# 2
# Pelvic Floor Anatomy: Made Clear and Simple

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## The Female Pelvis

The intent of this chapter is to give the primary care provider, to women of all ages, a clinical appreciation of the anatomy in the female pelvis that currently explains the mechanisms of pelvic organ suspension and support, as well as urinary and fecal continence. Though this chapter describes the current thinking in the "average normal" patient, the reader must realize that each woman is unique in her anatomic makeup. Her pelvic support anatomy is dependent upon the genetic composition of her visceral connective tissues and various muscles—both somatic and visceral—and their adaptations to her aging process and upon the many variables of her lifestyle. Lifestyle conditions that affect the functioning of her pelvic organs and their support include:

- habits of physical activities and the various mechanical stresses that weigh on her pelvic structures
- dietary habits and her state of nutritional balance and adequacy
- social habits such as cigarette smoking and drug use
- her state of health and use of some medications
- habits of urinary control and voiding, and habits of bowel control and defecation
- sexual activities and childbirth and their possible mechanical and infectious consequences
- previous gynecologic surgeries.[1]

The female pelvis includes the organs of storage and elimination of urine and feces—the bladder and urethra, and the rectum and anal canal. The vagina is the organ of vaginal sexual intercourse, elimination of menstrual discharge, and childbirth. These functions are best sustained when the organs are well suspended and supported within the pelvis, with a specific anatomic relationship to each other. Though each organ functions independently of the others, it is anatomically oriented and dependent upon that orientation. The urethra, lower third of the vagina, and anal canal are parallel and almost vertical in the standing nulliparous young woman.[2] These lower vertical structures are supported directly by their attachments to the levator hiatus muscles, perineal body and the anatomic urogenital and anal triangles. (Figure 2.1).

The bladder rests upon the upper two-thirds of the vagina and lower uterine segment. The upper vagina rests upon the rectum. The bladder, upper vagina, and rectum are approximately horizontal in orientation in the young, standing woman and overlie the muscular *levator plate.*[3] These horizontal relationships are especially apparent when the young woman puts stress on her pelvis during a Valsalva moment such as coughing, sneezing, lifting, exercising, and so on.

The levator plate is a dynamic backstop which contracts and strongly supports the upper vagina and rectum in the horizontal position, acting as a "flap valve" to close their walls and prevent their prolapse during moments of physical force.

Damage to the levator muscles and the levator plate compromises the capability of the pelvic suspensory structures to support these organs and is believed to represent a seminal event that often leads to prolapse. Such damage to the pelvic floor muscles usually occurs during vaginal childbirth

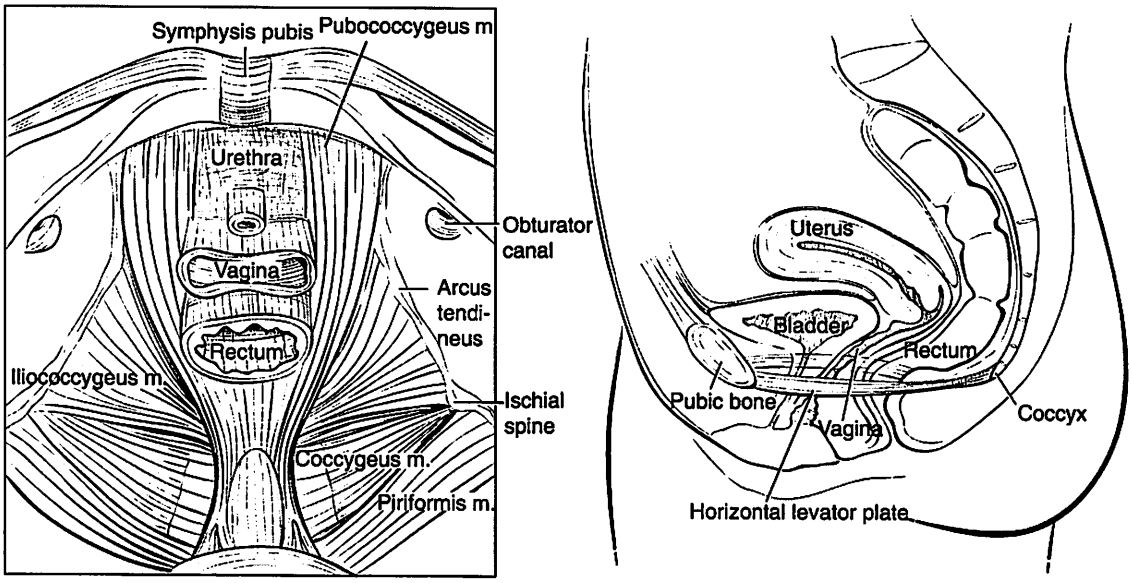


**FIGURE 2.1.** Levator muscles: the foundation of pelvic support. **(Left)** The Vagina, Rectum and Urethra rest on a firm "shelf" of levator muscle support. The platform of levator muscle support spans from the pubic bone back to the tailbone and side-to-side from one arcus tendineus to the other. **(Right)** The upper vagina is oriented horizontally when a woman is in the standing position. The strong horizontal levator muscle plate—seen here spanning from pubic bone back to tailbone—is the key to maintaining this normal anatomic position.

and in patients with chronic mechanical stress states such as chronic straining with chronic constipation, sustained heavy lifting over time, and heavy physical exercise.

The anatomic relationships between the pelvic organs and the tissue reactions to various physical stresses depend on the structures that house, suspend, and support the female pelvic organs. These pelvic structures are the bones and ligaments, the skeletal muscles and parietal fascia, and the various visceral connective tissues.

## Bones and Ligaments

The bones and ligaments of the female pelvis form the outer structure, which surrounds, protects, suspends and supports the pelvic organs and their suspensory tissues.[4] The *coxal bone* consists of three parts that have fused during a woman's teenage years and into her early twenties. These are the ilium, the ischium and the pubis. The *ilium* is the upper portion and consists of an alar, or upper wing, that is slightly concave on its inner surface. The muscles of hip flexion—iliacus and psoas—course on the medial surface. The crest of the ilium is the upper portion of the hip and serves as the attachment for the abdominal wall muscles. This crest also contains the anterior superior iliac spine and the anterior inferior iliac spine, both of which are attachments for hip girdle muscles. The inner inferior border of the ilium is the arcuate line, or linea terminalis, which is the line that defines entry into the true pelvis. The posterior edges of each ilium and ischium form the border of the greater sciatic notch, through which course the piriformis muscle and sciatic nerve out of the pelvis and into the hip.

The inferior and posterior part of the coxal bone is the *ischium*. When seated, the woman sits on her two ischial tuberosities. The hip extensor muscles, hamstrings, and gluteus muscles originate here. The sacrotuberous ligament also courses from the ischial tuberosity to the posterior part of the lower sacrum. This ligament defines and stabilizes the outlet to the pelvis.

The important *ischial spine* is the point within the pelvis central to learning and understanding

female pelvic support anatomy. The ischial spine can, from patient to patient, vary in physical characteristics such as size, shape, bluntness or sharpness, and prominence on palpation. The distance from ischial spine to ischial spine is approximately 10 cm and is the narrowest diameter in the pelvis. This has important implications during childbirth, where the infant's head diameter is also approximately 10 cm. (Figure 2.2)

The ischial spine points posteromedially and is the prominence that demarcates the upper greater sciatic notch and foramen from the lower lesser sciatic notch and foramen. Through the lesser sciatic foramen courses the tendon of the obturator internus muscle, as well as the internal pudendal vessels and pudendal nerve as they course into the pudendal canal on the lateral border of the ischioanal fossa. The ischial spine is best known as the bony landmark that the obstetrician uses to determine the progression of fetal vertex descent during labor. However, it is a key reference point during gynecologic surgery, as well, providing a fixed bony indicator of the level at which the upper vagina (and cervix) should be suspended. This landmark is easily palpated by the examiner, both through the vagina or rectum and during abdominal surgery. This fact is important and assists the operating reparative vaginal surgeon in determining the adequate length of the vagina for sexual intercourse. That satisfactory length should be approximately 8 cm–10 cm from the hymenal ring, which correlates to the level of the ischial spines.

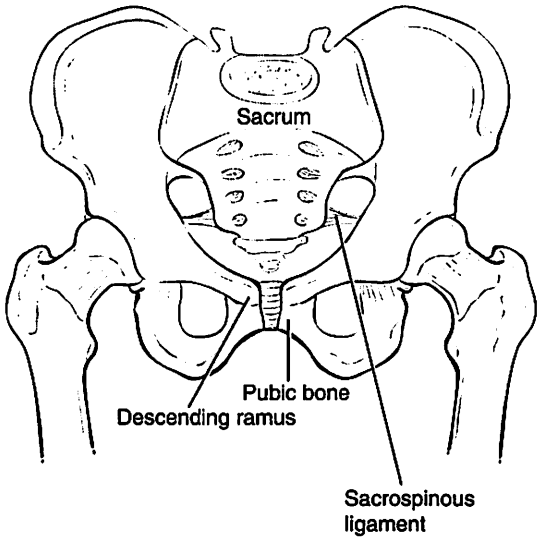


FIGURE 2.2. Bony pelvis.

The ischial spine is located 2 cm to 3 cm above the horizontal level of the pubic crest in the properly standing young woman, and is 7.5 cm to 9.5 cm from the back of the pubic bone. This distance and line also define the arcus tendineus fasciae pelvis (fascial white line), which is the anatomic structure important for understanding the lateral supports to the bladder and urethra, the vagina, and the rectum. One procedure for repairing a vaginal prolapse is a sacrospinous ligament colpopexy (fixation of the top of the vagina to the sacrospinous ligament). The sacrospinous ligament tapers and inserts onto the ischial spine laterally, while broadening out medially as it inserts onto the inner aspect of the lower part of the sacrum. The sacrospinous ligament frames the sciatic notches to form the greater and lesser sciatic foramina. The pelvic muscles and visceral connective tissues have important anatomic relations and attachments to the ischial spines.

The inferior but anterior part of the coxal bone is the *pubis or pubic bone.* The inferior pubic ramus fuses posteriorly with the ramus of the ischium, while the superior pubic ramus fuses laterally with the ilium at the iliopubic (iliopectineal) eminence. The inferior and superior pubic rami fuse medially to form the central body of each pubic bone. These bodies fuse centrally with the cartilaginous symphysis pubis. Located on the upper aspect of each pubic body is the pubic tubercle. The inguinal ligament is derived from the inferior edge of the aponeurosis of the external oblique muscle and courses from the anterior superior iliac spine to the pubic tubercle. Running laterally along the upper aspect of the superior pubic ramus, beginning at the pubic tubercle, is the pectineal line. On the pectineal line is found a thickened ridge of parietal fascia called Cooper's ligament. For surgeons performing a Burch retropubic colposuspension (a bladder neck suspension procedure employed to address stress urinary incontinence), Cooper's ligament is the site of suture attachment. (Figure 2.3)

The superior and inferior pubic rami, fusing posteriorly with the ischium, form a ring of bony edges that results in a large hole in the lower pelvis

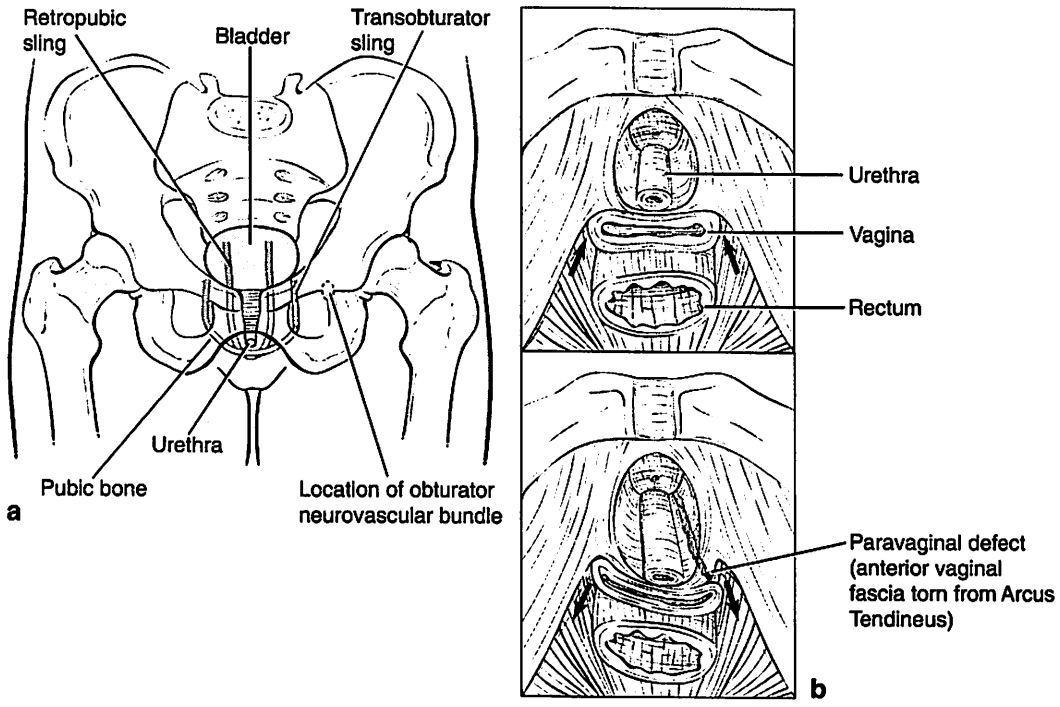


**FIGURE 2.3.** Two incontinence sling types, in the bony pelvis. The transobturator sling is seen passing from one obturator foramen to another, at a safe distance from the obturator neurovascular bundle. The retropubic sling is seen passing in, a u-shaped configuration, behind the pubic bone. **(b)** Paravaginal defect: tear in the lateral vaginal support.

called the obturator foramen. The obturator foramen is covered with a tough, fibrous membrane that attaches all around to its inner bony borders, except in its anterior and lateral portion, where the obturator artery, vein, and nerve pass from the obturator canal into the inner thigh region. The obturator canal is a groove on the underneath surface of the superior pubic ramus. The canal transmits the obturator vessels and nerve from the retropubic space (of Retzius) through the obturator foramen and membrane to the inner thigh. The FDA has recently approved the passage of instruments and various surgical tapes and meshes through the obturator foramen for surgical treatment of stress urinary incontinence and certain vaginal prolapse problems.

The bony *sacrum* is located centrally in the back of the pelvis and articulates with each coxal bone via the ilium at each sacroiliac joint. These joints are firm but partially synovial, allowing very little rotational movement.[5] The sacral promontory and the upper sacral vertebrae are nearly horizontal or parallel to the floor. Therefore, in the standing position, the weight of the abdominal and pelvic cavity pressure column rests primarily upon the backs of the pubic bodies and symphysis, not upon the muscles and the suspensory visceral connective tissues. This is important to realize because the pelvic muscles and the visceral connective tissue network that suspends the pelvic organs over the muscular levator plate are meant for "light" work or sporadic heavier loads. Chronic heavy workloads, such as chronic constipation, heavy lifting, and other physical stresses can overwhelm this soft-tissue suspensory network and cause "breaks" in its frame, decreasing the effective functioning of the "flap-valve" mechanism. As a result, the cervix and upper vagina slide off the levator plate and evaginate down the vaginal tube towards the introitus, causing tearing in the lateral vaginal supports. (Figure 2.3A) The bones of the pelvis are shaped like a wide funnel with a large, rounded entry; straight sidewalls formed by the sides of the ischii and the obturator foramina

and membranes; and the diamond-shaped outlet. To this bony frame is attached the muscles of the female pelvis.

## Pelvic Floor Muscles

The pelvis is a basin formed by muscles.[6] The entry is open and round. The back wall is formed by the sacrum centrally and the piriformis muscles laterally, the sidewalls are the right and left obturator internus muscles, and the front wall is formed by the backs of the pubic bodies and pubic symphysis. The floor is formed by the levator ani muscle complexes and the coccygeus muscles covering the sacrospinous ligaments. (Figure 2.4)

Through the floor of the pelvis—also called pelvic diaphragm—course the urethra, the lower third of the vagina, and the anal canal. These pass through the levator hiatus, or central opening between the levator ani muscles of the pelvic diaphragm. Passively resting on top of the posterior portion of the levator ani muscles, named the levator plate, are the upper two thirds of the vagina and the rectum. These orientations are crucial in maintaining pelvic organ support in the physically active woman. Just below or inferior to the pelvic diaphragm is the perineum anteriorly, and the ischioanal fossa posteriorly. The perineum, containing important muscles and fascia, is important in the maintenance of the vertical orientation of the urethra, the lower third of the vagina and the anal canal.

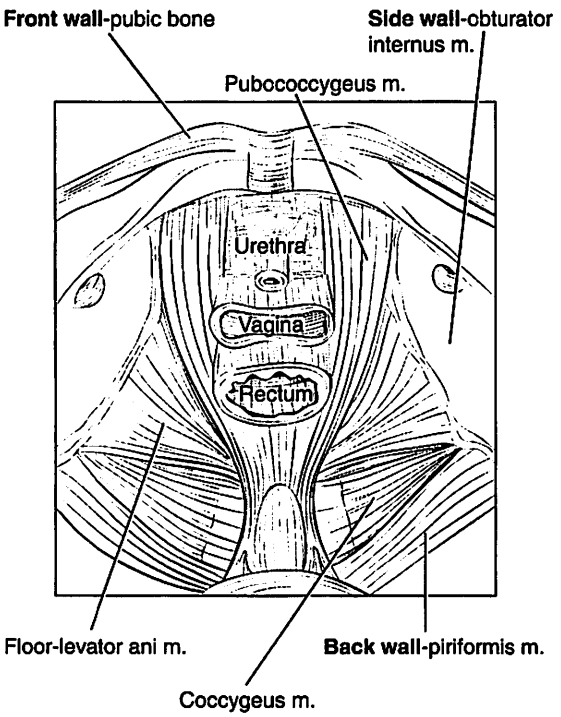


FIGURE 2.4. Boundaries of pelvic floor.

The *piriformis muscle* courses from the upper half of the sacrum, straight outward through the greater sciatic foramen, to insert onto the greater trochanter of the femur. The obturator internus muscle originates from the bony edges of the obturator foramen and the entire inner surface of the obturator membrane to form a wide, fan-shaped muscle. This muscle tapers into a strong tendon, which then turns 120 degrees to exit the pelvis through the lesser sciatic foramen to insert onto the greater trochanter with the piriformis tendon. These two muscles externally rotate the hip. Overlying the piriformis muscle is the sacral plexus of somatic nerves. The sacral plexus is the origin of the sciatic nerve, the pudendal nerve, and the nerves that innervate the pelvic musculature. Therefore, no surgical dissection or sutures should ever be placed near the piriformis muscles. However, the obturator internus muscles of the pelvic sidewall are readily available to guide surgical dissections and to accept sutures for repairing pelvic support problems.

The floor of the pelvis is formed by the upper, or pelvic, surfaces of the levator ani complex of muscles and the coccygeus muscles. The *coccygeus muscle* is a very thin, nonfunctional covering of the strong sacrospinous ligament. In fact, when using this ligament for vaginal support in the older woman, the coccygeus muscle is very fibrotic and not seen after dissection in this area. The *levator ani muscles* are traditionally described as the pubococcygeus and puborectalis anteriorly, and the iliococcygeus muscles posteriorly. The *pubococcygeus and puborectalis muscles* originate from the back of the pubic bone and the anterior part of the obturator internus muscle, along the arcus tendineus levator ani. These muscles form the levator hiatus and allow passage of the urethra, lower third of the vagina, and anal canal through the pelvic diaphragm and perineum to the outside

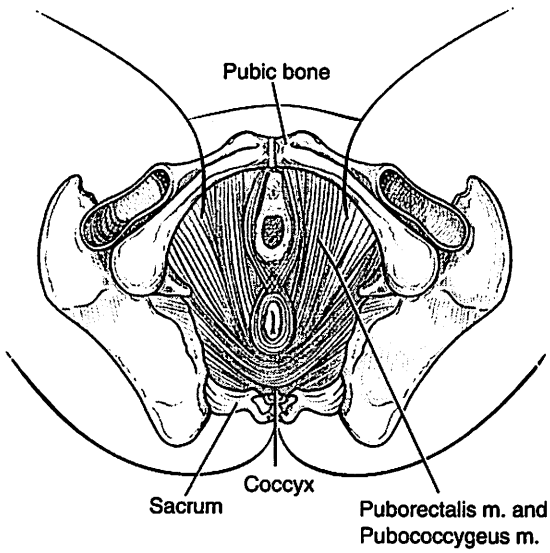


FIGURE 2.5. The sling-like pelvic floor muscles: pubococcygeus and puborectalis.

of the body. The pubococcygeus surrounds and is fused with the lower third of the vagina and inserts into the apex of the perineal body between the vagina and anorectal juncture. The puborectalis muscle is the medial and inferior portion of the pubococcygeus muscle and meets its sister puborectalis muscle behind the anorectal junction. (Figure 2.5)

The anatomic relationship of the puborectalis muscles with the anorectal junction is very important for fecal continence. The puborectalis muscles form the "right angle" of the anorectal junction, which is responsible for solid stool control. These muscles are innervated by branches from the sacral plexus that, in some cases, may be compressed, stretched, and significantly injured during vaginal childbirth. Surrounding the outlet of the anal canal is the sphincter ani muscle. The proper functioning of this muscle is responsible for continence of watery stool and flatus. This muscle is innervated by the inferior rectal nerves from the pudendal nerves, which also can be stretched and injured by childbirth.

The *iliococcygeus muscle* originates from the pelvic sidewall from the arcus tendineus levator ani. The arcus tendineus levator ani is a thickening of the parietal fascia overlying each obturator internus muscle and is directed from the back of the pubic bone to a point near the ischial spine. The iliococcygeus muscles then slope down in a horizontal manner to fuse into the *levator plate*, which runs from the anorectal junction to the coccyx and sacrum and is approximately 4 cm long. Inserting into the levator plate is also the puborectalis muscle. Lying passively on top of the levator plate and lower part of the sacrum is the rectum, cervix, and upper two thirds of the vagina. When the woman increases intrapelvic pressure with a Valsalva maneuver such as straining, coughing or laughing, the pressure generated pushes the upper vagina and rectum down against the contracted, firm levator plate. This "flap-valve" mechanism is responsible for prevention of pelvic organ prolapse in the "**normal**" woman. The other crucial mechanism for preventing pelvic organ prolapse is the contraction and closure of the pelvic diaphragm and levator hiatus by the pubococcygeus and puborectalis muscles.

The *perineum* is located inferior to the levator ani floor of the pelvis and is diamond shaped. Its major muscular components are illustrated in Figure 2.6. The sidewalls are the obturator internus muscles below the two arcus tendineus levator ani. The outer part of the perineum is bordered by the outlet of the pelvic bones. The perineum is anatomically divided into two triangles described by drawing a line through the two ischial tuberosities. The anterior portion towards the pubic arch

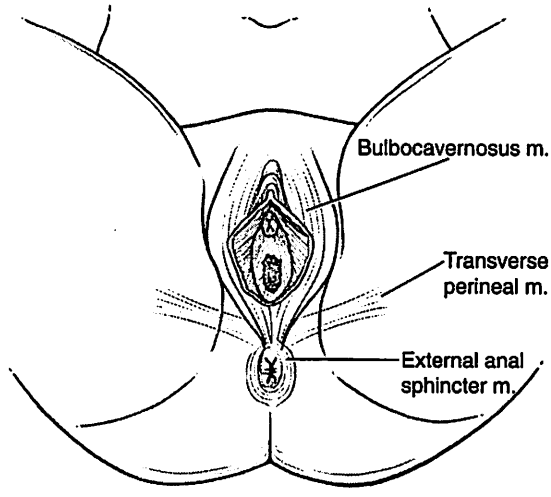


FIGURE 2.6. The perineal body.

is the urogenital triangle, while the posterior or anal triangle contains the anus and points towards the coccyx. The anal triangle also contains the fa-filled ischioanal fossa. The urogenital triangle has two layers described - the superficial space and the deep compartment. The boundary between these two spaces is the perineal membrane, a tough, fibrous membrane that stretches between the ischiopubic rami. Through the perineal membrane passes the lower third of the urethra and the lower third of the vagina. The posterior edge of the perineal membrane is the anterior border of the anal triangle.

The muscles in the superficial space are the superficial transverse perinei, the bulbocavernosus, and the ischiocavernosus. They overlie the vascular erectile bulbs and assist in clitoral erection and the woman's sexual response. These muscles are innervated by the perineal branches of the pudendal nerve. The muscles of the deep compartment apply to the urinary continence mechanism. On top of the perineal membrane are the compressor urethrae and urethrovaginal muscles. These small muscles run over the lower third of the urethra and are part of the external urethral sphincter, along with the sphincter urethrae, which surrounds the urethra from the urethrovesical junction down to the perineal membrane. All these muscles, as well, are innervated by perineal branches of the pudendal nerve. The pudendal nerve is also exposed to the injurious forces of compression and stretching during vaginal childbirth. Some women are then left with residual damage to their continence mechanisms.

Anchoring the urogenital and anal triangles centrally is the perineal body, found between the vaginal introitus and the anus. The lower third of the vagina is fused with the perineal body anteriorly, while the anal canal is fused with the perineal body posteriorly. The square base is located 1 cm–2 cm above, or superior to, the level of the ischial tuberosities. The apex of the perineal body, roughly shaped like a pyramid, is located at the transition of the lower third of the vagina with the middle third and at the 90° angulation of the anal canal with the rectum at the anorectal junction. The perineal body and pubic bones anchor the closure mechanisms of the vaginal introitus and anal canal. (Figure 2.6)

## Pelvic Organ Suspension—Visceral Connective Tissues

The crucial mechanisms of pelvic organ support are the flap valve of the upper vagina and rectum against the levator plate, and the closure of the vaginal introitus by the contraction of the pubococcygeus/puborectalis muscles around the lower third of the vagina and anorectal junction. The flap-valve mechanism is dependent upon the visceral connective tissue network that suspends the upper vagina, cervix, and rectum over the levator plate. The closure of the lower third of the vagina is the result of the direct fusion of the pubococcygeus/puborectalis muscles with the lower third of the vagina, perineal body, and anorectal junction.

Think of the suspensory function of the pelvic visceral connective tissues as a three-dimensional scaffold that is somewhat flexible, yet anchored to the muscular pelvic basin.[7,8] (Figure 2.7)

The scaffold is constructed of a tight webbing, and occasional fusion, of a meshwork of collagen and elastin. Histologically, visceral connective tissue is a three-dimensional meshwork composed predominantly of collagen fibers intermingled with some elastin and smooth muscle. It is located along the back wall and the sidewalls of the pelvic basin and then tapers down to the vaginal introitus and perineal body. The visceral

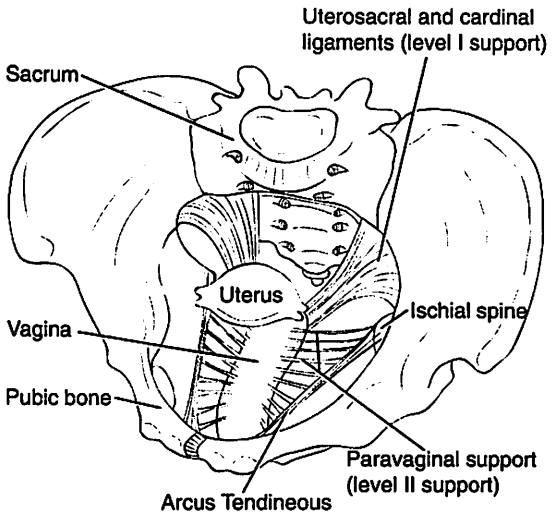


FIGURE 2.7. Endopelvic fascia: "scaffolding" for the pelvic organs.

connective tissues, or endopelvic fasciae, that form this scaffolding are attached to the parietal fasciae from the pelvic inlet and piriformis muscles posteriorly; the anterior border of the greater sciatic foramen, the obturator internus, and the levator ani muscles laterally; and the perineal membrane and perineal body inferiorly. These tissues surround and envelop the visceral arteries and veins, the lymph nodes and channels, and the visceral nerves that service the pelvic organs and tissues. This network of visceral connective tissues suspends the pelvic organs—bladder, urethra, vagina, and lower rectum—over the levator plate, while giving physical support to the many anatomic structures that travel through it. The visceral connective tissues are actually many sheets that fuse into sheaths, or further thicken into stronger septa, depending on the mechanical stress requirements of a particular segment of the visceral suspensory network.

The suspensory network is continuous and interdependent throughout the pelvis and is found beneath the parietal peritoneum and overlying the parietal fascia of the pelvic basin muscles. DeLancey has described three levels of pelvic organ suspension for the purposes of our understanding and visualization.[9]

## The "DeLancey Levels" of Pelvic Connective Tissue Support

*Level I: Connective tissues include the cardinal and uterosacral ligaments, suspending the cervix and upper vagina into the hollow of the sacrum and over the levator plate*

*Level II: Suspends each side of the vagina and rectum to the pelvic sidewall. Defines passive support of the bladder, mid- vagina, and rectum beneath the vagina.*

*Level III: Fusion of the lower third of the vagina and anal canal with the pubococcygeus muscles and perineal body. Secures the vertical orientation of the urethra, lower third of the vagina, and the anal canal in the standing woman.*

The *cardinal ligament-uterosacral ligament complexes* (Level I) are formed by multiple sheets of visceral connective tissue that fuse around the internal iliac artery and vein and artery leading to the uterine vessels, and then to the cervix. The supravaginal portion of the cervix is encircled by thicker visceral connective tissue, called the *pericervical ring*. These fused sheets form stronger sheaths and are anchored to the parietal fascia of the piriformis muscles and posterior part of the obturator internus muscles. The inferior and medial part of this sheath is the *uterosacral ligament*, which runs from the posterolateral aspect of the pericervical ring of visceral connective tissue to the tough presacral fascia overlying the edge of the middle sacrum. Running within the cardinal ligament sheath, but anterior to the uterosacral portion, is the ureter.

To explain uterine prolapse and vaginal relaxation, gynecologists, in prior years, felt and taught that these visceral suspensory ligaments became stretched or attenuated. However, observations in the 1970s and 1980s have been incorporated into present day concepts of uterine and vaginal prolapse. We now speak of pelvic organ support defects and site-specific repairs. The visceral connective tissues can be observed to stretch to a point, but then break, or form multiple breaks, to allow the pelvic organs to prolapse down, away from the supporting levator plate. The goal of reparative vaginal surgery is to find the defects in the suspensory network and repair them, usually with permanent suture material.

The Level II axis is oriented horizontally in the standing woman and forms passive platforms. The anterior platform passively supports the bladder and prevents anterior vaginal wall prolapse, better known as cystocele. The posterior platform passively restrains the rectum from protruding into the vagina and, thus, prevents a posterior vaginal wall prolapse, better known as rectocele. These platforms of visceral connective tissues are attached laterally to the sidewalls of the pelvis and posteriorly (proximally) to the pericervical ring. Therefore, these suspensory platforms are anchored posteriorly to the cardinal-uterosacral ligament complexes via their common attachments to the pericervical ring. This is an important concept for the reparative vaginal surgeon. This important junction at the pericervical ring occurs consistently at the anatomic location of the ischial spines, deep within the female pelvis. The anterior horizontal platform between the vagina and the bladder is the pubocervical fascia. The posterior horizontal

platform between the vagina and rectum is the rectovaginal fascia, or septum.

The *pubocervical fascia* is the common surgical term for the fibromuscular coat surrounding the vaginal epithelium. This anterior vaginal connective tissue is thickened and attached to each pelvic sidewall by a wing or septum of thickened, visceral connective tissue that forms each anterolateral sulcus found in the vagina of the nulliparous woman. This lateral vaginal septum is anchored to the sidewall by a linear thickening of the parietal fascia overlying the levator ani muscles. This linear structure—named the arcus tendineus fasciae pelvis, or fascial white line—runs from the pubic arch along the pelvic sidewall, ending at the ischial spine. This is a length of approximately 7.5 cm to 9.5 cm. The bladder passively rests upon and is supported by the hammock of pubocervical fascia.

Observed surgically in the retropubic space, the pubocervical fascia and lateral vaginal septum are continuous and appear as a horizontal hammock upon which the bladder passively rests. The proximal or posterior edge of the pubocervical fascia is attached to the pericervical ring at the level of the ischial spines. Thus, the upper edge is pulled back towards the hollow of the sacrum by its attachment to the cardinal-uterosacral ligament complexes. These attachments prevent anterior vaginal wall prolapse or *cystocele* formation. Observations indicate that most cystoceles are the result of upper transverse tears of the pubocervical fascia from one of two structures. The first tear is from the front of the pericervical ring. The second is where the pericervical ring itself transversely tears away from the cardinal-uterosacral ligament complexes. These support defects occur most commonly during vaginal childbirth.

As the anterior vaginal wall prolapse (cystocele) evolves, the pubocervical fascia progressively tears away from the lateral attachments to the fascial white lines, and the anterior vaginal wall progressively falls.

## Degrees of Prolapse

These days, many pelvic surgeons use the quantitative "POP-Q" prolapse grading system, which is reviewed in Chapter 5. However, in most primary care settings the following simplified grading scale will suffice:

*First Degree: Prolapse bulge extends into the vagina, below the halfway point to hymenal ring*
*Second Degree: Extends to hymenal ring*
*Third Degree: Extends beyond the hymenal ring and vaginal introitus (externally visible)*
*Fourth Degree: Complete prolapse with no visible support remaining*

Present-day reparative vaginal surgeons most commonly find transverse tears and paravaginal tears in most anterior vaginal wall prolapses (cystoceles). Therefore, surgical repair entails the reattachment of these connective tissue breaks to their "normal" anatomic attachments—to each arcus tendineus fasciae pelvis laterally and to an apical fixation point at the level of the ischial spines.

Likewise, the urethra has a hammock of pubocervical fascia underneath it, which is attached to each arcus tendineus fascia pelvis. When the woman increases the intrapelvic pressure by Valsalva, the urethra rotates back against the hammock of pubocervical fascia and is compressed. This is an important mechanism of urinary incontinence. A break, or breaks, of this hammock from the lateral pelvic sidewalls, as can occur in vaginal childbirth, produces a hypermobile urethra and stress urinary incontinence. Repair entails the restoration of this suburethral hammock. There are various surgical means to do this. Reflections of the pubocervical fascia around the middle third of the urethra to the underside of the pubic arch are modified histologically and called the pubourethral ligaments

Concerning the posterior vaginal wall and prevention of a prolapse or rectocele, the intact rectovaginal fascia or septum is found in the rectovaginal space and is attached to the pelvic sidewalls laterally, and then posteriorly, to the uterosacral ligaments and cervix. Likewise, vaginal childbirth can cause detachment of the rectovaginal fascia from its attachments, thus resulting in posterior vaginal wall prolapse or varying degrees of *rectocele*. Prolapse to the mid-vagina is a first-degree rectocele; to the introitus, second-degree; and outside the vagina, third-degree. Complete posterior vaginal wall prolapse is a fourth-degree rectocele. Most posterior defects are a transverse tear of the upper edge of the rectovaginal fascia from the uterosacral ligaments, with progression to lateral tears away from the sidewalls.

Occasionally, the transverse defect can occur from the apex of the perineal body. Repair entails finding and suturing the fascial defects to their "normal" anatomic positions. Many rectoceles are also accompanied by an enterocele.

Richardson has defined *enterocele* as a detachment of the pubocervical fascia from the rectovaginal septum, thus allowing the peritoneum to push the vaginal apex down into the vaginal canal.[10] Therefore, surgical repair of an enterocele now entails the reconstruction of the pericervical ring by attaching the pubocervical fascia to the rectovaginal fascia and, then, attaching this to each uterosacral ligament at the level of the ischial spines. This can be accomplished through either the vaginal route or an abdominal approach.

## Conclusion

The restoration of "normal" vaginal and pelvic anatomic relationships is the goal of the vaginal surgeon. Surgical placement of the upper vagina and rectum over the levator plate is paramount. This is done by finding and repairing the defects in the suspensory network of visceral connective tissues found in the female pelvis. Reconstruction of the perineal body is just as important. Repair of prolapse can be accomplished vaginally, abdominally, or laparoscopically. We continue to study and better understand the science of pelvic organ prolapse and dysfunction and to improve the art of surgical repair of vaginal support defects.

For primary care practitioners, an improved understanding of female pelvic anatomy will allow for more accurate identification of problems and more opportunities to provide relief.

## Key Points

- The foundation of "normal" female pelvic anatomy includes a strong horizontal orientation to the levator muscle plate. The intact levator plate acts as a "flap valve", supporting the upper two-thirds of the vagina and the rectum in a horizontal position. In many cases, loss of the horizontal levator plate may be the seminal event leading to prolapse.
- The *ischial spine* is a key landmark for learning and understanding female pelvic support anatomy. Vaginal suspension surgeries strive to support the vaginal apex to the depth of the ischial spine, using a variety of nearby muscular and ligamentous structures (e.g. sacrospinous, iliococcygeus, uterosacral).
- The pelvic connective tissue "scaffolding" consists of collagen, elastin and smooth muscle. This network of visceral connective tissue suspends the pelvic organs—bladder, urethra, vagina, and lower rectum—and tethers these organs to fixed pelvic sidewall structures.
- Anatomic boundaries of the female pelvis are *pubic bone* (front wall), *obturator internus* (side wall), *levator ani* (floor), and *piriformis* (back wall).

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