the presence of enterocele. Endorectal ultrasound is indicated in patients with underlying incontinence to assess sphincter defects. Anal manometry, pudendal nerve terminal motor latency, and rectal sensation are also available as symptoms dictate. In patients with chronic constipation,

a colonic transit study should be obtained to evaluate for colonic dysmotility.

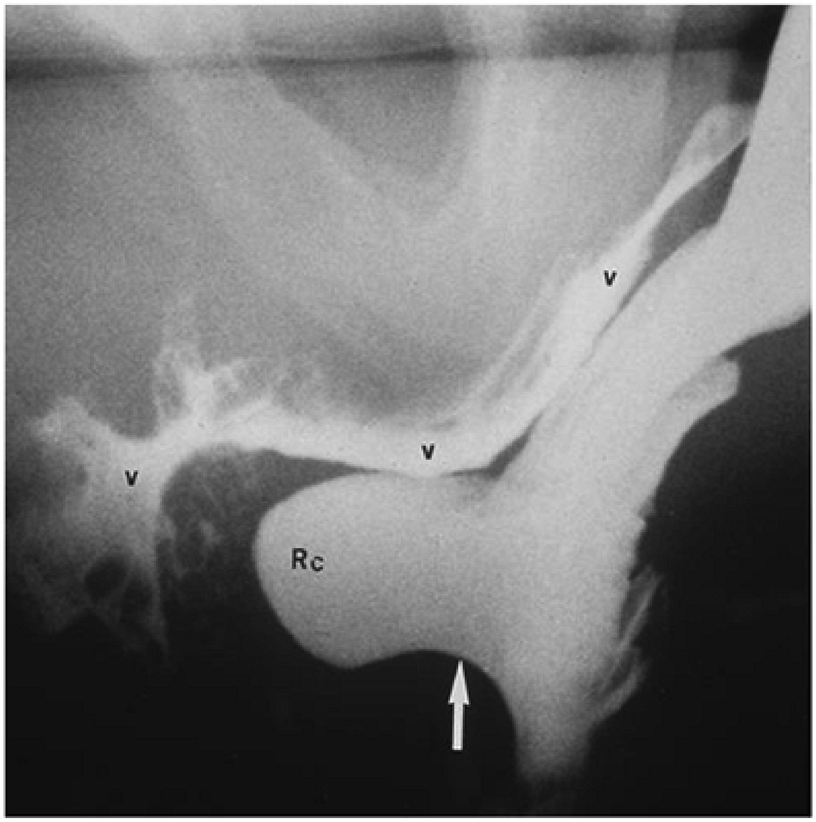

Figure 27-1 Defecography demonstrating rectocele.

Nonsurgical Treatment

Conservative treatment for rectocele is broken down into diet, pharmaceutical, biofeedback mechanisms, and mechanical assistance. Diet modifications include increasing water intake, dietary fiber, and physical exercise. Stool-bulking agents and laxatives assist in symptomatic treatment of bowel complaints. Biofeedback may have a role in patients with asynchronous mechanism of defecation (i.e., nonrelaxing puborectalis) or as a first-line therapy (12). Another line of treatment is the pessary. There are two general types of pessaries. The first type acts as an anatomical â€œspace-fillingâ€• pessary. Alternatively, â€œsupport pessariesâ€• provide pressure, lifting the superior vagina (13). In addition to supporting the posterior vaginal wall, the pessary assists with patients requiring perineal pressure for defecation. Despite their common use, randomized trials evaluating the efficacy of pessaries are lacking (14).

Surgical Treatment

Indications for Surgery

Patients with symptomatic rectoceles verified by evaluation, who have failed or do not desire nonsurgical therapy, and are medically suitable candidates for general anesthesia qualify for surgical treatment. Recent studies suggest that patients with a greater than 2-cm rectocele on defecography as well as those who require digital assistance for defecation may have improved results, but this is not exclusive (15).

The options for surgical treatment include transvaginal, transrectal, transperineal, and transabdominal repair. Additional modifications including mesh repair, stapled repair, and laparoscopic repair will also be discussed.

Transvaginal Repair

Transvaginal repair or posterior colporrhaphy has been the traditional repair by most gynecologists. Transvaginal repair includes posterior colporrhaphy alone or with discrete fascial repair as described by Porter et al. (16). After the patient is placed in the lithotomy position, a submucousal injection of saline or local anesthetic with epinephrine is performed in the posterior vagina to lift the mucosa. A transverse incision is made at the mucoepithelial junction. At the lateral extents of the transverse incision, the incision is carried proximally to the uppermost extent of the rectocele. The vaginal mucosa is dissected free from the underlying rectovaginal fascia with care to avoid the rectum creating a mucosal flap.

There are two options for repair of the defect. The traditional posterior colporrhaphy re-approximates the levator ani muscles with interrupted sutures. The discrete posterior colporrhaphy repair identifies posterior rectovaginal fascial defects by anterior pressure through the rectum. These defects are closed primarily with care not to enter the rectum. Both operations end with the excess vaginal mucosa excised and the posterior vaginal wall closed. Perineorrhaphy can be added to the repair for patients with an underlying perineal muscle defect.

Transrectal Repair

Transrectal repair was first described by Sullivan et al. in 1968 (17). After preoperative mechanical bowel preparation and with the patient in prone jack-knife position, a transverse incision is made just proximal to the dentate line. Two vertical incisions are then started at either end, and a broad based, submucosal flap is raised and carried proximal to the rectocele defect (approximately 5 to 7 cm). With an exam finger in the vagina, the posterior vaginal fascia and vaginal wall is embricated with interrupted sutures. The excess mucosa is then excised. The remaining mucosa is then closed over the repair.

An alternative repair demonstrated by Block is a quick transrectal repair known as an obliterative suture repair (18). A strangulating continuous locking suture is placed through the submucosa and muscularis layers of the anterior rectum starting at the apex of the rectocele. The excess tissue sloughs, closing the rectocele defect.

Transperineal Repair

The transperineal repair is an approach well known to most colon-rectal surgeons. With the patient in prone jack-knife position, an incision is made in the perineal body parallel

to the curvature of the rectum. The plane between the rectum and vaginal fascia is dissected to the proximal extent of the rectocele defect. The posterior vaginal fascia is then closed with interrupted sutures. A levatorplasty is included to reinforce the posterior rectovaginal septum and to augment the perineal body.

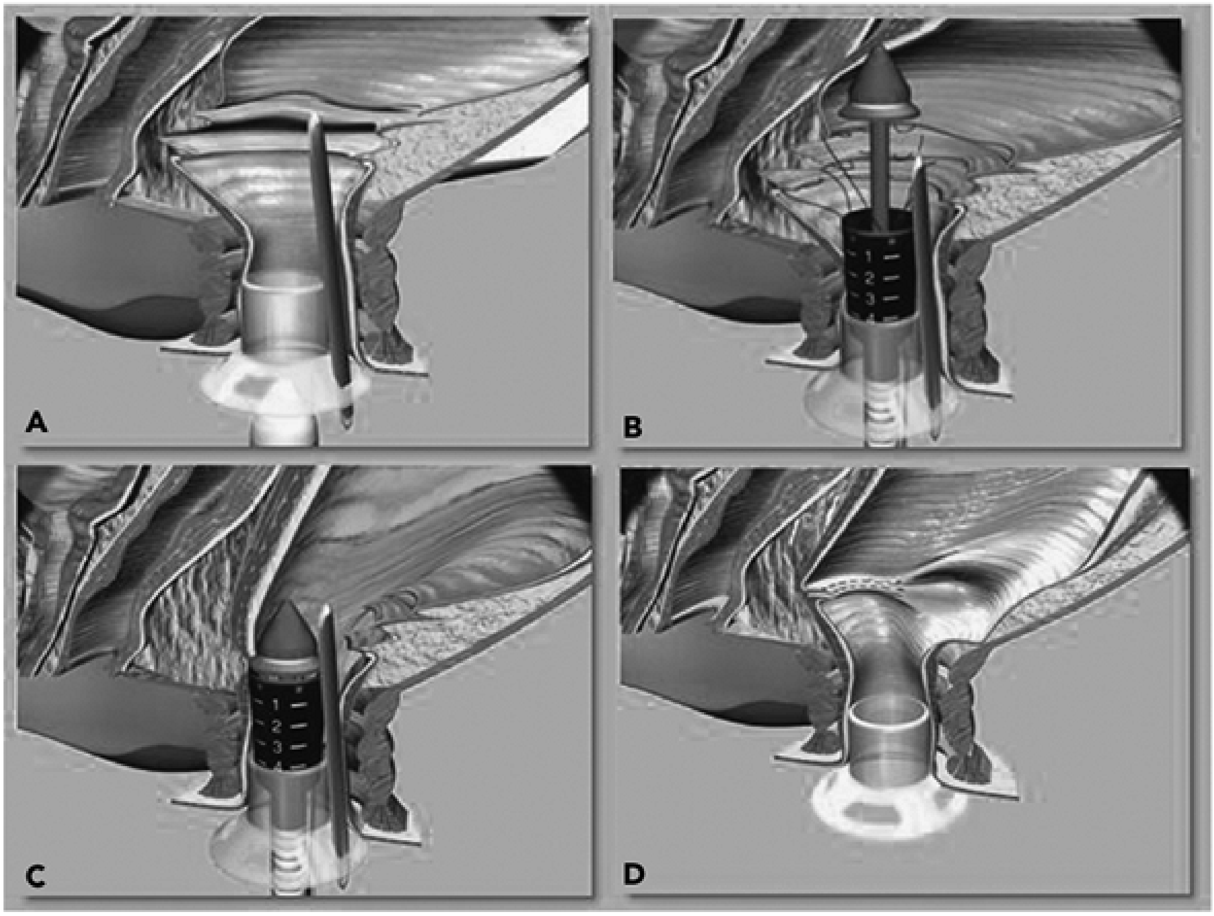

Figure 27-2 STARR procedure: Anterior resection. (Courtesy of Ethicon-Endo Surgery Inc.)

Transabdominal Repair

Transabdominal repair includes the sacrocolpoperineopexy (see previous discussion). It includes separating the posterior vaginal wall from the rectum through an abdominal approach, reinforcing the vaginal wall, and securing the posterior vaginal fascia (attached to the perineal body) to mesh. The mesh is then secured to the anterior sacral ligaments.

Mesh Repair

Numerous studies have described the placement of mesh to reinforce the rectovaginal septum. Approaches may include transvaginal, transperineal, and transabdominal repair. After dissection in the plane between the rectum and vagina, the mesh is secured in place. Options for mesh include Gore-Tex (polytetrafluoroethylene), Marlex, polyglactin (absorbable mesh), Prolene, and collagen. Each has been studied with varying results, but long-term outcomes are lacking.

Stapled Repair

Recently, stapled techniques have being introduced as a possible alternative for rectocele repair. STARR (STApled Repair of Rectocele) utilizes the technology of stapled hemorroidectomy to treat patients with outlet obstruction secondary to combined rectocele and internal rectal prolapse.

The anoscope is first secured to the perineum, and the posterior wall is protected by a retractor (Fig. 27.2A). Three 180-degree purse-string sutures using Prolene 2-0 are placed, incorporating mucosa, submucosa, and rectal muscle wall at the most proximal portion of the rectocele and internal rectal prolapse (Fig. 27.2B). A 33-mm circular stapler is inserted, and the head is placed proximal to the three purse strings (Fig. 27.2C). The stapler is then closed, and the posterior vaginal wall is inspected prior to firing. The staple line is reinforced with interrupted vicryl sutures. The result is a proximal to distal plication (Fig. 27.2D). This procedure is then repeated with the anterior wall (Fig. 27.3).

The STARR technique is currently under investigation in a multi-institution prospective trial. Early studies have reported shorter operative times and hospital stay, minimal postoperative pain, improved constipation, and no complaints of dyspareunia. Postoperative morbidity included incontinence to flatus (8.9%), fecal urgency (17.8%), stenosis (3.3%), bleeding (4.4%), and urinary retention (5.5%). However, follow-up was only 12 months; therefore, conclusions regarding recurrence are somewhat limited (19).

Laparoscopic Repair

The laparoscopic approach for rectocele mirrors the abdominal approach. Laparoscopic abdominal sacrocolpopexy, as described by Thornton et al., begins by dissection in the posterior pelvis (20). The uterus or vaginal vault is elevated to display the uterosacral ligaments, and the ureters are identified. The peritoneum is incised medial to the ureters, and dissection is then carried medial to the uterosacral ligaments into the pararectal space and distally to the levator ani muscles. Anteriorly, the dissection is carried through the rectovaginal space until it reaches distal to the perineal body. Next, the posterior vaginal fascial defect is repaired by interrupted sutures. A levatorplasty may also reinforce the repair. The repair may be buttressed with mesh.

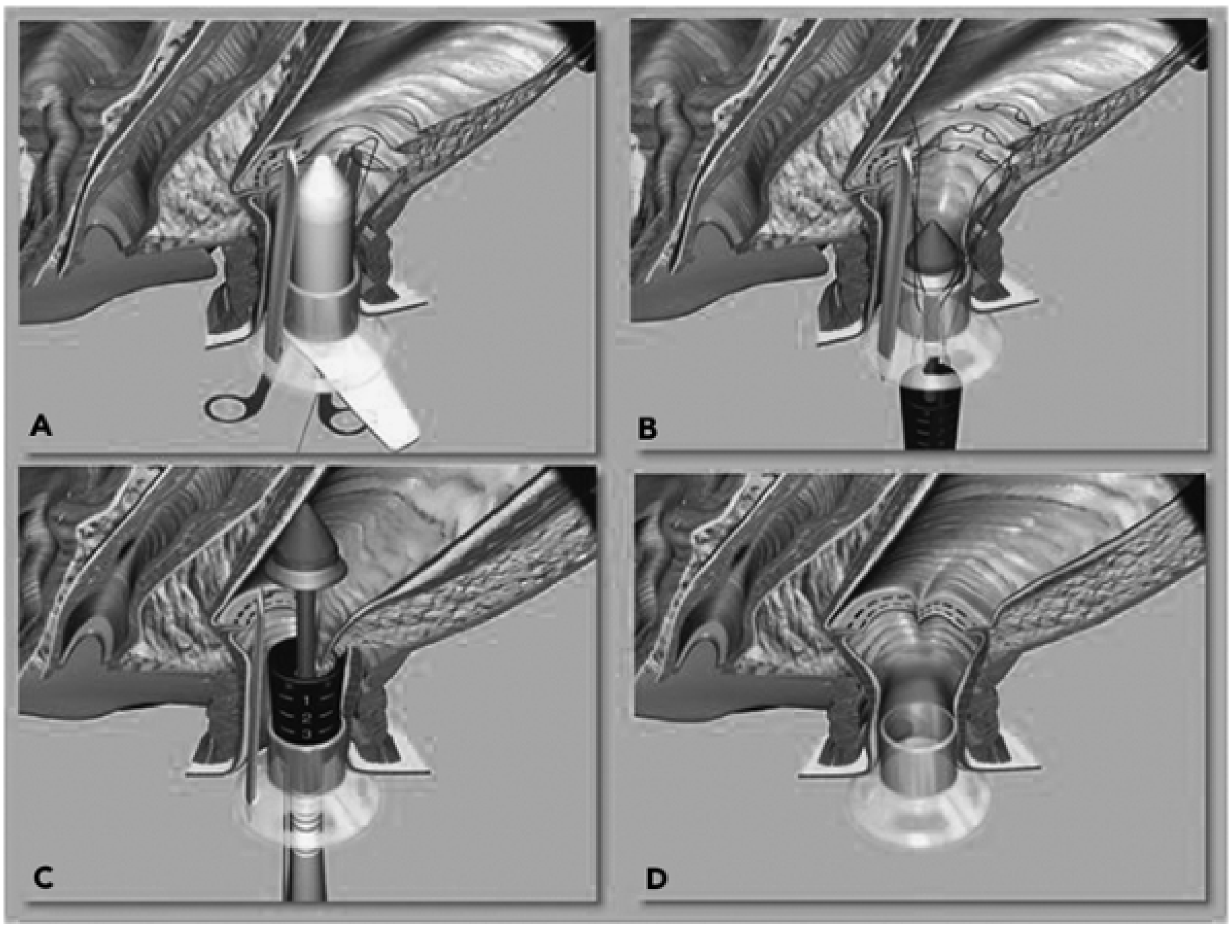

Figure 27-3 STARR procedure: Posterior resection (Courtesy of Ethicon-Endo Surgery Inc.)

The laparoscopic sacrocolpoperineopexy is described by the mobilization of the vagina in the anterior and posterior planes. A Y-shaped mesh is then used to reinforce the vagina. One branch of the â€œYâ€• is attached to the anterior vagina. A second branch is attached to the perineal body and posterior vagina. The base of the â€œYâ€• is then secured to the sacral ligaments (21).

Comparison Studies: What Is the Best Repair?

There are currently no prospective, randomized controlled trials studying the ideal approach to the repair of rectoceles. Each type of repair has been retrospectively reviewed, with mixed results. Studies for transvaginal repair demonstrate a 76% to 96% cure rate. However, the follow-up is short (12 to 42 months), and there is a trend toward a higher recurrence of complications with longer follow-up (22,23,24). Discrete fascia repair for transvaginal repair also had an 82% to 92% cure rate over only 6 to 18 months (16,25).

Studies on transrectal repair demonstrate a 50% (74-month follow-up) to 96% (18-month follow-up) success rate (17,26). Although patients also reported improved constipation, fecal incontinence was an important complication. Nieminen et al. compared transrectal repair with transvaginal repair in a prospective randomized study. His group found a higher recurrence rate of complication for transrectal repair. There was no difference in dyspareunia or relief of symptoms initially (27).

Studies on transperineal repair have demonstrated success in 63% to 87% of patients, as determined over a follow-up period of 24 to 44 months (20,28). Specifically, Fischer et al. compared transvaginal, transperineal, and transrectal repair of rectocele. They did not show any differences with regard to recurrence or postoperative function but emphasized the need to tailor the operation after full clinical evaluation (28).

Two recent studies reviewed mesh repair with rectocele. They concluded that most of the studies in the literature are retrospective, with limited power and poor follow-up. Issues of increased treatment cost and unknown long-term complications also were addressed (29,30).

A recent case-matched cohort study evaluating the differences between laparoscopic and transrectal repair illustrated a greater patient satisfaction and improved bowel symptoms in patients with transrectal repair but with slightly increased risk of incontinence (20). In general, studies on rectocele involve small numbers, and long-term follow-up is limited. The choice of repair is often based on the surgeon's experience and preference. Future studies are needed to better define the best option for surgical repair.

Table 27.2 Complications Associated with Rectocele Repair

Surgical Complications
â€¢ Bleeding
â€¢ Infection
â€¢ Ureteral injuries
â€¢ Recurrence
â€¢ Rectovaginal fistula
â€¢ Mesh erosion
â€¢ Sphincter injury
â€¢ Perineal nerve injury
Functional Complications

â€¢ Dyspareunia

â€¢ Incontinence

â€¢ Constipation

â€¢ Emptying difficulty

â€¢ Anismus

Functional Results: What Do We Tell Patients?

There are few prospective studies demonstrating a statistical difference in functional outcomes after rectocele repair. In one study, Mellgren et al. showed that 88% of patients with significant preoperative constipation attributed to rectocele had significant improvement (23). A second study demonstrated 90% improvement in protrusion, 43% improvement in constipation, 92% improvement in dyspareunia, and 36% diminished need for manual evacuation (31). A third study demonstrated significant improvements in quality of life, including daily activities (travel, housework, social activities), and decreased stooling difficulties, pelvic pressure, dyspareunia, and sensation of a vaginal mass (16). Although these results are encouraging, long-term studies on outcomes are needed.

Complications

Potential complications are listed in Table 27.2. Patients undergoing rectocele repair who are elderly and have underlying medical problems should be counseled regarding risks of general anesthesia. A report studying all surgeries treating perineal prolapse demonstrate a low morbidity rate of 5.5%, but patients with rectocele repair had a higher mortality when compared with other pelvic procedures (2).

Conclusions

Pelvic descent and rectocele are common problems for the gynecologist and colon-rectal surgeon. After a detailed description of symptoms and thorough evaluation for coexisting pathology, treatment strategies include nonoperative and operative approaches. Traditional surgical approaches should be part of the armamentarium of surgeons. Future investigations into mesh placement, stapled techniques, and laparoscopic repairs will provide additional options. Data from randomized controlled studies is lacking to fully assist with clinical decision making. Patients should be thoroughly counseled regarding these limitations and potential complications prior to accepting a treatment option.

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28

Vesicovaginal, Urogenital, and Rectovaginal Fistulas

Rony A. Adam

Urogenital Fistulas

It has long been noted that women suffering from vesicovaginal fistula, with its incessant dribbling of urine, are severely afflicted physically, socially, and emotionally. Although in the developed world these cases are prone to litigation, patients with vesicovaginal fistulas are among the most grateful once they are cured. Although the published literature regarding urogenital fistulas is voluminous, little scientifically validated research is available, and most of the data is based on retrospective case series and expert opinion. Many types of urogenital fistulas have been reported in the literature, however this chapter will primarily focus on posthysterectomy vesicovaginal and urethrovaginal fistulas that are amenable to repair by the vaginal route (Table 28.1).

Epidemiology

Genitourinary fistulas can be classified as congenital or acquired. Congenital fistulas are very rare, with only a few case reports found in the literature. Most reported cases are associated with other urogenital anomalies (1-2). Acquired fistulas may be the consequence of childbirth, pelvic surgery, malignancy, radiation, infection, or an assortment of unusual and rare presentations (Table 28.2).

In the developing world, the most common predisposing factor is obstructed childbirth, accounting for over 80% of genitourinary fistulas (3). These difficult, often large fistulas have become exceedingly rare in developed countries because of improvements in access to and delivery of obstetrical care. Ibrahim et al. report from Nigeria that the mean age of patients diagnosed with a fistula was 15 years old, patients were in labor for 4 days on average, and the fetus died in 87% of cases (4).

Hilton recently reviewed vesicovaginal fistulas in developing countries and outlined management strategies to include immediate catheter drainage as long as the tract had not yet epithelialized, perhaps even prophylactically following obstructed labor with evident vaginal sloughing. Attention to adequate vulvar skin care, nutrition, lower extremity rehabilitation, and counseling are important adjuncts in the care of these fistula patients (5). In about 80% of cases, surgical correction is curative in the first operation for obstetrical vesicovaginal fistula. Multiple attempts may be necessary to achieve a success rate of over 95% for large fistulas (3).

Nonobstetric urogenital fistulas have been reported following gynecologic, urologic, and general surgical procedures, and are most commonly seen in developed countries where hysterectomy is the preceding surgical procedure. Lee et al. showed that benign hysterectomy at the Mayo Clinic was associated with 65% of 303 genitourinary fistulas. Of 190 patients with vesicovaginal fistulas, 82% occurred following surgical treatment for benign gynecologic conditions and 11% from obstetric procedures (6). Harkki-Siren et al. reviewed the incidence of urinary tract injuries from a Finnish national database of 62,379 hysterectomies with a vesicovaginal fistula incidence of 0.8 per 1,000. Among laparoscopic hysterectomies, the rate was 2.2 per 1,000; for abdominal hysterectomies, the rate was 1 per 1,000; for vaginal hysterectomies, it was 0.2 per 1,000; and among subtotal hysterectomies, there were none (7).

Table 28.1 Anatomical Classification of Genitourinary Fistulas that Appear in the Literature

Vesicovaginal
Urethrovaginal
Vesicouterine
Vesicocervical
Ureterovaginal
Ureterouterine
Combination fistulas
Vesicoureterovaginal
Vesicoureterouterine
Vesicovaginorectal

A retrospective review of 17 urogenital fistulas following gynecologic surgery over a period of 15 years in Dublin found 12 vesicovaginal fistulas. The risk of vesicovaginal fistula was found to be 1 in 605 (0.16%) total abdominal hysterectomies, 1 in 571 (0.17%) vaginal hysterectomies, and 1 in 81 (1.2%) radical hysterectomies (8). In a review of 110 vesicovaginal fistulas following hysterectomy, Tancer reported that 92 occurred following abdominal hysterectomy, while 18 followed vaginal hysterectomy.

Twenty-four of these fistulas occurred despite intraoperative recognition and repair of cystotomy. In 77 of these fistulas, no risk factors, such as prior cesarean section, endometriosis, recent cervical conization, or prior radiation, were identified (9).

Table 28.2 Associated Conditions Related to The Development of Urogenital Fistulas

Obstetric Conditions or Procedures
Prolonged, obstructed labor
Placenta percreta
Cesarean section (especially a repeat section)
Cesarean hysterectomy
Operative vaginal delivery
Cervical cerclage
Gynecologic Procedures
Hysterectomy
Suburethral slings
Anterior colporrhaphy

Periurethral bulking

Burch colposuspension

Urethral diverticulum repair

Myomectomy

Loop excision of the cervix

Voluntary interruption of pregnancy

Pelvic Conditions

Endometriosis

Gynecologic cancer

Pelvic irradiation

Bladder stone

Infections

- Schistosomiasis
- Tuberculosis

Lymphogranuloma venereum

Intrauterine device

Neglected pessary

Vaginal foreign body

Since surgical bladder injury is thought (but not proven) to be a predisposing factor to subsequent development of vesicovaginal fistula, review of bladder injuries during hysterectomy is warranted. In a retrospective single-institution series in the United States, Armenakas et al. report on 65 patients with iatrogenic bladder perforations over a 12-year period. Obstetric and gynecologic procedures accounted for 62%, general surgical procedures 26%, and urologic procedures 12% of bladder perforation, excluding all endourologic procedures. Of the 40 patients from the obstetrics and gynecology service with bladder injury, 13 were associated with simple abdominal hysterectomies, 3 with radical hysterectomies, 12 with resections for pelvic mass, 10 with cesarean sections, and 2 with laparoscopies. Anterior vaginal repairs (done by the urology service) accounted for 6 cystotomies. All 17 cystotomies by the surgical service were sustained during colon resections. Sixty-three (97%) of the 65 patients had their cystotomies recognized and repaired intraoperatively by the urology service. With an average follow up of 36 months, 1 subsequent vesicovaginal fistula occurred in a patient who had an abdominal hysterectomy (10). Carley et al. reported the rate of recognized bladder injury during hysterectomies at Parkland Hospital. Of 1,722 abdominal hysterectomies, the cystotomy rate was 0.58%; of 590 vaginal hysterectomies, the rate was 1.9%; and of their 117 obstetrical hysterectomies, the rate was 5.1% (11). A retrospective single-institution review of 1,647 total laparoscopic hysterectomies report 16 recognized bladder lacerations (1%) and 2 vesicovaginal fistulas (0.1%) (12).

As previously noted, even recognized cystotomies that are repaired may subsequently develop a vesicovaginal fistula. In their data of over 43,000 total abdominal hysterectomies, Harkki-Siren et al. reported failure of primary bladder repair 18% of the time (7). Armenakas et al., in their review of 65 iatrogenic bladder injuries, reported that 13 cystotomies occurred after benign abdominal hysterectomy. Of these, 1 vesicovaginal fistula occurred, for a postcystotomy repair failure rate of 7.7% in their total abdominal hysterectomy patients (10). In the aforementioned laparoscopic series, the failure rate of primary bladder repair was 12.5% (12).

Gellasch and Adam presented similar data from the experience at Grady Memorial Hospital of 1,134 hysterectomies for benign indications from January 2000 to April 2004, in which 27 recognized cystotomies were repaired (2.4%) and 3 fistulas developed subsequently, for an overall cystotomy repair failure rate of 11%. Among 581 abdominal hysterectomies, there were 11 cystotomies (1.9%) and 1 subsequent vesicovaginal fistula, for a 9% cystotomy repair

failure rate. Among 484 vaginal hysterectomies, there were 12 (2.5%) cystotomies repaired with 1 subsequent fistula, for a failure rate of 8.3%. Among 35 supracervical hysterectomies, there were no cystotomies or fistulas found. Among 34 laparoscopic-assisted vaginal hysterectomies, there were 4 cystotomies (11.8%) with 1 subsequent vesicovaginal fistula, for a repair failure rate of 25%. The data reviewed suggests increased likelihood of fistula formation following more extensive bladder injury as assessed by the American Association for the Surgery of Trauma grading system (13,14).

Urethrovaginal fistulas are less common than vesico-vaginal fistulas, with an incidence ratio of 1 per 8.5 (15). In the developed world, the most common predisposing event is surgery for urethral diverticulum, anterior vaginal prolapse, incontinence following radiation therapy, or trauma. Operative vaginal delivery and, more rarely, cesarean section have also been reported to precede urethrovaginal fistula formation (16).

Urethrovaginal fistulas can occur from a variety of urogynecologic procedures such as anterior colporrhaphy, suburethral slings, Burch colposuspension, and periurethral collagen injections (10,15,17,18,19,20,21). Urethrovaginal fistulas have been reported following tensionfree vaginal tape (19).

Additional gynecologic procedures have been associated with urogenital fistulas, although with greater rarity including myomectomy, large-loop excision of the cervical transformation zone for cervical intraepithelial neoplasia (CIN), and voluntary interruption of pregnancy (22,23,24) (Table 28.2). Fistulas are noted following radiation therapy for gynecologic cancers (25). Fistulas that form within a previously irradiated field are more prone to recurrence, and most surgeons would agree that additional pedicled flaps are needed in their surgical repair because of underlying microvascular compromise (26,27).

In the future, it is expected that urethrovaginal fistulas may become more common and more complex with the increasing popularity of midurethral tapes for the treatment of stress incontinence. In general, the likelihood of urogenital fistula formation may indeed increase because of the increasing use of permanent suture and graft materials in pelvic reconstructive and incontinence surgery as well as the increasing complexity of laparoscopic surgery.

Pathogenesis

The precise pathophysiologic mechanism of fistula formation has been elusive and poorly understood. Etiologies have been proposed based on interpretation of the epidemiologic data and risk factors discussed previously. Prolonged soft-tissue compression and the resultant vascular compromise, as well as subsequent epithelial necrosis, are well described from cases of prolonged obstructed labor seen in developing countries. However, the pathophysiology of genital fistulas noted in developed countries is more difficult to ascertain with certainty. Vascular compromise and impaired healing may be the basis of fistulas caused by infection and subsequent urethral erosion of various graft materials used for suburethral sling and tape procedures, which then result in urethrovaginal fistula formation. Similarly, vascular compromise may explain fistulas that form following periurethral collagen injection and radiation. In posthysterectomy fistulas, it has been suggested that undiagnosed bladder injury, especially in the posterior wall, would result in vesicovaginal fistula formation, as would an inadvertently placed suture that incorporates the bladder and vagina. Direct injury with healing of the surfaces in a way to allow formation of a fistula may also explain formation of fistulas following trauma. However, it must be understood that these explanations represent opinion rather than scientifically proven pathophysiology. A few studies have attempted to answer this question in animal models.

In an effort to better understand the true pathophysiology of fistula formation, Meeks et al. demonstrated in a rabbit model that fistula formation did not occur when absorbable sutures were placed incorporating full-thickness bladder and vaginal cuff (28). This tends to contradict the notion that an errant suture alone is sufficient to result in fistula formation. In a laparoscopic dog model, none developed a fistula after bipolar cautery injury to the bladder base or when absorbable sutures were placed through the bladder and vaginal cuff. However, fistula formation was noted in the dogs that had a monopolar cautery-induced bladder base laceration and had either repair with single-layer absorbable suture or repair with suture that incorporated the anterior vaginal wall (29). This suggests a possible role for microvascular compromise as an important cofactor in the pathophysiology of vesicovaginal fistula.

Clinical Presentation

The classic presentation of urogenital fistula is continuous urinary leakage from the vagina. This often occurs in the absence of urinary urgency, Valsalva efforts, or changes in body position. The degree to which a particular woman presents in this fashion will depend primarily on the precise location and size of the fistula, and perhaps the pliability and healing of the surrounding tissue, as well as the condition of the rest of the vagina. Patients will present with a spectrum of leakage from truly continuous to intermittent primarily at bladder capacity with attendant urinary odor. Although it is generally accepted that the larger the fistula, the worse the leakage, it is always surprising to see how much urine can leak even through the smallest of fistulas. In developed countries, a prior gynecologic, urologic, or general surgical procedure involving the pelvis will invariably be noted. Delivery by the operative vaginal or, more commonly, by the cesarean section route may precede the onset of symptoms. The vast majority of cases will present 1 to 10 days following surgery, although the author has seen

patients manifest symptoms as late as 3 months postoperatively. The increasing prevalence of multiple procedures undertaken at the same time for complex pelvic floor disorders (often by multiple surgeons) may complicate the diagnosis of subsequent fistula formation related to multiple potential sites of injury, pre-existing symptoms, and a reticence to entertain the possibility of fistula as the cause for persistent urinary leakage. Urogenital fistula should be considered and reasonably ruled out in any patient presenting with persistent or worsening urinary leakage after surgery for pelvic floor dysfunction, incontinence, or indeed any pelvic surgery.

Many patients with vesicovaginal fistula develop coexisting urinary tract infections and symptoms of frequency, urgency, and dysuria. The predominant organism is *Escherichia coli*. Urinary leakage from any genitourinary fistula may be accompanied by hematuria. Patients with coexistent mesh erosion into the urinary tract will present with urgency, frequency, voiding dysfunction, and pain. If there is concurrent erosion into the vagina, coital discomfort, a vaginal discharge, and bleeding may occur as well.

Urine leakage, for even a short period of time, may result in significant irritation of the vagina, vulva, and/or perineum. This often occurs despite the patient's attempt at frequent cleansing. If urine leakage persists, severe perineal dermatitis may result due to exposure of the skin to ammonia. With more prolonged exposure to urine, phosphate crystals may precipitate on the vagina and vulva, which further irritates the area.

Diagnosis

The diagnosis of urogenital fistula is often straightforward, based on history and demonstrable pooling of urine in the vaginal vault; occasionally, however, the diagnosis may be elusive. In all cases, it is necessary to evaluate the fistula with regard to its size, precise location, degree of epithelialization, whether it is simple or complex, its accessibility, and the overall health status and pliability of the surrounding tissues. In the instance of a recurrent fistula, precise knowledge of prior, nonsurgical management and a detailed surgical description of prior repair attempts are mandatory for appropriate surgical planning. If no prior documentation is available to rule out upper urinary tract injury, it should be obtained by an intravenous urogram or a computed tomography (CT) scan with intravenous contrast.

When there is a clinical suspicion of urogenital fistula that cannot be verified on initial speculum examination, one may try concurrent Valsalva maneuvers and partial closure of the speculum to reduce the tension on the vaginal walls. If this is not helpful in visualizing vaginal leakage, then a dye test should be attempted. Indigo carmine or methylene blue-dyed sterile water is instilled by way of a transurethral Foley catheter (16 French), with great care taken to avoid spilling the dye externally. Once the vagina and vulva are cleaned, a tampon is placed, and the patient asked to ambulate and wait for Â½ hour. The tampon is removed and then inspected for the presence of blue dye. If the tampon is wet with urine but not dyed, then a ureterovaginal fistula is suspected, which is best diagnosed using an intravenous urography or a CT scan. On rare occasions, these office diagnostic procedures are nondiagnostic, despite a compelling history. In this case, the patient is asked to take phenazopyridine (Pyridium) and to wear a series of tampons at home over a longer period of time, with varying degrees of physical activity. The tampons are placed individually in plastic bags and are brought in for inspection. The patient must be counseled in careful use of the tampons to eliminate the possibility of dye contamination during their insertion or removal from urine exiting the urethral meatus.

Radiologic studies are not routinely helpful in aiding the diagnosis of urogenital fistula, beyond the aforementioned urogram or CT scan with contrast. Cystourethrography may be used to show a vesicovaginal or urethrovaginal fistula; however, it is rarely needed to make an initial diagnosis. Occasionally, it has been helpful in delineating a complex fistula with multiple channels but cannot evaluate the fistula's proximity to the ureters. Volkmer et al. described the use of Doppler ultrasound to diagnose vesicovaginal fistulas with a sensitivity of 92%. Although this modality may be useful in the follow-up of patients undergoing conservative bladder drainage (in one of four such patients, they demonstrated resolution of the fistula after 6 weeks), it too is rarely necessary to make an initial diagnosis (30).

All patients should undergo cystourethroscopy to delineate the fistula's location, size, whether it is simple or complex, and to evaluate ureteral patency and location. Although this could be done in the office, the author's preference is to perform an examination under anesthesia when possible, which allows better determination of fistula accessibility to the vaginal route of repair. If the fistula is large and does not allow adequate distension of the bladder during fluid-filled cystourethroscopy, placing a vaginal pack is helpful in allowing better visualization. Improved surgical planning and informed consent may be obtained when the definitive operation is done at a later time, especially in complex and/or recurrent cases.

Some have advocated urodynamics testing prior to repairing a vesicovaginal fistula on clinical and medicolegal grounds (31,32). Hilton reports abnormalities on preoperative urodynamics in a vast majority of patients with urogenital fistulas. Urodynamically proven stress incontinence was noted in 75% of patients with urethral or bladder neck fistulas (n = 12) and 36% of vesicovaginal fistulas (n = 14), with detrusor instability, impaired bladder compliance, and voiding dysfunction noted frequently as well. Of the 24 patients anatomically cured in this series, one (4%) had stress incontinence, and nine (38%) had urgency or urge incontinence (31). If the surgeon is contemplating

a concurrent anti-incontinence procedure, then preoperative urodynamics may be useful. Alternatively, anatomical correction may be undertaken and any residual symptoms addressed subsequently. The importance of preoperative counseling regarding the variety of lower urinary tract problems that can occur or persist following fistula surgery, even when deemed anatomically successful, cannot be overemphasized.

Prevention

Since the occurrence of a cystotomy is considered intuitively to predispose one to subsequent fistula formation, prevention is discussed primarily in terms of preventing a cystotomy or its adequate detection and closure if it occurs. Careful consideration of the bladder, trigone, and ureteral anatomy in relation to the anterior vagina is important to maintain during a total hysterectomy. The bladder base overlies the uterine isthmus and the cervix, the bladder trigone is positioned anterior to the upper third of the vagina, and the external cervical os is proximal to the base of the trigone (the interureteric ridge). During a simple hysterectomy (abdominal or vaginal), mobilization of the bladder involves the upper third of the vagina and, therefore, rarely puts the trigone itself at risk. A subtotal (supracervical) hysterectomy requires no bladder mobilization and indeed resulted in no fistulas in the largest series of urinary tract injuries due to hysterectomy (7). This is not the case, however, with anterior colporrhaphy or vaginal paravaginal repair, where the anterior vaginal dissection is carried more distally and laterally.

The likelihood of cystotomy is reduced when sharp dissection is utilized at the time of bladder mobilization during a hysterectomy. This is especially true when the vesico-vaginal space is scarred from a prior cesarean section. Gentle traction and countertraction is also helpful in dissecting the correct plane and thereby preventing bladder injury, as is utilizing an intrafascial hysterectomy technique. Another cause of bladder injury may be from direct trauma due to retractors, which should be used with appropriate caution. Kovac has reported a technique for reducing the risk of cystotomy during vaginal hysterectomy (33). In his report of urogenital fistulas, Tancer noted an absence of typical risk factors during the index surgery in 70% of cases (9). Therefore, liberal use of cystoscopy to assess for bladder and ureteral injury following hysterectomy, and more so after surgery for pelvic prolapse or urinary incontinence, would seem to be appropriate.

In the event of a cystotomy, the location and size seem to be crucial to the possibility of subsequent vesicovaginal fistula formation. A small anterior retroperitoneal bladder injury does not result in urogenital fistula formation, as is observed following removal of suprapubic catheters where the defect resolves spontaneously. Similarly, cumulative experience with trocar injuries from midurethral slings shows little or no consequence to leaving these small lateral and anterior defects to heal spontaneously, even when managed with no additional catheter drainage. Realizing that these injuries are 0.5 cm or less in diameter, any bladder injury greater than that may benefit from primary repair. Due to the dependent position of the bladder base, however, any recognized injury in this region requires suture closure, bladder drainage, or both. Once a cystotomy is recognized, it may be repaired immediately or delayed until the hysterectomy or other surgical procedure is completed. The benefit of immediate repair is that blood and urine do not continually flow into the surgical field, but with continued surgery and retraction, there may be potential compromise to the fresh suture line, and this must be avoided. Adequate dissection and wide mobilization of the bladder off the vagina is necessary to ensure tension-free closure and to allow enough tissue for a second layer. The first layer can be accomplished with 2-0 or 3-0 absorbable suture placed in an interrupted or running fashion. There is continued controversy regarding whether this first layer should be placed through the mucosa or if it should remain extramucosal. It is thought that the extramucosal technique may decrease the likelihood of subsequent fistula formation, although this has not been demonstrated.

Whereas there is no compelling reason to avoid transmucosal placement of absorbable suture in the nondependent (anterior) portion of the bladder when closing a cystotomy abdominally, it is preferable not to transgress the mucosa when sutures are placed in the dependent (posterior) portion of the bladder. Sokol et al. suggest that double-layer closure is superior to single-layer closure in preventing vesicovaginal fistula in an experimental laparoscopic hysterectomy model of electrocautery-induced bladder injury with laparoscopic repair in dogs (34). The second layer placed to imbricate the first is thought to diminish tension on the suture line and is recommended. Cystoscopy is imperative to evaluate ureteral and bladder integrity following completion of the repair but should avoid overdistention of the bladder. Some advocate retrograde filling of the bladder to check for integrity of the suture line. We have not found this very useful, as a hermetically sealed suture line may still break down subsequently and is therefore not the goal of bladder closure. Rather, the goal is approximation of healthy bladder mucosa and muscularis in a way that promotes subsequent normal healing of the suture line. Transurethral or suprapubic catheter drainage is designed to prevent bladder filling to avoid stretch on the suture line in the early phases of healing. Judgment should be exercised regarding duration of drainage based on the extent of injury, its location, the security of the closure, and any factors that may impact the normal healing process. Usually, we continue catheter drainage for 7 to 10 days following cystotomy and repair. A small extraperitoneal cystotomy with repair may require as little as 2 days for drainage; whereas transperitoneal bladder injury may require 3 to 4 weeks of catheter drainage following repair. Some advocate routine use of a cystogram prior to catheter removal, while others

recommend it only in cases where there is uncertainty regarding the healing of the bladder incision.

Nonsurgical Management of Vesicovaginal Fistula

Once a vesicovaginal fistula has been diagnosed, a trial of conservative management should be considered. Trans-urethral bladder drainage may help small early vesicovaginal fistulas resolve spontaneously and may be tried for 4 to 6 weeks, as long as catheterization is noted to resolve the vaginal leakage. Medical management should include optimizing nutrition, correcting anemia, and improving vaginal estrogenization (35). Some success has been reported with laser treatment of vesicovaginal fistula as well as fibrin glue and collagen (36,37,38). These novel approaches have not yet been adequately studied but may be considered in selected cases. The use of vaginal collection devices have been tried with limited success but may be offered for temporary relief from the constant urinary leakage that afflicts patients.

Surgical Correction of Vesicovaginal Fistula

When the patient fails or is otherwise not a candidate for conservative therapy, surgical repair is the only other alternative to relieve the patient's condition. Prior to surgery, some advocate the need to remove any transurethral catheterization for several days prior to clear the urine of any infection. This may be considered as long as the patient is able to adequately prevent skin excoriation and tolerate the increased leakage that she will experience.

The pelvic surgeon must determine the optimal timing, technique, and route of repair. There are no well-designed trials that adequately address any of these dilemmas. However, several general principles may apply and are discussed. Traditionally, delayed repair for several months was the norm to allow the tissue to heal from the inciting surgery, but more recently, surgeons have undertaken earlier repair following surgical fistulas as long as there is no evidence of infection, inflammation, or necrosis in the tissue bed (39,40,41,42). However, obstetrical and radiation injuries require more time to heal prior to attempting fistula repair. It is generally agreed that the first attempt at cure is also the best chance of cure.

In Sims's classic article regarding the surgical treatment of vesicovaginal fistulas, he emphasized the need to excise all scar tissue within the fistula and to create fresh tissue edges for reapproximation. Additional surgical principles include tensionfree closure of the wound with wide mobilization of the bladder to help achieve this, careful handling of tissues ensuring excellent hemostasis, and maintaining good bladder drainage postoperatively (43).

Despite these original tenets, there is no consensus whether to excise the margins of the fistula or not. Several series have reported success with preservation of the fistula margin, and some surgeons are concerned over making the fistulous opening larger, as occurs when one trims the fistulous tract (17,44). Others continue to report their experiences with excision of the tract (15,45). The purported benefit is allowing fresh tissue edges to be approximated, thereby promoting healing of these surfaces, and thereby reducing failure rates. Whereas there are no adequate studies that would conclusively show superiority of either of these techniques, it is interesting to note that there is limited discussion of retaining the fistula collar when operating transabdominally, reserving this debate primarily for the transvaginal approach. In the case of excision, another technical dilemma is whether to permit through and through suture reapproximation or to insist on excluding the mucosal layer from the stitch. Concern over incorporating the mucosal layer stems from the possibility that it would increase the likelihood of failure and may lead to stone formation, given that this region is the most dependent portion of the bladder and is always in contact with urine. The benefits of a through and through stitch is its ease and potentially better hemostasis at the incision site. It should also be noted that transvesical techniques used to perform complex procedures such as ureteroneocystotomy routinely make use of intravesical suture, albeit in more nondependent areas of the bladder, with no clear adverse effects. Since no evidence is available, the decision of how to close the suture line rests with the individual surgeon.

Perhaps the most intense debate surrounds the route of vesicovaginal repair-transabdominal or transvaginal. There seems to be general agreement that the vaginal repair is more convenient to the patient regarding recovery, length of hospital stay, and cosmetic issues but little agreement regarding which is the better operation. Absolute indications for an abdominal approach include conditions that require bladder augmentation (a small capacity or poorly compliant bladder, as may occur following radiation), a fistula involving or very close to a ureter requiring ureteral reimplantation, a combination fistula involving other intra-abdominal organs, inability to adequately expose the fistula transvaginally due to positioning, or other access problems. Given that posthysterectomy fistulas are uniformly supratrigonal in their location, the vast majority of vesicovaginal fistulas in the United States are in fact amenable to the vaginal approach (46). Some have concluded that abdominal approaches are outright superior, whereas others have used the vaginal approach as their preferred method (17,41,47,48,49,50).

Transvaginal repair reveals success rates of 77% to 99% (6,15,17,51). The use of this type of repair encompasses various techniques. No comparative studies are available to determine which specific vaginal procedure, if any, is superior. These success rates are comparable to success rates of 68% to 100% in various series that have been reported on transabdominal repairs (42,48,49).

Indeed, with the initial success rates being comparable, there remains no consensus regarding the optimal approach

to repair vesicovaginal fistulas. It is clearly important that surgeons who repair these lesions be comfortable with several different approaches and individualize their approach to the particular case at hand.

Various techniques have been described to augment fistula repairs, both for the transabdominal and transvaginal approaches. This is thought to bring additional tissue to interpose between the bladder and the vagina, and with it, a healthy blood supply. Occasionally, such grafts also serve to fill in large tissue defects as seen with large fistulas. The routine use of interposition grafts has been advanced by some; however, most surgeons use these adjuncts on an individual basis. It is generally agreed that tissue interposition is needed in radiation-induced fistulas or in other instances where there is local vascular compromise, such as recurrent, severely scarred, or previously infected fistulas.

Rangnekar et al. reported on Martius bulbocavernosus fat pad grafting to reinforce 21 obstetric urethrovaginal and vesicovaginal fistula repairs done transvaginally. Although they showed better cure rates for both types of fistulas with use of the graft, due to the small sample size, statistical significance was not reached. Out of 8 patients, 7 (87%) were cured of their urethrovaginal fistula, whereas all 13 patients (100%) with vesicovaginal fistulas were cured with use of the Martius graft (52). For extremely large defects, Punekar et al. reported 4 patients who had a myocutaneous modification of the Martius bulbocavernosus graft. The island of skin after sublabial transfer was sutured to the defect in the vaginal wall. This modified repair has been suggested for large obstetric or radiation-induced fistulas (53). Eilber et al. reported long-term results of transvaginal repair of complex or recurrent vesicovaginal fistulas with either peritoneal interposition graft for fistulas high in the vault or Martius flap or labial flap for distal defects (17). Cure rates were 96% of 83 patients with peritoneal graft, 97% of 34 patients with Martius fat pad graft, and 33% of 3 patients with a full-thickness labial flap, which was rotated onto the defect and was used mainly for very complex cases with multiple attempts at repair where there was insufficient vaginal epithelium for coverage of the fistula. Alternative flaps have been described, such as gracilis or rectus abdominis myocutaneous grafts in difficult circumstances (54,55). In 6 patients who failed urethrovaginal fistula closure with Martius transposition, Bruce et al. reported 100% successful resolution of the fistula when treated with a pedicled, tubularized rectus abdominis muscle flap interposed suburethrally (56).

When preparing patients for surgical correction of a vesicovaginal fistula, detailed informed consent and discussion are imperative. Patients with a fistula that occurs as a complication of benign pelvic surgery have already experienced an adverse outcome of which they usually have not been prepared. They present invariably with some degree of frustration, anxiety, and suspicion. All aspects of operative risk should be discussed with the patient prior to fistula repair, including the likelihood of fistula recurrence. Even in the event of successful anatomic repair, the occurrence or persistence of lower urinary tract symptoms such as incontinence, overactive bladder, voiding dysfunction, and bladder pain should also be reviewed. Discussing the expected recovery course of various available approaches and potential adverse consequences of associated procedures such as episiotomy or Schuchart incisions, disfigurement from flaps and discomfort from suprapubic and transurethral catheters seems to prepare patients for some of the difficulties that may lie ahead. This information should be incorporated into the decision of the route of repair, in which the patient should ideally be a partner. Patients undergoing a vaginal repair should be made aware of the possibility of needing to convert to an abdominal procedure, although this is a rare occurrence.

Transvaginal Vesicovaginal Fistula Repair

The patient is placed in the dorsal lithotomy position. Examination under anesthesia is performed with water cystoscopy. Utilization of the 30-degree and/or the 70-degree lens is used to best visualize the fistula intravesically and to identify any associated abnormalities. Identifying the intravesical and vaginal openings as well as assessing the tract's angle is important, because the next step is cannulation of the fistula. The fistula's proximity to the ureters is assessed, and transvaginal repair continued if it is not too close. Ureteral stenting may be done to continuously identify the ureters, if needed. Dilation of the fistulous tract allows an 8 French pediatric Foley catheter to be inserted and the balloon inflated. Appropriate traction allows the fistula to be brought distally for better access and exposure. When the tissue surrounding the fistula is extensively scarred, subepithelial injection of saline may be used to facilitate dissection of the vaginal flap. Some authors have advocated the use of epinephrine to diminish surgical bleeding. However, this technique raises a concern of delayed unrecognized bleeding in the dissected tissue bed, resulting in a hematoma and breakdown of the repair.

The vaginal mucosa is incised circumferentially around the fistulous opening; the vaginal mucosa is then carefully dissected off the bladder to a distance that will allow tension-free multiple-layer closure, approximately 1 to 2 cm radially around the circumferential incision. All tissue must be handled delicately with fine instruments that are of sufficient length to reach all levels of the fistula and the dissected tissues. Excellent hemostasis is best achieved with liberal use of pressure and subsequent suture closure, avoiding the use of electrocautery. if at all possible. If electrocautery must be used, it is used sparingly with a needle point at low-energy settings. The fistula collar is excised and sent for histological evaluation. Repeat cystoscopy may be used to verify the location of the ureters in relation to the somewhat larger fistulous opening, if this is a concern at

this time. A suprapubic catheter is then placed. The bladder mucosa is closed in the direction of least tension (side to side, or anterior to posterior) with interrupted 3-0 or 4-0 delayed absorbable suture, placed approximately 0.5 cm apart. Anterior to posterior orientation is preferable if the ureters are noted to be in close proximity to the defect once the fistula is excised. If extramucosal suturing is possible, then this is done; however, if desired, or if mucosal edge bleeding is encountered, through and through suturing should not be considered contraindicated. A second layer of bladder muscularis is brought together over the first suture line so that it imbricates over it. This is achieved with interrupted suture that is placed staggered in between the underlying stitches on the first layer (Fig. 28.1). If the bladder peritoneum can be mobilized over the repair, it is accomplished at this point. If a Martius fat pad transposition

is desired, this may be done instead of the peritoneal layer at this time. The vaginal mucosa is then closed with interrupted suture that is again staggered from the second bladder layer. At all stages of the closure, the absence of tension on each level is paramount to successful repair, as is hemostasis and verification of healthy, well-vascularized tissue for apposition. It is recommended to avoid using too many stitches and placing them too close together in an attempt to achieve a hermetically sealed closure, remembering that adequate tissue perfusion of well-oxygenated blood is just as important (if not more so) for ultimate healing of the incision. Repeat cystoscopy should be done to evaluate ureteral patency after injecting indigo carmine dye intravenously. Preventing overdistention of the bladder is important to maintain integrity of the fresh suture line; therefore, only a small volume of fluid is instilled.

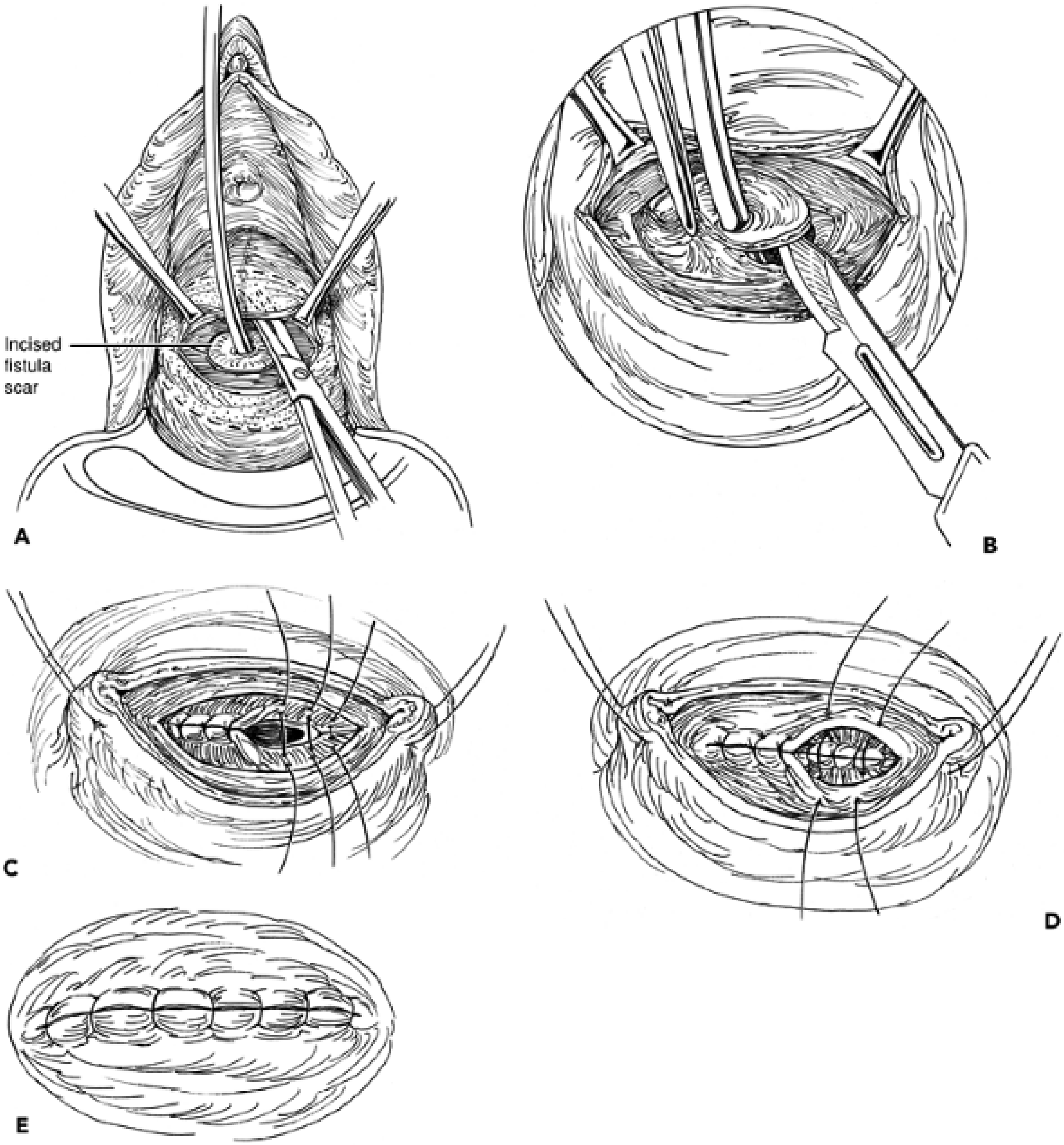

Figure 28-1 *Transvaginal vesicovaginal fistula repair with excision of the fistulous tract*. A: Initial incision of a circumferential collar around the fistulous opening. B: The vaginal mucosa is sharply dissected radially from the collar. C: The fistula is excised sharply, making sure that healthy vaginal tissue is left to be reapproximated. Excessive trimming should be avoided. D: Interrupted fine (3-0 or 4-0) delayed-absorbable suture on a small, tapered needle is used

(extramucosally, if possible) to close the first layer. Stitches are placed approximately 0.5-cm apart, with sufficient purchase of tissue to securely approximate the wound edges. Excessive tightening of the sutures and, thus, tissue strangulation must be avoided. E: The second layer imbricates over the first, with suture being placed in a staggered fashion using 3-0 interrupted delayed-absorbable suture.

The Latzko procedure begins in a similar fashion, with a circumscribing incision, and dissection of the vagina off the cervicovaginal fascia. Instead of excising the fistulous tract, it is imbricated into the bladder cavity with sequential layers of interrupted 3-0 or 4-0 delayed absorbable suture on a small, tapered needle. Care should be taken to stagger the sutures so that none lay atop the next layer. Cystoscopy should be used to verify adequate closure of the fistula and integrity of the ureters. Bladder peritoneum or a Martius flap can be interposed for additional support of the suture line.

Urethrovaginal Fistulas

The same principles of careful handling of tissues, good hemostasis, and tension-free apposition of tissues must be maintained with surgical correction of urethrovaginal fistulas. A distal fistula may be closed in a proximal to distal orientation to limit the possibility of urethral stenosis; otherwise, these lesions are closed side-to-side in layers. Eversion of the fistula edges into the limited urethral lumen is not recommended, and transmucosally placed suture are avoided if at all possible. If there is adequate substance, the fistula is minimally excised, but often there is enough loss of the urethral wall that this may be impossible without resultant stricture formation. Liberal use of a Martius flap or a pedicled rectus muscle flap for recurrent urethrovaginal fistula, if a previous Martius flap was employed and failed, is recommended (Fig. 28.2).

Postoperative Care

Ensuring proper bladder drainage is of utmost importance. This is accomplished in the early postoperative period with combined transurethral and suprapubic drainage. The transurethral catheter is removed once gross hematuria has cleared, usually within 1 or 2 days. The suprapubic catheter is left for 2 to 3 weeks, depending on the complexity of the repair. Some advocate routine evaluation with a cystogram prior to its removal, others do not.

Avoiding bladder spasms is considered important in preventing recurrence, although this has not been well studied. For most patients, anticholinergic medication, such as Oxybutynin (Ortho-McNeil Pharmaceutical Inc., Raritan, NJ) or Tolterodine (Pfizer Inc., New York, NY) is sufficient to avoid or treat these spasms. Some patients have severe pain associated with bladder spasms, and these may require belladonna and opioid (B&O) suppositories.

Single-dose antibiotic prophylaxis is given preoperatively with a first-generation cephalosporin similar to other gynecologic surgery cases. Routine use of oral postoperative antibiotic prophylaxis is not advocated in these patients.

Vaginal packing rarely seems necessary following fistula surgery and may place unnecessary tension on the suture line. Vaginal intercourse is prohibited for 2 to 3 months to allow complete healing of the suture line. The use of vaginal estrogen cream is encouraged preoperatively and is restarted 2 weeks following surgery to allow for re-epithelialization and strengthening of the incision.

Rectovaginal Fistulas

Epidemiology and Risk Factors

Rectovaginal fistulas are uncommon, comprising less than 5% of all anorectal fistulas, but present with severe distress and discomfort for the patient as well as a challenge for the operating gynecologist (57). They are classified on the basis of location, size, and etiology. Various classification systems have been proposed as they relate to location. A dichotomized system is used that separates high fistulas from low, states that a low rectovaginal fistula is located between the lower third of the rectum and the lower half of the vagina, and a high fistula is located between the upper two thirds of the rectum and the upper vagina. Low rectovaginal fistulas are further characterized by whether they are associated with disruption of the anal sphincter and/or the perineum. Another commonly employed system divides anatomic location of rectovaginal fistulas into low, near the vaginal opening up to the hymenal ring; mid, from the external cervical os to the hymenal ring; and high, which is in the area of the posterior cul-de-sac. Rectovaginal fistulas are in most cases less than Â½ cm in diameter, although when they are caused by obstructive labor or are recurrent in nature, they can involve loss of large areas of the rectovaginal septum.

Obstetric trauma such as perineal laceration or episiotomy, precipitous birth, forceps delivery, vacuum extraction, or unsuccessful attempts to repair third- or fourth-degree tears may result in a low rectovaginal fistula. Prolonged labor may cause a wide area of ischemic injury of the rectovaginal septum, with resulting large fistulas.

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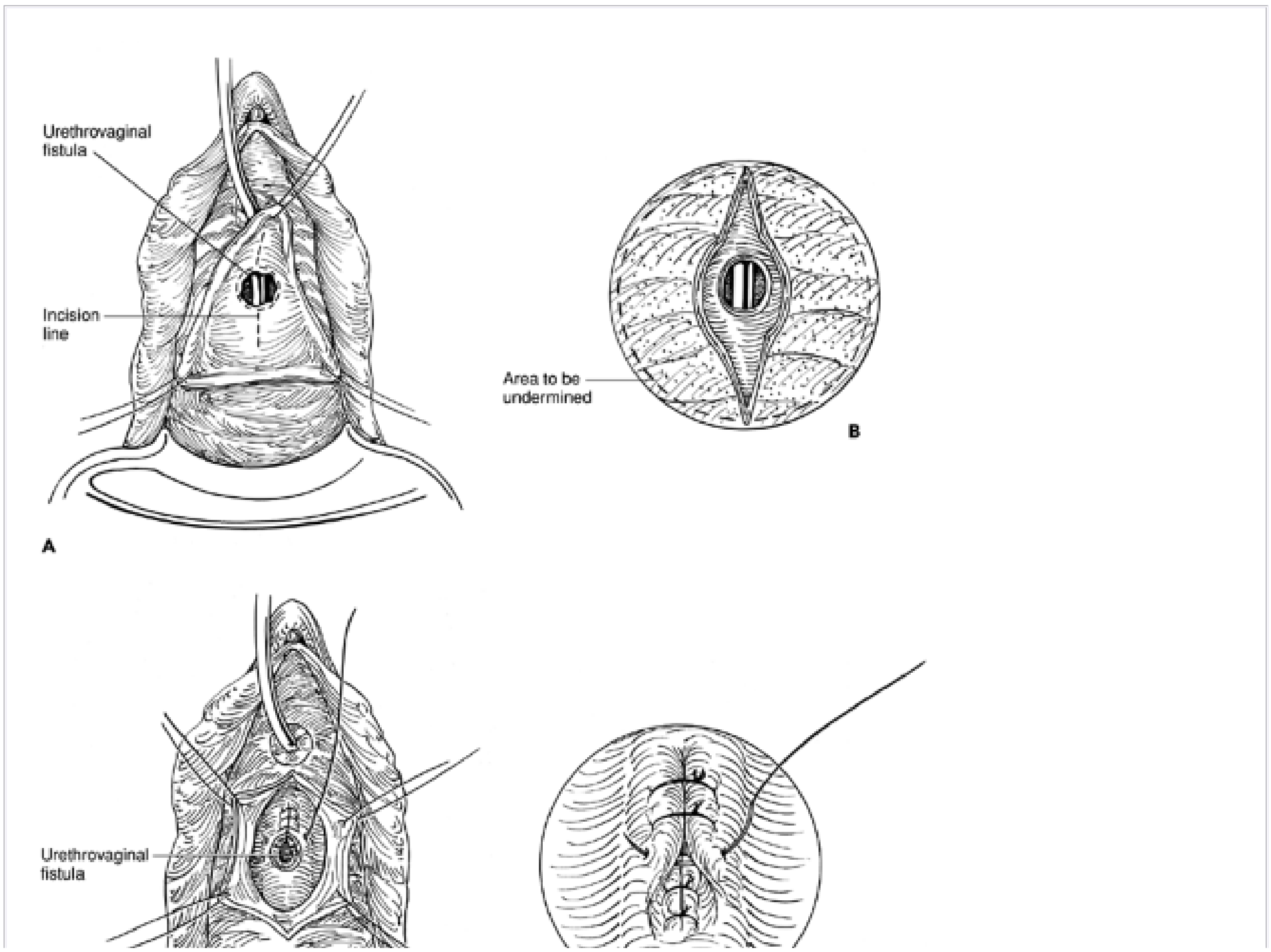
Vaginal or rectal operative procedures such as hysterectomy, rectocele repair, hemorrhoidectomy, excision of rectal tumors, and low anterior resection can also result in rectovaginal fistulas. Perirectal abscesses, when drained spontaneously or surgically, may result in fistulas that open into the vagina or perineum. Traumatic penetrating or blunt trauma including forced coitus may also be responsible for development of rectovaginal fistulas.



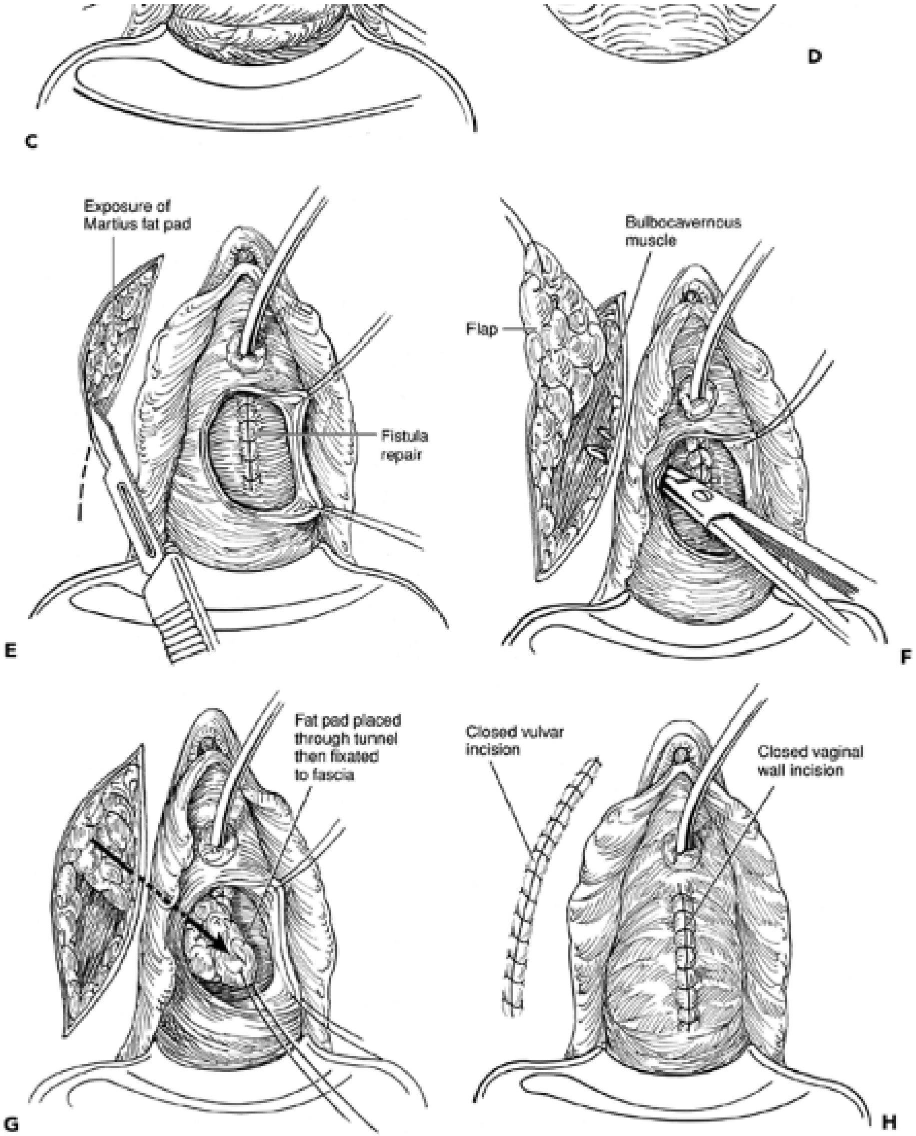


Figure 28-2 A-H: *Urethrovaginal fistula repair*. Note the initial circumferential incision with midline extension proximally and distally. Further lateral dissection exposes paraurethral tissue and allows for tensionfree closure. The first layer is closed by interrupted fine delayed-absorbable suture on a small, tapered needle, avoiding intramucosal placement. The second is an interrupted imbricating layer of paraurethral tissue. Martius fat pad transposition is highly recommended for these repairs and is achieved by making an incision over the labial fat pad, isolating the fat pad, and transecting it posteriorly to allow it to swing from its anterior attachment, relying on the blood supplied from the external pudendal and obturator arteries. Once it is detached, a submucosal tunnel is created and

enlarged to ensure adequate blood flow to the graft. The graft is pulled through the tunnel to the urethral incision and is sutured in place. Hemostasis of the donor site is verified, and the incision is closed.

Inflammatory bowel disease such as Crohn's or, much less commonly, ulcerative colitis is associated with rectovaginal fistula formation and should be strongly considered in any case of failed primary repair. These recurrent fistulas are complicated by the inflammatory disease process that causes them, and their management is beyond the scope of this chapter. A variety of infections, including diverticulitis, Bartholin's gland abscesses, lymphogranuloma venereum, tuberculosis, and HIV, may be seen as other complicating comorbidities.

Regressing or recurrent cervical, rectal, vaginal, or vulvar carcinoma, or the neoadjuvant radiation therapy prescribed for these conditions, may result in high rectovaginal fistulas. Radiation fistulas from external beam or intracavitary therapy may occur, with risk being dependent on the dose and method of application. Fistulas noted in these settings must be carefully evaluated for cancer recurrence and always treated as complex fistulas, with a propensity for failure.

In developed countries, rectovaginal fistulas after vaginal delivery are uncommon. A review of 20,500 vaginal deliveries in Arizona found only 25 patients (0.1%) who developed a rectovaginal fistula that required surgical correction (58).

Clinical Features

Extremely small rectovaginal fistulas may be entirely asymptomatic or intermittently so, often depending on stool consistency. When symptomatic, escape of gas may be the only complaint, or a slight fecal odor can be detected in the vaginal discharge. When the fistula is large, stool is evacuated through the vagina, with liquid fecal material passing even through small fistulous openings. Recurrent bouts of vaginitis and cystitis are common. When inflammatory bowel disease is the underlying etiology, bloody mucous and diarrhea are frequently noted.

The time from the initial insult to clinical presentation depends on the etiology of the fistula and the circumstances. Vaginal wall lacerations associated with unrecognized obstetric or operative injury typically present within the first 24 hours. In the case of an apparently normal fourth-degree laceration repair, infection and/or breakdown of the wound may occur within 7 to 10 days and result in formation of a rectovaginal fistula. In contrast, radiation-induced fistulas are slowly progressive, and necrosis due to devascularization may become symptomatic a few months or even years after the original insult.

Diagnosis

The diagnosis of simple rectovaginal fistulas usually can be accomplished by digital or anoscopic examination. In many instances, merely spreading the labia and inspecting the posterior vagina and perineum may reveal the fistulous tract. A speculum can be used and rotated 90 degrees to show a more proximal fistula. The darker rectal mucosa can often be seen at the fistulous opening in contrast to the pink vaginal mucosa membrane when the fistula is large. A pit or depression is palpable both rectally and vaginally on rectovaginal or rectoperineal examination. After prior unsuccessful repair, multiple fistula tracts can be identified by careful evaluation. In cases where there is difficulty in identifying the site of a small fistula despite strong clinical suspicion, filling the vagina with water and the rectum with air through a proctoscope will demonstrate bubbles rising from the fistula. Use of indigo carmine-stained surgical lubricant placed rectally while carefully assessing the vaginal mucosa for staining of blue dye is quite useful. If these diagnostic maneuvers are still not successful, the fistula may be higher in the vagina, and radiologic contrast studies are needed. This may include vaginography, barium enema, or CT scan with contrast. Proctosigmoidoscopy with biopsy should be used to exclude any underlying disease process whenever there is doubt regarding the specific etiology of a rectovaginal fistula.

Additional testing with endoanal ultrasound, anorectal manometry, and neurophysiologic studies may be useful in selected cases. It is currently recommended that patients with rectovaginal fistulas secondary to obstetric injury be evaluated for occult sphincter defects, as they influence the outcome of repair as well as the type of repair used (59). The assessment for occult sphincter defects may be done by endoanal ultrasound and/or anorectal manometry. Most low rectovaginal fistulas of obstetric origin involve the anal sphincter, and success rates are improved when concomitant anal sphincteroplasty is performed (59,60,61). Conversely, abnormal neurophysiologic testing would not preclude a surgical repair for rectovaginal fistula with or without sphincteroplasty, and it is therefore not routinely used in this context.

Management

Conservative management may be attempted in the hopes of allowing spontaneous healing following a small rectovaginal fistula of obstetric etiology; most, however, will require surgical intervention. The timing of repair depends on the integrity and health of the surrounding tissues. All infections must be treated with use of appropriate drainage and antibiotics. Traditionally, postobstetric fistulas required a waiting period of 3 to 6 months. This has been challenged, with earlier intervention being successful as long as the tissues remain soft, pliable, and adequately vascularized with no evidence of inflammation or infection. Vaginal estrogen cream and a bowel regimen, including fiber supplementation to improve bowel transit and consistency, may be used in preparation for surgery. It is not necessary, however, to unduly delay repair of a severely symptomatic patient as long as the tissues appear healthy. In contrast, attempted repair of radiation-induced fistulas may require up to a 1-year delay to ensure maximal resolution of tissue necrosis.

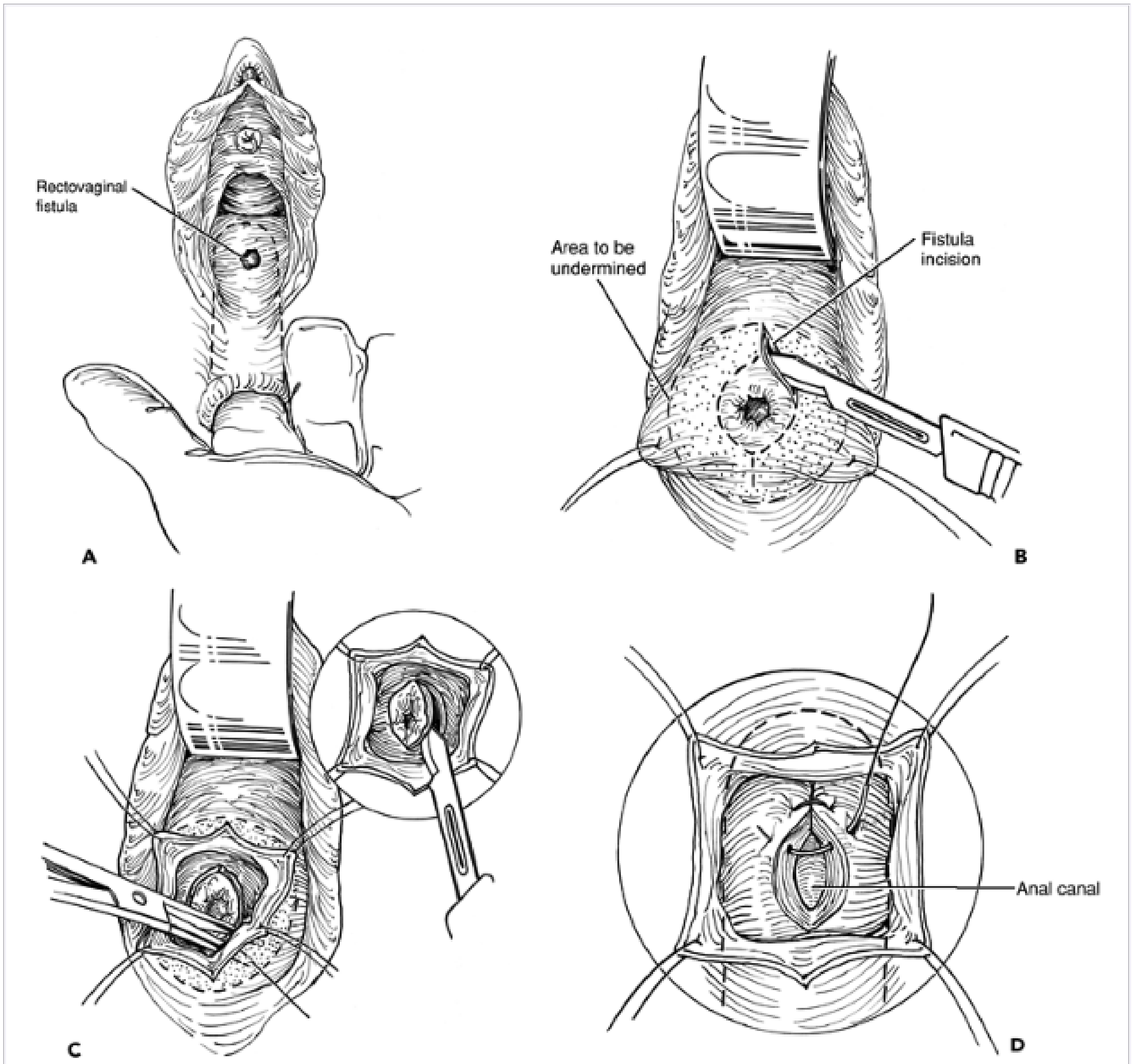
The patient is carefully counseled prior to surgery regarding the route, success, and any associated procedures she may need. Preoperative mechanical bowel preparation using magnesium citrate is given the day prior to surgery, and prophylactic antibiotics are administered intravenously 30 minutes prior to the procedure.

Surgical Therapy

The type of surgical repair depends on the size, location, and etiology of the rectovaginal fistula as well as surgeon preference and training. In case of a simple low fistula, transperineal, transvaginal, or transanal advancement flap closure may be selected. The transabdominal route of closure is often preferred for high rectovaginal fistulas. No adequately designed studies prove any of the approaches to be superior; therefore, the surgeon's experience dictates the operative choice.

Transperineal and transvaginal approaches have had good success rates ranging from 85% to 100% (62,63). In general, the transperineal approach is performed when the anal sphincters are involved and repair is necessary or when the perineal body is deficient and a perineorrhaphy is planned. This approach may be started with a curvilinear

incision along the anterior anal sphincteric border with dissection continuing cephalad to the level of the fistula and above. Alternatively, a transverse incision at the level of the posterior fourchette or dissecting off a triangular wedge of perineal skin may be used with further appropriate cephalad dissection. These also provide access to the posterior aspect of the bulbocavernosus muscles for performance of a perineorrhaphy, if needed.



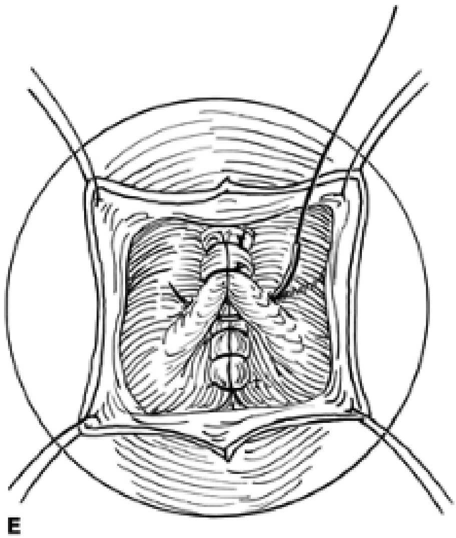

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Figure 28-3 A-E: *Low rectovaginal fistula, sparing the anal sphincter and with an intact perineal body*. Some authors consider this a midvaginal fistula. Repair involves circumcision of the fistulous tract, dissection of the vagina off the rectum, excision of the fistula, and closure of the rectal defect in two layers, followed by vaginal mucosal closure.

A fistulotomy involves cutting the entire bridge of perineal tissue superficial to the fistula. This is rarely necessary, except when a rectoperineal fistula is very distal and superficial.

Regardless of the incision used, the principles of repair are similar with all transperineal approaches. Wide dissection of the rectovaginal space is achieved sharply distal, proximal, and lateral to the fistula; the fistula is excised, and hemostasis is achieved with suture ligature and light electrocautery as long as it is away from the incision's edge. Closure of the wound starts with the rectal mucosa, with fine, delayed absorbable suture avoiding the bowel lumen. Then, the bowel serosa is imbricated on the first layer incorporating internal anal sphincter if it is disrupted with slightly larger caliber suture. This is followed by end-to-end repair of the external anal sphincter throughout its 4- to 5-cm length nearing the level of the levator ani muscle, without plicating it. Some authors prefer sphincteroplasty by an overlapping technique, although this has shown no definite benefit. If perineorrhaphy is needed, it is performed by plicating the posterior bulbocavernosus muscles to the midline. The newly rebuilt perineal body is used to anchor the distal torn end of the rectovaginal fascia to it using proximal to distal stitches to avoid stenosis at the introitus. The vaginal mucosa is trimmed only enough to provide fresh edges for reapproximation. All stitches are interrupted, including vaginal closure to allow careful apposition of surfaces with minimal distortion.

A transvaginal approach is preferable for low fistulas that do not involve the anal sphincters and for those in the midvagina. In all cases, excision of the fistulous tract is preferred with appropriate layered repair using interrupted delayed-absorbable sutures, avoiding sutures within the bowel lumen, followed by interrupted imbricating stitches (Fig. 28.3).

A Martius flap should be considered in cases of multiple surgical failure, extensive scar tissue, or radiation fistula. Fecal diversion with colostomy may be considered in unusual circumstances; however, in the author's experience, this is rarely necessary. The colorectal literature is replete with discussion of the merits of levatoroplasty. Nonetheless, levator plication is not recommended at the time of surgical repair due to the risk of subsequent dyspareunia.

Postoperatively, a liquid diet is recommended for several days. Pain control is administered by intravenous patient-controlled narcotics or epidural anesthesia. A Foley catheter is left in place for several days, and a low-residue diet is prescribed as well as stool softeners.

Small series of simple and recurrent rectovaginal fistulas have been treated with fibrin glue. In one report, six of eight patients with recurrent rectovaginal fistulas were successfully treated (64). This technique has not gained widespread popularity. Recently, some small case reports have surfaced utilizing polyglycolic acid mesh or porcine dermal graft materials to reinforce repair of rectovaginal fistulas (65,66). These adjuncts should be used with caution due to the potential increased risk of infection and subsequent breakdown of the repair.

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Urinary Tract Injuries

Ira R. Horowitz

Urinary tract injuries frequently are not diagnosed intraoperatively and can result in permanent disabilities. Quality of life can be negatively impacted if urinary tract injuries are not identified and corrected in an appropriate manner. Through early detection, we can enhance our ability to have a satisfactory outcome. Intraoperative diagnosis of an injury is frequently made through direct visualization at the operative site or with use of cystoscopy. Unfortunately, delayed diagnosis of ureteral injuries can present in a nonspecific fashion. If bilateral ureteral injury, such as ligation, has occurred, the patient may present with a transient elevation in creatinine. Symptoms may manifest as costovertebral angle tenderness, and fever and/or an intestinal ileus can also be secondary to ureteral injury (1). Diagnosis of a vesicovaginal or vesicoileo fistula is more straightforward, with urine draining through the vagina and/or colon. Throughout this chapter, studies that have evaluated the incidence of urinary tract injury with various gynecologic procedures, as well as methods of detection, repair, and prevention, will be reviewed. At the conclusion of the chapter, there will be a discussion of the medical and legal implications of urinary tract injuries.

Ureteral trauma is the most common form of injury to the urinary tract. A retrospective review of 45 patients with ureteral injuries at the University of Alabama-Birmingham, Hammontree et al. showed that 44% of these injuries were secondary to gynecologic procedures (2). Of all ureteral injuries, 65% were of the distal ureter. It should be noted that only one of 19 gynecologic injuries was secondary to a vaginal procedure (Table 29.1).

One percent of all gynecologic procedures are complicated by urinary tract injury (3). The incidence of ureteral injuries occurs in between 0.4% and 2.5% of benign gynecologic surgical procedures (3 ,4 ,5). Bladder injuries have been reported to be as high as 1.8% for abdominal hysterectomies and 0.4% for vaginal hysterectomies (6). Gilmour and Baskett report that overall bladder injury in benign gynecologic surgery occurs in 3 to 12 per 1,000 procedures (4). In laparoscopic-assisted vaginal hysterectomies (LAVH), ureteral injuries have been reported as high as 4.3% (7 ,8). In vaginal hysterectomies, urinary tract injuries have been reported from 0.04% to 0.98%. Abdominal hysterectomies are higher at 0.05% to 0.97%, and radical hysterectomies are 1.2% to 1.7% (7).

In a meta-analysis evaluating methods of hysterectomy, urinary tract injuries (bladder and ureter) in laparoscopic hysterectomies were at greatest risk followed by LAVH when compared with abdominal hysterectomies. All vaginal hysterectomies appeared to fare better (95% confidence interval [CI]) than the laparoscopic approach. Evidence-based reviews of randomized clinical trials do not support that LAVH have a significant increase in urinary tract injuries when compared with vaginal hysterectomies. A laparoscopic hysterectomy with laparoscopic uterine artery ligation, however, poses an increased risk of urinary tract injury (Fig. 29.1).

Vaginal Hysterectomy

In 1982, the collaborative review of sterilization (CREST) study reviewed complications of abdominal and vaginal hysterectomies (9). Bladder injury in vaginal versus abdominal hysterectomy was 1.4% versus 0.3%, respectively. This was consistent with Kovac's observation of 1.5% versus 0.6% in the difficult hysterectomy patient (10). As a result of procedures such as coring described by Kovac, surgeons are attempting to remove larger uteri vaginally. An additional reason for bladder injury during hysterectomy is secondary to the increasing number of patients postcesarean section (11). Vesicovaginal fistulas are reported to be between 0.1% and 0.2% of patients undergoing vaginal hysterectomies (12) (Table 29.2).

The CREST trial reported a ureteral injury rate of 0.2%. Vaginal hysterectomies have a lower incidence of urethral injury versus abdominal hysterectomies (Table 29.2).

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This is further illustrated by Harkki-Siren et al. who analyzed 142 urinary tract injuries after hysterectomy in Finland from 1990 to 1995 (13). A total of 62,379 hysterectomies were performed during this period of time (Table 29.3).

Gynecologic surgery
TAH-BSO benign
9
4
5
9
â€”
â€”
TAH-BSO cervical cancer[a]
5
2
5
7
1
â€”
TAH-BSO ovarian cancer
1
â€”
1
â€”
1
â€”
Recurrent pelvic mass (ovarian carcinoma)
1
1
â€”
1

â€”
â€”
Cesarean section
2
â€”
2
2
â€”
â€”
Pelvic prolapse vaginal repair
1
â€”
1
1
â€”
â€”
Subtotal
19
7
14
20
2
â€”
Trauma
Gunshot wound
9
4
5
5
2
2
Motor vehicle accident
2
1

1
â€”
â€”
2
Subtotal
11
5
6
5
2
4
Urologic surgery
Ureteroscopy for stones[b]
8
4
4
6
3
â€”
Other surgery
Vascular (AAA)
3
1
2
1
2
â€”
Colorectal
2
â€”
2
â€”
2
â€”

Orthopedic/spine
2
â€”
2
â€”
2
â€”
Subtotal
7
1
6
1
6
â€”
Total
45
17
30
32
13
4
Patients (%)
â€”
38
66
71
29
9
[a] Two patients with bilateral injuries and one multifocal mid and distal.
[b] One patient had multifocal injury with mid and distal stricture in the same ureter. TAH-BSO, total abdominal hysterectomy with bilateral salpingo-oophorectomy; AAA, abdominal aortic aneurysm.
Adapted from Hammontree, Wade BK, Passman CM, et al. Ureteral injuries. Recent trends in etiologies, treatment, and outcomes. *J Pelvic Med Surg.*

2005;11:129â€“136.

Number	Right	Left	Distal	Mid	Upper

Table 29.1 Etiologies and Location of Ureteral Injuries

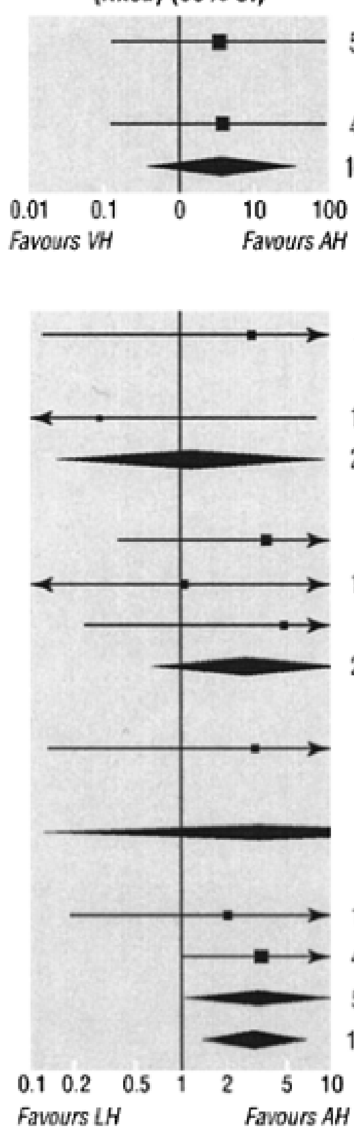
Ureteral injury was markedly less in the total vaginal hysterectomy (TVH) group. Of note, in this large series, bladder injury was the lowest in the total vaginal hysterectomy group as well. In a small series of vaginal hysterectomies reported by Mathevet et al. from Lyon, France, during a 26-year period, the authors performed 3,076 total vaginal hysterectomies (14). Fifty-four patients had bladder laceration (1.7%) and only one had ureteral injury. The patient with the ureteral injury had multiple conizations prior to her total vaginal hysterectomy. Four of the patients with bladder injury developed a vesicovaginal fistula postoperatively. Two were treated with catheter drainage for 1 month with complete resolution of the fistula, and the remaining two required a Latzko procedure at 1 and 3 months. Of the bladder injuries reported, 61% occurred during the vaginal hysterectomy step of the procedure. The remaining 39% occurred while performing additional procedures such as colporraphies after the hysterectomy had been performed.

Laparoscopic-assisted Vaginal Hysterectomies

Ostrzenski et al. performed a 37-year literature search and found 2,491 cases that discussed laparoscopic ureteral complications, with a total of 70 ureteral injuries identified (15). Fourteen of the 70 (20%) occurred during LAVH. Twenty-four percent utilized electrocautery, and 70% of all laparoscopic ureteral injuries were diagnosed postoperatively. A review of the literature from 1989 to September 1995 identified 3,112 laparoscopic-assisted hysterectomies, 1,618 abdominal hysterectomies, and 690 vaginal hysterectomies (16). Evidence of bladder injury was significantly higher for LAVH versus TAH (1.8% vs. 0.4%, $p = 0.01$). The complication rate from LAVH was significantly higher than that from abdominal hysterectomy (0.8% of LAVH had bladder trauma, 0.04% had fistula, and 0.3% had ureter trauma vs. 0% in the abdominal hysterectomy component of these studies). In Finland, the National Registry of Urinary Tract Injuries After Hysterectomy from

1990 to 1995 showed a significantly higher incidence with laparoscopic hysterectomy versus abdominal, supracervical abdominal, and vaginal hysterectomy, respectively (Table 29.4).

Utilizing female mongrel dogs to identify ways to decrease the formation of vesicovaginal fistulas in rectosurgical cystotomies, Sokal et al.showed that using two-layer closure 2-0 polyglactin was superior to single-layer closure (17). No benefit from these studies could be ascertained from resecting the electrosurgical burn margin or by utilization of an omental flap.



Type of hysterectomy			Weight (%)	Odds ratio (fixed) (95% CI)
Vaginal v abdominal	**No (VH)**	**No (AH)**		
Ottoson	1/40	0/40	50.92	3.08 (0.12 to 77.80)
Benassi	0/60	0/59		Not estimable
Ribiero	1/20	0/20	49.08	3.15 (0.12 to 82.16)
Total (95% CI)	2/120	0/119	100.00	3.11 (0.31 to 30.90)
Laparoscopic v abdominal				
LAVH v AH	**No (LH)**	**No (AH)**		
Marana	1/58	0/58	5.06	3.05 (0.12 to 76.48)
Ottoson	0/40	0/40		Not estimable
Tsai	0/100	1/100	15.50	0.33 (0.01 to 8.20)
Subtotal (95% CI)	1/198	1/198	20.56	1.00 (0.14 to 7.17)
LH(a) v AH				
Langebrekke	3/46	1/54	8.93	3.70 (0.37 to 36.83)
Olsson	1/71	1/72	10.16	1.01 (0.06 to 16.54)
Summitt	2/34	0/31	5.04	4.85 (0.22 to 104.99)
Subtotal (95% CI)	6/151	2/157	24.13	2.81 (0.64 to 12.29)
TLH v AH				
Perino	1/51	0/51	5.04	3.06 (0.12 to 76.88)
Ribiero	0/20	0/20		Not estimable
Subtotal (95% CI)	1/71	0/71	5.04	3.06 (0.12 to 76.88)
Non-categorisable LH v AH				
Lumsden	2/95	1/95	10.16	2.02 (0.18 to 22.68)
Garry	20/584	3/292	40.11	3.42 (1.01 to 11.59)
Subtotal (95% CI)	22/679	4/387	50.27	3.13 (1.06 to 9.28)
Total (95% CI)	30/1099	7/813	100.00	2.61 (1.22 to 5.60)
Laparoscopic v vaginal				
LAVH v VH	**No (LH)**	**No (VH)**		

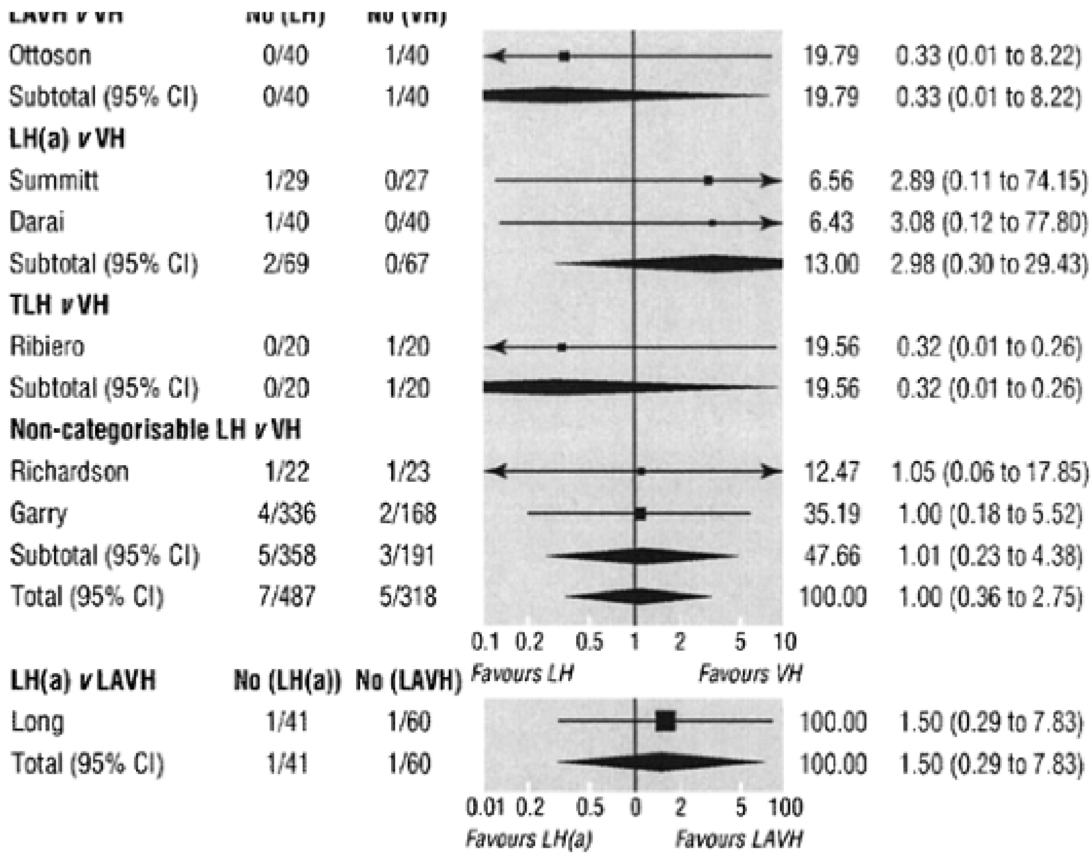


Figure 29.1 Meta-analysis of urinary tract (bladder or ureter) injury. Statistical pooling used fixed effects statistical model (no statistical heterogeneity present). AH, abdominal hysterectomy; VH, vaginal hysterectomy; LH, laparoscopic hysterectomy; LAVH, laparoscopic assisted vaginal hysterectomy; LH(a), laparoscopic hysterectomy where laparoscopic procedures include uterine artery ligation; TLH, total laparoscopic hysterectomy. (From, Johnson N, Barlow D, Lethaby A, et al. Methods of hysterectomy: systematic review and meta-analysis of randomized controlled trials. 2005;330:1478â€“1481 , with permission.

Vaginal Suspensions: Tensionfree Vaginal Tape

In 2001, Tamussino et al. reported on 2,795 tensionfree vaginal tape (TVT) operations reported to the Austrian registry by 55 institutions (18). Twenty-eight percent (773 patients) had previous incontinence procedures performed. Fifty-nine percent (1,640 patients) had tensionfree vaginal tape operations as a single procedure. The overall bladder perforation rate in this review was 2.7% (75 patients).

Those who had previous surgery were twice as likely to have bladder injury compared with surgically naive patients (4.4% vs. 2.2%, $p = 0.01$). Traumatic injuries requiring reoperation included 19 hematomas and one bowel injury. An additional 2.4% (68 patients) required additional surgery related to tape placement. Though bladder perforation increased with previous operative intervention, hemorrhage did not (18) (Table 29.5).

In their review of occult bladder injuries during the TVT procedure at Louisiana State University-New Orleans, Shobeiri et al. reported that 96% of patients had their defect identified during cystoscopy (19). Seepage of fluid around the plastic sheath was usually indicative of bladder injury. In a 13-month period, 140 patients underwent TVT with 16 complications (19) (Table 29.6). All bladder and uretheral injuries resolved spontaneously with prolonged catherization.

Over a 5-year period, Wang performed 600 TVT procedures at the Chang Gung University School of Medicine in Taiwan (20-29). Thirty-one percent (188 patients) had previous surgery, and 72% (431 patients) had TVT as a single procedure. Bladder perforation was present in 0.8% (5/600) of patients undergoing TVT. Cystourethroscopic surgery was used to identify injuries to the bladder. As with the group in New Orleans, fluid from the trocar sleeve was indicative of a bladder injury and required further investigation.

Karram et al. had a slightly higher complication rate in their first 350 patients (21). Seventeen patients had bladder perforation (4.9%), and six patients (1.8%) had hematomas postoperatively, with two patients requiring surgical intervention. Three additional patients experienced transient nerve injuries. The injuries were ilioinguinal, femoral, and obturator. All of these injuries resolved spontaneously within 6 weeks postoperative (Fig. 29.2).

Suprapubic Arch Slings

Kobashi and Govier reported on their first 140 patients undergoing SPARC polypropylene pubovaginal slings at the Continence Center of Virginia Mason in Seattle, Washington (22). Six patients (4.3%) required some form of intervention. Four patients (2.2%) experienced bleeding and required 2 to 6 units of packed red blood cells postoperatively. An additional patient had a postoperative hematoma that was drained percutaneously without further complications. The sixth patient presented with a bowel fistula identified on postoperative day 4. Computerized axial tomography (CAT) scans in this patient revealed a small bowel perforation that required surgical intervention. Postoperative findings revealed a loop of small bowel densely adherent to the pubic symphysis on which the sling was misplaced. A small bowel resection and reanastomosis was performed, and the patient's course was otherwise uneventful.

P.360

Bladder
0.2â€“2.3
1â€“2
0.3
0.3â€“1.5
0.5â€“1.5
1.4
Bowel
0.1â€“1
0.1â€“0.5
0.3
0.1â€“0.8
0.1â€“0.8
0.6
Ureter
0.1â€“1.7
0.1â€“1.5
0.2
0â€“0.10
0.05â€“0.1
0
Vesicovaginal fistula
0â€“0.25
0.1â€“0.2
0

0.05â€“0.6
0.1â€“0.2
0.2
Harris WJ. Early complications of abdominal and vaginal hysterectomy. *Obstet Gynecol Surv.* 1995;50(11):795â€“805.

Abdominal Hysterectomy			Vaginal Hysterectomy		
All Reported Rates (%)	Most Commonly Reported Rates (%)	CREST (%)	All Reported Rates (%)	Most Commonly Reported Rates (%)	CREST (%)

Table 29.2 Injuries to Adjacent Organs

Laparoscopic hysterectomy
38 (13.9%)
18 (6.6%)
6 (2.2%)
Total abdominal hysterectomy
18 (0.4%)
9 (0.2%)
45 (1.0%)
Supracervical abdominal hysterectomy
3 (0.3%)
3 (0.3%)
0
Total vaginal hysterectomy
1 (0.2%)
0
1 (0.2%)
Harkki-Siren P, Sjoberg J, Tiitinen A. Urinary tract injuries after hysterectomy. *Obstet Gynecol.* 1998;92:113â€“118.

Table 29.3 Urinary Tract Injury Per 1,000

Procedure	Ureteral Injury	Bladder Injury	Vesicovaginal Fistula	All
LH	38 (1.40%)	18 (0.70%)	6 (0.70%)	62 (2.30%)
TAH	18 (0.04%)	9 (0.02%)	45 (0.10%)	72 (0.20%)
SAH	3 (0.03%)	3 (0.30%)	0 (0.00%)	6 (0.06%)
VH	1 (0.02%)	0 (0.00%)	1 (0.02%)	2 (0.04%)

Values are given as number of injuries (%).

LH, laparoscopic hysterectomy; TAH, total abdominal hysterectomy; SAH, supracervical abdominal hysterectomy; VH, vaginal hysterectomy.

Adapted from Harkki P, Kurki T, Sjoberg J, et al. Safety aspects of laparoscopic hysterectomy. *Acta Obstet Gynecol Scand.* 2001;80:383â€“391.

Table 29.4 Urinary Tract Injuries After Hysterectomy in Finland in 1990â€“1995

Bladder perforation

75 (2.7)

41 (2.0)

34[a] (4.4)

<0.01

Increased bleeding

65 (2.3)

50 (2.5)

15 (1.9)

[a] Including four perforations (3.3%) in 120 patients after colposuspension.

TVT, tensionfree vaginal tape.

Adapted from Tamussino KF, Hanzal E, Kolle D, et al. Tension-free vaginal tape operation: results of the Austrian registry. *Obstet Gynecol.* 2001;98:732â€“736.

	Overall (*n* = 2795) (%)	Primary TVTs *n* = 2002) (%)	Secondary TVTs (*n* = 773) (%)	*p*

Table 29.5 Intraoperative Complications in 2795 Patients With or without Previous Surgery for Pelvic Organ Prolapse or Incontinence

All bladder injuries

6

4.0%

(0.016, 0.091)

Resolved with prolonged catherization

Occult bladder injuries

3
2.0%
(0.004, 0.061)
Noted with repeat cystoscopy
Overt bladder injuries
3
2.0%
(0.004, 0.061)
Resolved with prolonged catherization
Urethral injury
2
1.0%
(0.002, 0.510)
Resolved with prolonged catherization
Vaginal hematoma
4
3.0%
(0.008, 0.072)
Resolved spontaneously
Urinary retention
3
2.0%
(0.004, 0.061)
Resolved with intermittent catherization
Retropubic hematoma
1
0.7%
(0.0020, 0.0392)
Required evacuation

Adapted from Abbas Shobeiri S, Garely AD, Chesson RR, et al. Recognition of occult bladder injury during the tension-free vaginal tape procedure. *Obstet Gynecol.* 2002;99:1067â€“1072.

Intraoperative Complications	Incidence	Confidence Interval (95%)	Outcome

Table 29.6 Summary of Complications in 140 Patients

Andonian et al. randomized 84 women with stress urinary incontinence to the use of either the suprapubic arch sling (SPARC) or TVT (23). Forty-one patients were randomized to SPARC and 43 patients to the TVT procedure. Although blood loss was minimal (0 to 50 cc), bladder perforation was 24% and 23%, respectively. The SPARC group had one tape erosion as well as one patient with an infected hematoma. Cure rates at 12 months were not statistically significant between the two procedures (83% vs. 95%, *p* <-1pt 0.1).

A second prospective, randomized trial by Tseng et al. reported on 62 women assigned to SPARC and TVT groups (24). Although no statistical difference was noted, four patients in the SPARC group had a bladder injury (12.9%) versus none of the TVT patients. The authors contribute this to a learning curve, this being their first series of SPARC patients. The lack of significance is most probably secondary to the small number of patients in each group. In addition, both groups had comparable complication and success rate (Fig. 29.3).

Transobturator Tape

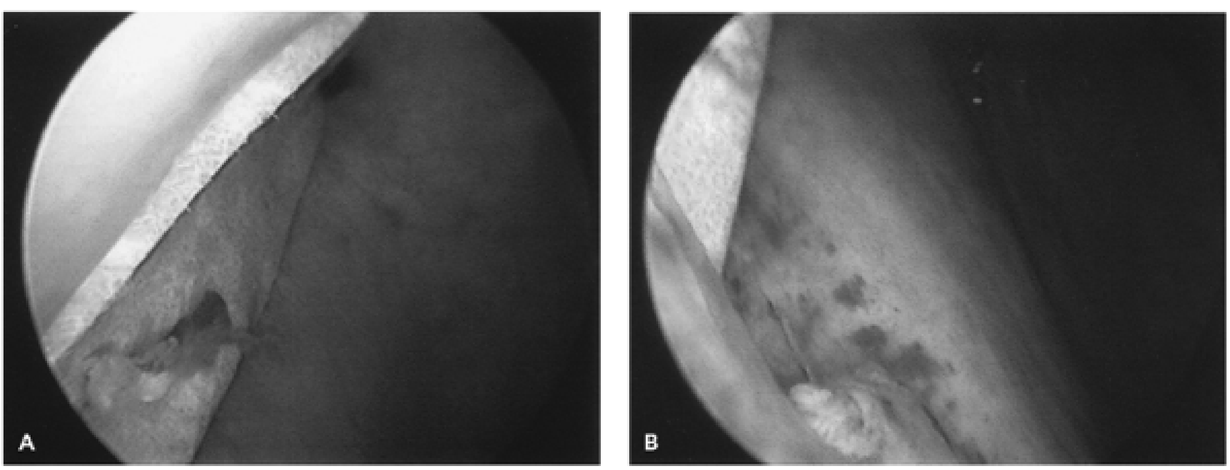


Figure 29.2 A,B: Cystoscopy of vaginal tape in bladder. (Courtesy of Rony Adam, M.D., Emory University School of Medicine.)

In 2001, Delorme reported on the transobturator suspension (25). In 2003, Delorme et al. reported on the success and complications of his first 32 transobturator tape (TOT)

(urotape) patients (26). No urinary tract injuries were identified with the TOT. Delorme feels that this technique is superior to other slings because its placement avoids the bladder, bowel, and vascular supply. deTayrac et al. performed a randomized, prospective trial comparing TVT (31 patients) and TOT (30 patients) (27). Three patients (9.7%) had an iatrogenic bladder injury versus none in the TOT group ($p > 0.05$). Operative time of TVT was significantly higher secondary to the addition of cystoscopy (Table 29.7).

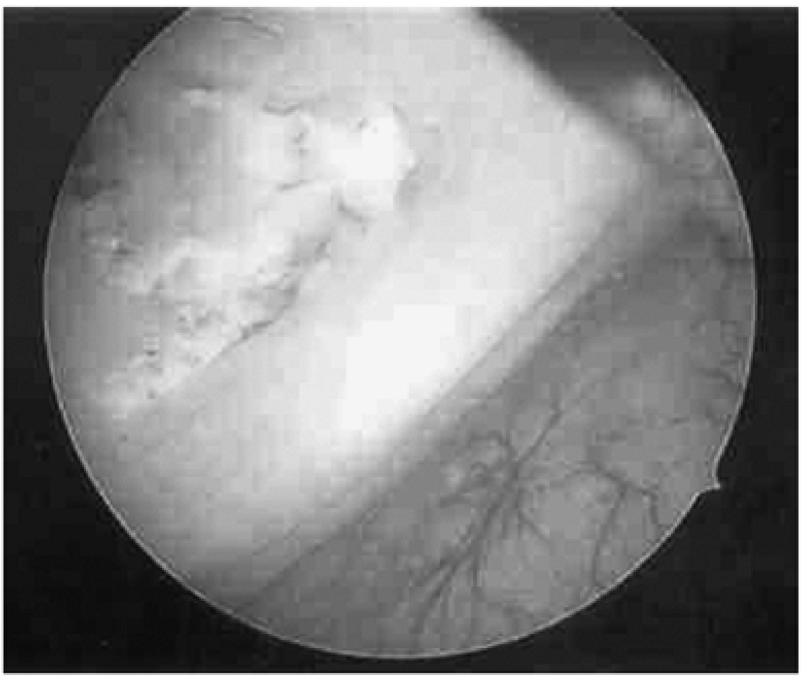


Figure 29.3 SPARC eroding into bladder. (Courtesy of Rony Adam, M.D., Emory University School of Medicine.)

The authors did not believe that cytoscopic evaluation was required in patients undergoing the TOT without cystoceles. The addition of cystoceles increased the risk of bladder injury and therefore required further evaluation. The lack of significance between the bladder injuries in the TVT and TOT patients is most probably secondary to the small number of patients in each group.

Location of the Ureters

Hurd et al. evaluated 52 randomly selected patients who had undergone computerized tomography and had a uterus and cervix present (28). Patients with pelvic pathology were excluded. The location of the ureter to the uterine cervix as well as the effect of age and body mass index (BMI) was evaluated. The mean distance of the ureter to the cervical margin was 2.3 0.8 cm. In 12% of patients, the ureter was 0.5 cm from the cervical margin of at least one side. Although not significant, there appears to be a linear relationship between BMI and the position of the ureter to the uterine cervix. The heavier the patient, the closer the ureter is to the cervical margin (p = 0.49) (Fig. 29.4).

Duration of procedure (minutes)
14.8 Â± 4.3
26.5 Â± 7.7
<.001[a]
Hospital stay (days)
1.2 Â± 1.3
1.1 Â± 0.4
NS[a]
Operative complications
Bladder perforation
0
3 (9.7)
NS[b]
Hemoglobin loss (g/dL)
1.1 Â± 0.6
1.2 Â± 0.5
NS[a]
Postoperative urinary retention
PVR at day 1 >100 mL
4 (13.3)
8 (25.8)
NS[b]
PVR at day 2 >100 mL

3 (10.0)

2 (6.5)

NS[b]

PVR >100 mL after day 2

1 (3.3)

0

NS[b]

Postoperative complications

Vaginal erosion

0

0

NS[b]

Urethral erosion

0

1 (3.2)

NS[b]

Obturator hematoma

1 (3.3)

0

NS[b]

Urinary infection

6 (20.0)

4 (12.9)

NS[b]

Values are mean Â± SD and n (%).

[a] Student t test.

[b] Chi-square test.

TOT, transobturator tape; TVT, tensionfree vaginal tape; PVR, postvoid residual volume; NS, not significant.

Adapted from deTayrac R, Deffieux X, Droupy S, et al. A prospective randomized trial comparing tension-free vaginal tape and transobturator suburethral tape for surgical treatment of stress urinary incontinence. *Am J Obstet Gynecol.* 2004;190:602â€“608.

	TOT (n = 30)	TVT (n = 31)	p Value

Table 29.7 Operation Details, Hospital Stay (Operative and Postoperative), and Complications

It is imperative that pelvic surgeons continue to develop and recommend techniques to prevent urinary tract injuries in gynecologic surgery. The mantra of adequate exposure and knowledge of anatomy holds true for vaginal as well as abdominal surgery. Some surgeons, unfortunately, try to perform vaginal procedures without the appropriate instrumentation. The type and size of the instrument will vary depending on the size of the patient and the planned procedure. The surgeons should make themselves knowledgeable of the various instrumentation available through their respective institutions and various surgical instrument companies prior to performing these procedures. The appropriately sized vaginal retractors will enable surgeons to have adequate exposure and to decrease the potential of urinary tract injury. As mentioned previously, distance from the ureter to the cervix can be less than 0.5 cm in approximately 12% of the population. Placing the hysterectomy clamp close to the cervix will decrease the likelihood of ureteral injury. Cruikshank and Kovac were able to demonstrate that after incising the uterosacral cardinal complex, the ureters were deviated away from the field downward traction (29 ,30 ,31). Recently, endovascular staplers, harmonic scalpels, and electrosurgical devices have been used to ligate and incise the vascular supply and cardinal ligaments. It is incumbent on surgeons to ensure that the bowel is not in close proximity to the cautery device. Prior to using a cautery device, the surgeon should also be familiar with thermal damage that occurs adjacent to the clamp. Harmonic scalpels may provide a slight advantage in this setting. The use of some harmonic products requires more experience and a steeper learning curve. Irrespective of the methods used, there is a potential risk of injury to or ligation of the ureter. It is imperative that the surgeon maximizes his or her ability to prevent these injuries.

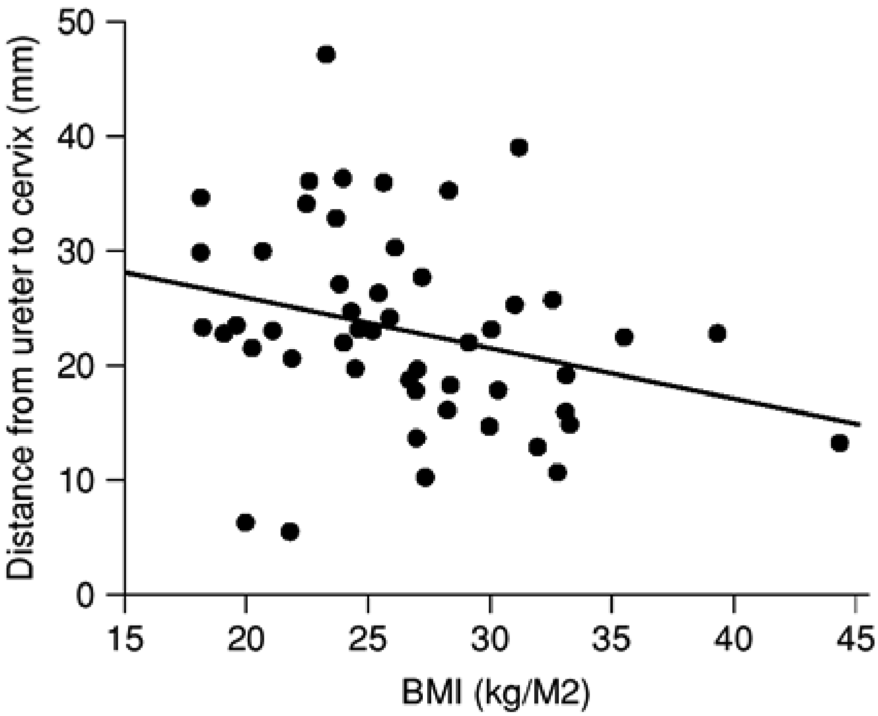


Figure 29.4 Relationship of distance between ureter and uterine cervix and BMI. Each *point* is the average distance for the right or left ureter for a single patient (*n* = 52). The *bold line* is the plot of linear regression of these two measurements. (From,
Hurd WW, Chee SS, Gallagher KL, et al. Location of the ureters in relation to the uterine cervix by computed tomography *Am J Obstet Gynecol.* 2001;184:336â€“339 , with permission.)

Cystoscopy

A 6-year study by Dowling et al. revealed that 52% of iatrogenic ureteral injuries were secondary to gynecologic surgery (32) (Table 29.8). In review of the literature for a 22-year period from 1966 to 1998, Gilmour et al. reviewed the role of cystoscopy in identifying intraoperative urinary tract injuries (33). In patients who underwent cystoscopy, the injury was identified and permitted immediate repair.

Kwon et al. performed 526 urologic and vaginal reconstructive procedures in a 4-year period ending in April 2001 (34). All patients underwent postoperative cystoscopy. Twenty-six patients (4.9%) had cystoscopic findings. Fifteen (2.9%)

were secondary to iatrogenic injuries (Table 29.9).

Anterior colporrhaphy is the common cause of unrecognized injury. Vakili et al. at Louisiana State University-New Orleans reported a 4.8% incidence of urinary tract injury during hysterectomy (35). Ninety-six percent (24/25) were detected intraoperatively. One patient had a normal cystoscopic examination and developed a vescovaginal fistula postoperatively. Only eight injuries were identified prior to cystoscopy. Sixteen injuries would not have been identified if universal cystoscopy had not been performed in addition to the hysterectomy.

Table 29.8 Ureteral Injuries Secondary to Gynecologic Surgery

	Studies without Cystoscopy	Studies with Cystoscopy
Ureteral injury		
Range	0 to 14/1000	0 to 26.8/1000
Incidence identified intraoperatively	1.6/1000	6.2/1000
Bladder Injury		
Range	0.2 to 19.5/1000	10.4/1000
Identified intraoperatively	51.6%	85%

Adapted from Dowling RA, Corriere JN Jr, Sandler CM. Iatrogenic ureteral injury. *J Urol.* 1986;135:912â€“915.

Visco et al. evaluated the cost-effectiveness to perform universal cystoscopy to identify ureteral injuries at the time of hysterectomy (36). Table 29.10 shows that cystoscopy resulted in a cost savings with a ureteral injury rate of 1.5% in abdominal hysterectomies and 2% in total vaginal and

P.364

laparoscopic-assisted vaginal hysterectomies. Costs that are listed in the table do not include pain and suffering or malpractice for injuries not identified.

Table 29.9 Operative Injuries with Significant Cystoscopic Findings

Cystoscopic Findings (Number of Cases)	Intraoperative Intervention	Causative Surgical Procedure (Number of Affected Cases/Total Cases)
Ureteral obstruction (6)	Removal and replacement of suture	Anterior colporrhaphy (6/346)
Intravesical suture (2)	Removal and replacement of suture	Abdominal Burch (2/147)
Puckering of bladder mucosa with suture seen (2)	Removal and replacement of suture	Anterior colphorrhaphy (6/346), abdominal paravaginal repair (1/82)
Bladder perforation	Removal of needle/trocar with no cystotomy repair needed	Vesica procedure (1/10), TVT (1/31)
Cystotomy, unrecognized (2)	Repair of cystotomy	Abdominal Burch (1/147), vaginal wall bone-anchored sling (1/12)
Insufficient cystotomy repair (1)	Revision of cystotomy closure	Abdominal vesicovaginal fistula repair (1/1)

Adapted from Kwon CH, Goldberg RP, Koduri S, et al. The use of intraoperative cystoscopy in major vaginal and urogynecologic surgeries. *Am J Obstet Gynecol.* 2002;187:1466â€“1472.

It is imperative that gynecologic surgeons identify occult urinary tract injuries during vaginal surgery. As noted previously, many authors have recommended universal cystoscopy to these types of injuries. The use of sterile milk or solutions containing indigo carmen dye or methylene blue can assist in identifying bladder defects when suspected. Indigo carmen dye, intravenously, will help surgeons to evaluate ureteral patency during cystoscopy (Fig. 29.5).

Highly trained and experienced surgeons can evaluate function by observing the efflux from the ureteral orifice without the addition of indigo carmen dye. The use of sterile milk allows the surgeon to identify a bladder defect and repair it without staining the adjacent tissue. This permits the reinstallation of the bladder with milk for evaluation of the surgical repair.

TAH
Low 0.2%
1/500
$108
$54,000
Threshold 1.5%
1/67
0
0
High 2.0%
1/50
($44)
Cost saving
TVH or LAVH
$113
Low 0.2%
1/500
0
$56,500
Threshold 2.0%
1/50
($184)
0

High 5.0%
1/20
Cost saving
TAH, total abdominal hysterectomy; TVH, total vaginal hysterectomy; LAVH, laparoscopic-assisted vaginal hysterectomy.
Adapted from Visco AG, Taber KH, Weidner AC, et al. Cost-effectiveness of universal cystoscopy to identify ureteral injury at hysterectomy. *Obstet Gynecol.* 2001;97:685â€“692.

Ureteral Injury Rate	Injuries Identified per Number of Cases	Marginal Cost (Savings) per Case	Marginal Cost Effectiveness per Ureteral Injury

Table 29.10 Effect of Varying Injury Rates on Outcomes, Costs, and Cost Effectiveness

Patients who have had previous caesarian sections or myomectomies are at increased risk of bladder injury (37). Rooney et al., in their case controlled, retrospective study, evaluated 5,092 hysterectomies performed at their institution during a 4-year period (38). The overall odds ratio in a patient undergoing hysterectomy with a history of cesarean section was 2.04. When stratified by type of hysterectomyâ€”TAH, TVH, and LAVHâ€”the odds ratios were 1.26, 3.00, and 7.5, respectively. If a patient has had previous surgery and/or extensive adhesions or complications are anticipated, the surgeon should consider LAVH. This will enable the surgeon to assess the pelvis and lyse adhesions that would not be readily accessible by way of the vagina. The remainder of the procedure can then be performed vaginally, thereby decreasing the potential of

a ureteral injury during a total laparoscopic hysterectomy. When there is the likelihood of potential bladder injury, sterile milk or colored fluids should be used to evaluate the integrity of the bladder both laparoscopically and vaginally during an LAVH.

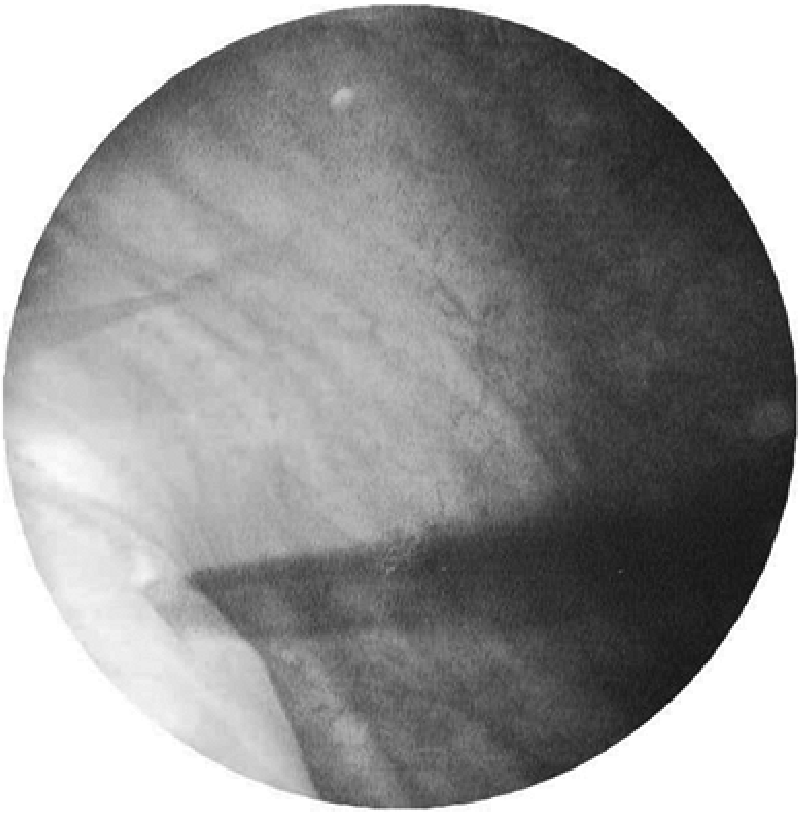


Figure 29.5 Indigo carmen dye during cystoscopy. Blue jet from urethral orifice.

During a hysterectomy, there is potential for urinary tract injury, which is increased with anterior colporrhaphies and sling procedures for stress urinary incontinence. The majority of these injuries occur in the bladder; however, the ureter can also be injured through the placement of deep lateral sutures. Cystoscopy can assist the surgeon with identifying urinary tract injuries during procedures (1). Previously, it was felt that placement of a suture into the bladder enclosure of the vaginal cuff increases the risk of vesicovaginal fistula. However, Meeks et al., using a New Zealand rabbit model, were able to demonstrate that the placement of the suture, in itself, does not increase the risk of postoperative vesicovaginal fistulas in a transabdominal hysterectomy (39). Others, however, have suggested that the placement of sutures and erosion through the bladder can result in a vesicovaginal fistula postoperatively (40).

Primary gynecological diagnosis

Adnexal diseases

1.00
â€”
â€”
Uterine fibroids
3.69
0.72 to 21.97
.13
Abnormal uterine bleeding
6.16
1.13 to 39.01
.04
Other uterine pathology[c]
3.95
0.74 to 23.79
.03
Other pelvic diseases[d]
5.06
1.27 to 23.74
.03
Type of surgical procedure
Adnexal or other pelvic surgerye[e]
1.00
â€”
â€”
Hysterectomy
0.20
0.05 to 0.68
.01

[a] Only categories with significant independent variables are reported.

[b] The categories â€œtype of urinary tract injuryâ€• and â€œtime of recognition of the injuryâ€• did not have any independently associated variables and are therefore not included.

[c] Other uterine pathology consisted of primary gynecologic diagnoses such as adenomyosis, uterine prolapse, cervical dysplasia, or unwanted pregnancy.

[d] Other pelvic diseases consisted of primary gynecologic diagnoses such as pelvic adhesions, pelvic endometriosis, vaginal disorders, or general pain and symptoms associated with the female genital organs (e.g., pelvic congestion syndrome).
[e] Other pelvic surgery consisted of lysis of pelvic adhesions, vaginal vault suspension and fixation, therapeutic abortion, cervical amputation, and diagnostic laparoscopy.
Adapted from Gilmour DT, Baskett TF. Disability and litigation from urinary tract injuries at benign gynecologic surgery in Canada. *Obstet Gynecol.* 2005;105:109â€“114.

Category of Independent Variables[b]	Odds Ratio	95% Confidence Interval	p

Table 29.11 Logistic Regression of Urinary Tract Injuries Resulting in Major Disability in Canada From 1996 to 2001[a]

Surgical Repair

The repair of iatrogenic bladder injuries can frequently be performed vaginally. Closure would be identical to an injury at the time of exploratory laparotomy. A two-layer closure is recommended. The bladder should be closed with a 3-0 absorbable suture such as Vicryl. The first layer may be a continuous running suture and the second an embrocating layer. Many surgeons prefer the embrocating layer to be placed in an interrupted fashion. This not only buries

the initial suture line but provides additional stability to the repair. A cytoscopic evaluation is performed prior to and on completion of the repair. Double-J stents should be placed if the laceration is adjacent to the trigone and ureteral orifice. The double-J stent will remain for 7 to 14 days and a Foley catheter placed for 3 to 7 days, depending on the severity of the injury. There is no advantage to either a suprapubic or transuretheral bladder drainage. It is left up to the surgeon, who may have some anecdotal experience to support utilizing either of them. If a large section of bladder has been inadvertently excised, bladder augmentation with a segment of illeum should be considered. If the trygone has been resected, an ileoneocystotomy with ureteral implantation should be performed.

Primary gynecological diagnosis
Adnexal diseases
1.00
â€”
â€”
Uterine fibroids
0.15
0.03 to 0.61
.01
Abnormal uterine bleeding
0.23
0.05 to 0.96
.05
Other uterine pathology[c]
0.25
0.04 to 1.22
.10
Other pelvic diseases[d]
0.27
0.05 to 1.23
.10
Type of urinary tract injury
Other urinary tract injuries[e]
1.00
â€”
â€”
Obstruction of ureter
4.54
1.55 to 14.88
.008
[a] Only categories with significant independent variables are reported.
[b] The categories â€œtype of surgical procedureâ€• and â€œtime of recognition of the injuryâ€• did not have any independently associated variables and are

therefore not included.

[c] Other uterine pathology consisted of primary gynecologic diagnoses such as adenomyosis, uterine prolapse, cervical dysplasia, or unwanted pregnancy.

[d] Other pelvic diseases consisted of primary gynecologic diagnoses such as pelvic adhesions, pelvic endometriosis, vaginal disorders, or general pain and symptoms associated with the female genital organs (e.g., pelvic congestion syndrome).

[e] Type of urinary tract injury consisted of obstruction of a ureter, perforation or laceration of a ureter, perforation or laceration of a bladder, and urinary tract fistula. Because no hierarchical order exists for these types of urinary tract injuries, for each variable, the reference group consists of the remaining three variables combined.

Adapted from Gilmour DT, Baskett TF. Disability and litigation from urinary tract injuries at benign gynecologic surgery in Canada. Obstet Gynecol. 2005;105:109â€“114.

Category of Independent Variables[b]	Odds Ratio	95% Confidence Interval	p

Table 29.12 Logistic Regression of Urinary Tract Injuries Resulting in Permanent Disability in Canada from 1996 to 2001[a]

In a situation where the defect is not identified in the immediate postoperative period, repair should be delayed 6 weeks to 6 months to allow inflammation to resolve (39 ,40 ,41). A small defect postoperatively can frequently be treated with drainage of the bladder by way of a suprapubic or transurethral bladder catheter. More extensive defects that are not amenable to immediate surgery should have urinary stream deviated with use of nephroscopy tubes until surgical repair is performed. A more conservative and less invasive approach would be to have the patient use pads or diapers. This will frequently result in irritation of the vulva and difficulty with hygiene during the 3- to 6-month period prior to surgical intervention (40 ,41).

Ureterovaginal fistulas frequently are not identified intraoperatively if the ureter has not been fully transected. A transected ureter will be identified by the lack of ureteral efflux on cystoscopy. Unfortunately, a small ureteral defect may have efflux on cystostomy and therefore is not recognized intraoperatively. At this point, retrograde placement of catheters and radiographic evaluation of the ureter should be performed to identify the defect. Depending on the location of the injury, the repair will vary. Small minor injuries can be treated conservatively with the ureteral stem placement. An intravenous pylogram should be performed approximately 4 to 8 weeks postoperatively to evaluate patency prior to removal. Major injuries require anastomosis based on their location. Distal ureter injuries should be treated with reimplantation into the bladder wall. At times, tunneling made into the bladder muscularis may assist in decreasing reflux. If a significant amount of ureter has been destroyed, a posas hitch or Boari flap reconstruction is required. Some defects between the mid- and distal ureter can be repaired with a primary anastomosis if there is no tension on the anastomatic site. If the former is present, the posas hitch should be performed. Midureteral injuries are treated with an end-to-end anastomosis with and without a posas hitch, depending on the amount of tension. The

ends of the ureter are usually spatulated prior to anastomosis to help decrease stenosis. A double-J catheter should be placed for 6 to 8 weeks prior to radiographic evaluation and removal. Upper urinary tract injuries should be treated with a uretero-ileoneocystotomy. This repair incorporates a segment of ileum to augment the bladder and to allow implantation of the ureter directly into the ileo extension. Uretero ureterostomies are recommended for various uretral injuries. A major disadvantage of this repair is the potential damage to the contralateral kidney and/or ureter (1 ,42 ,43). For long-term follow-up of patients with ureteroanastomosis and implantation, renal ultrasound, intravenous pylograms, and computerized axial tomography remain controversial. The major concern of these repairs is the short- and long-term complication of stenosis at the anastomotic or implantation site. Additional evidence-based recommendations are warranted to assist in recommending the appropriate radiographic follow-up of these patients.

Hysterectomies and adnexal surgeries 95% CI
636/192,281 (0.33) 0.31 to 0.36
19/636 (3.0) 1.8 to 4.7
63/191,645 (0.03) 0.02 to 0.04

91 55 to 158

Hysterectomies only 95% CI

515/70,047 (0.74) 0.67 to 0.80

16/515 (3.1) 1.8 to 5.0

31/69,532 (0.04) 0.03 to 0.06

70 39 to 133

Adnexal surgeries only 95% CI

121/122,234 (0.10) 0.08 to 0.12

3/121 (2.5) 0.5 to 7.1

32/122,113 (0.03) 0.02 to 0.04

95 29 to 321

Values are number and (percentage) except where otherwise specified.

[a] Excluding Quebec and rural Manitoba.

[b] From the Canadian Institutes of Health Information Discharge Abstract Database.

[c] From the Canadian Medical Protective Association Database.

[d] Confidence intervals for the litigation rate ratio were based on logistic regression with litigation as the binary outcome, urinary tract injury as a binary predictor, and approximation of the rate ratio to the odds ratio.

CI, confidence interval (percent).

Adapted from Gilmour DT, Baskett TF. Disability and litigation from urinary tract injuries at benign gynecologic surgery in Canada. *Obstet Gynecol.* 2005;105:109â€“114.

Surgical Procedure	Prevalence of Urinary Tract Injury[b]	Litigation Rate[c] with Tract Injury	Litigation Rate[c] with No Urinary Tract Injury	Litigation Rate Ratio[d]

Table 29.13 Estimates of Prevalence of Urinary Tract Injury at Benign Gynecological Surgery, Litigation Rates with and Without Urinary Tract Injuries, and Litigation Rate Ratios in Canada[a] from April 1, 1998, To March 31, 2000

Litigation as a result of urinary tract injuries is increasing. Urologic injury from gynecologic and obstetric procedures is responsible for 10% of all claims filed. Twenty percent of all claims settled are secondary to urologic injuries, the second most common cause being vesicovaginal fistulas (44 ,45 ,46). Gilmour and Baskett evaluated the prevalence of urinary tract injury in Canada and the risk of litigation (4). In their study, only 18% of urinary tract injuries were identified intraoperatively. The diagnosis with the highest risk of urinary tract injury was abnormal uterine bleeding (Table 29.11). This diagnosis had a 95% CI of 1.13 to 3.901 with $p = 0.04$. Obstruction of the ureter resulting in permanent disability had an odds ratio of 4.54 with a 95% CI of 1.55 to 14.88 with $p = 0.008$ (Table 29.12). Table 29.13 shows the prevalence of urinary tract injury and the risk of litigation.

Communication

Communication is very important when a surgical injury occurs. As mentioned previously, urinary tract injuries are debilitating and can result in permanent disabilities as well as a decrease in the quality of the patient's life. Many urinary tract injuries will require extensive evaluation and multiple surgical procedures to repair. The surgeon must support the patient throughout this process. Complete honesty from the initial diagnosis is paramount to developing this relationship. If the surgeon does not practice in an institution where there is adequate expertise to repair this injury, the patient should be transferred to one that is more qualified. However, even the most experienced surgeon can have urinary tract injuries and/or complications from its repair. It is imperative that all attempts be made to identify these injuries intraoperatively and to provide the appropriate surgical repair. Diagnosis of injuries postoperatively requires a thorough evaluation and discussion of treatment options with the patient.

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30

Bowel Injuries

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Ann C. Lowry

Injury to the bowel is an extremely rare but potentially devastating complication of vaginal surgery. The best treatment for iatrogenic bowel injury is immediate recognition and repair, as the consequences of a missed injury and delayed presentation can be dramatic. The majority of our understanding of bowel injuries draws from the experiences and data in the trauma community; however, the nature of iatrogenic bowel injury may differ in both mechanism and severity (1,2). Unlike transabdominal and laparascopic approaches, many vaginal surgical procedures avoid the peritoneal cavity, and thus, the incidence of bowel injury is lower. Nevertheless, a vaginal approach does not exempt the surgeon from the possibility of injuring either the large or small intestine. Bowel injury has been a reported complication in tensionfree vaginal tape (TVT) repair, laparoscopic-assisted vaginal hysterectomy (LAVH), and even large loop excision of the transformation zone (LLETZ) of the cervix (3,4,5,6,7,8). The frequency of iatrogenic bowel injury during vaginal surgery is difficult to estimate, though a large series with laparoscopic-assisted vaginal hysterectomy reported an incidence of 1.0% (7).

In this chapter, the important anatomic relationships of the vagina and female pelvis will be reviewed. Mechanisms of iatrogenic bowel injury as well as potential complications arising from such an injury to the bowel are also discussed. As well, the diagnosis, evaluation, and recommended treatment strategies for bowel injuries are presented.

Anatomic Considerations

The anatomy of the vagina and female pelvis is presented in an earlier chapter. However, the proximity of the vagina and female pelvic structures to the gastrointestinal tract merits discussion to help prevent injury to the bowel. The intraperitoneal location of the small intestine, rectosigmoid colon, cecum, and the extraperitoneal location of the middle and distal rectum are important anatomic relationships for the practicing surgeon to understand. The close relationship of the posterior vaginal wall and the anterior wall of the rectum represents an area of risk during performance of vaginal surgery (Fig. 30.1A). Alterations of normal rectal anatomyâ€”namely, rectoceleâ€”may heighten the risk of injury and should be appreciated by thorough preoperative examination (Fig. 30.1B). Similarly, other pelvic floor defects such as enterocele or peritoneocele that place the small bowel at risk for injury should be known prior to embarking on a perineal operation (Fig. 30.1C). Involvement of the small and large intestine by gynecologic pathology, such as endometriosis, presents another consideration for the surgeon. Resection and ablation of endometriosis has been associated with injury to the bowel and significant morbidity (9). One should recognize the separate layers of the bowel wallâ€”serosa, muscularis propria, submucosa, and mucosaâ€”because the management of partial-thickness injuries may differ from one of full thickness.

Laparoscopically assisted vaginal surgery carries the additional risk of bowel injury during the laparoscopic portion of the procedure. In any type of procedure such as this, access to the abdominal cavity, presence of intra-abdominal adhesions, incomplete visualization of the operative field, and unintended conduction of thermal energy by laparoscopic instruments may contribute to an injury of the small intestine, colon, rectum, or other abdominal organ (10,11). With respect to gynecologic surgery and laparoscopy, a 10-year experience from Memorial Sloan-Kettering Cancer Center has identified older age of the patient, malignancy, previous abdominal surgery, and previous radiation therapy as factors that increase the risk of complications and conversions to laparotomy (12).

Mechanisms of Bowel Injury

The potential mechanisms of bowel injury include laceration and perforation, hematoma, crush and ischemic

injury, serosal tear, thermal and burn injury, and mesenteric tear and vascular injury.

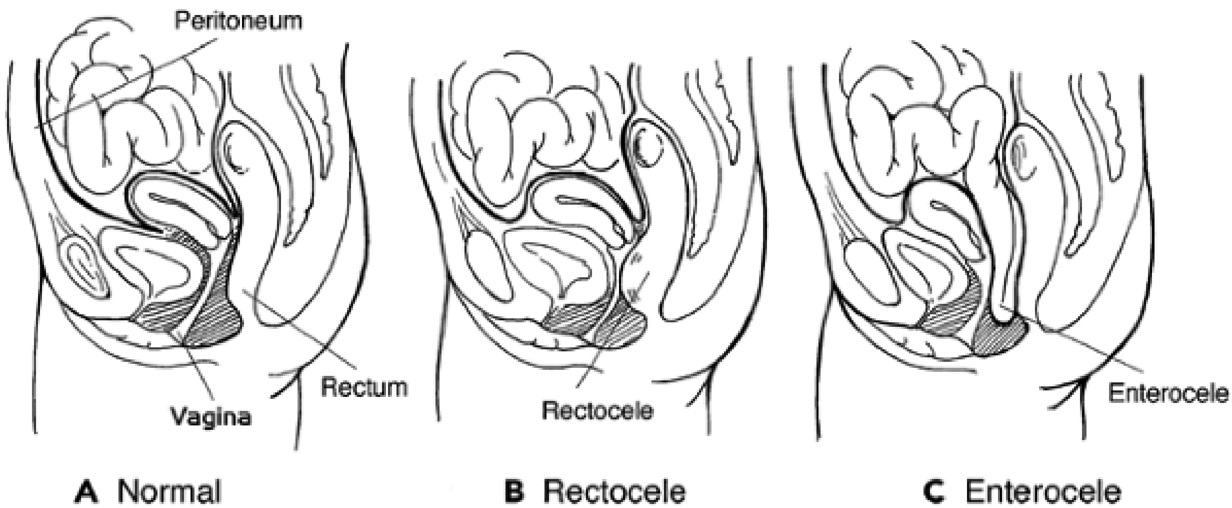

Figure 30.1 *Anatomic considerations.* A: Normal female pelvic anatomy, sagittal view, demonstrating proximity of posterior vagina and anterior rectum. The abnormal anatomic relationships are also shown for rectocele (B) and enterocele (C).

A majority of our knowledge of bowel injuries arises from trauma literature. The American Association for the Surgery of Trauma (AAST) developed a grading scale to describe severity of colon injury from either blunt or penetrating trauma (13). This injury scale is helpful in classifying degree of bowel injury and is shown in Table 30.1. The grading system has been helpful in addressing traumatic injuries of the bowel and in determining the suitable treatment strategy based on the extent of injury. The relevance of this scale to iatrogenic colon and small bowel injuries in gynecologic surgery is twofold; it assists the surgeon in characterizing the degree of injury and guides clinical decision making and treatment (i.e., the decision to divert using colostomy or ileostomy).

It is important to recognize the different mechanisms of injury, as the type of injury dictates the approach for management. For example, most simple, small, full-thickness bowel lacerations may be repaired primarily with suture, but the ischemic injury associated with crushing of the bowel or thermal injury may require debridement of surrounding bowel and possible resection of the affected segment. Likewise, injury to the bowel mesentery and vascular supply should be approached by careful assessment of the adequacy of the blood supply to the involved bowel.

Table 30.1 American Association For The Surgery Of Trauma Colon Injury Scale

Grade	Injury	Description
I	Hematoma	Contusion or hematoma without devascularization
	Laceration	Partial thickness, no perforation
II	Laceration	Laceration <50% of circumference
III	Laceration	Laceration >50% of circumference
IV	Laceration	Transection of the colon
V	Laceration	Transection of the colon with segmental tissue loss

Reproduced from Moore EE, Cogbill TH, Malangoni MA, et al. Organ injury, scaling II: pancreas, duodenum, small bowel, colon, and rectum. *J Trauma.* 1990;30:1427, with permission.

Complications of Bowel Injury

The spectrum of complications arising from bowel injury ranges from the clearly apparent to the occult. The ideal approach to bowel injury is careful avoidance, but if it occurs, immediate recognition of the injury and repair is critical. If the diagnosis is delayed, the range of complications expands. A brief description of possible complications from bowel injury follows. Each will be addressed later in postoperative presentation and treatment.

Peritonitis and Sepsis

Frank peritonitis and sepsis may occur when a bowel injury is missed intraoperatively. Over the patient's postoperative course, clinical signs of fever, abdominal rigidity and guarding, and rebound tenderness on exam may present coupled with hemodynamic instability and respiratory compromise. This presentation is usually fairly obvious and dramatic, representing one of the more dire manifestations of a missed bowel injury.

Abscess

An abscess represents a localized infection, where a collection of pus is contained by surrounding inflamed tissue. A missed perforation of the bowel may contaminate the abdominal and/or pelvic cavity; however, when the body can isolate and surround this contamination, an abscess will result.

Cellulitis and Soft-Tissue Infection

Unlike an abscess, cellulitis represents infection in the skin and subcutaneous tissue that may not be well contained by surrounding tissue. Soft-tissue infection following bowel injury in vaginal surgery usually implies contamination of the subcutaneous tissues and skin of the perineum. These

infections may be relatively minor in their clinical course or may evolve into major perineal sepsis requiring surgical debridement (14).

Fistula

Fistula formation after bowel injury may involve a number of different structures, originating at the injured small intestine, colon, or rectum. The injured bowel segment may fistulize to the skin, vagina, bladder, or other adjacent organs.

Ileus and Gastrointestinal Dysfunction

An ileus may represent an early warning sign that a bowel injury has occurred. Abdominal distension, obstipation, nausea, and vomiting may herald the presence of a missed bowel injury and should prompt the astute clinical surgeon toward further investigation.

Bowel Obstruction

Mechanical intestinal obstruction may occur following injury to the small intestine, colon, or rectum. Postoperative adhesions or inflammatory changes arising from bowel injury can contribute to complete obstruction.

Diagnosis of Bowel Injury

It is worth repeating that the best chance for an optimal outcome following an iatrogenic bowel injury is immediate recognition and treatment. Intestinal contents in the operative field heralds a full-thickness injury. Partial-thickness injuries require a high index of suspicion. Direct visualization of the injured bowel segment may be difficult to achieve but obviously makes the diagnosis an easier task. Palpation of the anterior rectal wall may define an injury. A number of modalities are available to assist in making this diagnosis in the operating room. For distal injuries to either the rectum or sigmoid colon, the use of either rigid proctoscopy or flexible sigmoidoscopy should be considered to confirm an injury to the bowel and identify the location of injury. Both techniques have proven useful following pelvic gynecologic surgery (15). Air insufflation of the rectum with sterile water or saline in the operative field is also helpful in demonstrating a full-thickness perforation.

In the case of the missed bowel injury, a delayed presentation can be obvious or subtle in nature. Clinical signs and symptoms will likely include a combination of fever, leukocytosis, abdominal pain with or without peritoneal findings on examination, and ileus. Perineal erythema may suggest a localized process or a more serious problem in the abdomen or pelvis. Spontaneous drainage of succus or stool from the wound or vagina heralds the development of an enteric fistula.

A number of investigations are useful in establishing the diagnosis and plotting treatment strategy. A flat and/or upright abdominal X-ray may show an abnormal bowel gas pattern to suggest ileus or show free air to indicate bowel perforation. Computed tomography (CT) scanning of the abdomen and pelvis is routinely used to diagnosis intra-abdominal abscesses or extraluminal leakage of bowel contents. CT also offers the ability to guide percutaneous drain placement as a therapeutic measure. Contrast enema using water-soluble gastrograffin is useful to demonstrate perforation and leakage from the colon and rectum. An antegrade contrast examination, such as a small bowel follow-through study, can be useful in cases of fistula or ileus to evaluate intestinal anatomy and areas of concern. Rigid proctoscopy, flexible sigmoidoscopy, or full colonoscopy may help to identify the exact site of injury. Endoscopic examination also allows assessment for possible colonic ischemic injury and the extent of tissue involvement.

Treatment of Bowel Injury

Prevention

Bowel cleansing (using oral polyethylene glycol, enemas) prior to elective gynecologic surgery serves several functions. First, solid stool is evacuated from the colon and rectum, which facilitates manipulation of the bowel and palpation in the rectum during pelvic surgery. Second, the bacterial load of the intestinal tract is reduced by purgative oral preparations or enemas. Third, preoperative bowel preparation may also reduce the incidence of postoperative constipation or fecal impaction. The use of a mechanical bowel preparation (MBP) has recently been reviewed in elective colorectal surgery. Three large-scale reviews question the efficacy of preoperative mechanical bowel preparation in reducing anastomotic leaks and other infectious complications (16,17,18). Similar to the data in colorectal surgery, there is some limited emerging evidence that questions the advantage of MBP in gynecologic procedures (19). Despite this data, mechanical bowel preparation prior to elective colorectal and gynecologic operations continues as an established practice and will likely remain until further data emerges to dispute its use. To prevent bowel injury in laparoscopic gynecologic surgery, there are several tenets worth emphasizing (10). First, adhesions between the bowel and abdominal wall should be dissected at the connection to the parietal peritoneum, not at the attachment to the bowel. Second, forceful dissection of extremely dense adhesions must be avoided. Laparoscopic instruments should be insulated down to their tips to minimize unnecessary spread of electrical current and resultant thermal burns. Bowel that has been grasped during the procedure must be carefully inspected to ensure that no traction or crush injury has occurred. Third, the surgeon must be aware of position,

movement, and direct visualization of all instruments to avoid bowel injury outside the visible field.

Intraoperative

The management approach after intraoperative recognition of bowel injury differs from treatment options in cases of delayed presentation. Approaches to treatment vary depending on whether the injury affects the small intestine, colon, or rectum. For small bowel serosal tears, simple single-layer interrupted suture repair using 3-0 or 4-0 absorbable suture or silk is adequate. The aim in treatment of partial thickness tears is to reapproximate the serosa over the underlying layers without undue tension. For a small (less than 50% of the bowel circumference) enterotomy (with a full-thickness perforation of the small intestine), certain principles of treatment must be followed. It is imperative to assure viable edges of the injured bowel, debride any devascularized or nonviable tissue, and perform primary repair using either single- or double-layer 3-0 or 4-0 suture. The repair should be performed perpendicular to the orientation of the bowel lumenâ€”in a transverse rather than longitudinal fashionâ€”to avoid unnecessarily narrowing the bowel lumen (Fig. 30.2). Copious irrigation following repair is required. For larger enterotomies (those affecting greater than 50% of the bowel circumference), the likelihood of successful primary repair is lower. One must still ensure the viability of surrounding tissue and debride as needed. These larger injuries usually will require resection and anastomosis, either hand-sewn or stapled (Fig. 30.3).

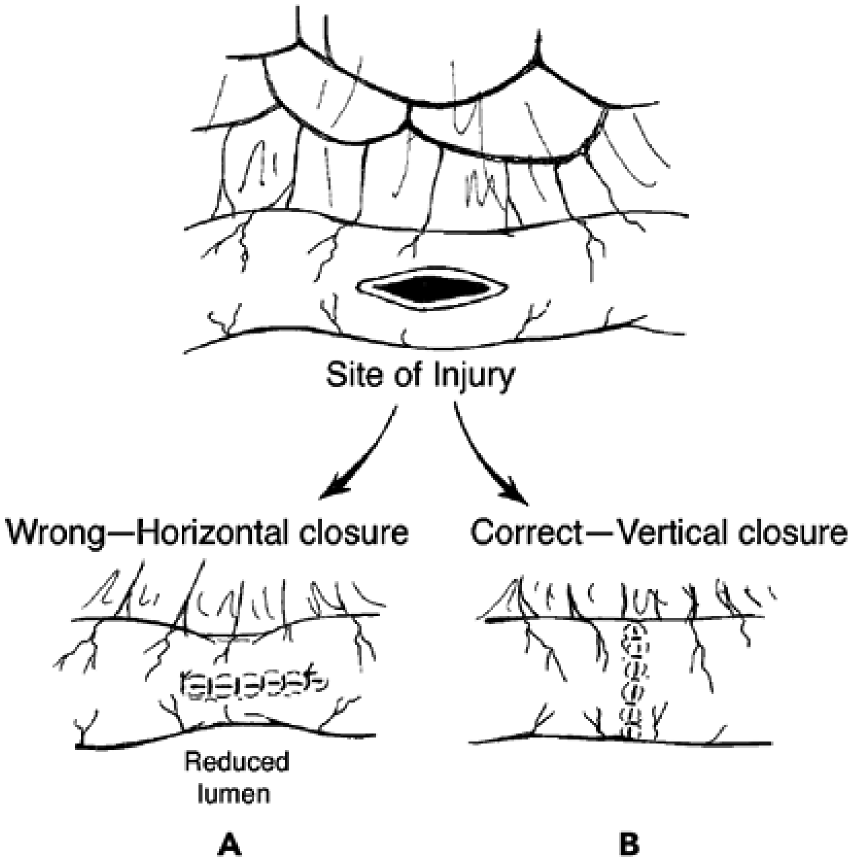

Figure 30.2 *Repair of small enterotomy*. When possible, holes in the small intestine should be closed in a transverse (A) rather than longitudinal (B) direction so that the bowel lumen is minimally not narrowed.

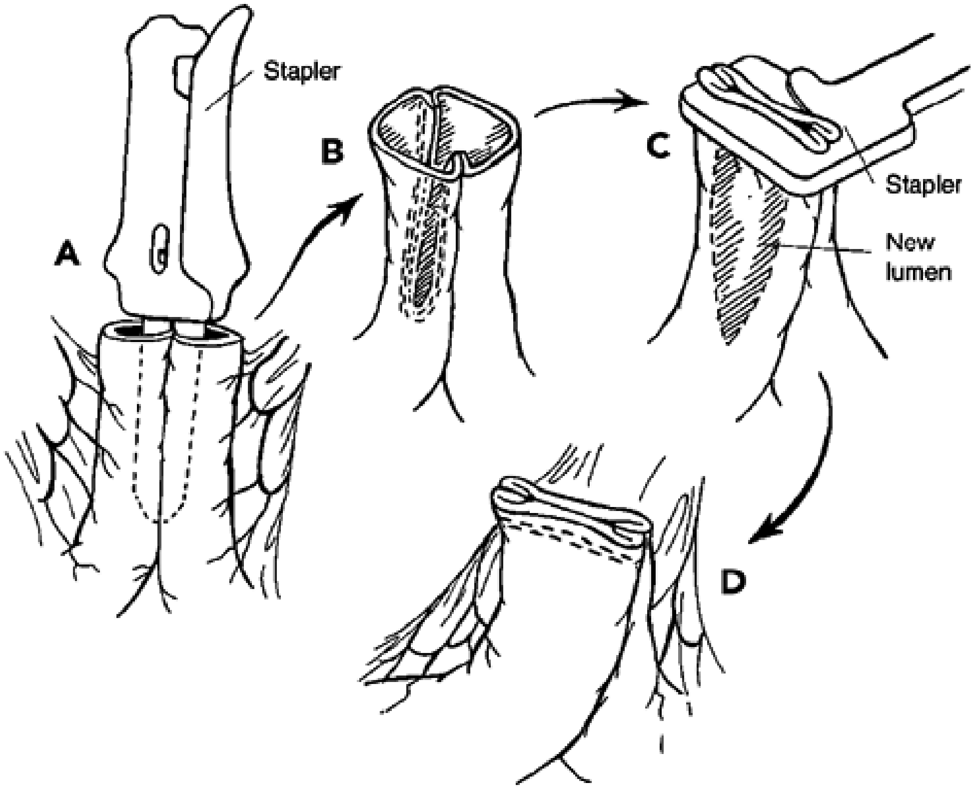

Figure 30.3 *Stapled bowel anastomosis.* A stapled anastomosis can be easily accomplished if a bowel segment requires resection. A side-to-side functional end-to-end anastomosis is constructed with a GIA stapler (A,B). Subsequent firing of the TA stapler across the free ends of the joined loops of bowel completes the anastomosis (C,D).

Mesenteric injuries affecting the small bowel should be approached by suture closure of the resulting defect. Hemostasis and the viability of the bowel supplied by the injured mesentery must be ensured. Care must be taken to avoid injury to the vascular supply when closing a mesenteric defect. Direct observation of the affected bowel, Doppler ultrasound or intravenous fluorescein have been used to determine adequacy of blood flow to areas of the small bowel (20,21,22,23).

Thermal injuries to the intestine can occur as unintended consequences of the use of electrocautery. The full extent of these injuries may be uncertain, as the visible cautery burn does not necessarily represent the thermal injury to the surrounding tissue. Treatment of these types of injuries should follow the principles of repair of an enterotomyâ€”primary repair with approximation of the edges after any appropriate debridement of nonviable tissue.

For injuries of the colon and rectum, the approach is similar to repair of serosal tears and thermal injury in the small intestine. However, a caveat should be included when one faces a full-thickness injury to the colon or rectum. Most patients undergoing vaginal surgery should receive a preoperative bowel preparation, usually in the form of an enema, to evacuate solid and liquid stool, but release of the high bacterial load of the colon raises the stakes for infectious consequences of an injury in this area. Small injuries to the colon or rectum may be approached with a single- or double-layer primary repair performed in an interrupted fashion using 3-0 or 4-0 absorbable suture. For large injuries to the colon or rectum, resection is required, and serious consideration for fecal diversion with colostomy should be given to prevent further postoperative complications. Again, the trauma literature is instructive for

guidance on which patients may need fecal diversion. Several authors have identified hemorrhage (>1 L), advanced age, hemodynamic shock, delayed presentation, and significant fecal contamination as factors that support the use of diverting colostomy (24,25,26). For full-thickness injury of the colon and rectum, regardless of the size of the injury, copious irrigation should be performed to reduce contamination. Additionally, adequate drainage of the pelvis using any of the available closed-suction drains must strongly be considered. Broad-spectrum antibiotics targeting gram-negative organisms and anaerobes should be administered in the postoperative period.

Postoperative

As discussed previously, a missed bowel injury may manifest itself in a variety of ways in the postoperative period. Patients who present with frank peritonitis should receive prompt resuscitation and antibiotics and then be taken for abdominal exploration, with a goal of identifying and treating the causative injury. Principles of treatment for a patient presenting in this fashion include copious irrigation of the abdominal cavity and drainage with resection of the injured bowel segment. Consideration may be given to primary repair of the injured bowel; however, this approach should be utilized with caution in the face of associated sepsis and gross contamination of the abdomen and pelvis. Fecal diversion by way of colostomy or ileostomy should be strongly contemplated in the setting of a sick, septic patient with a significantly contaminated abdominal cavity. Following exploration, irrigation and drainage, resection, and possible diversion, postoperative broad-spectrum antibiotics should be administered to cover intestinal flora.

An abscess identified on postoperative CT scan may be drained by way of a percutaneous catheter, using either CT or ultrasound as guidance (27). A drain may be introduced either transabdominally or transgluteally, depending on the location of the abscess and its proximity to other important structures. After sending the abscess fluid for gram stain and culture, broad-spectrum antibiotics are indicated until sensitivities return to guide more precise antimicrobial therapy. The patient's clinical response to abscess drainage and overall status will dictate further treatment. A repeat CT scan is often performed to evaluate adequacy of abscess drainage and to determine timing for catheter removal. Additional studies, such as a sinogram by way of the drainage catheter or contrast enema examination, are warranted to assess for any communication with the bowel. Operative exploration and drainage is reserved for an abscess that is not amenable to percutaneous drainage or fails to respond to nonoperative drainage measures.

The topic of rectovaginal fistula is discussed in Chapter 28. For this and other types of fistula (enterocutaneous, colocutaneous, etc.), several treatment principles apply. First, the adequacy of drainage must be ensured. A study of the abdomen and pelvis by use of CT or ultrasound will evaluate for an unsuspected abscess or any poorly drained collection. Second, there must be adequate treatment of any associated infection. Antibiotics should be administered at least initially. Proper wound care to promote healing of the drainage site and to protect the surrounding skin is particularly important. Third, adequate nutritional support is mandatory, as patients are at risk of significant depletion from fistula losses and require optimal nutrition for healing (28,29). Distal obstruction should be excluded, as it will also prevent closure of the fistula. Fistulas may be categorized by the amount of output; high-output fistulas (those draining more than 500 cc in 24 hours) are associated with lower rates of spontaneous closure (30). A course of observation is reasonable, and reoperation is reserved for cases in which a fistula fails to close spontaneously. The vacuum-assisted closure (VAC) system is a new and emerging approach for conservative management of enterocutaneous fistulas. Several case reports, as well as a series of 74 patients, have described the VAC system as an effective, successful technique for treating complex perineal wounds and enterocutaneous fistula (31,32,33).

A postoperative ileus may suggest the presence of an underlying bowel injury or may simply be a consequence of surgery and general anesthesia. The approach to a patient with an ileus includes eliminating a mechanical obstruction from the differential diagnosis and correction of any contributing factors. Electrolyte deficiencies must be identified and corrected, and postoperative narcotic use should be minimized due to its effect on bowel motility. For cases of prolonged ileus, nutritional support in the form of total parenteral nutrition (TPN) should be considered until the ileus has resolved and the patient is able to resume oral intake.

In cases of bowel obstruction, an initial course of nonoperative management is appropriate except when the patient presents with signs and symptoms of peritonitis. The obstruction may present as either partial or complete; the two are distinguished by the patient's ability to pass stool and/or flatus. Bowel rest, nasogastric decompression, and nutritional support should be included in early treatment of a bowel obstruction. A CT scan is useful to delineate a transition point and to identify the area of the obstruction (34). In cases of large bowel obstruction, a retrograde contrast enema may also identify the point of obstruction and help to guide therapy. Operative intervention is pursued for cases of persistent obstruction with failure to improve or progression of symptoms to appropriately identify and address the intra-abdominal pathology.

Conclusions

Injury to the small intestine, colon, or rectum during vaginal surgery represents a rare but serious complication. These injuries are best treated by immediate recognition and repair in order to avoid the potentially devastating

consequences of a delayed presentation. The management of bowel injuries depends on the type of injury, time of presentation, patient's clinical status, and location and extent of the injured bowel segment. Careful attention to the anatomic relationships, both normal and abnormal, of the female pelvis and gastrointestinal tract will help to avoid and prevent these injuries.

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Hemorrhage

Howard W. Jones III

Urogenital Fistulas

Although every surgeon tries diligently to avoid troublesome bleeding and massive blood loss, he or she will occasionally be confronted with uncontrolled bleeding during the course of a surgical procedure (1,2,3). The ability to organize and direct the surgical team to control the bleeding in these situations is one of the important qualities of a competent and respected surgeon.

Prevention and management of hemorrhagic complications starts with the preoperative evaluation and continues through the operative procedure and into the postoperative phase.

Preoperative Evaluation

Some patients may have bleeding tendencies that can contribute to excessive bleeding during surgery, and it is clearly important to identify these women prior to surgery. Patients may be taking medication such as warfarin, heparin, clopidogrel, or aspirin, which prolong clotting time or interfere with platelet function. Still others may have some congenital abnormality of coagulation such as von Willebrand disease (4) or other uncommon clotting factor deficiency. Obtaining a good history is the best way to identify these patients. Routine laboratory testing of all preoperative patients is not an efficient way to identify these uncommon problems. Simple questions should help to identify women with a possible coagulation disorder. â€œDo you bleed heavily when you are cut or have surgery or dental work?â€• â€œDo you have heavy menstrual periods?â€• â€œHave you been anemic?â€• â€œHave you required blood transfusions or taken iron tablets to build up your blood counts?â€• â€œDo you have blood clotting problems, or are you taking any medicine that could slow down or prevent your blood from clotting?â€• Those patients with a history that suggests the possibility of a clotting disorder should undergo additional laboratory testing and possible consultation. Women who are chronically ill with hepatic or renal disease or a malignancy of some type should also be carefully evaluated and cleared by their internist or consultant before being scheduled for surgery.

If preoperative testing indicates that the patient is anemic, the cause of the anemia and its severity need to be addressed (5). If heavy menstrual bleeding from uterine fibroids is the cause, then preoperative iron and possibly GnRH agonist or antagonist therapy may get the patient in better shape before surgery. The proper time to operate is always a judgment call and depends on the underlying diagnosis, indications for surgery, and the patient's overall condition. Do not hesitate to ask the opinion of her medical consultants and the anesthesiologist. Good communication with all relevant specialists will help to get the patient to the operating room in optimal condition to undergo surgery.

The possibility of blood transfusion and the risks associated with it should be a part of every preoperative informed consent discussion. Patients who are Jehovah's Witnesses or who refuse transfusion of blood or blood products usually identify themselves to the surgeon as soon as any possibility of a surgical procedure is mentioned. Each surgeon must decide how he or she wishes to deal with these patients, as their religious beliefs should be respected; if you are not willing to abide by their wishes, the patient should be referred to another surgeon who will agree to their conditions.

Another area that needs to be considered prior to surgery is the anticipated difficulty of the surgical procedure. A dilatation and curettage in a postmenopausal woman with bleeding and a hemoglobin of 9.5 g/dL is probably safe and indicated, while a vaginal hysterectomy on another woman with 18-week-sized fibroids and similar low hemoglobin may not be advisable. The more difficult the surgical procedure, the more important it is to have the patient in the best shape possible (6). The same applies to the surgeon and the operative team. If a particularly difficult surgical procedure is anticipated, it is important to ensure that good assistants are available and that adequate time is set aside. This is not the type of procedure one should schedule immediately prior to leaving on vacation or the same afternoon of a daughter's school play. If special retractors or instruments may be required, it is best to check ahead of time with the head nurse in the operating room to be sure that all required equipment will be available. *Prior Planning Pays!* By mentally going through the various steps in the planned operative procedure in this particular patient with her unique anatomy, potential problems or technical operative difficulties can be anticipated and possible solutions considered before a crisis arises during surgery. If everything and everyone is ready and the surgeon is well rested, the surgical procedure will start on a positive note. On the other hand, if the surgeon's favorite lighted retractor is not available or the start of the case is delayed because the anesthesiologist wants to check one more clotting study, it is easy to become frustrated and angry. Surgeons must immediately begin to work hard to stay positive and focused and to keep the rest of the surgical team in a good frame of mind.

Hemorrhage

Intraoperative Bleeding

It is easier to stay of out of trouble than to get out of trouble. Precise execution of a carefully considered and well-planned surgical approach is important. A good knowledge of the anatomy is essential. Adequate exposure and good lighting of the operative field, careful handling of the tissues, accurate placement of clamps, precise cutting with sharp instruments, and skillful placement and tying of sutures are all key ingredients to successful and uncomplicated surgery. However, even the best technical ability must be accompanied by good judgment in order to obtain a consistently excellent surgical outcome. Is it a good idea to try and remove the ovary transvaginally once it can be seen that it is adherent to the pelvic sidewall high in the pelvis over the ureter? The bladder is adherent in another woman with two previous cesarean sections. When does the surgeon say â€œenough is enoughâ€• and convert to an abdominal approach? Good surgical judgment and an honest self-appraisal of one's technical skills will go a long way toward avoiding trouble.

From a technical standpoint, rough handling of tissues, which leads to tearing and poor suture-tying technique, is the most common cause of hemorrhage during vaginal surgery (7). The surgeon or assistant will pull or push too hard on the uterus trying to provide better exposure, and the vaginal wall or uterine artery will tear. Someone will try to jam the long-billed, weighted speculum into the posterior colpotomy incision before it is large enough to fit. The surgeon will try to get her or his whole hand into the colpotomy incision to palpate uterine fundal adhesions or the ovary. Rough handling of the tissues results in tearing of the tissue, loosening or avulsing ties on pedicles, or pulling tissue out of clamps. This is largely a matter of experience, but surgeons should practice careful handling of tissue at all times. Some experts have recommended injecting saline or a vasoconstrictive agent into the paracervical tissues to facilitate dissection and reduce venous bleeding (8,9). Kammerer-Doak et al. reported decreased blood loss in a prospective randomized trail comparing vasopression injection with normal saline during vaginal hysterectomy (10). However, they also reported an increased rate of infection in the patients.

Tying down sutures is another problem, especially for the inexperienced surgeon. When chromic catgut suture was used, it was relatively coarse and held tight without slipping after only the first half hitch was thrown. Newer suture materials are better in many ways, but they do tend to slip until the second half hitch is snugged down. The assistant must be instructed to release the clamp slowly to allow the suture to fully compress the pedicle without slipping off. Suctioning or adjustment of the retractors should not be done until the second half hitch is placed so that the first knot will not slip. When a Haney suture ligature is placed, the second pass through the pedicle should be close to the â€œhandle endâ€• of the pedicle so that end is also transfixed and will not slip out of the tie as the clamp is released.

Clamp placement is important. Clamps are placed and pedicles ligated because the tissue contains possible bleeders. If the next clamp is not placed immediately adjacent to the previous pedicle, there will be a gap in the ligated tissue, which is a potential site for bleeding. If the surgeon cuts past the tip of the clamp, this area may also bleed. Several studies have shown that bipolar electrosurgical clamps are safe and effective for sealing even the uterine vessels in the course of a vaginal hysterectomy (11,12). This technique requires some practice, but it can be quickly learned; and if used correctly on appropriately sized pedicles, it reduces operative time and blood loss.

â€œTroublesome bleedingâ€• may be defined as bleeding that keeps obscuring the operative field but may not be severe enough to stop the orderly progression of the procedure to go back and control the bleeding. This is a potentially dangerous trap because it tends to irritate the surgeon and because it may lead to inaccurate placement of clamps or sutures due to poor visualization of the operative field. This may lead to more bleeding, and the process may soon spiral out of control. Except in short operative procedures or occasionally when exposure will be better in a few minutes, it is best to stop and control â€œtroublesome bleedingâ€• when it is first noticed. This may involve electrocoagulation or suture of oozing on the posterior vaginal cuff or under the bladder or an unsutured gap between the cardinal and uterosacral ligament. It is usually fairly easy to fix, and prompt attention often prevents a bigger problem later.

Uncontrolled arterial bleeding is rarely encountered in vaginal surgery, but as with arterial bleeding anywhere, it is usually so vigorous that the source can be easily identified and clamped. Good exposure is important, and handheld

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retractors are usually the best. Lighted retractors may be especially useful if the vessel has retracted. Care must be taken to clamp and suture as little tissue as possible, because the ureter runs just above the uterine artery. Brisk venous bleeding may be more difficult to manage. The veins are more numerous and delicate, and it is not uncommon that rough attempts to control venous hemorrhage result in even more bleeding. Pressure with a finger, a gauze sponge in a ring forcep, or a small pack will usually control the bleeding temporarily and allow the surgeon to review the cause and site of the bleeding, the surrounding anatomy, and to develop a plan to control the bleeding (13). The anesthesiologist and the rest of the operative team should be alerted to the possibility of significant blood loss. Additional specialized instruments such as lighted retractors or long clamps may be requested and plans discussed with the team. This preparation may take only seconds and the operation proceeds with hardly a pause, or it may take several minutes while equipment and personnel are assembled. Additional pauses may be indicated as the situation unfolds. The anesthesiologist may need to catch up with the blood loss and restore the patient's blood pressure, or consultation, additional personnel, or instruments may be needed. Tight pressure on areas of venous bleeding will usually control the bleeding and actually promote clotting, which will help to solve the problem.

When the patient is relatively stable and good exposure and good lighting are available, an attempt should be made to visualize and clamp the bleeders. A headlight, lighted retractors, and sometimes two suctions may be helpful. The author prefers Allis or long tonsil clamps. In most cases, the author believes Haney clamps or other hysterectomy clamps are too gross for precise clamping of the bleeding point. Mattress or figure of eight sutures of 0 delayed absorbable suture should then be used to suture ligate the clamped tissue. Large bites of tissue should be avoided because they can incorporate the ureter, bladder, or rectum, leading to ureteral obstruction, fistula, or abscess. It may be advisable to check ureteral patency and bladder or rectal integrity before the end of the surgical procedure.

If the bleeding is high in the pelvis such as from the infundibulopelvic ligament or in the pararectal space, it may be necessary to abandon attempts to control the bleeding transvaginally and explore the patient through an abdominal incision. This is rare, but it is preferable to do this and control the hemorrhage from above rather than spend hours with the patient in shock thus increasing the risk of postoperative problems such as pelvic abscess, acute tubular necrosis, coagulopathy, and fistula. Other surgical consultants may be called to help assess the situation, offer advice, and scrub in to assist.

Use of Blood and Blood Products

The necessity for blood transfusion during vaginal surgery is uncommon, but the possibility should always be discussed during the informed consent. In recent years, surgeons have been more hesitant to give blood transfusions due to increasing concern over transmission of hepatitis and HIV. The risk of transfusion-related infections are listed in Table 31.1. While these and other complications are real, the surgeon should not hesitate to order a blood transfusion in the face of significant operative bleeding. Rapid transfusion of blood and blood products can be lifesaving in the face of massive hemorrhage.

Table 31.1 Risk of Transfusion-Related Infections

Infection	Risk
Hepatitis B	1:31,000
Hepatitis C	1:1.9 million
Hepatitis A	Rare
HIV	1:2.3 million
HTLV	Rare

HTLV, human T-lymphotropic virus.
Santoso JT, Saunders BA, Grosshart K. Massive blood loss and transfusion in obstetrics and gynecology. *Obstet Gynecol Surv.* 2005;60:827â€“837.

Today, most perioperative bleeding is treated with packed red blood cells. Total blood volume is about 8% of body weight or between 4.5 and 5.0 liters in the average woman. Acute blood loss exceeding 25% of the total blood volume produces symptoms of tachycardia, tachypnea and decreased urine output, and mild mental status changes in the awake adult. As the blood loss approaches 1000 cc, the surgeon should consult with the anesthesiologist. Is the patient stable? Is her urine output satisfactory? How much more bleeding is anticipated? How much longer will the operation last? Transfusion should be initiated sooner rather than later if additional blood loss is expected. A unit of packed red blood cells is about 300 cc in volume and should be expected to increase the hematocrit by 3% if the patient is not bleeding. Packed red blood cells do not contain platelets or other coagulation factors. When multiple units of packed cells are given for massive hemorrhage, fresh frozen plasma and/or platelet transfusion may be needed to restore depleted clotting factors. After about six units of blood have been transfused, a prothrombin time (PT), platelet count, and calcium should be checked. If the PT is greater than 1.5 times normal, four units of fresh frozen plasma should be given (1 unit FFP/ 20 kg body weight). Platelets are usually not required unless the platelet count is less than 50,000. With massive transfusion, the fluids should be warmed. Calcium and other coagulation factors should be monitored and replaced as needed.

Postoperative Bleeding

Bleeding from the operative site may not occur or become apparent until the patient is in the recovery room or even

until several days later (14,15). Vaginal bleeding is obvious, but tachycardia, low urine output, hypotension, and pelvic or low back pain may all be indicators of bleeding. A hematocrit should be checked, but it may not reflect the true situation if acute blood loss is ongoing and significant. If anemia and hypovolemia are diagnosed, the next question is whether the patient is still bleeding or if these signs and symptoms are the result of intraoperative bleeding that was underestimated and not adequately replaced. At this point, if possible, it is desirable for the surgeon to personally evaluate the patient in the recovery room. Is her pulse weak and thready or strong? Is there any sign of vaginal bleeding? If a vaginal pack is in place, should it be removed? Is her abdomen soft and flat or distended?

If some vaginal bleeding is present, the patient is stable, and her abdomen is soft, tight vaginal packing with 3- or 4-inch roller gauze can be attempted. This may be successful if there is a small venous bleeder on a vaginal mucosa edge. If bleeding is more substantial, sutures will be required; it has been the author's experience that attempts to evaluate these patients in the recovery room using a vaginal speculum and a flashlight are rarely helpful and result in significant patient discomfort. When significant vaginal bleeding is present, the patient should be promptly taken back to the operating room. Satisfactory anesthesia, good exposure and good lighting, and the correct instruments provide the best opportunity to correctly identify the site of bleeding and control it effectively with one or more sutures.

As much as possible, the patient and her family should be informed of the bleeding situation and management plans. The patient, if possible, and her next of kin should sign an informed consent for reoperation. It is often difficult to be both honest about the situation and yet reassuring. You might say â€œAlthough there was no bleeding when we left the operating room, she has had some bleeding in the recovery room. I think it will be best if we take her back to the operating room now and solve this problem. I'm planning (to give her some blood to replace the blood she has lost and) to start with a vaginal examination, but there is always the possibility that we will have to make an abdominal incision to control the bleeding. I will keep you posted.â€•

Even if the decision is to observe the patient in the recovery room for a little longer while the situation becomes clarified, preparations for transfusion and a possible return to the operating room should be initiated. One or more large-bore intravenous lines should be started. The blood bank should be informed of current and possible future needs. The anesthesiologist and operating room should be notified. It may be helpful to ask one of your partners or a colleague for a formal or informal consultation. It can be difficult for some surgeons to admit that reoperation may be necessary soon after the original surgery. An impartial outside expert may provide good advice, as well as some medical-legal documentation and support, and even some assistance at reoperation.

The magnitude of the vaginal bleeding, the patient's vital signs, and any concerns about potential bleeders during the original surgical procedure will all figure into the decision to take a patient back to the operating room to control hemorrhage. Except in the most dire circumstances, this should be done when the patient is hemodynamically stable and the necessary personnel and instruments are available. If indicated, the patient should already have been transfused or blood should be immediately available, if it is needed. Coagulation studies including a platelet count, PT, and partial throboplastin time should already have been done or be in process. Fibrinogen, fibrin split products, and other clotting factors may be indicated in special circumstances of massive blood loss or suspected coagulopathy. Broad-spectrum antibiotics should be started or redosed as appropriate.

After sedation or anesthesia has been induced, the patient should be placed in the dorsal lithotomy position for a thorough exam of the operative site. The author prefers the old fashioned â€œcandy caneâ€• stirrups because he believes that they provide better exposure and allow the assistants to position themselves more closely and comfortably in a position to assist. Initial vaginal exposure may be provided by a Graves vaginal speculum; but if suturing is necessary, a weighted speculum and one or more handheld retractors are best. Gauze sponges on ring forceps and suction will be needed to carefully and methodically expose and evaluate the vaginal cuff and all suture lines.

If there has been significant vaginal bleeding, it is usually a simple task to identify the bleeding site, clamp it with a long tonsil or Allis clamp, and ligate it with a figure of eight suture. We use either 0 or 2-0 delayed absorbable sutures in the vagina for this purpose. Even after one or two major bleeders have been identified and controlled, the entire operative site should be meticulously evaluated to be sure that there are no other bleeding points in need of suture. Good surgical judgment is required to say when enough is enough. Meddlesome poking around may stir up more bleeding, and a generalized ooze may be indicative of decreased clotting factors, which will respond better to packing, a warm patient, and time for transfusion or the patient herself to replenish the clotting factors in her blood.

The anatomy may be somewhat distorted from a hematoma or from the previous surgery, but the surgeon should be aware of the location of the bladder, ureters, rectum, and uterine vessels during reoperation (16). It will occasionally be necessary to reopen the cuff or other vaginal suture lines to expose persistent bleeding from deeper vessels. After the clamps have been placed and the bleeding controlled, briefly review the anatomy to determine that the sutures placed to control the hemorrhage will not kink or ligate the ureter or result in a bladder fistula or a large

uterine artery hematoma. When the bleeding has been controlled, it is a good idea to evaluate the bladder, ureters, or rectum by the usual, well-known techniques. It may also be advisable to obtain a pelvic CT scan with intravenous contrast in the next 24 hours to look for a hematoma and to document ureteral patency. The patient must be monitored carefully to be sure that she is stable, no further bleeding is ongoing, and her hematocrit and other laboratory parameters return to acceptable levels.

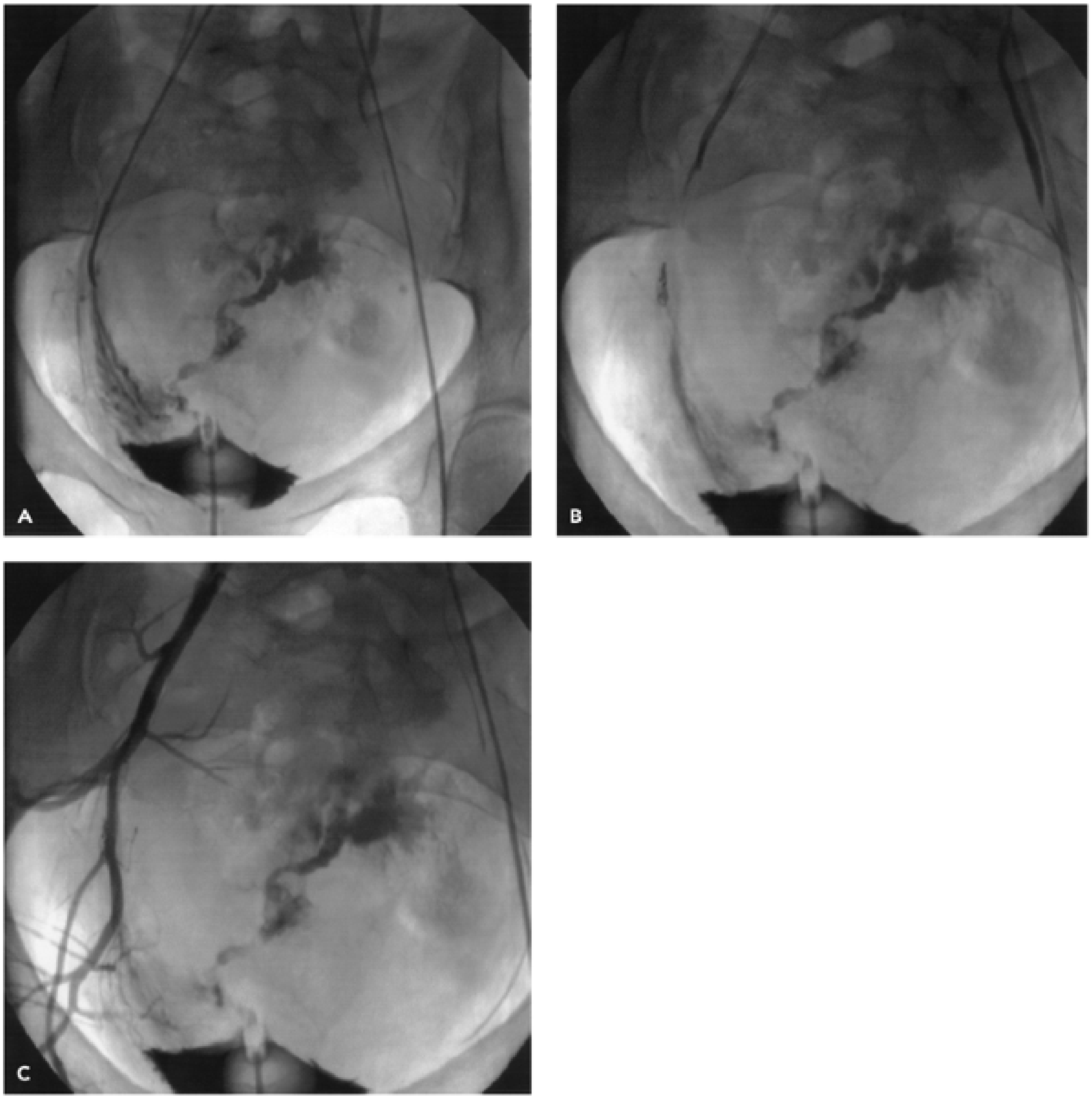

Figure 31-1 A: A young woman who is postoperative hysterectomy had a falling hematocrit, and CT scan demonstrated blood pooling in the pelvis and abdomen. A catheter has been inserted in the left femoral artery and threaded around to the right hypogastic. Injection of contrast shows extravasation in the pelvis. B: A small coil is used to embolize the bleeding vessels. C: Reinjection of contrast shows no further extravasation. There is residual contrast in the pelvis (compare with figure 31.1A). (Courtesy of Leann S. Stokes, M.D., Department of Radiology, Vanderbilt University.)

As a rule, vaginal packing with roller gauze is effective for controlling minor venous oozing from the raw edges of the vaginal mucosa. These packs should be removed within 24 hours. Repacking is rarely necessary or indicated. Patients who bleed through good vaginal packing in 1 to 4 hours and whose coagulation parameters are normal will require re-examination under anesthesia and suturing of significant bleeders. Large pelvic packs (parachute packs) have been described, but these are only appropriate for patients who have had ultraradical pelvic surgery such as pelvic exenteration.

Following vaginal surgery, pelvic hemorrhage will occur occasionally without vaginal bleeding. These patients often have a large retroperitoneal hematoma from the ovarian or uterine vessels. Unless this is an arterial bleeder, these

patients are usually not diagnosed immediately; but in the first 24 hours or so following surgery, their urine output is poor, they are tachycardic, and they may complain of back or hip pain. Their hematocrit will suggest much more blood loss than was estimated at surgery. Fluids and/or blood should be given, the patient should be stabilized if she is significantly anemic, and a work-up should be initiated to evaluate the presumed postoperative hemorrhage. If the patient is entirely asymptomatic and her routine postoperative hematocrit comes back as 23%, it is the author's experience that this is usually due to an inaccurate laboratory value. If a lab test result does not fit with the rest of the clinical picture, repeat the study before becoming too excited. Once again, the question is â€œIs the patient actively bleeding now, or is the current situation a result of previous bleeding that has now stoppedâ€•? If the patient is reasonably stable, this question can best be answered by observation over time. A coagulation profile and other indicated lab studies should be drawn. A large-bore IV should be started if not already available, and urine output should be carefully monitored with a Foley catheter, if necessary. Serial hematocrits should be monitored. A CT scan of the pelvis and abdomen or an ultrasound (17) may be useful to identify a hematoma and rule out possible ureteral obstruction.

If the patient is stable and serial hematocrits and the clinical picture suggest that bleeding has stopped, it is sufficient to monitor the patient. The hematoma will be reabsorbed, and she will rebuild her red blood cell volume over the next 4 to 8 weeks.

On the other hand, if active bleeding is present, action must be taken.

In most hospitals today, transcatheter embolization under radiologic guidance can be done by the interventional radiologists, and this offers an attractive alternative to reoperation. This technique is appropriate for either arterial or venous bleeding and has a high rate of success. The patient should be stable. A catheter is passed by way of the femoral artery, and the hypogastric and/or ovarian vessels are visualized by injection of contrast. If the bleeding site is identified, inert microspheres or small coils are injected to clog the artery, promote thrombosis, and stop the bleeding (Fig. 31.1).

Operative intervention is indicated if the patient is unstable and bleeding is significant or if transcatheter embolization is unavailable or unsuccessful. Preparation and communication with the patient and her family as well as the operative team as discussed previously is essential. An operative consent form should be signed. If the patient is not having vaginal bleeding or the radiologic studies suggest a pelvic hematoma, an initial vaginal exam can be done; however, exploratory laparotomy will almost certainly be needed. It is best to perform a midline incision, as this provides the most exposure and can be extended if needed.

Blood and blood products should be available and already transfused, if needed, because the patient may become hypotensive once the abdomen is opened. Intraperitoneal clots should be evacuated while a diligent and systematic search is made for the site of bleeding. The ovarian or uterine vessels are the usual suspects. When the bleeding vessel is identified, it should be clamped with a long tonsil clamp and carefully sutured. As discussed previously, care must be taken to avoid incorporating large wads of tissue in an attempt to control a large area of not-well-identified bleeding, as this approach runs the risk of injury to the ureter, bladder, or other important structures. Hematomas found on reoperation should be evacuated so that active or potential bleeders can be visualized and controlled. In some cases, no significant bleeding points will be found after the clots and hematomas have been evacuated and a thorough search has been made throughout the pelvis and abdomen. If the ovarian and uterine vessels have been visualized, are dry, and no further pelvic or abdominal bleeding is observed over a 5 to 10 minute period of â€œhands offâ€• observation, it is probably safe to assume that the patient stopped bleeding on her own on the way to the operating room. Such a patient can be safely closed and will almost always do well.

Conclusions

Hemorrhage during or after an operative procedure is a challenge to the technical skill and the emotional control of the surgeon. He or she must take charge of the situation, organize a plan to control bleeding, instruct and motivate the other members of the surgical team, and finally execute the technical steps necessary to stop hemorrhage. Each part of this approach is important. The leadership, knowledge, and experience of the surgeon will be severely tested in patients with life-threatening hemorrhage. The author hopes that the ideas and techniques in this chapter will make the reader more equipped to meet this challenge.

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Infections of the Vulva, Vagina, and Cervix

Sebastian Faro

Infections of the lower genital tract constitute one of the major reasons that patients come to the gynecologist's office. Such infections are usually easy to diagnose but can also be perplexing and difficult to eradicate. The difficulties in the management and treatment of lower genital tract infections are determining which condition is actually an infection and whether or not the condition is related to a microbe. Many conditions of the vulva are not caused by an infection but may be a result of a chemical coming in contact with the skin or a local immunologic response. Likewise, many disturbances in the vagina are caused by an alteration in the ecology of the vagina that results in a symptomatic condition referred to as either vaginosis or vaginitis. However, there is a condition that can be related to a true infection of the vagina or lower genital tract, namely trichomoniasis. This chapter will focus on two areas, true infections and disturbances in the vaginal endogenous microflora and how these conditions may impact the gynecologic health of the patient.

Infections of the Vulva

The skin of the vulva consists of three layers-the epidermis, dermis, and subcutaneous fat. The epidermis is the thinnest layer, but it provides the first line of defense against infection of the vulva. An intact epidermis forms a formidable barrier against invasion of the various microbes. However, the epidermis is easily breeched, and even a microscopic break in the epithelium can permit microbes to gain entrance to the dermis and subcutaneous tissue. The epithelium consists of metabolically active cornified squamous cells (1). The epidermis contains five types of cells: squamous cells, keratinocytes, melanocytes, Langerhans cells, and Merkel cells (1).

The dermis lies between the epidermis and subcutaneous fat, made up of connective tissue (collagen, elastic fibers, and ground substance) containing nerves, blood vessels, lymphatics, pilosebaceous-apocrine glands, and eccrine glands (sweat glands) (1). In addition, fibroblasts, mast cells, histocytes, Langerhans cells, lymphocytes, and rare eosinophils are found throughout the dermis.

The skin possesses some degree of antimicrobial activity, namely the dryness of the skin, and the normal skin flora forms a protected environment prohibiting colonization by pathogenic bacteria. The precise mechanisms involved in preventing infection of the intact skin are not known. It is theorized that the resident microflora hydrolyzes triglycerides found in sebum, releasing fatty acids that inhibit the growth of pathogenic bacteria. In addition, desquamation of the epithelium also provides a mechanism of shedding bacteria along with the epithelium (2). The mons pubis, vulva, perineum, inguinal areas, perianal area, and inferior aspect of the buttocks all fall within the domain of the obstetrician and gynecologist with regard to infection. Therefore, the gynecologist performing pelvic surgery should be cognizant of the condition of the skin.

Pyoderma

A pyoderma is any purulent skin condition. Typically, it is localized but can assume a spreading manifestation, characterized by an area of diffuse erythema with numerous pustules (Fig. 32.1). Localized pyoderma can either be solitary or form multiple lesions distributed on the skin (Fig. 32.2). The base is usually erythematous with a small central pustule. Usually, the infection does not penetrate the deep tissue but is confined to the epidermis. If there is a solitary lesion or just a few lesions, systemic antibiotics are not necessary. This condition can be managed by cleansing the

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area with an antiseptic solution and then applying a dressing to prevent clothing from irritating the area. If there are associated ulcerations of the lesions, these should cleansed with an antiseptic solution followed by application of a topical antibiotic cream or ointment, such as Bacitracin, Neosporin, or Bactroban, two to three times a day. If there is an apparent cellulitis associated with the skin infection, this indicates a progressive infection and requires systemic antibiotics.

Figure 32-1 *Pyoderma* . Multiple erythematous lesions in different stages of development. Small lesions are in the early stages of development; the central pustule has not yet developed. Larger lesions are in late stages of development, with a central area of scaling.

In all cases, a specimen should be obtained, preferably by aspiration or, if that is not possible, by swabbing the surface of the lesion. If there is an exudate on the surface, this should be removed with saline, and the lesion surface should be swabbed. The specimen should be placed in an appropriate transport medium, labeled correctly, and sent to the laboratory for the culture, identification, and antibiotic sensitivity testing of the isolated bacterium.

Figure 32-2 *Pyoderma of the right labium minora, lateral aspect* . Note the pointed pustule.

An infection of the vulva and surrounding area, unlike a skin infection occurring elsewhere on the body, may very well be due to either *Staphylococcus aureus* , including methicillin-resistant strains (MRSA), *Streptococcus pyogenes* (GAS, group A streptococcus), *Streptococcus agalactiae* (GBS, group B streptococcus), or polymicrobial involving a combination of Staphylococcus and Streptococcus or other bacteria from the endogenous vaginal microflora. Therefore, if there is progressive infection-that is, the presence of cellulitis-then empiric antibiotic therapy should provide coverage for MRSA and Gram-negative facultative bacteria as well as Gram-negative and Gram-positive obligate anaerobic bacteria. Empiric antibiotic therapy can be initiated with doxycycline or minocycline 100 mg orally twice a day for 7 to 10 days. If vaginal microflora is suspected as the cause of infection, a Gram stain would be helpful in distinguishing between an infection caused by Gram-positive cocci or a mixture (polymicrobial infection) of bacteria. If a polymicrobial infection is suspected, then the patient can be started on doxycycline or minocycline plus metronidazole 500 mg orally three times a day for 7 to 10 days. Once the bacterium or bacteria have been identified and the antibiotic sensitivities are known, adjustments to the antibiotic therapy can be made.

Impetigo

This infection is caused by *S. aureus* , *S. pyogenes* , or *S. agalactiae* (Fig. 32.3). Most often, the infection is caused by *S. aureus* , typically community MRSA. It is important to remember that although *S. aureus* is the most common organism to cause impetigo, skin infections of the vulva may involve bacteria from the vagina. Initially, the infection appears as small pustules that become confluent and rupture, creating erosion that can advance rapidly. In the early stage of the disease, the initial lesion can resemble

the vesicle of herpes. The vesicle is surrounded by an erythematous area and usually ruptures spontaneously from slight trauma (clothing rubbing against the vesicle), leaving a purulent exudate. A specimen should be obtained from the base of the lesion for Gram stain and culture. If there is a crust or purulent exudate covering the lesion, it should be cleared away by washing the surface with sterile normal saline. Treatment should be instituted with doxycycline or minocycline 100 mg administered orally for 10 days. The patient should be re-examined at the completion of therapy to document that there has been resolution of the infection. The patient should report, immediately, any recurrence of infection.

Figure 32-3 Pyoderma with a central area of necrosis.

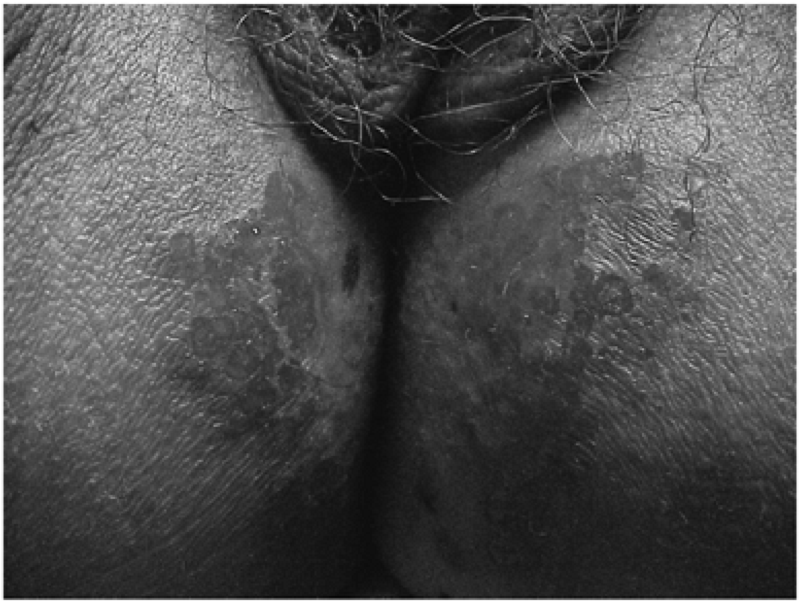

Figure 32-4 Impetigo of the buttocks.

Folliculitis

Folliculitis is inflammation of a hair follicle; it is a benign infection that can be characterized as a pyoderma of the hair follicle (Fig. 32.4). The infection is usually limited but may involve several hair follicles. Treatment rarely, if ever, requires systemic antibiotics. The patient should cleanse the infected areas with an antiseptic solution.

Furuncle

Furuncle (commonly referred to as a *boil*) is a painful, inflamed nodule that involves the epithelium, dermis, and subcutaneous tissue enclosing a central core of purulent material (3). Furuncles are infections involving the hair follicle that penetrate the epidermidis and dermis. Typically, the infection, most commonly caused by *S. aureus* , is usually community-acquired methicillin resistant. The initial lesion is a small, raised, erythematous nodule and is painful. The lesion rapidly enlarges and can become quite large (~ 2 cm in diameter). The lesion is erythematous, hot to touch, painful, raised toward the center, and indurated. The center of the lesion develops a characteristic yellow-green color. The lesion can rupture spontaneously or may require surgical incision. The purulent material is often thick and requires extraction of the core. A furuncle tends to be a localized infection without systemic symptoms and signs. However, if the patient has multiple furuncles, she may report a fever and generalized malaise. Approximately 5% or fewer strains of *S. aureus* produce Panton-Valentine leukocidin (PVL), a cytotoxin that has highly specific lytic activity against polymorphonuclear cells, monocytes, and macrophages in humans (4). Strains containing the PVL gene appear to be associated with infections causing necrosis of the skin, subcutaneous tissue (furuncles) and community-acquired severe, necrotizing pneumonia (5 ,6). In a recent Japanese study, PVL genes were detected in 40% (16 of 40) of *S. aureus* isolates from furuncles, 28% (2 of 7 isolates) from carbuncles, 14% (1 of 7) from abscesses, and 5% (1 of 20) from folliculitis (7). In France, the PVL gene has been isolated in 83% to 93% of *S. aureus* isolates from cases of furunculosis, 55% of isolates from cases of cellulitis, and up to 50% of isolates from cases of abscesses (5 ,6). Infection with *S. aureus* strains containing PVL genes does not appear to be associated with chronic illnesses, such as diabetes, leukemia, or autoimmune disorders (7). However, individuals infected with *S. aureus* strains containing the PVL genes were more likely to have multiple lesions and a larger area of erythema (7).

Carbuncle

A carbuncle forms when a group of furuncles is in close proximity to one another and penetrates the deep tissues (Fig. 32.5). The lesions can coalesce and progress to the subcutaneous tissue. Patients with carbuncles are more likely to exhibit systemic effects than patients with a furuncle. The carbuncle has a significant area of erythema and swelling, and the lesion is painful. Individuals with

advancing cellulitis, a body temperature of 101Â°F or greater should receive intravenous antistaphylococcal antibiotic (Table 32.1). Once the patient's temperature and white blood cell (WBC) count have returned to normal, the antibiotic should be switched to an oral form. Surgical intervention is often indicated by incising the lesion over the central collection of pustules and extracting the core of purulent material, leaving behind a cavity (Figs. 32.6 , 32.7 and 32.8). The cavity should be irrigated with normal saline or a solution of Bacitracin (50,000 units) and Kanamycin (1 g) dissolved in 1 L of normal saline. The cavity should be inspected to ensure that there is no remaining purulent material, packed with iodoform gauze and left in place for 24 hours, then removed. A topical antibacterial ointment or cream, such as mupirocin, can be applied twice a day for 7 to 10 days.

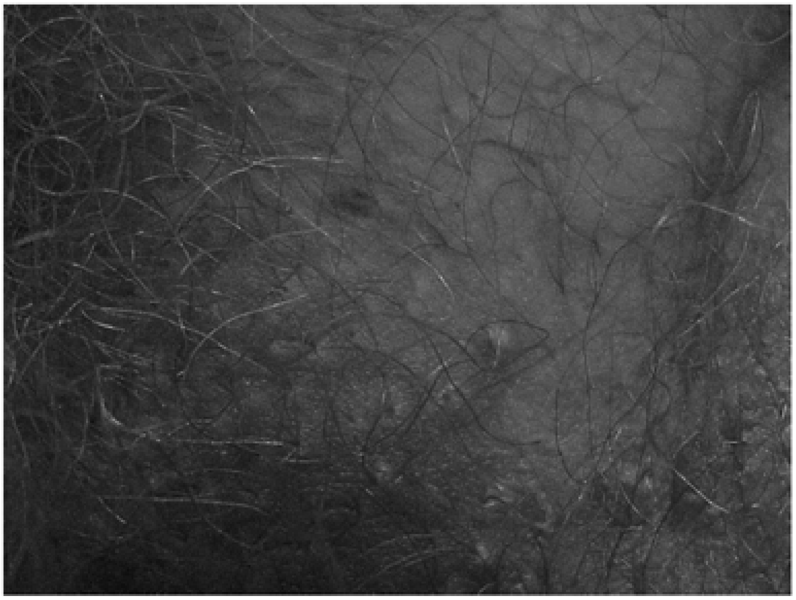

Figure 32-5 *Folliculitis* . Note multiple erythematous lesions with peeling of the skin and a lesion with a central pustule surrounding a hair.

Pyoderma
aureus Staphylococcus
Doxycycline 100 mg bid
Impetigo
Streptococcus pyogenes
Furuncle
Streptococcus agalactiae
Carbuncle
Hidradenitis
Staphylococcus aureus
Streptococcus agalactiae
Facultative Gram-negatives
Enterococcus faecalis

Obligate anaerobes
Clindamycin 300 mg tid +
Levaquin 500 mg q day

Infection	Microorganisms	Antibiotic Regiment

Table 32.1 Antibiotic Treatment for Skin Infections

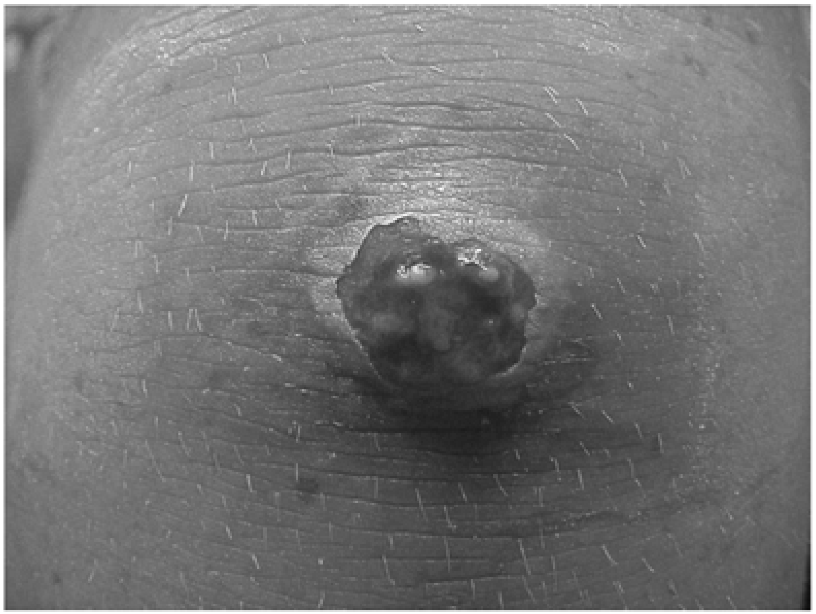

Figure 32-6 *Four furuncles that are in close proximity* . If left untreated, the furuncles will eventually coalesce to form a carbuncle. Note the erythematous base surrounding the pustules.

Figure 32-7 *Large carbuncle of the right labia majora* . Note the raised, tense, erythematous lesion with a central area of eschar. This is an extremely painful lesion that requires incision and extraction of the central core of pus.

Patients who have elevated temperature (â‰¥67 101Â°F), elevated WBC count, or â‰¥ 10% immature neutrophils or bands should be admitted to the hospital and treated with intravenous antibiotics such as clindamycin 900 mg every 8 hours plus gentamicin 5 mg/kg of body weight every 24 hours or vancomycin 1 g every 12 hours.

Bartholin's Gland Abscess

Approximately 2% of women will experience either a Bartholin's gland abscess or cyst at least once in their lifetime (8). A differentiation must be made between a

Bartholin's cyst and an abscess. The latter is usually asymptomatic unless it becomes large, and then it will function as a space-occupying lesion. Such a lesion causes pain because of the pressure exerted on the surrounding tissues and because of pressure within the cyst created by its contents. Bartholin's gland abscess can be a contained infection, or it can be associated with a spreading cellulitis in the tissue surrounding the abscess.

Figure 32-8 Carbuncle after the central core purulent material has been removed.

There are two Bartholin's glands, located at the 4 o'clock and 8 o'clock position, respectively, just distal to the hymenal ring (Fig. 32.7). The glands are small, approximately 2 to 3 mm, lined with cuboidal epithelium. They drain to the vestibule through ducts lined by transitional epithelium and change to squamous epithelium as it exits between the hymenal ring and the labium. Squamous carcinoma or adenocarcinoma can develop in Bartholin's gland, and because of this possibility, although remote, it is customary when operating on the Bartholin's gland to submit a tissue specimen for histologic analysis (9). Adenocarcinoma of Bartholin's gland is rare and is more likely to appear in women over 60 years of age. The incidence of Bartholin's gland adenocarcinoma is estimated in postmenopausal women to be 0.114 per 100,000 woman years (10).

The patient with a Bartholin's abscess presents with a mass at either the 4 o'clock or 8 o'clock position in the vestibule (Fig 32.9A). The patient will complain of pain because of the pressure within the Bartholin's gland, elevated body temperature, and pain with sexual intercourse. The abscess develops because Bartholin's duct becomes occluded and drainage of the gland is blocked. It is not uncommon for the abscess to drain spontaneously; however, the patient should still be evaluated and most likely will need surgical intervention. Bartholin's abscesses that drain spontaneously often seal over and the patient experiences an exacerbation of the abscess.

The procedure is initiated after deciding if a marsupialization is needed or if it can be managed with a Word catheter (Rusch Corporation, Duluth, GA) (11). In dealing with a Bartholin's gland abscess, the decision to proceed with marsupialization or placement of a Word catheter can be based on whether the abscess is contained or if it is associated with a progressive infection. If there is an associated cellulitis, which appears to be advancing, the patient is febrile, and the WBC count is elevated, then marsupialization is the better procedure. Whether or not the marsupialization is performed in a treatment room or the operating room depends on the patient's condition and her ability to cooperate.

The procedure is performed by first administering intravenous antibiotics, prepping the area with Betadine or other suitable antiseptic solution, then draping the area appropriately (Table 32.2). After appropriate anesthesia has been administered, an 18-gauge needle should be inserted into the abscess and at least 2 mL of fluid should be aspirated. The fluid should be placed in an anaerobic transport vial and taken to the microbiology laboratory immediately. The specimen should be immediately Gram stained and the results called to the physician. The remainder of the specimen should be processed for the detection of *Chlamydia trachomatis* , *Neisseria gonorrhoeae* , and facultative and obligate anaerobic bacteria, since bacteria endogenous to the vagina can cause a Bartholin's gland abscess (Fig. 32.9B) (12 ,13).

Once the microbiology of the infection is identified and the antibiotic sensitivities are known, the antibiotics being administered can be changed, if indicated. The antibiotics listed in Table 32.2 provide coverage against both Gram-positive and Gram-negative facultative and obligate anaerobic bacteria, as well as *C. trachomatis* and *N. gonorrhoeae* . The needle should not be withdrawn from the abscess but left in place to serve as guide to the depth required for scalpel blade to enter directly into the abscess cavity. The incision length should reach the entire length of the abscess. An elliptical-shaped tissue should be excised and sent to pathology. The abscess cavity should be checked with the surgeon's index finger or a hemostat to break up septations that may be present (Fig. 32.9C). The cavity should be irrigated with copious amounts of saline or an antibiotic solution, such as bacitracin 50,000 units plus Kanamycin 1 g dissolved in 1 L of normal saline.

Once the abscess cavity has been completely emptied and no loculated compartments remain, the wall of the gland should be sutured to the epidermis of the labia with interrupted sutures, such as 3-0 Vicryl. The cavity should be packed with iodoform gauze with the packing left in place for 24 hours (Fig. 32.9D). After removing the iodoform gauze, the cavity should be packed with plain gauze and changed on a daily basis. The cavity will shrink rapidly if the infection has resolved. When the patient's oral body temperature has returned to normal, the WBC count has normalized, and the cellulitis has begun to resolve, the intravenous antibiotics can be changed to oral antibiotics. This should occur within 24 to 48 hours.

If the abscess is well contained and there are signs or symptoms of progressive infection-that is, there is no advancing cellulitis, elevated temperature, and the WBC count is not significantly elevated-a Word catheter can be used. The area should be prepped with an antiseptic cleansing agent, with local infiltration along the vermillion border, at approximately where the duct opening is expected to be, with either 1% or 2% Xylocaine or 0.05% Marcaine. An 18-gauge needle is inserted into the abscess cavity, drawing 1 to 2 mL of purulent fluid and sending it to the microbiology laboratory for appropriate processing. A stab incision is made at the site where the needle was placed, and the cavity is irrigated with copious amounts of normal saline or antibiotic solution until the fluid turns clear. A hemostat is inserted into the abscess cavity, opened, and rotated 360 degrees to rupture any septations that are present. The incision should be no wider than the diameter of the Word catheter. The catheter is placed into the abscess

cavity, and the balloon is filled with sterile water. The catheter is left in place until it falls out spontaneously or after several weeks (approximately 4 to 6 weeks), and when the induration and erythema has resolved and epithelialization of the new tract has been completed, it can be removed. Whether a Word catheter is used or marsupialization is performed, when healing is complete, the patient will be left with a small and in most cases almost unnoticeable function gland and duct.

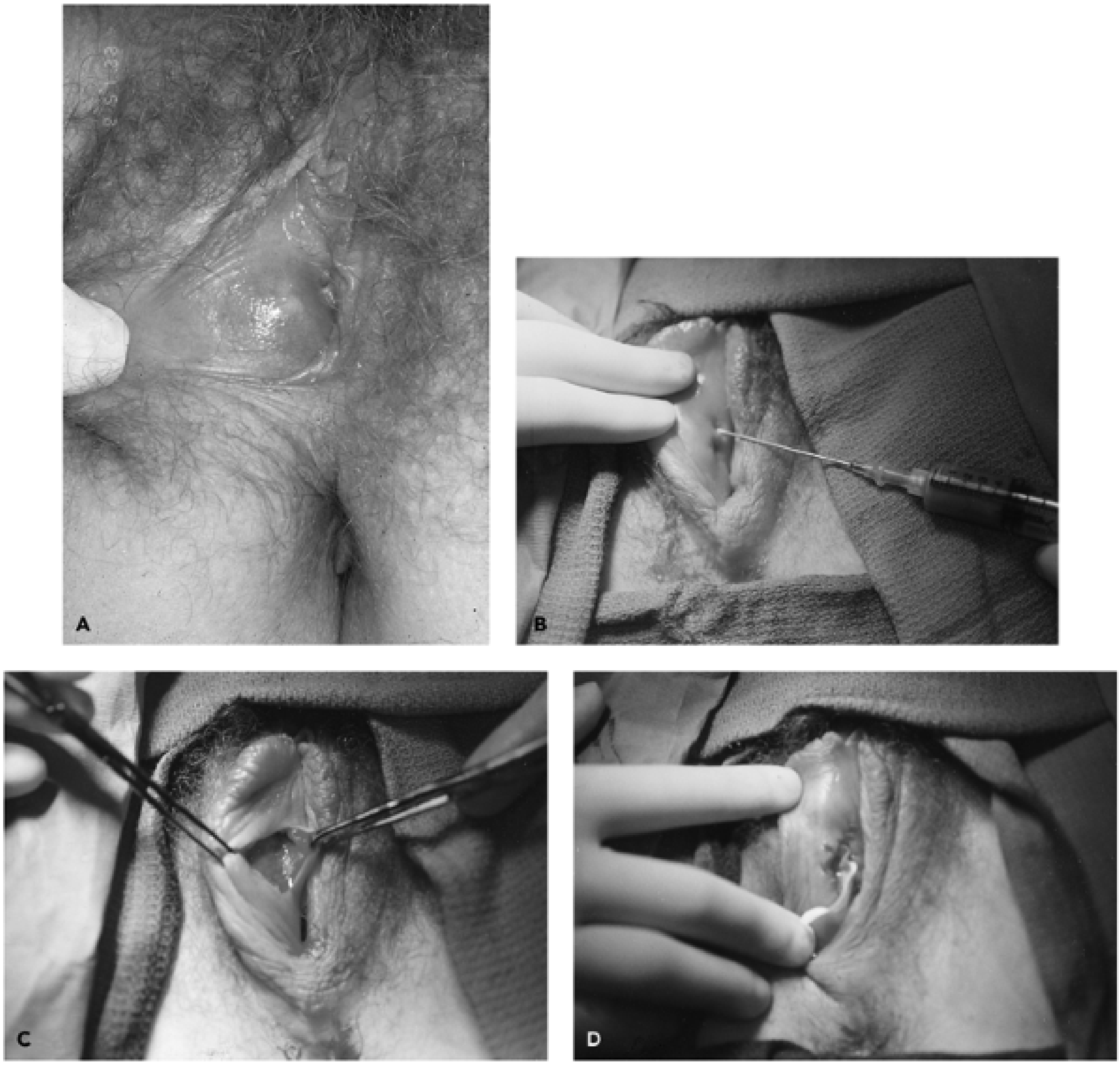

Figure 32-9 A: Abscess of the right Bartholin's gland. B: Aspiration of a Bartholin's gland abscess. This allows the surgeon to determine the depth of the abscess. The specimen is sent to the microbiology laboratory for Gram stain and culture for *Chlamydia trachomatis* , *Neisseria gonorrhoeae* , and facultative and obligate anaerobic bacteria. C: The abscess cavity is examined for septations, and if present they are lysed, thus creating a single cavity. D: Marsupialization is completed-that is, the inner wall of the abscess is sutured to the epidermidis of the labia minora. The cavity is packed with iodoform gauze, which remains in place for 24 hours.

The patient with a Bartholin's abscess has a potentially serious infection. This is especially true if the patient has a significant underlying chronic illness, such as diabetes. Serious complications are bacteremia, sepsis and septic shock (14). The physician should remain cognizant that the microbiology of a Bartholin's abscess can frequently be polymicrobial. Many of the microbes involved in this infection are highly virulent and therefore can cause serious infections, as mentioned previously, as well as necrotizing

fasciitis. Therefore, when a Bartholin's gland abscess occurs, it should not be simply aspirated and drained. This will result in the redevelopment of the abscess or the development of a more severe infection.

Metronidazole 500 mg q 8 hrs +
Metronidazole 500 mg q 8 hrs +
Levofloxacin 500 mg q 24 hrs
Levofloxacin 500 mg q 24 hrs
Clindamycin 900 mg q 8 hrs +
Clindamycin 300mg q 8 hrs +
Levofloxacin 500 mg q 24 hrs
Levofloxacin 500 mg q 24 hours

Intravenous Oral

Table 32.2 Antibiotic Choices For The Empiric Treatment Of A Bartholin's Abscess

Labial Abscess

A labial abscess must be differentiated from a Bartholin's gland abscess because the spread of infection is more likely. A labial abscess occurs within the dermis or within the fatty tissue of the labia majorum, not within a gland like the Bartholin's gland abscess. A labial abscess is likely to originate within a hair follicle or sebaceous gland, or it can occur from minor trauma to the labium, such as a scratch. As with any infection of the vulva, these infections are likely to go unnoticed in their earliest stage, and when recognized, the patient is likely to apply pressure to the lesion in an attempt to initiate drainage. This often results in the infection spreading radially and downward into deeper tissue. The application of pressure, â€œthe squeeze,â€• results in disruption of the tissues adjacent to the infection, allowing the infection to infiltrate these tissues and gain entrance to small vessels.

Labial abscess can arise after any surgical procedure has been performed on the labia itself or in close proximity to it, such as with a transobturator suburethral sling. The portal of entry for bacteria into the labia majora can be either one of the two stab incisions that are made lateral to the labia majora for placement of the tunneling needles or the incision in the anterior vaginal wall. The infection is likely to be either unimicrobial due mainly to methicillin-resistant *S. aureus* or polymicrobial involving, in addition to MRSA, bacteria endogenous to the lower genital tract. Labial abscesses, as with any other vulva abscesses, can lead to serious infection, such as necrotizing fasciitis, especially in the elderly patient with a chronic illness like diabetes, chronic hypertension, or renal disease (15 ,16).

The patient will present with pain caused by swelling of the labia, erythema, fever, and an elevated WBC count. Treatment should be initiated with broad-spectrum antibiotics to provide activity against Gram-negative and Gram-positive facultative and obligate anaerobic bacteria. Antibiotics should be administered intravenously. The patient should be brought to the operating room for incision, drainage, disruption of loculated compartments, removal of any foreign body, and copious irrigation of the abscess compartment. After the area has been prepped with an antiseptic solution and the patient draped, the mass should delineated. An 18-gauge needle should be inserted into the mass and 1 to 2 mL of fluid aspirated. The fluid should immediately be taken to the microbiology laboratory for Gram staining and processing for the isolation and identification of facultative and obligate anaerobic bacteria. All abscesses and significant infections of the vulva should always be considered serious and not managed by simple aspiration.

The incision should be made on the medial lateral aspect of the labial mass and not through the anterior surface. This will allow incision through a thinner aspect of the dermis and avoid the hair-bearing areas as well as provide some degree of cosmesis. The cavity should be checked for septations, and if present, they should be disrupted. The abscess cavity should be copiously irrigated with sterile normal saline or antibiotic solution. When the irrigation is complete, the cavity should be packed with iodoform gauze. After 24 hours, the packing should be removed and replaced daily with plain gauze. After the patient has recovered from anesthesia, she can be managed as an outpatient. If the patient cannot come to the office daily, a visiting nurse can see the patient daily, and the patient can be seen weekly in the physician's office. The packing needs to be changed daily to allow for proper healing and to prevent premature closure of the cavity. If the cavity closes prematurely, reinfection is likely to occur. The incision should be allowed to heal by secondary intention.

Hidradenitis Suppurativa

Hidradenitis suppurativa is a chronic disease with episodes of remission, and the specific etiology is unknown. The prevalence of hidradenitis suppurativa is estimated to be 4%, which means 5.8 million women in the United States are affected (17 ,18). The areas of the body most commonly affected are the axilla, vulva, groin, medial aspect of the thighs, perianal, buttocks, breast, and abdomen.

Hidradenitis is believed to be a disorder of the terminal follicular epithelium within apocrine gland-bearing skin (19). The current hypothesis is that keratization results in occlusion of the hair follicle, blocking egress from the follicle and associated apocrine gland. This occlusion results in inflammation of the tissue surrounding the hair follicle and subsequent infection (17 ,20 ,21 ,22 ,23). There has been a keen interest in the possible genetic transmission of hidradenitis suppurativa linked to a single gene. Fitzsimmons et al. studied three families involving a total of 62 individuals affected with hidradenitis suppurativa (24 ,25 ,26). These investigators found that 11 families demonstrated evidence of a single dominant gene, while three other

families had histories of genetic transmission. In these studies, men and women were affected and demonstrated vertical transmission consistent with autosomal dominant inheritance through several generations. Hidradenitis suppurativa appears to occur more frequently in women than in men (27 ,28). Hidradenitis suppurativa initially appears as a localized, erythematous-raised lesion associated with local hyperhidrosis and pruritus (29 ,30). The lesions become firm, enlarging nodules that can rupture spontaneously. Prior to rupturing, the lesions are painful, and the drainage can be quite foul smelling. The lesions heal after rupture, become fibrotic, and leave a scar. Recurrences occur, usually adjacent to a recently healed lesion. When the lesion ruptures on the surface, there is usually a rupture below the dermis and a fistulous track forms to an adjacent follicle, starting the process again. Multiple abscesses can develop over time, forming a honeycomb network below the dermis. If the disease process becomes significantly advanced, it can involve the underlying fascia and muscles (31 ,32). Frequently, multiple open comedones are obvious in areas adjacent to new and old lesions.

The abscessed follicle is a secondary process, and infection is not the initiating event. The bacteriology is not constant and can vary within the patient (Table 32.3). The foul-smelling drainage frequently observed with the spontaneous rupture of abscesses is quite noticeable and often results in the patient having soiled under- and outer garments, and retreating from social situations as well as having a negative impact on her employment and social life. Many of these patients avoid intimate relationships because of the foul odor associated with the purulent drainage. In patients with very advanced disease, there is a constant foul drainage forcing them to shower or bathe repeatedly and resort to wearing pungent perfumes.

Appropriate treatment is based on making a correct diagnosis, which is based on clinical findings and the presence of multiple sinuses, abscesses, and frequent recurrences. It is difficult to achieve an accurate diagnosis when the patient has her initial disease and there are only one or two lesions. Criteria for diagnosis is shown in Table 32.4 . Typically, the patient presents with recurrent inflammation and one or two abscessed follicles, usually mistaken for a furuncle or carbuncle (31). This approach to the management of hidradenitis suppurativa is incorrect. No other disease results in the development of recurrent abscesses involving hair follicles and the formation of sinus tracts leading to the appearance of new abscesses. Therefore, incision and drainage is doomed to fail and result in recurrent disease. The recurrence rate with simole incision and drainage is 100% (33). Prior to initiating treatment, the correct diagnosis must be established and differentiated from the many conditions that resemble hidradenitis suppurativa (Table 32.5).

Enterobacter
Bacteroides
Escherichia coli

Fusobacterium
Klebsiella
Peptococcus
Proteus
Peptostreptococcus
Staphylococcus
Prevotella
Streptococcus

Table 32.3 Bacteriology Of Hidradenitis Suppurativa

1. Erythematous, painful nodule
2. Spontaneous draining lesion
3. Foul-smelling drainage
4. Recurrent abscesses
5. Poor response to antibiotic therapy
6. Multiple comedones in association with abscesses
7. Comedones, which usually form a triangle
8. Multiple scars from spontaneously healed lesions

Table 32.4 Clinical Criteria For Establishing A Diagnosis Of Hidradenitis Suppurativa

Patients who present with one or two lesions can be treated with antibiotic therapy, but this usually does not result in eradication of the disease, and recurrences are common. Medical therapy may offer some comfort during the early stage of hidradenitis, but once it has progressed to either the development of multiple lesions or recurrences, medical therapy is of limited value (34). The hallmark of treatment is surgical excision of the abscess and the associated tracts (31 ,34 ,35 ,36). The author's approach is to take the patient to the operating room. Then, while the patient is under general anesthesia, each lesion is probed with a narrow probe in an attempt to locate the fistulous tract or tracts and to determine the length and direction of the tract. This area

is marked, and the entire area is excised. A margin of tissue at least 0.5 mm beyond the erythematous border of the lesion should be taken. The entire epidermis and dermis should be removed down to the fatty subcutaneous tissue. Rarely does the dissection require removing the fatty tissue down to the fascia, but occasionally, the abscess will penetrate the deep fatty tissue. The entire fistulous tract must be excised; otherwise, the recurrence rate will be high. The surgical excision of tissue often results in significant dissection and leaves defects in the tissue. The surgical site can be left to heal by secondary intention or closed primary. All surgical sites are then closed with 3-0 proline suture. Harrison et al. reported on 82 patients treated with 118 radical surgical excisions and found that there was a recurrence rate that varied according to site: axillary 3%, perianal 0%, inguinoperineal 37%, and submammary 50% (37). The overall recurrence rate with limited and wide local excision was 43% and 27%, respectively (33). The author's recurrence rate using wide excision, including the fistulous tracts, is approximately 15%. Since the lesions of hidradenitis are abscesses, the surgeon must treat these cases as contaminated surgical procedures. These patients should be regarded as potentially seriously infected individuals because the infection can potentially spread locally as well as systemically and can, in rare situations, cause septicemia (24 ,26). Other complications associated with hidradenitis are anemia, restricted mobility secondary to scarring especially with axillary disease, perianal fistula formation, and squamous cell carcinoma (29 ,38 ,39 ,40 ,41 ,42 ,43).

1. Furuncles
2. Carbuncles
3. Granulomatosis disease
4. Infected epidermoid cyst
5. Tuberculosis cutis
6. Actinomycosis
7. Tularemia
8. Carcinoma
9. Granuloma inguinale
10. Lymphogranuloma venereum

11. Perirectal abscess
12. Anal fistulas
13. Pilonidal cysts
14. Crohn's disease

Table 32.5 Differential Diagnosis Of Hidradenitis Suppurativa

Urethritis

Urethritis is a common disease but is often diagnosed as either cystitis or vaginitis and then treated as such. The result is that the patient often returns with the same symptoms, and often she is frustrated. The most common cause of urethritis in women appears to be *C. trachomatis* and *N. gonorrhoeae* , with *C. trachomatis* being the more frequent cause (44 ,45 ,46 ,47). The finding of WBC in a Gram-stained urethral smear is positively correlated with the presence of *C. trachomatis* , *N. gonorrhoeae* , and *Trichomonas vaginalis* . Conversely, in the absence of WBC, these organisms are rarely present (44). The role of *Mycoplasma genitalium* has been fairly well established in nongonococcal, nonchlamydial urethritis in men, and data regarding the role of this bacterium in genitourinary tract infections in women are accumulating.

The diagnosis of urethritis is established by performing a speculum and bimanual pelvic examination. The urethral meatus should be examined for the presence of purulent discharge prior to inserting the speculum. Also before insertion of the speculum and opening its blades, the anterior vaginal wall should be palpated to compress the urethra for the expression of a purulent discharge. This can be repeated on inserting the speculum, as the anterior blade presses against the anterior vaginal wall and urethra. The vaginal pH should be determined and a specimen examined microscopically for the presence of an altered vaginal microflora, the presence of clue cells, >5 WBCs/high power microscopic field, and *T. vaginalis* (48). The presence of >5 WBC's/40X magnification or *T. vaginalis* should inspire the physician to obtain an endocervical specimen for the detection of *C. trachomatis* and *N. gonorrhoeae* . The next step in the evaluation is to remove the speculum and perform a bimanual examination. During this examination, the urethra should be gently palpated and the urethral meatus simultaneously observed for the expression of a purulent discharge. A urethral swab should be inserted into the urethra, rotated, and sent for the detection of *C. trachomatis* , *N. gonorrhoeae* , *M. genitalium* , and facultative anaerobic bacteria. A urine analysis, culture for the detection of bacterial uropathogens, and antibiotic sensitivities should also be performed. The evaluation of urethritis is depicted in Table 32.6 .

1. Inquire as to any history of dysuria or urethral meatus burning.
2. Check for pain with palpation of the urethra.
3. There may be urinary pyuria but negative cultures.
4. Obtain a specimen with a urethral swab.
5. Process the swab for the detection of C. trachomatis, *N. gonorrhoeae, M. genitalium* , and uropathogens.
6. Examine the vaginal discharge for the presence of altered vaginal microflora and trichomoniasis.

Table 32.6 Evaluation Of The Patient Suspected Of Having Urethritis

Patients strongly suspected of having urethritis should be treated with either doxycycline 100 mg or minocycline 100 mg taken orally twice a day for 7 days (49). Alternative treatment is levofloxacin 500 mg or ofloxacin 400 mg orally once a day for 10 days (50).

Vaginitis/Vaginosis

The vaginal ecosystem is complex and exists in a delicate equilibrium that is constantly challenged. When the vaginal ecosystem is in a healthy state, *Lactobacillus* is the dominant bacterium. There are many bacteria that form the endogenous vaginal microflora, which consists of many different Gram-positive and Gram-negative facultative and obligate anaerobic bacteria (Table 32.7) (51). The important concepts regarding the relationship between *Lactobacillus* and the other bacteria include the following:

- The endogenous vaginal microflora consists mainly of pathogenic bacteria.
- The dominance of *Lactobacillus* is tenuous at best and can easily be overcome.
- The ratio of lactobacilli to the pathogenic bacteria is important in maintaining the patient's vaginal health.

- Reversal of the ratio of lactobacilli to pathogenic bacteria can result in the potential for upper genital tract infection, especially following transvaginal procedures such as hysteroscopy and sonohysterography.
- Reversal of the ratio of lactobacilli to pathogenic bacteria can increase the risk of developing pelvic infection following pelvic surgery.

Lactobacillus crispatusâ€”most common
Lactobacillus casei
Lactobacillus gasseria
Lactobacillus iners
Lactobacillus jensei
Lactobacillus is usually present in a concentration of â‰¥10^6 bacteria per milliliter of vaginal fluid.
Facultative anaerobic bacteria is usually present in a concentration of â‰¤10^3 bacteria per milliliter of vaginal fluid.
Gram-positive
Streptococcus agalactiae (present in 5% to 40% of women depending on geographic location)
Streptococcus viridans
Streptococcus spp.
Staphylococcus epidermidis
Enterococcus faecalis
Gram-negative
Escherichia coli
Enterobacter agglomerans

Enterobacter aerogenes
Enterobacter cloacae
Klebsiella oxytoca
Klebsiella pneumoniae
Morganella morganii
Proteus mirabilis
Proteus vulgaris
Obligate anaerobic bacteria is usually present in a concentration of â‰¤10^3 bacteria per milliliter of vaginal fluid.
Gram-positive
Gram-negative
Eubacterium spp.
Fusobacterium necrophorum
Peptococcus niger
Fusobacterium nucleatum
Peptostreptococcus anaerobius
Prevotella bivia
Prevotella melaninogenica
Veillonelia spp.

Dominant bacterium in a healthy vaginal ecosystem

Table 32.7 Bacteria Of The Endogenous Vaginal Microflora

The list of bacteria in Table 32.7 is by no means complete, but many other bacteria have been found to be part of the endogenous vaginal microflora. Bacteria, such as *Pseudomonas aeruginosa* , *S. aureus* , *Haemophilus influenzae* , and *Bacteroides* spp. as well as others have been isolated from the vaginas of healthy asymptomatic women. When the vaginal ecosystem is in balance, *Lactobacillus* is the dominant bacterium, and *Lactobacillus crispatus* is the most common species. *Lactobacillus* maintains dominance through the production of abundant organic acids, and lactic acid is the most abundant, thereby lowering the vaginal pH to below 4.5 (51).

L. crispatus or other hydrogen peroxide (H_2O_2)-producing species maintains dominance through the production of organic acids, mainly lactic acid, H_2O_2, and bacteriocin (lactocin). *Lactobacillus* does not possess catalase, neither do many of the obligate anaerobic bacteria, so it cannot breakdown H_2O_2 to water and oxygen (52 ,53 ,54). *Lactobacillus* also produces bacteriocin, a low molecular weight protein that has antibacterial properties (55 ,56 ,57). Thus, when the vaginal ecosystem is in a balanced equilibrium and *Lactobacillus* is dominant, the pathogenic bacteria are maintained in a suppressed state and pose no threat to the gynecologic and obstetric health of the patient. When this equilibrium is disrupted and the pH rises, the pathogenic bacteria begin to grow at a rate faster than *Lactobacillus* and eventually outnumber it. Which bacterium or bacteria gain dominance will determine the status of the ecosystem and the type of bacteria that will maintain dominance.

Bacterial Vaginitis

Not much has been written about bacterial vaginitis because the conditions referred to as *vaginitis* are complex, and most attention has been paid to bacterial vaginosis. There is no doubt that bacterial vaginitis exists, and every gynecologist and obstetrician has had to manage patients with an altered vaginal bacterial flora. The obstetrician has dealt with group B streptococcal amnionitis, postpartum endometritis, and prevention of neonatal sepsis. The obstetrician has also managed *Escherichia coli* , pyelonephritis, and postpartum endometritis. In addition, many Gram-negative facultative anaerobic bacteria have caused pyelonephritis and postpartum endometritis. Likewise, the gynecologist has been confronted with postoperative pelvic infections caused by Gram-positive and Gram-negative facultative bacteria. These bacteria not only can cause infection but can initiate a proinflammatory response (58). Vaginitis can be divided into *Candida* vaginitis, *Trichomonas* vaginalis vaginitis, *Gardnerella* vaginitis, bacterial vaginosis, and either unibacterial and polymicrobial vaginitis. In one study of patients not having bacterial vaginosis, symptomatic patients were found to have facultative Gram-negative bacteria, *Enterococcus* , or *S. agalactiae* isolated in significantly higher numbers than in asymptomatic patients (59 ,60 ,61).

Patients with an altered vaginal endogenous microbiology skewed to dominance by a Gram-negative facultative bacterium undergoing a transvaginal procedure or pelvic surgery are at risk for development of a pelvic infection. In situations where there is one or more facultative Gram-negative bacteria, the numbers of bacteria per species is likely to be â‰¥10^6 bacteria per milliliter of vaginal fluid. This colony count is sufficient to initiate an infection. This

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is seen in patients who enter labor without infection and subsequently develop postpartum endometritis.

The author recommends the following evaluation for all patients undergoing a transvaginal procedure, such as sonohysterography, hysterosalpingogram, laparoscopy, or vaginal and abdominal hysterectomy. It is recommended that for any procedure where the pelvic cavity is exposed to bacteria of the lower genital tract, the patient's vaginal microflora be evaluated as follows:

- Examine the vulva for the presence of inflammation, excoriations, folliculitis, pyoderma, and cellulitis.
- Note whether or not the Skene's glands, Bartholin's glands, or the urethra have any evidence of inflammation, enlargement, or purulent drainage.
- Insert a dry or water-moistened speculum into the vagina without traumatizing the cervix.
- Note the color of the discharge. Any color other than white or slate gray is abnormal.
- Note if the discharge has an odor. A healthy or *Lactobacillus* -dominant discharge is odorless.
- Determine the pH of the vagina by placing a pH strip against the lateral vaginal wall. The pH of a *Lactobacillus* -dominant vagina is 3.8 to 4.2. A pH of 4.3 to <5 indicates a transitional state where *Lactobacillus* is losing dominance. A pH â‰¥ 5 indicates that *Lactobacillus* has lost dominance.
- Obtain a sample of the discharge from the lateral pelvic wall, and immerse the swab in 2 mL of normal saline. Vigorously agitate the swab in saline, place one to two drops of the specimen on a glass slide, and cover the specimen with a glass cover slip. Then, examine the specimen under 40X magnification.

- The characteristics of the discharge are listed in Table 32.8 .

The consistency of the discharge is not significant because if *Lactobacillus* is the dominant bacterium, the consistency of the discharge can be from liquid to pasty.

Once a diagnosis has been made, then appropriate treatment can be instituted prior to performing the elective procedure. If there are uniform small rods appearing to dominate the vaginal microflora, this is most likely a facultative anaerobic Gram-negative rod, such as *E. coli* . If there are cocci in clusters, then it is most likely *Staphylococcus* (community-acquired methicillin-resistant *S. aureus* , CMRSA); if the cocci are grouped into clusters, it is most likely *Enterococcus* ; and if it is in chains, then it is *Streptococcus* . If identification of the dominant bacterium is required, a specimen from the vagina should be obtained and sent to the microbiology laboratory for processing.

When treating bacterial vaginitis, the goal is to restore *Lactobacillus* to dominance and to suppress all pathogenic bacteria. This can be best accomplished by administering boric acid vaginal capsules, each containing 600 mg of boric acid, in the morning and at bedtime for 2 weeks. If instituted 2 weeks prior to surgery, this treatment will not select for one particular bacterium other than *Lactobacillus* (no data available). However, since *Lactobacillus* grows at a pH â‰¤ 4.5 and the pathogenic bacteria favor a pH â‰¥ 5, it is logical to conclude that if boric acid does indeed lower the pH to <4.5, one of two things could happen: the pathogenic bacteria will be suppressed to â‰¤ 10^3 bacteria per milliliter of vaginal fluid, which is an ineffective inoculum size; or *Lactobacillus* will be given an opportunity to grow. Subsequently, the patient with a low number of pathogenic bacteria in the vagina will likely respond favorably to the administration of antibiotic for surgical prophylaxis.

Bacterial Vaginosis

Bacterial vaginosis (BV) is another condition that results from an alteration in the vaginal ecosystem, which causes a shift in the endogenous bacteriology of the vagina away from a *Lactobacillus* -dominant microflora to an obligate anaerobic-dominant bacterial microflora. This condition may be more dangerous than unibacterial vaginitis because similar to polymicrobial vaginitis, BV can bring together extremely virulent bacteria, including abscessogenic combinations such as *Prevotella* + *E. coli* , *Prevotella* + *Enterococcus* and others not yet identified (62). The bacteriology that constitutes BV has not been well described; there is no doubt that probably the major component consists

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of Gram-positive and Gram-negative obligate anaerobes. However, the Gram-negative and Gram-positive facultative anaerobic bacteriology has not been elucidated. Because most postoperative pelvic infections develop within 24 to 48 hours, there can be little doubt that the facultative anaerobic bacteria play a significant role in initiating the infection, as their reproductive times are much shorter than the obligate anaerobes. The inoculum size of the facultative anaerobes when growing with the obligate anaerobes in a BV population is likely to be â‰¥ 10^5 bacteria per milliliter of vaginal fluid and the inoculum size of the obligate anaerobes â‰¥ 10^8 bacteria per milliliter of vaginal fluid. These inocula sizes are more than enough to initiate a pelvic infection following hysterectomy. Patients undergoing hysterectomy, vaginal or abdominal, who have BV and receive antibiotic prophylaxis are at greater risk of developing a postoperative pelvic infection than women who do not have BV (63 ,64 ,65). Therefore, it seems logical that any woman undergoing pelvic surgery where the lower genital tract will be entered or manipulated, which can cause bacteria from the lower genital tract to gain entrance to the pelvic cavity, should be evaluated prior to surgery to determine the status of the vaginal microflora (Table 32.9).

Color

White to slate gray

Purulent

Dirty gray

White

Purulent dirty gray

pH

3.8 to 4.2

â‰¥5

â‰¥5

3.8 to 4.5

â‰¥5

Table 32.8 Characteristics of Vaginal Discharge

Characteristic	Healthy	Bacterial Vaginitis	Bacterial Vaginosis	Candidiasis	Trichomoniasis
Odor	None	None	Fishlike	None	None
WBC[a]	â‰¤5	â‰¥5	â‰¤5	â‰¥5	â‰¥5
Squamous cells	Estrogenized	Estrogenized	Estrogenized	Estrogenized	Estrogenized
Dominant bacterial morphotype	Large rods	Small rods or cocci	None	Large rods	None

[a] WBC, white blood cells/high-power field (40 Ã— magnification)

I. Evaluate the patient 1 to 2 weeks prior to surgery.
II. Perform the standard pelvic examination:

   A. Determine vaginal pH.
   B. If the pH â‰¥4.5, perform the whiff test.
   C. Examine the vaginal discharge microscopically for the presence of:
      1. Clue cells
      2. WBCs
      3. Estrogenized squamous cells
      4. *Trichomonas vaginalis*

III. If WBCs (>5/hpf) are present and no pathogen is detected:
   A. Obtain a culture of vaginal fluid or rapid test for detection of *T. vaginalis* , and
   B. Obtain a cervical specimen for the detection of *C. trachomatis and N. gonorrhoeae* , if the patient has risk factors.

Table 32.9 Evaluation Of The Vaginal Microflora Of The Patient Scheduled For Pelvic Surgery

The goal of treating BV, especially in the pelvic surgery patient, is to restore *Lactobacillus* to dominance without selecting for resistant bacteria within the multitude of bacteria that inhabit the lower genital tract. Administering antibiotics has the potential of selecting for resistant bacteria. Therefore, the administration of boric acid, 600 mg capsule, intravaginally twice a day for 7 to 14 days should facilitate restoring *Lactobacillus* to dominance. Administering boric acid the night prior to surgery should help to acidify the vagina and therefore inhibit the growth of pathogenic bacteria (no data available). Exposure to boric acid throughout the night prior to surgery should prevent a regrowth of pathogenic bacteria, should *Lactobacillus* not achieve dominance. Administration of antibiotic prophylaxis to patients pretreated with boric acid should be more successful than antibiotic prophylaxis administered to patients with an altered vaginal microflora (BV or bacterial vaginitis) who have not been pretreated with boric acid.

Cervicitis

Cervical inflammation and cervicitis are commonly diagnosed by Papanicolaou smear. In the absence of *C. trachomatis* and *N. gonorrhoeae* , cervicitis is usually ignored because the etiology is not determined. Whether or not cervicitis has an impact on the patient undergoing pelvic surgery is not known. However, the two most common causes of cervicitis are *C. trachomatis* and *N. gonorrhoeae* . These two sexually transmitted organisms are responsible for a significant number of mucopurulent cervicitis cases (66). Leukocytes can be found in 10% to 15% of the cervical mucosa. While their function is not well understood, their presence does not necessarily indicate an infection (67). The cervix does not appear to significantly contribute to the development of postoperative pelvic infection.

Conclusions

The lower genital tract is a complex area of the body that presents numerous opportunities for bacterial and fungal infections. The skin of the vulva is susceptible to infections just like any other part of the body covered with skin. These infections can be localized or extensive, resulting in disseminated infection. The lower genital tract contains a variety of structures that can become infected, such as the urethra, Skene's glands, Bartholin's glands, vagina, and cervix. Again, these structures can contain limited infections or become seriously infected. When the lower genital tract becomes infected, surgery is often required in addition to antibiotics in order to resolve the infection. The lower genital tract contains numerous bacteria, many of which are pathogenic. When the endogenous vaginal microflora is dominated by *Lactobacillus* , this microflora poses no threat to the patient's well-being. However, when the endogenous microflora is dominated by the pathogenic bacteria and the patient is undergoing an invasive pelvic procedure, the patient's health is placed in jeopardy. These bacteria can cause pelvic infection.

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Surgical Management of Pelvic Inflammatory Disease

Sebastian Faro

Pelvic inflammatory disease (PID) continues to be a major problem with significant consequences, especially for women of reproductive age. PID is most frequently seen in women in the earlier reproductive age group of those 15 to 25 years of age (1 ,2 ,3). However, PID can occur in any woman regardless of age if she possesses her reproductive organs. PID is an inflammation of the reproductive organs most likely caused by infection. PID should be thought of as a continuum of infection, which is initiated with an infection of the cervix. The infection can remain isolated to the cervix or it can progress to the uterus and then to the fallopian tubes. One of the difficult aspects of PID it that it is frequently subtle, that is, the symptoms are so mild that both the patient and physician overlook them. Therefore, the infection can progress, and significant damage can be done to the fallopian tubes. This occurs without the patient having any indication that the infection exists. The process causes significant damage that can result in inhibition of a fertilized egg to migrate through the fallopian tube and implant in the uterus, thus resulting in an ectopic pregnancy. Additional sequelae are chronic pelvic pain, pyosalpinx, hydrosalpinx, or tubo-ovarian abscess. Approximately 10% to 15% of women in the United States will experience at least one episode of PID involving the fallopian tubes (4 ,5).

Epidemiology

PID is most commonly the result of infection with *Chlamydia trachomatis* or *Neisseria gonorrhoeae* . *C. trachomatis* is considered the most commonly sexually transmitted bacterium. In 1998, it was estimated that there were 250 cases in 100,000 people with PID (6). The incidence of *C. trachomatis* is higher in women, approximately 400 cases in 100,000 women; in men, it is prevalent in approximately 80 cases in 100,000 (6) (Fig. 33.1). It has been reported that up to 90% of *C. trachomatis* and *N. gonorrhoeae* in both men and women are asymptomatic and can persists for months (7 ,8).

The number of gonorrhea cases slowly decreased from 1976 through 1982 and has steadily decreased since (6) (Fig. 33.2). However, gonorrhea continues to be a significant problem in the southeastern United States (Fig. 33.3). The number of gonorrhea cases has steadily decreased in both men and women (6) (Fig. 33.4). Although there has been an overall decrease in the number of cases of gonorrhea in all races and ethnic groups sampled, a significant degree of infection among African Americans remains (Fig. 33.5). *C. trachomatis* and *N. gonorrhoeae* continue to be the most common precursor diseases leading to PID. However, since 1984, the number of PID cases has continued to decrease and so has the number of hospitalizations (Figs. 33.6 and 33.7). The reason for this decrease is not known, but it may be related to two factors: (i) chlamydial infection is more frequently asymptomatic than symptomatic in women, and (ii), antibiotics like ciprofloxacin, levofloxacin, doxycycline, and azithromycin are commonly prescribed for a variety of suspected infections and are effective in treating both *C. trachomatis* and *N. gonorrhoeae* .

There are an estimated 1 million cases of PID each year in the United States. Although the actual number of PID cases has decreased, the severity of the disease has not changed. Every gynecologist is well aware of the destructive nature

of this infection and that the key to successful treatment is early recognition and institution of appropriate antibiotic therapy. Surgical intervention should not be delayed when indicated but should be preceded by appropriate imaging studies (9).

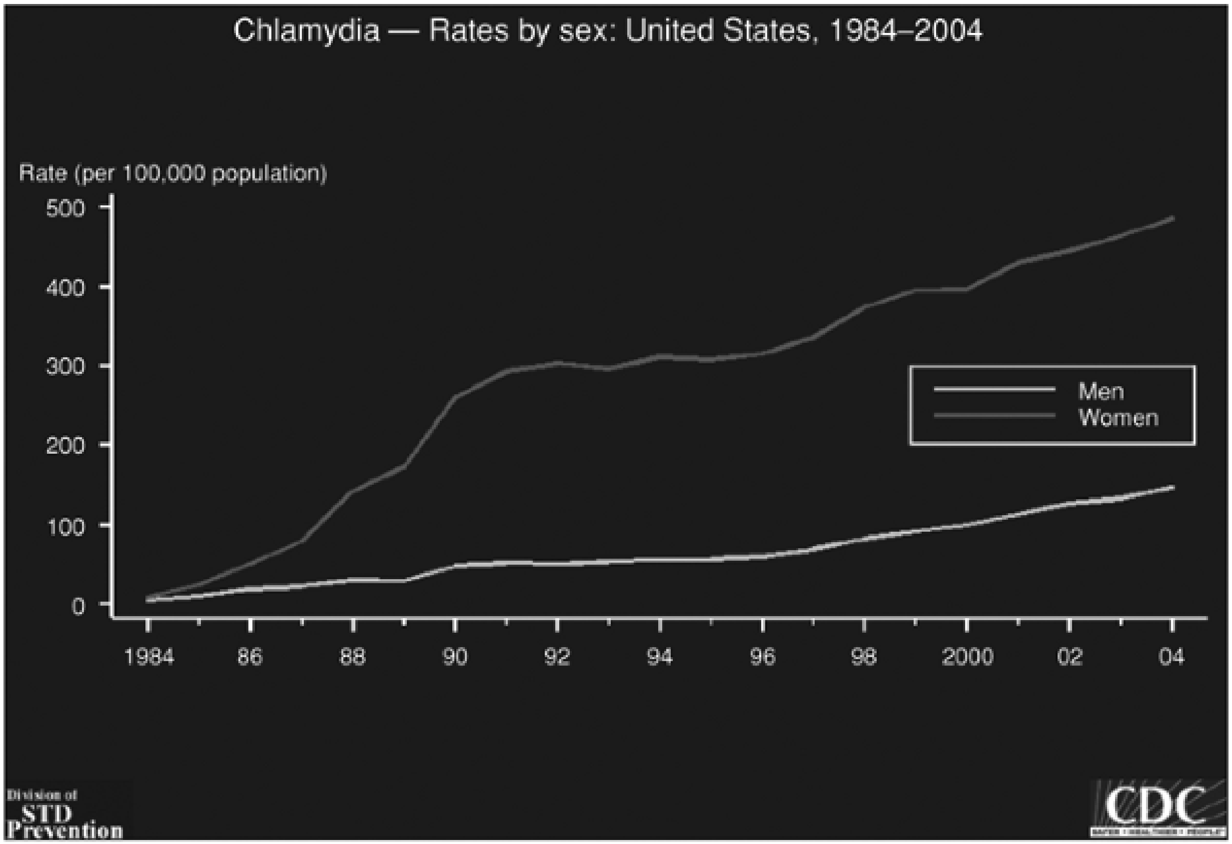

Figure 33.1 The number of cases of *Chlamydia* continues to increase more dramatically in women than in men. (From 2004 STD Surveillance Report, Centers for Disease Control and Prevention.)

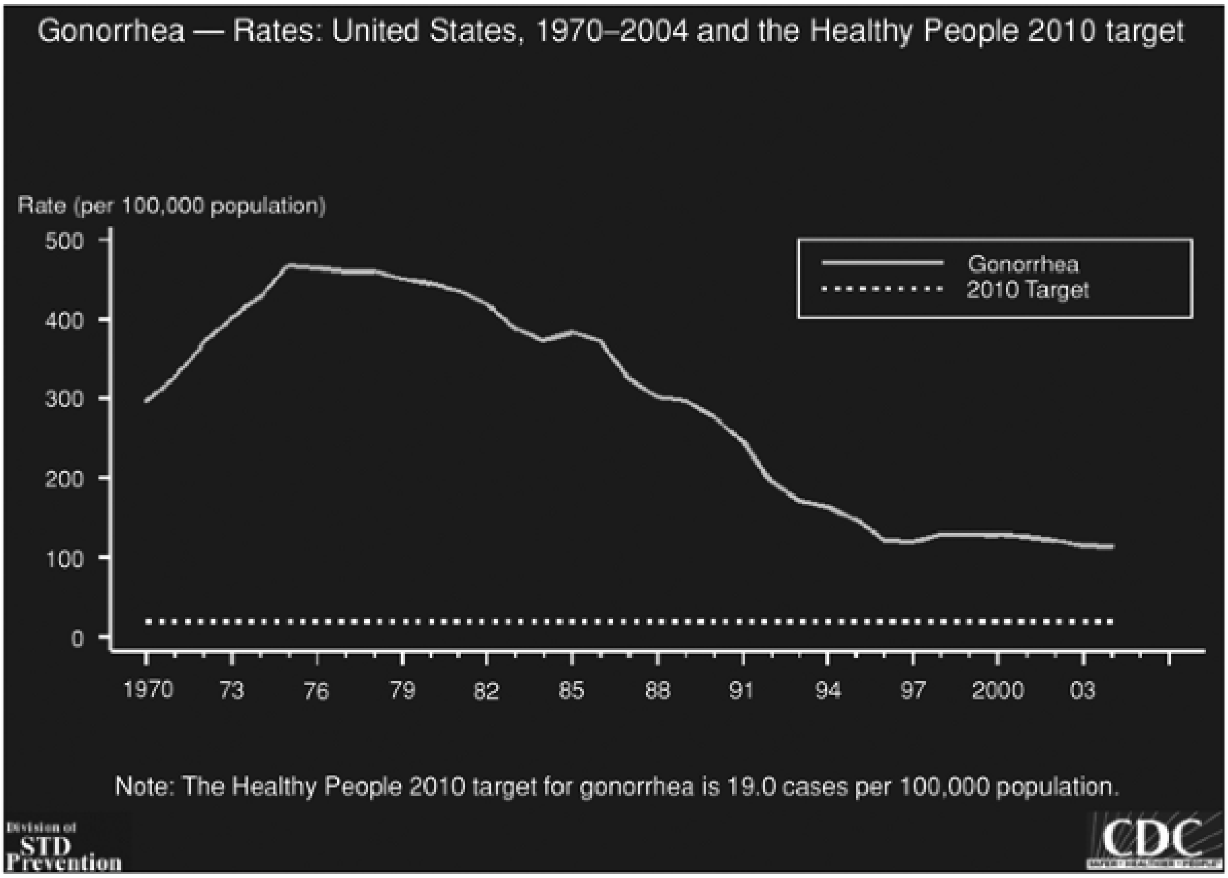

Figure 33.2 The number of cases of gonorrhea strongly declined after 1975 and has increased since 1995. (From 2004 STD Surveillance Report, Centers for Disease Control and Prevention.)

Microbiology

The microbiology of PID has been oversimplified. To state that PID is most commonly caused by *C. trachomatis* , *N. gonorrhoeae* , or both is misleading. Both of these bacteria frequently cause infection that is either asymptomatic or associated with minimal (10 ,11 ,12). However, it is likely that once the acute episode has been established, secondary infection with pathogenic bacteria endogenous to the lower genital tract become involved in the infectious process. It is important that all physicians and allied health care providers who treat women in the reproductive age group, especially those from 15 to 25 years of age at risk for sexually transmitted infections, recognize the signs and symptoms of subtle or subacute infection. *C. trachomatis* has been isolated from the cervix of approximately 39% of women diagnosed with PID and from the fallopian tubes in 10% of women with PID (2). *N. gonorrhoeae* has been isolated in the cervix of approximately 80% of women with PID and from the fallopian tube in 18% of women with PID (2). The bacteria from the lower genital,

especially facultative and obligate anaerobic bacteria, have been shown to cause destructive PID and tubo-ovarian abscesses (8 ,13).

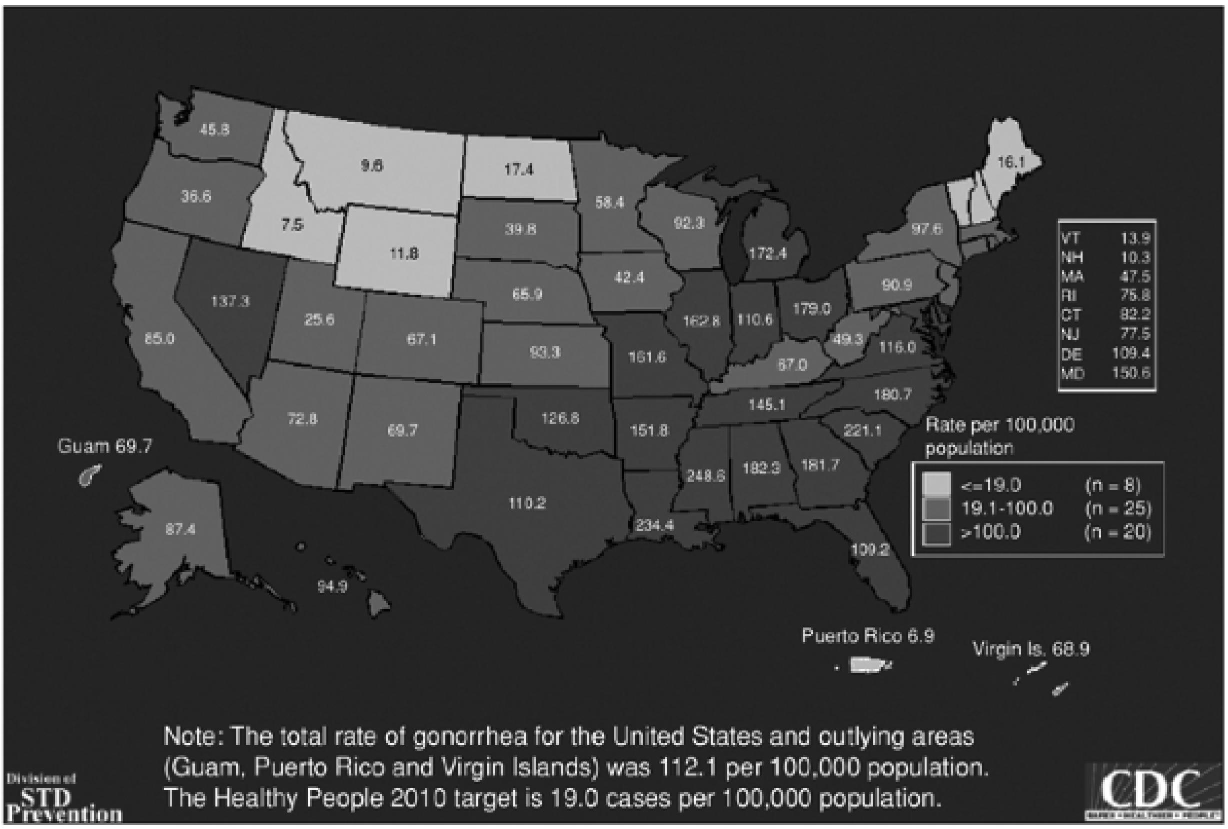

Figure 33.3 Gonorrheaâ€"Rates by state: United States and outlying areas, 2004. (From 2004 STD Surveillance Report, Centers for Disease Control and Prevention.)

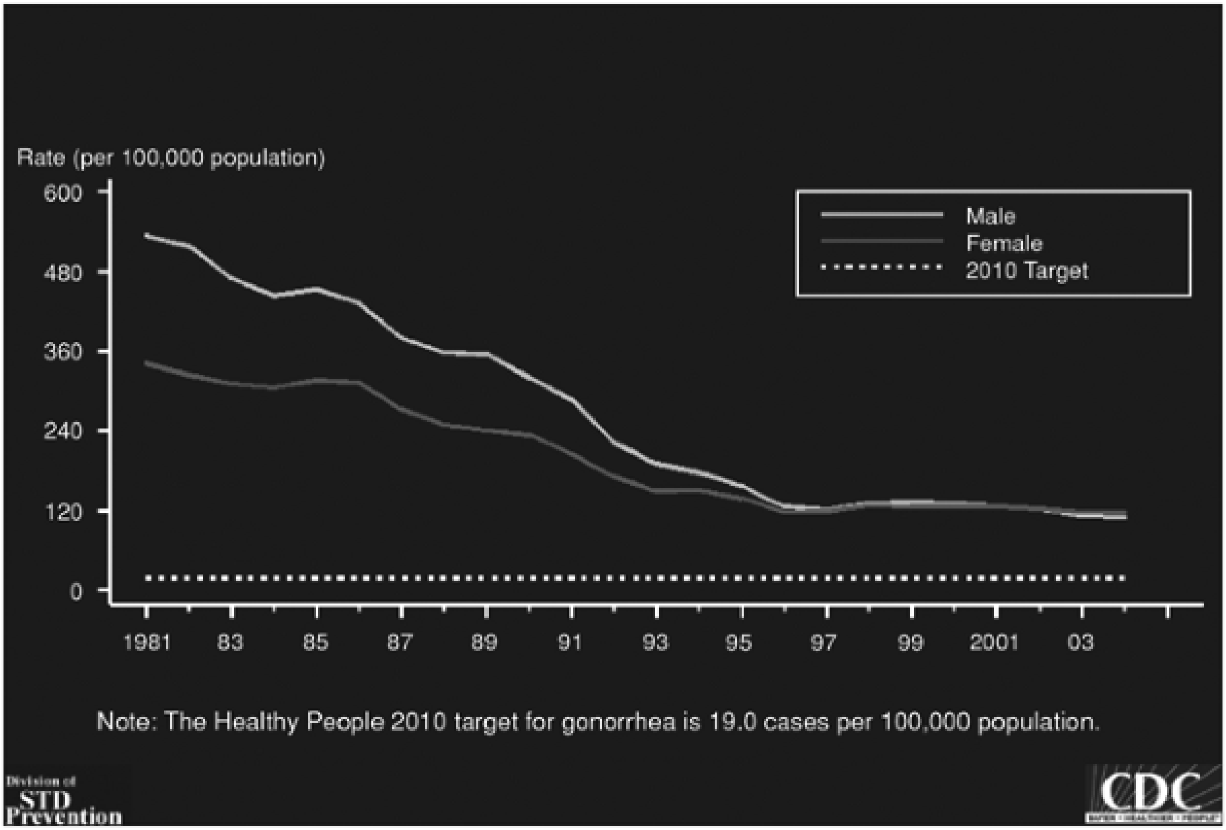

Figure 33.4 Gonorrheaâ€”Rates by sex: United States, 1981-2004 and the Healthy People 2010 target. (From 2004 STD Surveillance Report, Centers for Disease Control and Prevention.)

Women with a *Lactobacillus* -dominant vaginal microflora who subsequently contract *C. trachomatis* or *N. gonorrhoeae* cervicitis are probably less likely to develop a polymicrobial PID than women whose endogenous vaginal microflora is already altered. However, individuals who lack a *Lactobacillus* -dominant vaginal microflora and who subsequently develop *C. trachomatis* or *N. gonorrhoeae* are more likely to develop a polymicrobial PID and subsequently experience more tissue destruction and develop pyosalpinx and tubo-ovarian abscesses.

Risk Factors

Any sexually active woman who is not in a monogamous relationship is at risk for contracting a sexually transmitted disease. This can be a direct risk if she has had more than one sexual partner. The woman may be indirectly exposed if her partner has had multiple sexual partners even though she is only sexually active with one partner. Several aspects of sexual behavior, such as sexual intercourse at an early age, multiple sexual partners, high frequency of sexual intercourse, acquiring new sexual partners within the previous 30 days, and not living with the sexual partner, place an individual in a high-risk group (14 ,15 ,16). Therefore, any

unmarried and sexually active patients, especially those between 15 and 25 years of age, should be considered at risk for a sexually transmitted disease. These individuals should also be screened for *C. trachomatis* and *N. gonorrhoeae* .

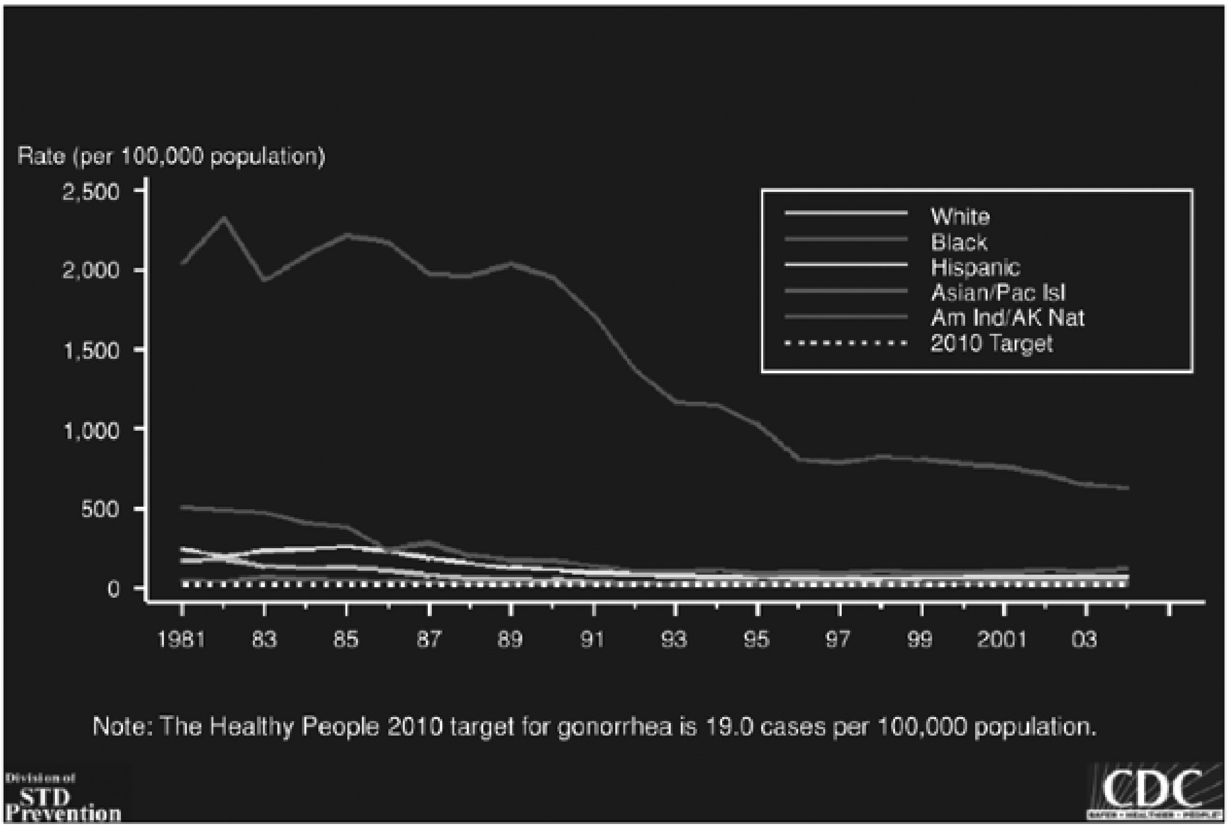

Figure 33.5 Gonorrheaâ€"Rates by race and ethnicity: United States, 1981-2004 and the Healthy People 2010 target. (From 2004 STD Surveillance Report, Centers for Disease Control and Prevention.)

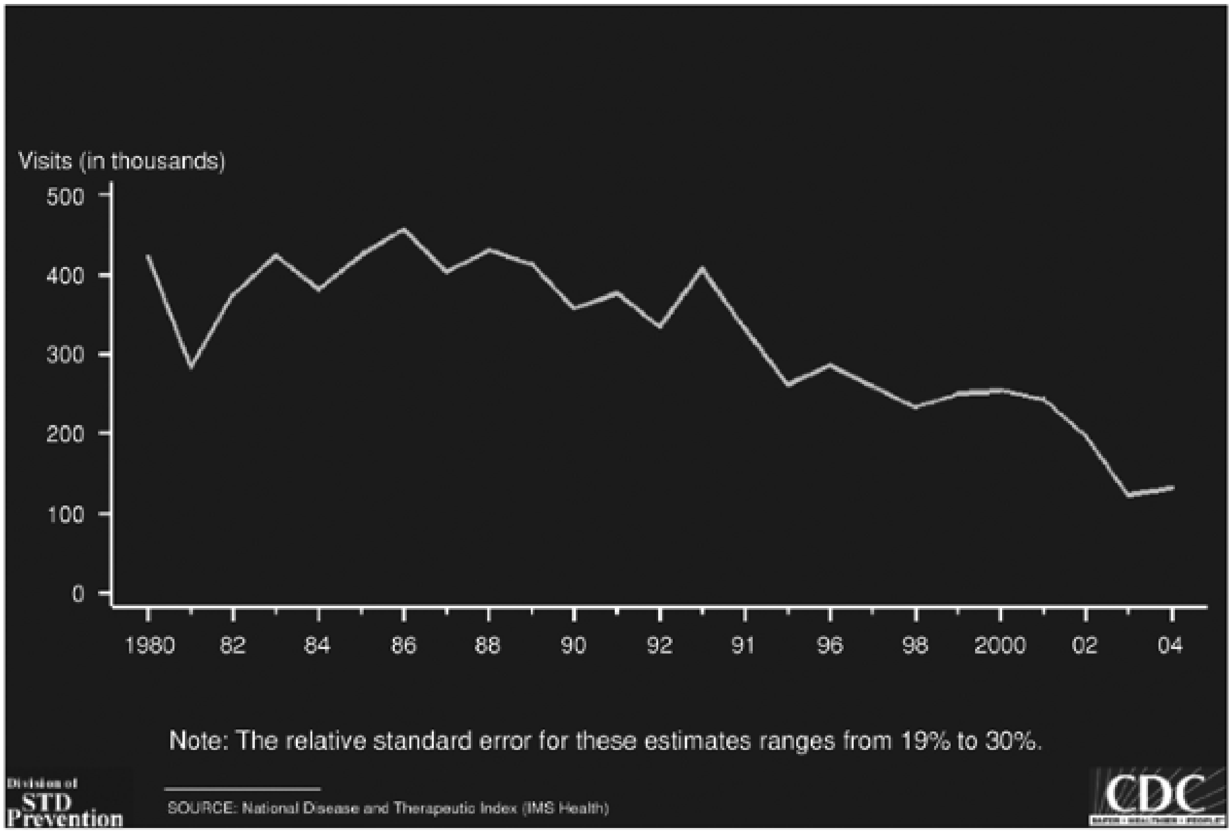

Figure 33.6 Pelvic inflammatory diseaseâ€"Initial visits to physicians' offices by women 15 to 44 years of age: United States, 1980-2004. (From 2004 STD Surveillance Report, Centers for Disease Control and Prevention.)

Specimens should be obtained from the endocervix for the detection of *C. trachomatis* and *N. gonorrhoeae* . An endometrial biopsy specimen should also be obtained if the patient is suspected of having endometritis. First, the cervix should be cleansed with betadine or a suitable antiseptic solution, then a biopsy instrument such as a Pipelle is inserted through the endocervical canal and into the uterine cavity. The specimen should be divided into two portions, with one sent for histology and the other placed in an anaerobic transport medium for the culture of aerobic, facultative, and obligate anaerobic bacteria as well as for *C. trachomatis* and *N. gonorrhoeae* . If a laparoscopy or laparotomy is performed, fluid from the posterior cul-de-sac should be aspirated and also sent for culture of aerobic, facultative, and obligate anaerobic bacteria as well as *C. trachomatis* and *N. gonorrhoeae* . If pyosalpingous fallopian tubes, ovarian abscesses, or tubo-ovarian abscesses are found, the structures can be aspirated and the specimens sent for detection of aerobic, facultative, and obligate anaerobic bacteria. All specimens should be

taken to the microbiology laboratory without delay to avoid loss of the more fastidious bacteria. The laboratory should be contacted to inform personnel that the specimens have been sent for processing as well as the origin of the specimens. The specimens should be gram stained to provide initial information as to the possible bacteria involved in the infection. This will identify whether the specimens are Gram-negative, Gram-positive, or if both bacteria are present. The Gram-stain characteristics of the bacteria detected can aid in selecting an appropriate antibiotic therapy.

Clinical Presentation and Diagnosis

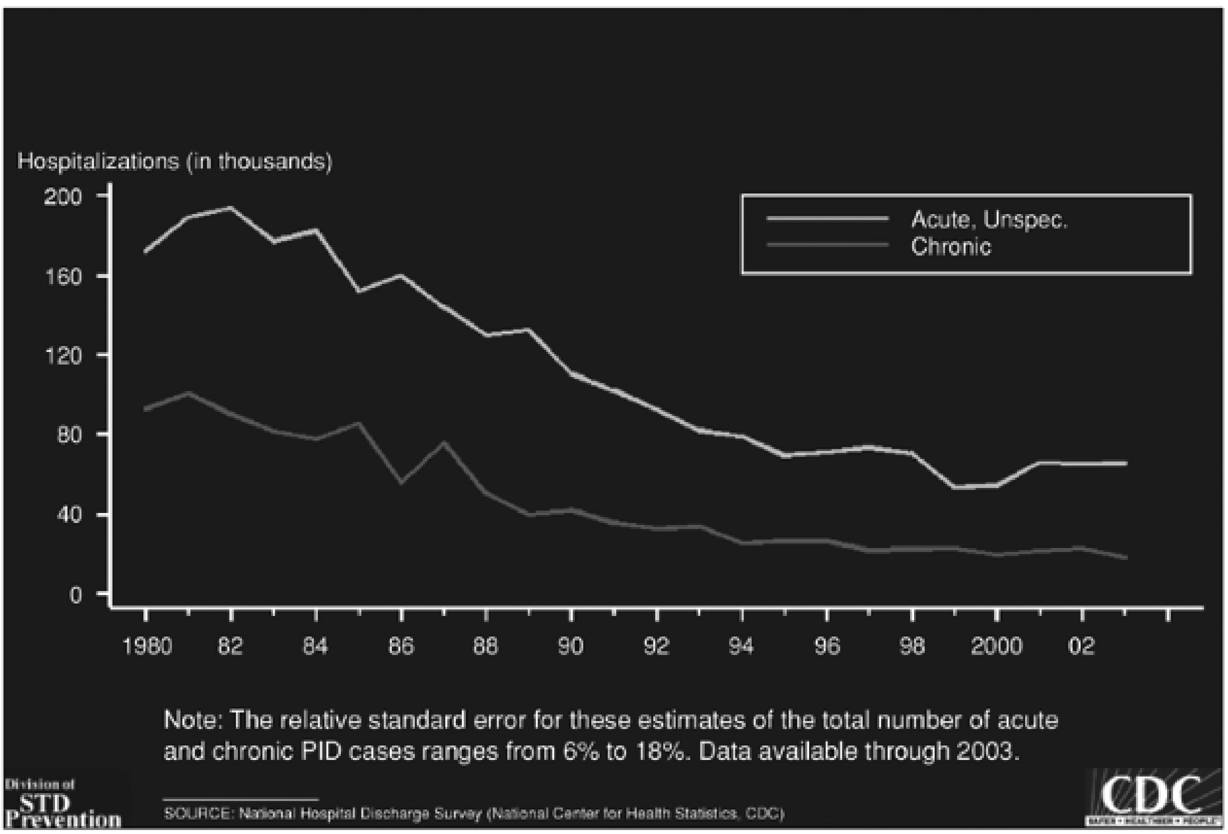

Figure 33.7 Pelvic inflammatory diseaseâ€”Hospitalizations of women 15 to 44 years of age: United States, 1980-2003. (From 2004 STD Surveillance Report, Centers for Disease Control and Prevention.)

There are two opportunities to diagnose PIDâ€"when the patient presents for her routine examination and when she presents with a specific problem such as vaginal discharge, irregular uterine bleeding, or breakthrough bleeding if she is taking contraceptive hormones. Patients with early stages of PID cervicitis and endometritis typically present with vague complaints, such as spotting associated with coitus, spotting within the cycle distant from their menses, or a lower abdominal cramping pain similar to that associated with the menses (Figs. 33.8 and 33.9). Thus, although it may not be time for the patient's menses, lower abdominal cramping is often mistaken for menstrual pain.

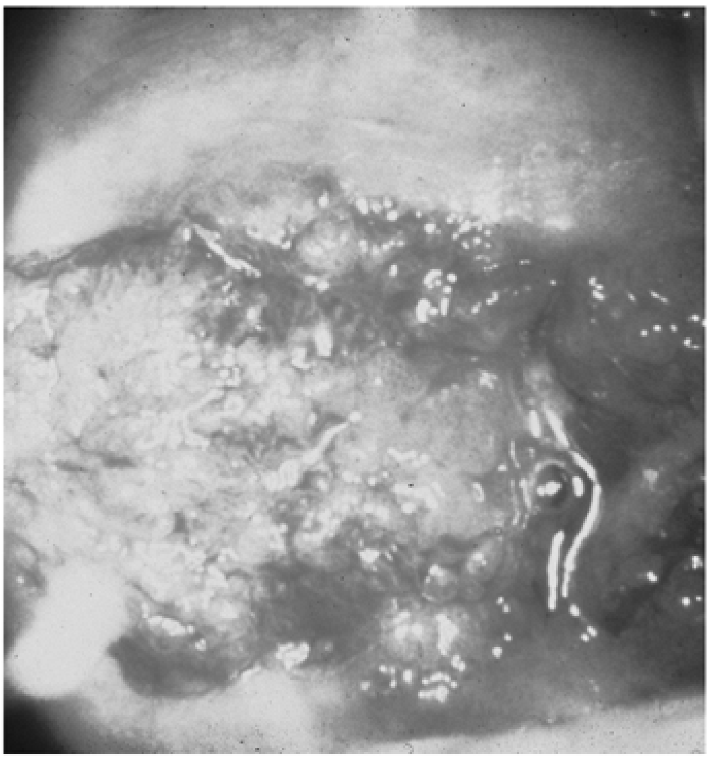

Figure 33.8 *Hypertrophy of the endocervical epithelium secondary to infection* . The endocervical epithelium is â€œbeefy redâ€• and is very friable; bleeds easily to touch.

The pelvic examination is vital in establishing a PID diagnosis. Leukorrhea and purulent vaginal discharge should alert the physician to the possibility of an infectious process such as trichomoniasis or PID. Since *Trichomonas vaginalis* is a sexually transmitted organism, it can serve as a marker for the presence of other sexually transmitted infections. Therefore, patients with a diagnosis of trichomoniasis vaginitis or cystitis should be screened for, at the very least, the presence of *C. trachomatis* and *N. gonorrhoeae* . The patient that presents with any of the findings listed in Table 33.1 should be considered for possible PID. *C. trachomatis* and *N. gonorrhoeae* can cause a spectrum of infections, and any one of the non-PID diseases should serve as indicators for the possible presence of PID regardless of whether or not there are overt physical findings. It may be possible, in some instances, to auscultate a friction rub in the upper right quadrant; however, most patients with adhesions between the liver capsule and the anterior parietal peritoneum of the abdomen will not have a detectable friction rub (Fig. 33.10). It is estimated that approximately two thirds of infertility cases due to damaged fallopian tubes and one third

of ectopic pregnancy cases can be attributed to chlamydial infection (17 ,18) (Figs. 33.11 and 33.12). Patients who have a pelvic infection secondary to *C. trachomatis* are commonly left with pelvic adhesions (Fig. 33.13).

Figure 33.9 Note the presence of purulent mucus within the endocervical canal pooling in the posterior fornix. This is secondary to infection, and a specimen must be submitted for the detection of *C. trachomatis* and *N. gonorrhoeae* .

Certain infections require surgical intervention in addition to antibiotic therapy to achieve resolution of the infection. However, surgical intervention can result in long-term adverse sequelae, especially when fallopian tubes and ovaries are compromised by both the infection and the operative intervention (Table 33.2).

1. Urethritis
2. Bartholin's gland abscess
3. Skene's gland abscess
4. Cervicitis
5. Endometritis
6. Salpingitis
7. Pyosalpinx
8. Tubo-ovarian abscess
9. Fitz-Hugh-Curtis syndrome
10. Ectopic pregnancy
11. Infertility
12. Chronic pelvic pain

Table 33.1 Clinical Disease Associated With C. Trachomatis And N. Gonorrhoeae Infection

Patients suspected of having PID can be diagnosed based on clinical presentation (Table 33.3). Frequently, it is difficult to determine whether the patient has a true mass, such as pyosalpinx or tubo-ovarian mass, versus a pelvic complex consisting of small and large bowel adherent to the adnexa, which is often found adherent to the lateral pelvic wall and posterior aspect of the broad ligament as well as the uterus and posterior cul-de-sac. Patients with PID can be divided into two groups: those who require surgical intervention and those who can initially be treated with medical therapy alone (Fig. 33.14). If there is any suspicion that the patient has a pyosalpinx or tubo-ovarian abscess that is leaking or ruptured, then immediate surgical intervention is indicated.

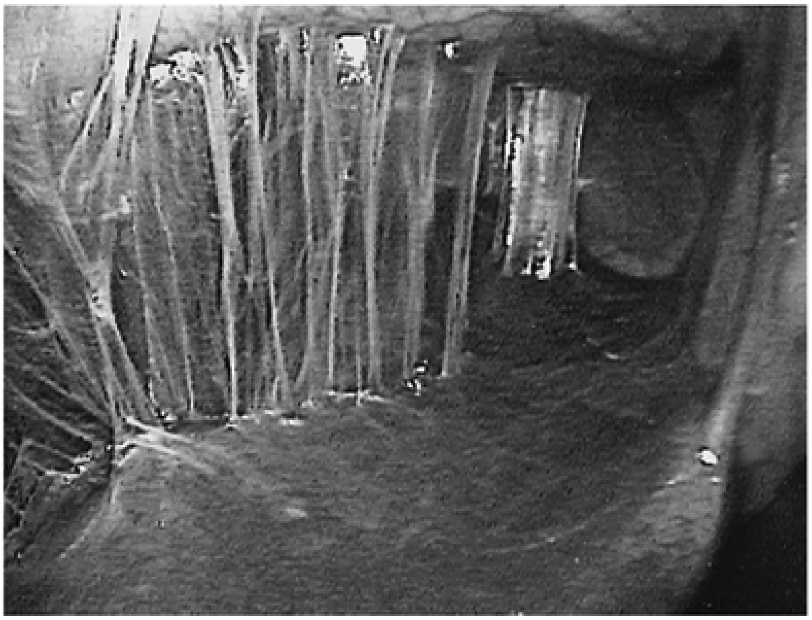

Figure 33.10 The presence of filmy adhesions between the liver capsule and the anterior parietal peritoneum of the anterior abdominal wall (Fitz-Hugh-Curtis syndrome).

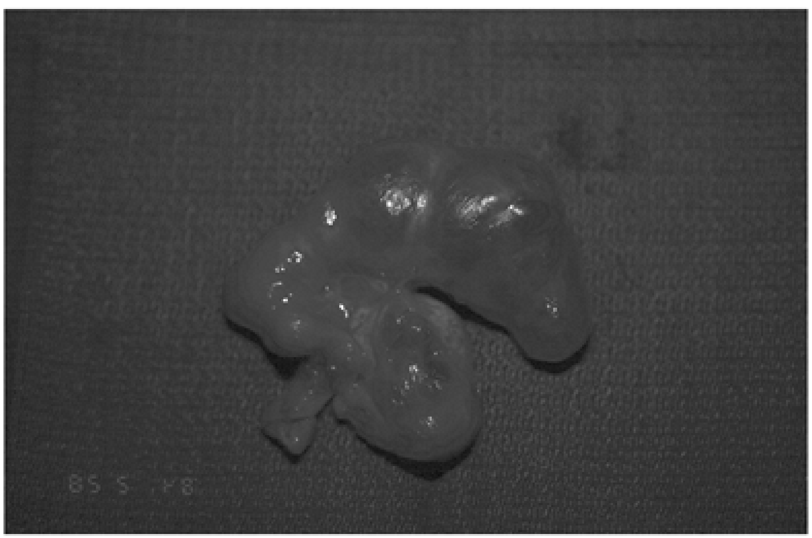

Figure 33.11 Hydrosalpinx secondary to *C. trachomatis* infection.

The criteria for the clinical diagnosis of PID are imprecise, and there are no clinical criteria or laboratory tests that can be completely relied on. The minimal criteria are cervical motion tenderness, uterine tenderness, and adnexal tenderness. The diagnosis can be strengthened if any or more of the following are present: (i) oral body temperature >101 F (>38 C); (ii) endocervical mucopus; (iii) purulent vaginal discharge; (iv) elevated sedimentation rate; (v) elevated C-reactive protein; and (vi) documented presence of

cervical infection with *C. trachomatis* or *N. gonorrhoeae* (19). A diagnosis of PID is strengthened with results from endometrial biopsy, transvaginal ultrasonography, and laparoscopy. The endometrial biopsy specimen, from a patient with endometritis, will reveal the presence of plasma cells. In addition, the culture of the specimen for *C. trachomatis* , *N. gonorrhoeae* , and facultative and obligate anaerobes frequently will be positive for one or more bacteria. Transvaginal ultrasonography may reveal one of the following: asymmetric mass (tubo-ovarian complex), fluid-filled fallopian tubes, free fluid in the posterior cul-de-sac, or tubo-ovarian abscess (Figs. 33.14 , 33.15 , and 33.16). Laparoscopy is not 100% effective in detecting PID (19).

The use of ultrasonography or a computed tomography (CT) scan of the abdomen and pelvis should be performed on all patients who have a pelvic mass. Ultrasonography can provide important information such as whether or not there is a tubo-ovarian abscess versus a pyosalpinx or hydrosalpinx. If there is an abscess present, is it multiloculated, uniloculated, thin walled, or thick walled? A CT scan can assist in determining if the mass is an abscess or a blood-filled cyst and define the relationship of the abscess to other structures such as the bowel, ureter, and position in the pelvis. This information can assist in determining whether or not the abscess can be drained percutaneously or if a more direct surgical approach would be better.

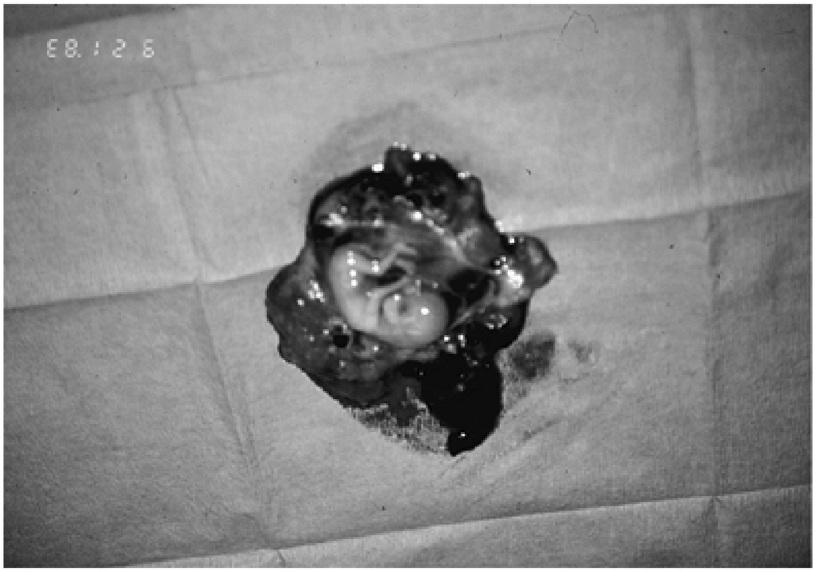

Figure 33.12 *Ectopic pregnancy* . Note the presence of the embryo within the amniotic sac and placental tissue at the periphery of the amniotic sac.

1. Skene's gland abscess
2. Bartholin's abscess
3. Pyometra
4. Pyosalpinx
5. Tubo-ovarian abscess

Table 33.2 Infections That Require Surgical Intervention

A purely medical approach to the treatment of a pyosalpinx or abscess is successful in 34% to 87.5% of patients (20). Frequently, it is difficult to determine if a true abscess is present. Often, a bimanual pelvic examination reveals the presence of a mass that has no distinctive characteristics. If a fullness or nondescript mass is palpated in the pelvis, this frequently can be identified in imaging studies of the bowel, small and large bowel, adherent to the adnexa. Therefore, all patients presenting with a clinical picture of PID with a suspected mass should undergo imaging studies to determine (i) if a mass is present, (ii) the characteristics of the mass, and (iii) which organs are contiguous with the mass (Table 33.4).

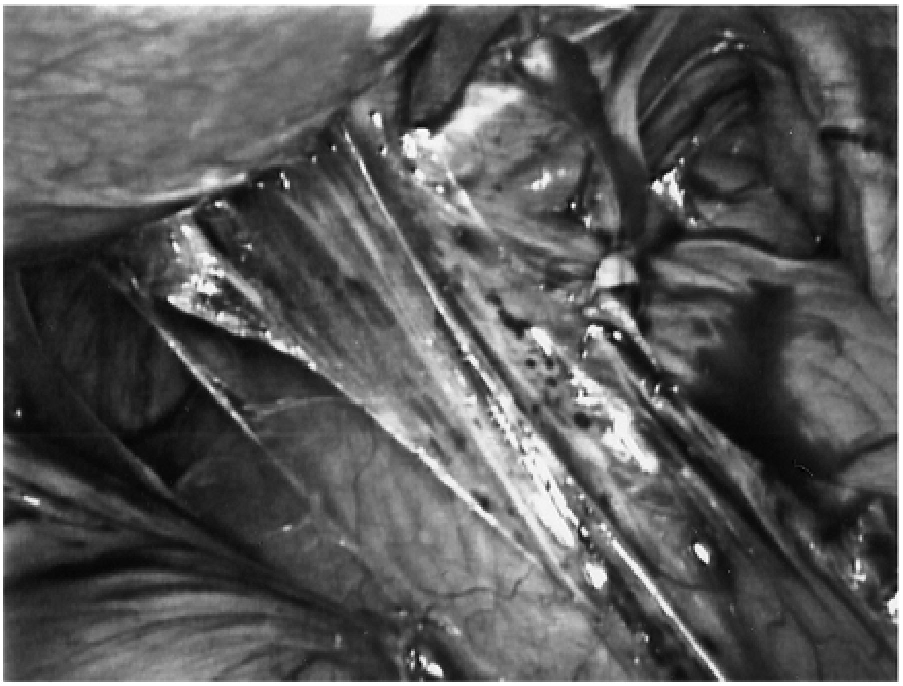

Figure 33.13 Filmy adhesion typical of past pelvic infection associated with infection caused by *C. trachomatis* .

1. Lower abdominal cramping
2. Breakthrough bleeding in patients using hormonal contraception
3. Irregular uterine bleeding
4. Postcoital bleeding
5. Purulent vaginal discharge
6. Endocervical mucopus
7. Hypertrophy of the endocervical columnar epithelium
8. Chronic pelvic pain

Table 33.3 Clinical Characteristics Associated With Pelvic Inflammatory Disease

The basis for antibiotic treatment is the understanding that PID is most commonly caused by *C. trachomatis* and *N. gonorrhoeae* . One initial treatment decision is whether or not the patient requires admission to the hospital (Table 33.5). The success of outpatient treatment depends on the diagnosis being correct, the patient being able to obtain the medication, compliance in taking the medication as directed, and return for re-evaluation as requested. The individuals most likely to respond successfully to outpatient

treatment are those who are experiencing their initial infection or who are diagnosed shortly after becoming infected. However, for individuals with progressive disease, the infection most likely has evolved to one of a polymicrobial nature, involving facultative and obligate anaerobic bacteria that are endogenous to the lower genital tract. There is no way for the physician to determine how long the patient has had the infection or when she was initially infected. There is also no way to determine whether or not there is a polymicrobial infection. Therefore, empiric antibiotic therapy should provide broad-spectrum activity, even though this may be the patient's first infection (Table 33.6). Prior to instituting antibiotic therapy, the following laboratory tests should be obtained: complete blood count (CBC) with a white blood cell differential, serum electrolytes, blood urea nitrogen, creatinine, and blood glucose. Patients known to have had a previous episode of PID or who are suspected of having advanced PID should definitely be hospitalized and treated with broad-spectrum antibiotics (8).

Patient Evaluation for Pelvic Inflammatory Disease

Outpatient treatment	*Hospitalized patient treatment*	
Oral antibiotics	No definitive mass	Definitive mass
Re-evaluate in 48 to 72 hours.	Ultrasonography	
If not improved, admit to hospital.	Uniloculated mass	Multiloculated mass
	Intravenous antibiotics	
	If no improvement within 96 hours, or if the patient's condition worsens, surgical intervention is indicated.	

Figure 33.14 Algorithm for the management of PID.

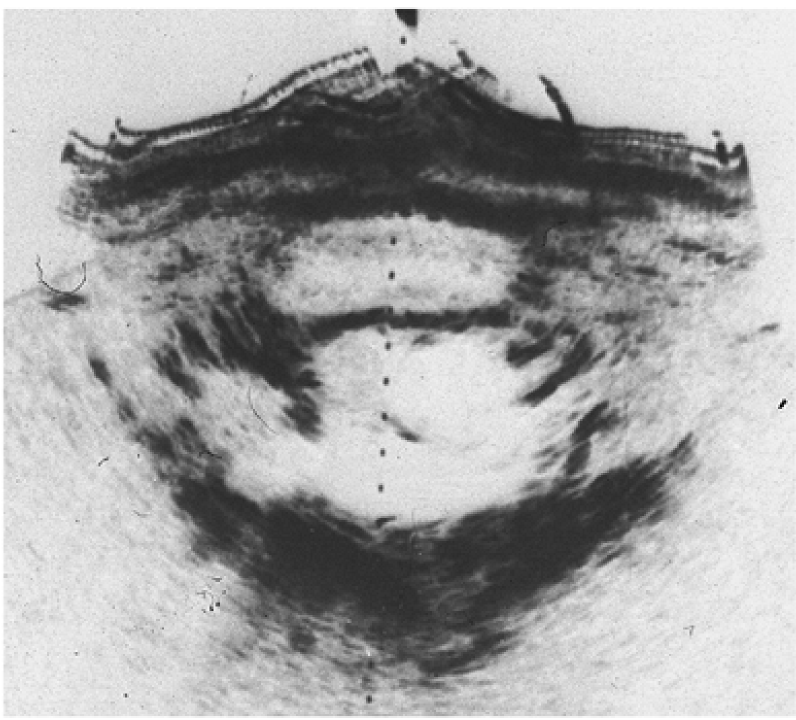

Figure 33.15 Note the asymmetrical mass below the bladder. This represents the adherence of bowel to the uterus and the adnexa. This can be confused with a tubo-ovarian abscess.

Figure 33.16 *Tubo-ovarian abscess* . Note the presence of septations (multiloculated abscess) and a thickened outer wall.

Outpatient Therapy

1. The patient's oral body temperature is <101Â°F.
2. No nausea is present.
3. There is no detectable pelvic mass.
4. Patients should be re-evaluated within 48 to 72 hours of starting treatment.

Hospitalization

1. There is presence of a surgical abdomen.
2. There is presence of severe illness, nausea, or vomiting, or the oral body temperature is â‰¥101F.
3. A pelvic mass is present (e.g., tubo-ovarian abscess).
4. The patient is not demonstrating improvement treated as an outpatient.

Table 33.4 Criteria For Treating The Patient: Outpatient Versus Hospitalized Treatment

Patients treated initially with antibiotic therapy should show signs of improvement within 72 to 96 hours of initiating antibiotic therapy (Table 33.7). There is no data to guide the physician as to when antibiotic therapy has not made a positive impact on the patient's condition. However, patients with evidence of fluid (pus) in their abdomen should be administered broad-spectrum antibiotics and taken to surgery immediately. Patients with advanced PID who have pus in their abdomen should be viewed as similar to patients with large bowel perforations. The purulent fluid of

a ruptured or perforated tubo-ovarian abscess frequently contains virulent Gram-positive and Gram-negative facultative and obligate anaerobic bacteria such as *Escherichia coli* , *Enterobacter cloacae* , *Enterococcus faecalis* , *Peptostreptococcus* , *Peptococcus* , *Prevotella bivia* , and *Bacteroides fragilis* . Therefore, these patients are at risk for sepsis and septic shock and the associated morbidity and mortality. Once the patient has demonstrated that she has purulent fluid in the pelvis or abdomen, or has a surgical abdomen, surgical intervention should not be delayed. Antibiotics should be ordered immediately, and the patient should be taken to the operating room.

An ultrasonogram should be performed immediately prior to initiating surgery to determine if there is free fluid in the abdominal pelvic cavity. If free fluid is present, a laparotomy should be performed through a vertical incision. Culture tubes should be immediately available so that specimens can be obtained when first entering the peritoneal cavity. The specimen should be Gram stained and processed for the isolation, identification, and antibiotic sensitivities of facultative and obligate anaerobic bacteria. After the specimens have been obtained, the abdomen and peritoneal cavity should be irrigated with either normal saline or antibiotic solution (e.g., bacitracin 50,000 units plus kanamycin 1 g dissolved in 1 L of normal saline). Undoubtedly, extensive filmy and thick adhesions will be encountered, and these should be lysed with sharp dissection. Blunt dissection should be limited to those adhesions that are thin and that separate with very little force. Blunt dissection of adhesions often results in peeling the serosa off of the mucosa, thus rendering the bowel vulnerable to perforation by way of devascularization. If a severe ileus develops, the pressure within the bowel lumen can cause a rupture of the weakened area. The entire bowel must be checked at the end of the case to ensure that there are no defects. If there are significant areas where the serosa has been removed, the area should be sewn to repair the defect. A standard bowel repair can be performed by first bringing the serosa edges together with interrupted absorbable suture (e.g., 3-0 chromic), followed by a second layer of nonabsorbable interrupted suture of 2-0 or 3-0 silk. The closure should be performed with the repair parallel to the long axis of the bowel to prevent constriction of the lumen of the bowel. Once the adhesions have been lysed, the pelvic organs can be identified and a determination made as to which, if any, organs should be removed. Any possible procedures that may have to be done should have been discussed with the patient and her family prior to commencing the operative procedure. The patient's age, previous reproductive history, and desire to have children as well as her understanding of the meanings of hysterectomy and bilateral salpingo-oophorectomy should be considered when operating for PID and tubo-ovarian abscess. If there is a unilateral abscess, there is no need to remove the uterus, contralateral fallopian tube, or the ovary.

1. Levofloxacin 500 mg orally once a day for 14 days plus metronidazole 500 mg twice a day for 14 days
2. Ceftriaxone 250 mg intramuscularly plus doxycycline 100 mg orally twice a day for 14 days plus metronidazole 500 mg orally twice a day for 14 days

From Sexually Transmitted Disease Surveillance 1998, CDC.

Table 33.5 Antibiotic Regimens For The Outpatient Treatment Of Pelvic Inflammatory Disease

Surgical Management

Medical treatment of uncomplicated PID resulting in the resolution of acute symptoms and signs of infection is successful in 100% of cases. However, there are reports that medical treatment of tubo-ovarian abscesses is successful in 34% to

87% of cases (20). There are three approaches to the surgical management of PID: percutaneous drainage, laparoscopy, and laparotomy. Prior to embarking on either laparoscopy or laparotomy, if time permits, ultrasonography or a CT scan should be obtained to determine what pathology is present. CT imaging can also be of significant assistance when performing percutaneous drainage of a pelvic or intra-abdominal abscess.

1. Clindamycin 900 mg administered every 8 hours plus gentamicin 5 mg/kg of body weight every 24 hours plus ampicillin 2 g every 6 hours
2. Clindamycin plus gentamicin plus ampicillin 2 g every 6 hours
3. Metronidazole 500 mg every 8 hours plus gentamicin plus ampicillin
4. Piperacillin/tazobactam 3.375 g every 6 hours plus gentamicin
5. Clindamycin or metronidazole plus levofloxacin 500 mg every 24 hours

Table 33.6 Empiric Intravenous Antibiotic Therapy For Treatment Of The Patient With Advanced Pelvic Inflammatory Disease (Pyosalpinx Or Tubo-Ovarian Abscess)

Ultrasonography can be used to locate the tubo-ovarian abscesses in relation to the other pelvic organs. Ultrasonography also has been shown to be specific and sensitive in diagnosing pelvic abscesses with an accuracy rate of 97% (21). When viewed by ultrasound, abscesses usually appear as rounded masses with well-delineated outer walls whether they are uniloculated or multiloculated. Internal echoes within the cystic mass reflect the presence of cellular debris floating in the purulent material contained within the abscess. Percutaneous drainage can be achieved by

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either the transvaginal or transabdominal route if the abscess is adjacent to the vaginal or abdominal wall. This is necessary to avoid puncturing an organ. If free space exists between the abscess and the vaginal or abdominal wall, infected fluid will spill into the peritoneal cavity, resulting in infection of uninfected tissue (22 ,23 ,24).

Color
White to slate gray
Dirty
Gray to purulent
White
Dirty gray to purulent
Odor
None
Fishy
None
None
None to foul
pH
<4.5
â‰¥5
â‰¥5
â‰¤5
â‰¥5
WBC
<5/hpf
<5/hpf
>5/hpf
>5/hpf
>5/hpf
Squamous cells
Estrogenized
Estrogenized
Estrogenized
Estrogenized
Estrogenized
Dominant bacterium
Lactobacillus
Mixture
One or more

Lactobacillus
Mixture
Whiff test
Negative
Positive
Negative
Negative
Negative; can be positive
BV, bacterial vaginosis; AVF, altered vaginal flora; WBC, white blood cells.

Character	Healthy	BV	AVF	Candida	Trichomoniasis

Table 33.7 Characteristics Of Vaginal Discharge

Transvaginal ultrasonography provides a direct approach to drainage of a tubo-ovarian or pelvic abscess. Tubo-ovarian abscesses are typically located in the posterior cul-de-sac and therefore can be aspirated with little fear of puncturing the small bowel or rectosigmoid colon (25). In a study of 302 women with tubo-ovarian abscesses, Gjelland et al. reported that 282 (93.4%) were successfully treated by transvaginal aspiration and intravenous antibiotics (26). Of the 302 women, 197 (65%) underwent a single aspiration, 80 (27%) required two aspirations, 15 (5%) had three aspirations, and 10 (3%) required four aspirations to drain the abscesses of all purulent fluid. Twenty women (6.6%) required surgical intervention to achieve a cure of their infection. Several other investigators have reported successful drainage of tubo-ovarian abscesses using transvaginal ultrasound-guided transvaginal aspiration (27 ,28 ,29).

Laparoscopic intervention for the management of tubo-ovarian abscesses should begin with imaging studies to determine if the abscesses contain septations, the proximity of small and large bowel to the abscesses, and if the bowel is adherent to the anterior abdominal wall. It is prudent to perform open laparoscopy in contrast to blindly inserting the Voorhees needle into the peritoneal cavity to establish a pneumoperitoneum. Laparoscopy has been used to successfully drain tubo-ovarian abscesses (30 ,31 ,32). The laparoscopic approach is associated with risks that are similar to laparotomy. Whether one operates in the immediate acute phase or allows the patient to go through the so-called â€œcooling down phaseâ€• is a judgment call for the surgeon. Operating in the acute phase, if indicated, usually results in adhesions that tend to be filmy and easily separated. Waiting for the patient to resolve her acute symptoms allows the adhesion to become dense and more difficult to divide.

If there is no indication of a leaking or ruptured tubo-ovarian abscess, the most rewarding approach is the administration of broad-spectrum antibiotics. This approach may negate any surgical intervention. However, if the patient has not demonstrated significant improvement after 72 to 96 hours of antibiotic intervention, surgical intervention should be initiated.

Prior to beginning the actual operation on the reproductive organs, normal anatomical structures should be identified. Frequently, whether laparoscopy or laparotomy is performed, the surgeon encounters a mass of adherent bowel involving the omentum completely overlying the pelvic organs. The adhesions should be carefully lysed, paying strict attention to the serosa of the bowel. The bowel should be carefully inspected to determine that there has not been any significant violation of the serosa and mucosa.

The round ligaments can usually be identified because the inflammatory process, which is frequently extensive, is usually on the posterior aspect of the uterus and broad ligaments. The posterior cul-de-sac is obliterated by the adhesion of the ovaries, fallopian tubes, and both small and large bowel. The infundibular ligaments can be identified at the pelvic brim; therefore, the ureters should and can be identified as they cross over the external iliac artery. The ureters travel anterior to the internal iliac arteries, and the uterine artery crosses over the ureter and is in close proximity to the uterus and cervix. The lateral pelvic peritoneal tissue overlying the ureter is usually markedly inflamed and edematous. Thus, the ureters are often not visible in their retroperitoneal position. Typically, the adnexa are adherent to the posterior aspect of the broad ligaments, the peritoneum overlying the lateral pelvic walls, and the ureters. The adhesions tend to be dense and not easily divided. Therefore, caution must be taken when dividing the adhesion involving the peritoneum overlying the ureter to prevent the peritoneum from being torn away from the ureter, resulting in its devascularization, laceration, and avulsion.

It is usually not possible to trace the course of the ureter through the pelvic peritoneum overlying the ureter because of the marked inflammatory response. The inflamed peritoneum becomes edematous and thickened, obscuring the ureter. So, prior to lyses of the adhesions between the adnexa and the lateral pelvic wall, the peritoneum lateral to the infundibular pelvic ligament should be opened, allowing entrance to the retroperitoneal space and exposing the ureter in its encasement of peritoneum. This allows for safe separation of the adnexa from the lateral pelvic wall and protects the ureter.

The small bowel, cecum, and rectosigmoid colon are frequently found adherent to the adnexal, posterior aspect of the uterus and the posterior cul-de-sac. Although adhesions of the bowel are usually encountered when entering the peritoneal cavity, adhesions between loops of bowel tend to be thin, whereas the adhesions between the bowel, pelvic organs, and cul-de-sac tend to be dense and more difficult to separate. The latter adhesions are associated with a higher risk of damage to the bowel. The type of adhesions that can be encountered are, in part, dependent on the organisms causing the infection. These adhesions can be thin and filmy or dense, thick, and extremely difficult to separate. Unlike filmy adhesion that can be separated with little force, using sharp or electric cautery, ultrasound, or an irrigation device such as an Aquapurator or VitalVue to divide the adhesions, dense adhesion requires sharp dissection and lyses. However, care must be taken not to remove the serosal layer overlying the mucosa. When using electric cautery, care must also be exercised in not allowing the energy to dissipate into the bowel, which can cause delayed necrosis that results in perforation and subsequent leakage of its contents, causing intra-abdominal or pelvic infection.

The bowel should be carefully examined at the time of the enterolysis and prior to closing the abdomen. The two inspections are conducted to look for immediate damage such as removal of significant serosa, perforation, and devascularization, resulting in the bowel becoming dusky or necrotic. If a significant amount of serosa has been removed, the defect should be closed in two layers. An interrupted dissolvable suture should be used to close the first layer, and then a permanent suture should be used to imbricate the second layer. The suture should not penetrate the mucosa. The suture line should be placed parallel to the long axis of the bowel to prevent a constriction at the repair site. A nasogastric tube should be placed; intermittent suction should be used and left in place until bowel sounds have returned. Once bowel sounds have returned and prior to removing the nasogastric tube, the tube should be clamped for 1 hour and then unclamped. If after unclamping there is less than 100 mL of gastric fluid aspirated, the tube can be removed.

Once the abdominal wall has been incised and the peritoneal cavity has been entered, specimens should be obtained for microbiologic culture regardless of whether the peritoneal fluid is clear, cloudy, or frankly purulent. The peritoneal cavity should be thoroughly irrigated with copious amounts of normal saline or antibiotic solution. After completing the operative procedure, the peritoneal cavity should be irrigated, again, with copious amounts of normal saline or antibiotic solution (bacitracin plus kanamycin).

Pelvic drains should be placed if the peritoneal fluid is purulent or if a slight degree of blood is leaking or oozing from the areas of the pelvic wall where adhesions have been lysed. If suture or hemaclips cannot be placed because of the risk of damaging structures, such as to the ureter or major vessels or nerves, gel foam soaked with thrombin can be placed against the areas of oozing. When using drains, a large-bore Jackson-Pratt or Blake drain attached to self-contained suction devices should be placed deep in the pelvic cul-de-sac, in the right and left colonic gutters. If there is no free pus in the pelvic or abdominal cavities, there is good hemostasis, and the small or large bowel has not been damaged there, so there is no need for drains to be placed in the abdominal and pelvic cavities. Drains do not serve to prevent infection but are used to monitor bleeding and changes in the color and consistency of the peritoneal fluid. Drains have multiple functions: to drain fluid, to prevent fluid from accumulating within intra-abdominal compartments, and to monitor developing conditions within the peritoneal cavity. The fluid exiting the drain can be Gram stained to determine if bacteria are present.

The fluid obtained for Gram staining and culture of aerobic, facultative, and obligate anaerobic bacteria should be aspirated from the drainage tube and not collected from the vessel collecting the fluid. Postoperative patients who are not responding in a positive manner should have the drainage fluid sampled on a daily basis (author's preference). The Gram stain characteristics can facilitate the choice of antibiotics. If blood is being collected in the drainage vessel, the fluid can be sent for determination of the hematocrit. If serial hematocrits are tested and the hematocrit is dropping, this indicates that the patient is not continuing to bleed; however, rising hematocrits indicate that there is active bleeding.

Typically, drains are removed when there is either less than 30 mL of fluid collected over a 24-hour period or the serous fluid remains clear and free of bacteria or yeast. Once the drainage has decreased and <30 mL are collected over a 24-hour period, the drains should be advanced. It is not unusual for the fluid to form a pocket and for the drainage tube to appear to not be functioning because of loculation or bowel blocking the egress of fluid through the drain. Advancing the drain can loosen the block that has formed, allowing free flow of intra-abdominal fluid to exit the drain tube. When the drain is finally removed, fluid may leak out through the drain site, but if the fluid has significantly decreased, this drainage should cease within 24 hours of removing the drain tube.

Prior to initiating the surgical procedure, a detailed discussion should be held with the patient and family members to go over possible scenarios and the meaning of each option. One of the main factors determining what will be done is the patient's desire to attempt to retain her potential for pregnancy. It must be pointed out, depending on the degree of tissue destruction, that there is a significant possibility that the patient will require assisted reproductive technology to achieve pregnancy.

If only one fallopian tube or ipsilateral fallopian tube and ovary do not appear to be infected or minimally infected and the contralateral fallopian tube and ovary are not abscessed and appear to be fairly normal, then the diseased fallopian tube and ovary should be removed. If both fallopian tubes and ovaries are abscessed, then the options are total abdominal hysterectomy with bilateral salpingo-oophorectomy, bilateral salpingo-oophorectomy with retention of the uterus and cervix, and incision of the fallopian tubes and ovaries, destruction of all loculations, and copious irrigation of the pelvis and abdominal cavities. If the third option is selected, the patient must understand that if a positive response is not achieved, then a hysterectomy with bilateral salpingo-oophorectomy may have to be performed.

The author (unpublished) has performed incision and drainage of bilateral tubo-ovarian abscess on 10 patients who desired to retain their reproductive organs. The procedures were performed through vertical incisions, unless the patient already had a lower abdominal transverse incision. After all adhesions were lysed, the author performed inspection of the subdiaphragmatic spaces and colonic gutters, and ran the bowel to ensure that there were no intra-abdominal abscesses. Then, the bowel was packed into the mid- and upper abdomen. The fallopian tubes were occluded distally, and an anterior incision was made along the length of the fallopian tube and carried into the lumen of the tube. All loculations were severed, and the purulent material was removed. The incision of the ovaries was carried down into the abscess cavities, and all septa were divided. The fallopian tubes and ovaries were irrigated with copious amounts of normal saline or antibiotic solutions. Jackson-Pratt or Blake drains were placed into the pelvis existing from the right and left lower quadrants. Similar drains were placed in the right and left colonic gutters extending to the diaphragm and exiting from the midabdomen on the right and the left. All drains were attached to suction devices. Antibiotic, such as cefotetan, cefoxitin, and piperacillin/tazobactam, was infused through one of the upper clamps. While the infusion was in progress, the other drains were clamped shut. On completion of the infusion, the drain was clamped shut. All drains were clamped for 4 hours and then unclamped for 4 hours, and the infusion was repeated. The dosage used was cefoxitin 100 mg and piperacillin/tazobactam 500 mg per 100 mL of normal saline. A total of 300 mL of fluid was infused each time. These patients received clindamycin 900 mg every 8 hours plus ampicillin 2 g every 6 hours plus gentamicin 5 mg/kg of body weight every 24 hours intravenously. When the patient became afebrile for 72 to 96 hours and her white blood cell count returned to normal, the intraperitoneal antibiotic infusions were discontinued. The drains were removed within 24 to 48 hours after discontinuing the antibiotic infusions. The intravenously administered antibiotics were continued until the patient was afebrile for 48 hours, white blood cell count and pulse rate returned to normal, and bowel function returned. The patients were placed on metronidazole 500 mg orally three times a day and levofloxacin 500 mg orally once a day for 10 days. A repeat ultrasonogram was obtained at the conclusion of oral antibiotic therapy to determine if there was a residual or newly formed fluid-filled mass. All patients responded successfully and required no further operative procedure. No information is available regarding their ability to bear children. Undoubtedly, they will require assisted reproductive technology to achieve pregnancy.

Other situations where patients may develop a pelvic abscess is by way of transvaginal instrumentation such as intrauterine insemination and by the development of diverticulitis. Women â‰¥ 35 years of age who develop a left adnexal abscess should be considered to have diverticulosis. Individuals with diverticulosis, who subsequently develop diverticulitis, can form an adhesion between the inflamed diverticulum and the left ovary. A fistula develops between the two structures, and infected material can pass from the sigmoid colon into the ovary, resulting in the formation of an ovarian abscess. Prior to performing surgery on this type of patient, a general surgeon should be consulted because the patient will require resection of the sigmoid colon as well as removal of the left adnexa.

Patients undergoing intrauterine procedures conducted transvaginally should have their vaginal microflora assessed prior to the procedure. When in a healthy state, the endogenous vaginal microflora is dominated by *Lactobacillus* . However, numerous other pathogenic bacteria are present, such as *Escherichia coli* , *Enterobacter* species, *Streptococcus agalactiae* , *Peptostreptococcus* , *Peptococcus* , and *Prevotella* . When *Lactobacillus* is dominant, it is present in a concentration of $>10_6$ bacteria per mL of vaginal fluid, and the pathogenic bacteria are present in a concentration of â‰¤ 10_3 bacteria per mL of vaginal fluid. These numbers are important because the low number of pathogenic bacteria is not sufficient to initiate infection. When the endogenous vaginal microflora becomes altered and *Lactobacillus* is no longer dominant, one or more of the pathogenic bacteria becomes dominant, and the concentration of pathogens â‰¥ 10_6 bacteria per mL of vaginal fluid increases, which is sufficient to initiate infection. Therefore, prior to any transvaginal invasive upper genital tract procedure, the lower genital tract microflora must be assessed. This can be easily performed by carefully placing a speculum into the vagina so that the cervix is not traumatized and does not bleed. Blood will cause the vaginal pH to increase. A

pH strip is then placed along the lateral pelvic wall, and the color change observed on the litmus end of the strip is matched up with the chart provided. A pH â‰¥ 5 indicates a non-*Lactobacillus* -dominated endogenous vaginal microflora (Table 33.7). The bacterial morphotype present in the vaginal fluid can be discerned when examining the vaginal discharge under 40 Ã— magnification.

Therefore, patients undergoing procedures such as intrauterine insemination, sonohysterography, and hysteroscopy should have their endogenous vaginal microflora assessed to determine if *Lactobacillus* is dominant. If it is not dominant, the procedure should be delayed until *Lactobacillus* can be restored to dominance. Sable et al. reported a case of a 35-year-old patient who had intrauterine insemination and subsequently developed PID and a pelvic abscess (33).

Surgeons planning transvaginal procedures that invade the upper genital tract would best be served by identifying those patients at risk (altered vaginal microflora) and administering antibiotic prophylaxis (no data available). It is logical to administer metronidazole 500 mg orally twice daily plus levofloxacin 500 mg orally once daily, beginning the day before the procedure and ending the day after the procedure. A currently available drug that could be used in place of metronidazole is tinidazole (off-label use), as it has an antibacterial spectrum of activity that is similar to metronidazole. There is little doubt that the endogenous vaginal flora plays a significant role in inducing pelvic infection.

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