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# Anatomy of the Female Genital System

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## Abstract

Female pelvic anatomy requires a great deal of comprehensive knowledge that can often seem unattainable. This chapter focuses on the basics of this arena into thirteen sections that may be easier to understand once separated. These 13 sections will cover the uterus, adnexa, and vulvar organs as well as the pelvic bones, vessels, and innervation. With the addition of specific and important surrounding structures and planes, there is emphasis on clinical and surgical application. This information is geared toward a better understanding of the female anatomy for the gynecologist, internist, and family physician, but it is particularly directed to the pelvic surgeon performing laparotomy and/or laparoscopy within this area.

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## Keywords

Female pelvic anatomy • Pelvis • Gynecology • Surgical gynecology

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## 1 Introduction

The word “gynecology” was first used in the middle of the nineteenth century. Gynecological anatomy was first explored in Alexandria by the Roman physician, Soranus. Soranus was interested in the disease of women and children, and one of his most important textbooks was named *Gynecology*. He focused his textbook on normal and abnormal anatomy, care of the newborn, and care of abnormal pregnancy but is particularly remembered for describing the anatomy of the anatomy of the gravid uterus. It was the Hungarian obstetrician, Dr. Ignaz Semmelweis, who pioneered the way with the importance of hygiene in preventing postsurgical sepsis. Two fathers in the world of surgical gynecology that need recognition are Dr. Ephraim McDowell who performed the first ovarian cystectomy and Dr. James Marion Sims who performed the first vesicovaginal fistula repair. These are the leaders that paved the way for a modern understanding of gynecological anatomy in the nongravid woman and the techniques of surgical repair.

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It is interesting that the first recorded surgery in history is a cesarean section that remarkably showed a fairly contemporary understanding of gynecological anatomy. This dichotomy can be better understood by the words of medical historian Howard Kelly when he stated “the history of gynecology seems to me more full of dramatic interest than the evolution of any other medical or surgical specialty.” However, before understanding the gravid state or the pathology that can affect this system, it is important to know the foundation of its anatomy. This chapter is divided into 13 sections. The anatomy of the female genital system including the uterus, adnexa, and vulva along with the blood vessels, lymphatics and nervous system is addressed below (Baggish 2011; Howard and Rock 2015).

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## 2 Genital Structures

### 1. Vagina

- The vagina is a flexible viscus that is shaped by its surrounding structures and its attachments to its adjacent walls.
- The vagina is bent at a 120° angle at the distal one third and proximal two third junction at the level of levator ani attachment. It is typically 7–9 cm in length with the anterior wall typically shorter by 3 cm than the posterior wall as this is where the cervix lies. But these dimensions vary between individuals.
- The vagina’s anatomical relations can be best understood by dividing it into thirds. The distal one third is fused anteriorly with the urethra and posteriorly with the perineal body and laterally to the levator ani by the fibers of Luschka. The mid one third portion of the vagina is comprised of the vesicle neck and trigone anteriorly, the rectum posteriorly, and the levators laterally. The proximal one third of the vagina is adjacent to the bladder and ureters anteriorly, posteriorly to the cul-de-sac, and laterally to the cardinal ligaments.
- The wall of the vagina is compromised of the same layers of all hollow viscera

which include the mucosa, submucosa, muscularis, and adventitia. This holds true for all parts of the vagina excluding the segment covered by the cul-de-sac which contains no serosal layer. The vaginal mucosa is nonkeratinized squamous epithelium. The submucosa is a dense, dermis-like layer and is fused with the muscularis in a bihelical arrangement. Outside the muscularis is the adventitia which is the connective tissue labeled “endopelvic fascia.”

### 2. Uterus

#### A. The Uterine Corpus

- The uterus is a fibromuscular organ that varies in shape and size according to the amount of estrogen stimulation and previous parity. It is divided into two parts: the upper muscular corpus and the lower, fibrous cervix. The corpus is generally much larger than the cervix in women of reproductive age (particularly in gravid women). However, in prepubescent girls and menopausal women, the sizes of both these structures are more equal.
- The uterus is divided into three layers: the endometrium, a surrounding thick muscular wall called the myometrium, and the top layer called the serosa. The endometrial cavity is triangular in shape. The top of the endometrial cavity is called the fundus. The endometrium is comprised of glandular columnar epithelium and specialized stroma. The myometrium is the thickest part of the uterus and is comprised of smooth muscle. The serosa consists of the visceral peritoneum

#### B. The Uterine Cervix

- The cervix is a tubular structure that serves as a channel between the vagina and uterine corpus. It is comprised of two portions: the portio vaginalis which protrudes into the vagina and the superior portion called the portio supravaginalis that is above the vagina but below the corpus. The portio vaginalis

is made up of nonkeratinized squamous epithelium. Its endocervical canal is made up of columnar mucus-secreting epithelium.

- The proximal border of the cervical canal is defined by the internal os that opens into the endometrial cavity. The distal border is defined by the external os that incorporates the squamous epithelium of the portio vaginalis and the glandular epithelium of the endocervical canal. This squamocolumnar junction is termed the “transition zone” and is particularly subject to malignant transformation.
- The cervix is covered laterally by the broad ligament and anteriorly by the bladder and posteriorly serves as the anterior boundary of the posterior cul-de-sac (pouch of Douglas). The posterior segment of the cervix is the only part that has a serosal covering.

### 3. Adenexal Structures

#### A. The Fallopian Tubes

- The fallopian tubes are paired tubular structures that serve as highways between the ovaries and uterus. They typically range 7–12 cm in length. Each tube is divided into four parts. The portions include the interstitium, where the tube passes through the uterine cornu, the isthmus that is the narrowest segment of the tube comprised of a thin lumen and a thick muscular wall, the ampulla that contains an expanding lumen and muscular folds, and the infundibulum located at the end of the tube forming smooth muscle projections to increase the surface area for facilitating ovulated ova pick-up. The lumen of the fallopian tube thus connects the uterine cavity to the abdominal cavity.
- The inner layer of the fallopian tube, the internal mucosa (endosalpinx), is comprised of three types of columnar epithelium: secretory, ciliated, and peg cells. The endosalpinx is arranged in folds that increase in number toward the fimbria.
- The middle muscular layer (myosalpinx) of the fallopian tube is composed of an outer layer of longitudinal smooth muscle fibers and an inner circular layer. A third layer is added in the interstitial portion.
- The outermost layer of the fallopian tube, the serosa, is composed of an epithelial layer that is histologically the same as peritoneal cells. The mesosalpinx is part of the broad ligament that stretches from the ovary and wraps round the fallopian tube forming the serosal layers.

#### B. The Ovaries

- The ovary is suspended laterally to the pelvic wall by the infundibulopelvic (IP) ligament. The IP contains the ovarian artery and vein. The ovary is connected medially to the uterus by the utero-ovarian ligament. It measures about 2.5–5 cm long, 1.5–3 cm thick, and 0.7–1.5 cm wide depending on its activity or suppression during reproductive life.
- The ovary’s external epithelial layer is composed of cuboidal germinal cells. For ovulation, this layer is ruptured. Beneath this layer is a layer of dense connective tissue, the tunica albuginea. The external layer or ovarian cortex contains ovarian follicles with stroma between them. The cortex also contains corpora lutea and corpora albicantia.
- The innermost layer is the ovarian medulla. The medulla is fibromuscular with many blood vessels and connective tissue.
- The mesentery of the ovary is called the mesovarium. The mesovarium is the portion of the broad ligament that reflects onto and holds the ovary in place. The mesovarium does not cover the ovary.
- The round ligaments extend from the uterus laterally and are a homolog of the gubernaculum testis. After moving laterally from the deep inferior

epigastric vessels, they become rounded and enter through the inguinal canal to the subcutaneous tissue of the labia majora. The mesentery of the round ligament and uterus is called the mesometrium.

The ovaries and fallopian tubes form the adnexa.

#### 4. Support Structures

- The parametrium is composed of the fibrous tissues that connects to the uterus and separate the supravaginal portion of the cervix from the bladder. The parametrium extends laterally between the two layers of the broad ligament. The uterosacral and cardinal ligaments form the medial and lateral borders of the parametrium. These ligaments extend laterally from the cervix to the pelvic wall. These ligaments form the suspensory tissues that hold the cervix posteriorly in a position over the levator plate of the pelvic diaphragm.
- The uterosacral ligament marginates the cul-de-sac of Douglas. It is formed by a combination of smooth muscle, autonomic nerves, connective tissues, and blood vessels. The uterosacral ligament extends from the posterior base of the uterus to the anterior sacrum.
- The cardinal ligament attaches at the isthmus above the cervix and attaches to the pelvic wall over the piriformis muscle in the greater sciatic foramen. The cardinal ligament provides support for the uterus, cervix, and upper portion of the vagina, whereas the uterosacral ligament only provides support for the uterus and cervix.

#### 5. Blood Supply

- The aorta provides the blood supply to the pelvic structures through both the iliac branches and the ovarian artery. The aorta bifurcates at spinal level L4–L5 into the right and left common iliac arteries. The common iliac arteries are only about 4 cm long as they run along the psoas muscles and bifurcate at the pelvic brim forming the external and internal (hypogastric) iliac

arteries. The internal iliac artery is the main blood supply to the pelvic organs. The branches of the iliac artery are variable but include the uterine, vaginal, obturator, inferior vesical, middle rectal, and internal pudendal arteries:

- The uterine artery enters the uterus at the junction of the corpus and cervix and rises laterally. It also flows into the marginal artery on the side of the uterus and thus is able to provide upward and downward flow to the uterus.
- The vagina receives its blood supply from the uterine artery and the vaginal branch of the internal iliac artery, and they anastomose at 3 o'clock and 9 o'clock positions of the vagina. The distal vagina also receives blood from the pudendal and hemorrhoidal vessels.
- Bifurcation of the internal and external iliac blood vessels occurs within the sacroiliac joint. Before descending under the inguinal ligament, the external iliacs give form to the deep circumflex and deep inferior epigastric vessels. The internal iliac artery supplies the pelvic structures and splits into anterior and posterior divisions about 3–4 cm after leaving the common iliac artery. The posterior division is comprised of the iliolumbar, lateral sacral, and superior gluteal vessels that supply the pelvic wall and gluteal region. The anterior division is comprised of the obturator, internal pudendal, and inferior gluteal branches that supply pelvic muscles; the uterine, superior vesicle, inferior vesicle (vaginal), and middle rectal supply pelvic organs. Ligation of the internal iliac artery is helpful in the management of postpartum hemorrhage.
- The adnexa blood supply consists of the ovarian artery, which is a branch of the aorta just below the renal artery. The venous plexus drain into the vena cava on the right and the renal vein on the left. The

ovarian artery and vein also pass along the ovarian mesentery to connect with the upper part of the marginal artery of the uterus.

## 6. Innervation

- Many of the pelvic structures are innervated by nerves originating from the sacral plexus, coccygeal plexus, and pelvic autonomic nerves:
  - The sacral plexus (innervated by the 4–5th lumbar spinal nerves) runs down the posterior pelvic wall anterior to the piriformis muscle. The nerves that form from the sacral plexus include pudendal nerves (clitoris), perforating cutaneous and posterior femoral cutaneous nerves, pelvic splanchnic nerves, sciatic nerve, superior and inferior gluteal nerves, as well as the nerve to the obturator internus, piriformis, and quadratus femoris muscles.
  - Coccygeal nerves (formed by the 4th and 5th sacral spinal nerves) innervate the coccygeus and levator ani muscles and that sacrococcygeal joint.
  - Pelvic autonomic nerves control blood flow, peristalsis, contraction of the bladder and rectum, and hormone levels. They include sacral sympathetic trunks, superior hypogastric plexus, inferior hypogastric plexuses, and pelvic splanchnic nerves.
- The ovaries and fallopian tubes are innervated by the T10–11 renal plexus and the parasympathetics of the vagus nerve.
- The superior hypogastric plexus (L1–2) receives input from the splanchnic nerves and afferent pain input from the pelvic viscera. Parasympathetic input derives from S2 to S4.
- The inferior hypogastric plexus (L2–5) is comprised of three parts: vesical plexus, uterovaginal plexus, and middle rectal plexus. It can be affected during parametrial tissue dissection during hysterectomies and cause post-operative voiding dysfunction and urinary retention.

- The uterus receives nerve innervation via the uretovaginal plexus called Frankenhauser ganglion. This plexus lies medial to the medial to the uterine vessels and lateral to the uterosacral ligament and receives sympathetic input from T10 to L1 and parasympathetic input from S2 to S4. Its caudal fibers also innervate the vestibule.
- During surgery it is important to be cognizant of nerves that may be injured. Retraction during laparotomy can cause injury to the genitofemoral branch of the lumbosacral plexus (L1–L2), leading to anesthesia to the lateral labia and medial thigh. Retraction or hyperflexion of the hip while in lithotomy position can cause injury to the femoral cutaneous nerve (L2–L3), leading to anesthesia or abnormal sensation to the anterior thigh.

## 7. Lymphatics

- Most of the lymph nodes of the pelvis follow the corresponding blood vessels.
- The ovaries drain into the para-aortic lymph nodes. During dissection, the boundaries are the following: superiorly includes the origin of the inferior mesenteric artery, inferiorly is the midportion of the common iliac and laterally bordered by the ureters.
- Lymph drainage from the uterus flows in the direction of its attachments, starting with the cardinal, uterosacral, and eventually round ligaments. These drain into internal iliac nodes.
- Within the pelvis, lymph node chains can be divided into external iliac, internal iliac, common iliac, medial sacral, and pararectal nodes. The medial and pararectal nodes are rarely involved in gynecological diseases.
- External iliac nodes receive drainage from the inguinal nodes from the leg.
- Internal iliac nodes drain the pelvic viscera, and most of these nodes lie in adipose along the lateral pelvic wall.
- The upper two thirds of the vagina and bladder drain into the uterine lymphatics into the internal iliac lymph nodes. The

lower one third of the vagina and distal urethra drain into the inguinal nodes.

#### 8. The Ureter

- The ureter is medial to the ovarian vessels when it crosses over the bifurcation of the internal and external iliac arteries entering the pelvic brim. Upon entering the pelvis, it lies in connective tissue attached to the peritoneum of the lateral pelvic wall and medial leaf of the broad ligament. It then passes under the uterine artery at 1.5 cm lateral to the cervix. It then lies on the anterior wall of the vagina where the cervix is detached during a hysterectomy.

#### 9. The Vulva and Erectile Structures

- The bony outlet of the pelvis is bordered by the ischiopubic rami anteriorly and the coccyx and sacrotuberous ligaments posteriorly and divided into anterior and posterior triangles. These triangles share a base between the ischial tuberosities. The layers of the anterior triangle mimic that of the abdominal wall. The superficial layer is composed of the vulva, overlying the fascial layer that is the perineal membrane and deep to that is the muscular layer comprised of the levator ani muscles.
- The structures of the vulva consist of the mons, labia, clitoris, vestibule, and associated erectile structures. The mons lies on the pubic bone in a layer of adipose and hair-covered skin. Posteriorly from the mons lies the labia majora which also shares the same hair-covered skin. The labia minora, vestibule, and glans clitoris lie between the labia majora. The labia minora are skin folds that split anteriorly over the clitoris.
- The vestibule is the area between the labia minora, where the urethral introits and vaginal introitus are located. The hymenal membrane is a ring that surrounds the vaginal orifice. The ducts of the Bartholin's glands are located posteriorly laterally of the vestibule at 4 o'clock and 8 o'clock. The ducts of the Skene's glands

are located laterally of the urethra within the vestibule. Blockage of these ducts can cause cysts or abscesses.

- The pudendal nerve (S2–S4) supplies sensory and motor innervation to perineum. The blood supply originates from the pudendal artery. The nerve and artery are differentiated into three branches: the clitoral, perineal, and inferior hemorrhoidal.

#### 10. The Pelvic Bones

- In order to assume an upright position, without pelvic organs descending out through the abdominopelvic cavity, a support system is crucial. This system is called the pelvic floor and consists of the levator ani muscles and perineal membrane.
- The perineal membrane, formally called the urogenital diaphragm, forms the inferior portion of the anterior pelvic floor. It provides support to the posterior vagina by forming the attachment between it and the perineal body and then from perineal body to the ischiopubic rami. It can be torn during parturition and that can result in abnormal descent of the pelvic floor.
- Cephalad to the perineal membrane are the compressor urethral and urethral vaginal sphincter that help the two urethral sphincter muscles to compress the distal ureter. It is controlled by a branch of the pudendal nerve.
- The perineum is the genital skin between the thighs including the external genitalia and anus. The perineal body consists of the lower vagina and skin of the perineum and anus.
- The ischiorectal fossa forms the posterior triangle of the pelvis and lies between the levator ani muscles (they lie medially and superior) and the obturator internus muscle (lies laterally). It contains the external anal sphincter and the pudendal neurovascular trunk.
- The external anal sphincter is attached to the coccyx posteriorly and attaches fibers

to the perineal body superiorly. The internal anal sphincter is a smooth muscle that can be torn during labor and delivery (fourth degree laceration).

- The levator ani muscles are composed of the pubococcygeus, puborectalis, and iliococcygeus muscles. The medial area that contains the openings of the urethra, vagina and rectum is called the urogenital hiatus. The sling of anterior support for this area is formed by the pubococcygeal and puborectal muscles. The posterior portion of support is formed by the iliococcygeus muscle.

### 11. Pelvic Bones and Ligaments

- The bones of the pelvis are comprised of the ilium, ischium, pubis, sacrum, and coccyx.
- In a standing woman, the anterior superior iliac spines (ASIS) and front of the pubic symphysis are in the same plane, perpendicular to the floor, tilting the pelvic inlet anteriorly and making the urogenital hiatus and ischiopubic rami parallel to the ground.
- The ischial spines can be palpated vaginally and rectally and serve as a point of fixation for pelvic support structures such as levator ani muscles and sacrospinous ligament. The ischial spine is also palpated to determine fetal station during labor.
- Beneath the pubic symphysis, two pubic bones form the pubic arch which can vary between 44 and 110° (mean angle is 75°). The pubic arch in men is generally 50–60° and that of women is around 70–90°. A narrow pubic arch can result in dystocia during labor and delivery.
- The pubic symphysis normally has a 4–5 mm gap, but it has increased mobility during pregnancy. It can become abnormally separated during childbirth called pubic diastasis. Greater than a 2 cm gap requires surgical intervention.
- The sacrospinous ligament is a strong, triangular shaped ligament that divides the

lateral pelvic outlet into the greater and lesser sciatic foramen. It is an attachment point for the vaginal apex in the treatment of vaginal prolapse.

- The sacrotuberous ligament is also triangular shaped and forms the inferior lateral border of the lesser sciatic foramen. The apex is attached to the medial ischial tuberosity.

### 12. Avascular Planes

- The anterior cul-de-sac, also known as the vesicouterine pouch, is the space that separates the uterus from the dome of the bladder. During hysterectomy the vesicouterine peritoneal fold is dissected off the bladder to enter the vesicovaginal space.
- The posterior cul-de-sac, also known as the pouch of Douglas or rectouterine pouch, is the space between the uterus and rectum.
- The prevesical space of Retzius separates the bony pelvis and rectus muscles. It is bounded dorsally by the proximal urethra and bladder.
- The rectovaginal space is located dorsally to the vagina and it begins at the apex of the perineal body. The lower urinary and lower genital tracts are separated by the vesicovaginal space and vesicocervical space.

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## 3 Cross-References

- ▶ [Benign Vulvar and Vaginal Pathology](#)
- ▶ [Laparoscopic Hysterectomy](#)
- ▶ [Management of Intraepithelial Lesions of the Cervix](#)
- ▶ [Management of Intraepithelial Lesions of the Cervix](#)
- ▶ [Operative Hysteroscopy](#)
- ▶ [Pelvic Organ Prolapse: Diagnosis, Treatment, and Avoiding Complications](#)
- ▶ [Vaginal Hysterectomy: Indications, Avoiding Complications](#)

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