# Surgical female pelvic anatomy: Uterus and related structures

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All topics are updated as new evidence becomes available and our peer review process is complete.

Literature review current through: **Sep 2023.**
This topic last updated: **Feb 06, 2023.**

## INTRODUCTION

Pelvic surgery requires a comprehensive knowledge of the pelvic anatomy to safely attain access, maximize exposure, ensure hemostasis, and avoid injury to viscera, blood vessels, and nerves.

The anatomy of the female genital tract and lower urinary and gastrointestinal tracts relevant to the surgeon performing laparotomy or laparoscopy, with an emphasis on clinical relevance and avoiding potential complications, is reviewed here. Surgical pelvic anatomy from a vaginal approach and the surgical anatomy of the anterior abdominal wall are discussed separately. (See "Surgical female urogenital anatomy" and "Anatomy of the abdominal wall".)

In this topic, when discussing study results, we will use the gender terms as they are used in the studies presented. However, we encourage the reader to consider the specific counseling and treatment needs of transmasculine and gender-expansive individuals.

## SURGICAL PEARLS

Anatomic features that are clinically applicable to female pelvic surgery are indented and bulleted throughout the text.

## GENITAL TRACT VISCERA

The female upper genital tract consists of the cervix, uterine corpus, fallopian tubes, and ovaries. A sagittal view of the female pelvis is shown in the figure ( figure 1).

The anatomy of the lower genital tract, comprised of the vulva and vagina, is discussed separately. (See "Surgical female urogenital anatomy", section on 'Lower genital tract'.)

**Uterus —** The uterus includes the uterine corpus and uterine cervix ( figure 2). In reproductive age women, the corpus is much larger than the cervix while, during the prepubertal and postmenopausal stages, they are of similar sizes. However, the size of the uterus can vary considerably, depending upon hormonal levels, previous parturition, or the presence of uterine pathology (eg, fibroids, adenomyosis) ( picture 1).

**Uterine corpus —** The corpus, or body, of the uterus has an inverted triangular shape ( figure 3). The most superior portion is called the fundus and the most inferior portion that is continuous with the cervix is called the isthmus, or the lower uterine segment. There are no anatomic landmarks that divide these portions from the rest of the uterine corpus. The uterus is made up of three layers:

- **Endometrium –** The endometrium is the lining of the uterine cavity, with a superficial layer that consists of glandular epithelium and stroma. The thickness of the endometrium changes with the menstrual cycle or other hormonal stimulation. (See "Normal menstrual cycle".)

- **Myometrium –** The myometrium is the thickest layer of the uterus. It is composed of smooth muscle fibers that are oriented diagonally and crisscross with fibers from the contralateral side of the uterus.

- **Serosa –** The serosa is the thin outer lining layer of the uterus, investing the body of the uterus, consisting of visceral peritoneum.

Congenital anomalies of the uterus are discussed in detail separately. (See "Congenital uterine anomalies: Clinical manifestations and diagnosis".)

**Uterine cervix —** The cervix is a tubular structure that serves as the conduit between the endometrial cavity and the vagina. The superior portion is continuous with the uterus. During surgery, the junction between the uterine corpus and cervix can be located by palpating the area to feel the superior border of the cervix, which is tubular and bulky compared with the uterus.

The inferior portion of the cervix protrudes into the vagina. In some women (eg, postmenopausal, following pelvic radiation), the cervix may appear flush with the vagina on examination rather than protruding.

The cervical canal opens into the endometrial cavity at the internal os and into the vagina at the external os. The ectocervix is the surface of the cervix that protrudes into the vagina.

The cervix is composed of dense fibrous connective tissue with a minimal amount of smooth muscle located on the periphery that forms a continuous layer between the myometrium and the muscle in the vaginal wall.

The endocervical canal is lined with glandular epithelium. This transforms into stratified squamous epithelium on the ectocervix due to exposure to the acidic environment that is present in the vagina after menarche. The area where the epithelium changes from glandular to squamous is known as the transformation zone and is the area of the cervix that is most susceptible to dysplasia and malignant transformation [1].

The anterior cervix is apposed to the bladder, while the lateral aspects of the cervix are covered by the broad ligament. The posterior aspect of the cervix forms part of the anterior boundary of the pelvic posterior cul-de-sac (pouch of Douglas).

### Uterine support structures

**Uterosacral and cardinal ligament complex** — The uterosacral/cardinal ligament complex suspends the uterus and upper vagina in its normal orientation [2]. It serves to maintain vaginal length and keep the vaginal axis nearly horizontal in a standing woman so that it can be supported by the levator plate. Loss of this support contributes to prolapse of the uterus and/or vaginal apex.

The cardinal ligaments are condensations of connective tissue that are several centimeters in width and run from the cervix and upper vagina to the pelvic sidewall. The uterine vessels run for much of their course within the cardinal ligaments.

The uterosacral ligaments are bands of connective tissue that are fused with the cardinal ligaments at their point of insertion in the cervix. The uterosacral ligaments pass posteriorly and inferiorly to attach to the ischial spine and sacrum [3,4].

**Round ligaments** — The round ligaments are extensions of the uterine musculature. They begin at the uterine fundus anterior and inferior to the fallopian tubes ( picture 2 and figure 4), travel retroperitoneally through the layers of the broad ligament, then enter the inguinal canal, and terminate in the labia majora. The male homolog of the round ligaments is the gubernaculum testis.

**Broad ligament** — The broad ligament covers the lateral uterine corpus and upper cervix. The boundaries of the broad ligament are: superiorly, the round ligaments; posteriorly, the infundibulopelvic ligaments; and inferiorly, the cardinal and uterosacral ligaments. It consists of anterior and posterior leaves that separate to enclose viscera and blood vessels.

Structures within the broad ligament are considered retroperitoneal. Dissection between these leaves is necessary to provide exposure of these structures.

Various portions of the broad ligament are named for nearby structures (ie, the mesosalpinx [located near the fallopian tubes] and the mesovarium [located near the ovary]).

The broad ligament is composed of visceral and parietal peritoneum that contains smooth muscle and connective tissue.

**Endopelvic fascia —** The pelvic viscera are covered by endopelvic fascia, a connective tissue layer that provides support to the pelvic organs, yet allows for their mobility to permit storage of urine and stool, coitus, parturition, and defecation.

Histologically, endopelvic fascia is composed of collagen, elastin, adipose tissue, nerves, vessels, lymph channels, and smooth muscle.

**Adnexa —** The uterine adnexa consist of the ovaries and fallopian tubes.

**Ovary —** The ovaries are suspended lateral and/or posterior to the uterus, depending upon the position of the patient. The supporting structures of the ovaries include the utero-ovarian ligament that attaches the ovary to the uterus; the infundibulopelvic ligament (also referred to as the suspensory ligament of the ovary), through which the ovarian vessels travel, that attaches the ovary to the pelvic sidewall; and the broad ligament, which condenses to form the mesovarium. It is also attached to the broad ligament through the mesovarium.

- During hysterectomy, if the ovaries are conserved, the utero-ovarian ligament is transected. If salpingo-oophorectomy is performed, the infundibulopelvic ligaments (with the ovarian vessels) are ligated ( figure 4). (See "Hysterectomy: Abdominal (open) route", section on 'Adnexal conservation or removal'.)

The ovary consists of an outer cortex, where the ova and follicles are located, and medulla, where the blood vessels and connective tissue compose a fibromuscular tissue layer ( figure 5).

**Fallopian tube —** The fallopian tubes arise from the uterine corpus posterior and superior to the round ligaments. The broad ligaments support the tubes with a condensation of connective tissue called the mesosalpinx. Paratubal cysts may develop within the mesosalpinx; these are often remnants of the mesonephric or paramesonephric ducts that form and then resorb during embryologic development. The lumen of the fallopian tubes communicates with the uterine cavity and the intraabdominal cavity. (See "Adnexal mass: Differential diagnosis", section on 'Paraovarian/paratubal cysts and tubal and broad ligament neoplasms'.)

Each tube is divided into four distinct portions: the interstitial portion, where the tube passes through the uterine cornu; the isthmus, with a narrow lumen and thick muscular wall; the ampulla, with a larger lumen and mucosal folds; and the fimbria, located at the end of the tube with frond-like projections that increase the surface area of the end of the tubes, thereby facilitating contact with ovulated ova ( figure 2).

The fallopian tubes consist of an outer muscularis layer of the tube with longitudinal smooth muscle fibers and an inner layer with circular fibers. The fallopian tube mucosa is composed of numerous delicate papillary folds (plica) consisting of three cell types: ciliated columnar cells; nonciliated, columnar secretory cells; and intercalated cells, which may simply represent inactive secretory cells [5].

## VASCULATURE

The aorta provides the blood supply to the pelvic structures. The aorta bifurcates at approximately vertebrae L4 to L5 into the right and left common iliac arteries.

The inferior vena cava, where the right and common iliac veins return their blood flow, is located to the right of the aortic bifurcation. Compression of these veins while packing the bowels during abdominal surgery may cause the patient's blood pressure to drop because of the decreased venous return.

**Common and external iliac vessels —** The common iliac arteries divide into the external iliac and internal iliac arteries; the internal iliac artery is also referred to as the hypogastric artery. The left common iliac vein travels anterior to the sacrum and medial to the aortic bifurcation and joins the right common iliac vein to form the vena cava posterior to the right common iliac artery.

The external iliac artery is located medial to the psoas muscle; it continues its course inferiorly to ultimately become the femoral artery. In the pelvis, the external artery gives off several branches, including the inferior epigastric artery; recurrent obturator artery; and the deep circumflex iliac artery ( figure 6) [6].

The external iliac vein is much larger and lies posterior and medial to the artery. The external iliac vein also covers the obturator fossa, where the obturator neurovascular bundle and lymph nodes are located medial to the obturator internus muscle.

The umbilicus is the location on the abdominal wall with the shortest distance from skin to peritoneum. Therefore, it is commonly used as the entry point for the first trocar insertion during laparoscopy. The bifurcation of the aorta can be located directly underneath the umbilicus with those with a normal body mass index, to 3 to 4 cm caudal to the umbilicus in the patient with obesity.

- During laparoscopy, in the thin patient, placement of the initial umbilical trocar or Veress needle should be performed at a 30 to 45 degree angle to the anterior abdominal wall in order to avoid injury to the common iliac vessels or the aorta. (See "Complications of laparoscopic surgery", section on 'Major vessels'.)

**Inferior and superficial epigastric vessels** — The inferior epigastric vessels perfuse the rectus abdominis muscles. The inferior epigastric artery originates from the external iliac artery, travels through the transversalis fascia into a space between the rectus muscle and posterior sheath ( figure 7). In their course from the lateral position of the external iliac vessels, the inferior epigastric artery and vein run obliquely toward a more medial location as they approach the umbilicus.

- When a muscle-splitting technique is used during laparotomy (eg, Maylard), care must be taken to ensure hemostasis of the inferior epigastric vessels, which may retract quickly when the muscle is transected. (See "Incisions for open abdominal surgery", section on 'Maylard's incision'.)

The superficial epigastric vessels perfuse the anterior abdominal wall. These vessels run from the femoral vessels and branch extensively as they approach the umbilicus.

- When lower abdominal lateral ports are placed during laparoscopy, the inferior and superficial epigastric vessels should be identified to avoid vascular injury. The superficial epigastric vessels can be seen by transilluminating the anterior abdominal wall, with the exception of some patients with obesity. The inferior epigastric vessels must be visualized intraabdominally where they run lateral to the medial umbilical ligaments ( picture 2) [7-9]. (See "Complications of laparoscopic surgery", section on 'Minor vessels'.)

The anatomy of the anterior abdominal wall is discussed in detail separately. (See "Anatomy of the abdominal wall".)

**Anterior and posterior divisions of the internal iliac artery** — The internal iliac artery (hypogastric artery) branches into the anterior and posterior divisions.

The posterior division travels toward the ischial spine, branching into the lateral sacral, iliolumbar, and superior gluteal arteries. The anterior division of the internal iliac artery branches into the obliterated umbilical, uterine, superior vesical, obturator, vaginal, and inferior gluteal and internal pudendal arteries ( figure 6). The internal iliac vein lies medial to the internal iliac artery, while the other veins travel with their corresponding arteries.

The internal iliac artery is a retroperitoneal structure and to identify and access any of its branches of interior iliac artery, a retroperitoneal dissection must be performed. In addition, the ureter runs retroperitoneally in this region, and should be identified prior to the vessel desiccation or ligation of any vessel.

- Ligation of the hypogastric artery is a useful surgical technique to control massive pelvic hemorrhage ( figure 8). Following hypogastric artery ligation, collateral flow from the aortic branches (ie, lumbar and middle sacral artery) or through the inferior mesenteric branches (ie, superior hemorrhoidal vessels) prevents ischemia of the pelvic organs. (See "Management of hemorrhage in gynecologic surgery", section on 'Internal iliac artery ligation'.)

**Blood supply to the uterus, tubes, and ovaries** — The majority of the blood supply to the uterus, tubes, and ovaries derives from the uterine arteries and the ovarian arteries.

The uterine arteries originate from the anterior division of the internal iliac arteries in the retroperitoneum ( picture 3). They may share a common origin with the obliterated umbilical artery, internal pudendal, or vaginal artery. In the fetus, the pattern of oxygen delivery through the umbilical artery and vein is reversed from the usual pattern. The umbilical artery carries waste, carbon dioxide, and deoxygenated blood away from the fetus; the umbilical vein delivers oxygenated blood [10].

- The obliterated umbilical arteries (also referred to as the medial umbilical ligaments) can serve as a useful landmark during laparotomy or laparoscopy, since tugging on the obliterated umbilical artery can help identify the uterine artery in cases of distorted pelvic anatomy.

The uterine artery travels through the cardinal ligament and passes over the ureter, which is located approximately 1.5 cm lateral to the cervix. It then joins the uterus near the level of the internal cervical os and gives off branches that run superiorly towards the uterine corpus and inferiorly towards the cervix ( figure 9). The uterine corpus branches anastomose with vessels that derive from the ovarian arteries, thus providing collateral blood flow.

The uterine artery also sends a branch to the cervicovaginal junction at the lateral aspect of the vagina. The vagina also receives its blood supply from this uterine branch, as well as from a vaginal branch of the internal iliac artery, which anastomose along the vagina laterally at the 3 o’clock and 9 o'clock positions.

The ovarian arteries arise from the abdominal aorta. The right ovarian vein returns to the inferior vena cava while the left ovarian vein returns to the left renal vein. The ovarian vessels travel through the infundibulopelvic ligaments in close proximity to the ureter, along the medial aspect of the psoas muscle ( picture 4 and picture 5).

## LYMPHATICS

The lymphatic drainage follows the pelvic vessels, with the nodes located anterior, posterior, or lateral to the vessels. The pelvic lymphatic system is located retroperitoneally, like the pelvic vasculature. The pelvic lymphatics include the common iliac, external iliac, internal iliac, medial sacral, and pararectal lymph nodes ( figure 10 and figure 11).

The medial sacral lymph nodes run along the middle sacral artery in the presacral space, while the pararectal nodes drain the sigmoid colon; these lymph node chains are usually not involved in gynecologic disease.

- For pelvic lymph node dissection, the anatomic boundaries are: the ureter medially; the body of the psoas muscle and genitofemoral nerve laterally; the mid-portion of the common iliac artery (2 cm above the bifurcation) superiorly to the deep circumflex iliac vein inferiorly; and posteriorly, the obturator nerve at the base of the obturator fossa. The nodal tissue from the distal one-half of each common iliac artery should be removed. The nodal tissue from the anterior and medial aspect of the proximal half of the external iliac artery and vein should be excised, as well as nodal tissue from the distal portion of the obturator fat pad.

**Obturator lymph nodes —** The obturator lymph nodes are located in the obturator fossa, medial to the external iliac vessels and lateral to the obliterated umbilical ligament. The obturator nodes can be located by identifying the obturator nerve, which is usually the most easily visualized component of the obturator neurovascular bundle as it enters the obturator canal.

**Internal iliac lymph nodes —** The internal iliac lymph nodes are located along the internal iliac vessels and are most numerous in the lateral pelvic sidewalls. In addition to the lymphatic drainage from the pelvic viscera, these nodes drain the pelvic viscera, the lower urinary tract, and some of the gluteal region drainage.

**External iliac lymph nodes —** The external iliac lymph nodes are located lateral to the external iliac artery and medial to the external iliac vein. They receive their lymphatic flow from the legs via the inguinal nodes.

**Superficial inguinal lymph nodes —** Some of the uterine lymphatic flow also drains to the superficial inguinal lymph nodes along the round ligament, as well as to the lateral sacral nodes along the uterosacral ligaments. Because of the anastomotic connections, metastasis of uterine or cervical malignancies may occur to the superficial inguinal lymph nodes, as well as to the external and iliac nodes, and the lateral sacral nodes [11].

**Paraaortic lymph nodes —** The paraaortic nodes are located in the lumbar region near the bifurcation of the aorta and inferior vena cava. These lymph nodes are found both anterior and posterior to the vessels.

- For paraaortic lymph node dissection, the uppermost boundary is to the origin of the inferior mesenteric artery, with the inferior border the mid-portion of the common iliac artery, and the lateral borders the ureters. The nodal tissue on the inferior vena cava, aorta, and upper common iliac arteries should be removed [12]. For higher grade or higher risk tumor histologies, some surgeons elect to extend the superior border of the dissection up to the renal artery and vein.

**Lymphatic drainage of the pelvic viscera**

**Uterus and proximal vagina** — The lymphatic drainage of the uterus and the upper two-thirds of the vagina flows through the obturator and internal and external iliac lymph nodes, and ultimately drains into the common iliac lymph nodes.

**Ovary** — The lymphatic drainage of the ovaries travels with the ovarian vessels to the paraaortic lymph nodes.

**Distal vagina and vulva** — The distal one-third of the vagina, urethra, and vulvar lymphatic drainage goes to the inguinal nodes, reflecting their distinctly different embryologic origin (sinovaginal bulbs) compared with the upper genital tract (paramesonephric, or müllerian, ducts). (See "Congenital anomalies of the hymen and vagina", section on 'Vagina'.)

## NERVES

**Aortic plexus** — The ovaries and fallopian tubes are innervated by a nerve plexus that originates in the renal plexus with fibers from T10 and parasympathetic fibers from the vagus nerve that run along the ovarian vessels ( figure 12).

**Superior and inferior hypogastric plexi** — The nerve supply to the pelvis runs through the superior hypogastric plexus ( figure 12), a ganglionic plexus that lies over the bifurcation of the aorta in the presacral space. The superior hypogastric plexus receives sympathetic input from the thoracic and lumbar splanchnic nerves and afferent pain input from the pelvic viscera. Parasympathetic input derives from S2 to 4 via the pelvic splanchnic nerves that travel to join the hypogastric plexi through the lateral pelvic wall.

From the superior hypogastric plexus, the nerves split into two hypogastric nerves that run along the internal iliac vessels. These nerves connect to the inferior hypogastric plexus.

The inferior hypogastric plexus is located lateral to the pelvic viscera and consists of three areas: the vesical plexus, uterovaginal plexus, and the middle rectal plexus. The uterovaginal plexus lies on the medial side of the uterine vessels, lateral to the attachment of the uterosacral ligaments to the uterus, and continues cephalad along the uterus and caudally along the vagina. The caudal fibers innervate the vulvar vestibule and clitoris, and travel in the parametrial tissue lateral to the uterine artery and uterosacral and cardinal ligaments, but within the tissue that is taken during a radical hysterectomy. The uterovaginal plexus receives sympathetic input from T10 to L1 and parasympathetic input from S2 to S4.

- The inferior hypogastric plexus may be involved during the dissection of the parametrial tissues during hysterectomy, resulting in short-term postoperative voiding dysfunction and urinary retention. The plexus can also be affected by retroperitoneal hematoma or a low anterior rectal resection and cause voiding dysfunction.

**Lumbosacral plexus** — The lumbar and sacral plexi are formed from the lumbar and sacral nerve roots, lateral to the intervertebral foramina. The lumbar plexus lies within the psoas muscle. The femoral nerve is the major branch of the lumbar plexus, supplying sensory and motor function to the thigh. Its genitofemoral branch (L1 to L2) lies on the surface of the psoas muscle.

- The genitofemoral branch can be damaged from pressure from a retractor blade during laparotomy and lead to anesthesia in the medial thigh and lateral labia.

- The femoral cutaneous nerve (L2 to L3) may be compressed from a retractor placed lateral to the psoas muscle or from hyperflexion of the hip in lithotomy position, leading to numbness or altered sensation in the anterior thigh.

Nerve injury associated with pelvic surgery is discussed in detail separately. (See "Nerve injury associated with pelvic surgery".)

The sacral plexus lies on the piriformis muscle. The major branch of the sacral plexus, the sciatic nerve, exits the pelvis through the inferior portion of the greater sciatic foramen to innervate the muscles of the hip, pelvic diaphragm, perineum and lower leg.

**Nerves of the anterior abdominal wall** — The anatomy of the anterior abdominal wall that is relevant to the incisions used for pelvic surgery is discussed in detail separately. (See "Anatomy of the abdominal wall", section on 'Nerves'.)

## LOWER URINARY TRACT

The lower urinary tract is in close proximity to the uterus, tubes, and ovaries, as well as their vascular supply. Therefore, pelvic surgeons should have a comprehensive knowledge of lower urinary tract anatomy to avoid injury to these structures.

The lower urinary tract includes the urethra, bladder, and distal ureters. The anatomy of these structures is discussed in detail separately. (See "Surgical female urogenital anatomy", section on 'Lower urinary tract'.)

## SIGMOID COLON, RECTUM, AND ANUS

The sigmoid colon descends into the pelvis curving from the left (descending) colon slightly to the left of the midline and sacrum and is intraperitoneal (located within the peritoneal cavity), unlike much of the colon, which is retroperitoneal. Its blood supply derives from the sigmoid arteries, branches of the inferior mesenteric artery.

- The sigmoid colon is attached to a distinct mesentery in its mid-portion, which can be traumatized during packing of the bowel out of the pelvis and cause bleeding.
- There are often physiologic attachments of the sigmoid colon epiploicae to the left pelvic sidewall that may need to be dissected in order to adequately visualize the left infundibulopelvic ligament or left ureter at the time of left salpingo-oophorectomy. During this dissection, care should be taken to avoid injury to the genitofemoral nerve, which runs on the surface of the psoas muscle. (See 'Lumbosacral plexus' above.)

Once the sigmoid colon has descended into the pelvis, its course straightens and it enters the retroperitoneum at the pelvic posterior cul-de-sac and becomes the rectum. It then expands into the rectal ampulla, an area of stool storage, then bends downwards to almost a 90-degree angle to become the anus. The rectum and anus rest on the sacrum and levator ani muscles and the vagina lies anterior to the rectum.

The blood supply to the rectum and anus consists of an anastomotic arcade of vessels from the superior rectal (hemorrhoidal) branch of the inferior mesenteric artery, and the middle and inferior rectal (hemorrhoidal) branches of the internal pudendal artery.

Anal continence is maintained by a series of anal valves. The anus is surrounded by the internal anal sphincter and external anal sphincter. The internal anal sphincter consists of a thicker layer of the circular involuntary smooth muscle fibers, which provides 80 percent of the resting tone of the sphincter, while the external anal sphincter consists of skeletal muscle fibers and is attached to the coccyx.

## AVASCULAR PLANES

The pelvis contains several potential spaces and connective tissue planes that allow the urinary, reproductive, and gastrointestinal systems to function independently of each other. They lack blood vessels and nerves and are filled with loose areolar tissue, allowing blunt dissection without disruption of these structures. Within these spaces, connective tissue septa form compartments that limit the spread of infection or hematomas.

Knowledge of these spaces is fundamental for most major pelvic surgery. Familiarity with these avascular spaces, as well as their relationships to each other, helps to avoid injury to the viscera and vasculature, restore normal anatomic relationships in the case of distorted anatomy, perform pelvic reconstruction, and resect pelvic pathology (eg, endometriosis, cancer).

The avascular spaces of the female pelvis include the vesicovaginal, paravesical, pararectal, rectovaginal, and presacral spaces ( figure 13). There are also potential spaces within the pelvis: the anterior and posterior cul-de-sacs, and the retropubic space (space of Retzius).

**Anterior and posterior cul-de-sacs** — The anterior and posterior pelvic cul-de-sacs separate the uterus from the bladder and rectum, respectively. The anterior cul-de-sac is also known as the vesicouterine pouch ( figure 1), and is the space between the dome of the bladder and the anterior surface of the uterus. The peritoneum overlying the dome of the bladder is loose and allows the bladder to expand. This loose peritoneal fold is called the vesicouterine fold.

- During abdominal hysterectomy, the vesicouterine fold is dissected to create the bladder flap, access the vesicovaginal space, and dissect the bladder off the lower uterine segment and anterior cervix.

The posterior cul-de-sac (also referred to as the rectouterine pouch or pouch of Douglas) is the space between the uterus and rectum. Its borders are the vagina anteriorly, the rectosigmoid colon posteriorly, and the uterosacral ligaments laterally.

**Vesicovaginal space** — The vesicovaginal space is located in the midline. Its boundaries are the bladder anteriorly, the bladder pillars laterally, and the vaginal adventitia posteriorly. The bladder pillars are composed of connective tissue and blood vessels, specifically the veins from the vesical plexus and the ureter, some cervical branches of the uterine artery anteriorly into the sides of the bladder base, and some extensions of the stronger connective tissue portions of the cardinal ligament.

- During abdominal hysterectomy, to dissect the bladder off the lower uterine segment and anterior cervix, sharp dissection in the midline between the bladder pillars will reveal a loose areolar avascular layer when in the proper plane. Veering laterally can result in bleeding from the bladder pillars and obscure visualization during this dissection.

**Retropubic space** — The retropubic space, also called the space of Retzius, is a potential space between the bladder and the pubic bone. It is bounded by the pubic bone, the peritoneum and muscles of the anterior abdominal wall. Its lateral borders are the arcus tendineus fascia pelvis and the ischial spines.

Within the retropubic space lie the dorsal clitoral neurovascular bundle, located in the midline, and the obturator neurovascular bundle, located laterally as it enters the obturator canal. In some women, an accessory obturator artery arises from the external iliac artery and runs along the pubic bone. The space lateral to the bladder neck and urethra contains nerves innervating the bladder and urethra, as well as a venous plexus (venous plexus of Santorini) that can ooze with the placement of sutures (ie, while performing a Burch retropubic colposuspension).

- The sutures for a Burch procedure are anchored into the iliopectineal line, or Cooper's ligament, which runs along the superior border of the ischiopubic rami bilaterally.

**Paravesical space —** The paravesical spaces are paired spaces that lie anterior to the cardinal ligaments. Their boundaries are the bladder pillars medially, the obturator internus and levator ani muscles and the pelvic sidewalls laterally, and the medial umbilical ligaments superiorly. This space is located within the space of Retzius, or the retropubic space.

During laparotomy, entry into this space entails dissection close to the pubic bone, avoiding the midline dorsal clitoral neurovascular bundle. During a laparoscopic procedure, retrograde filling the bladder and noting the location of the median and medial umbilical ligaments can aid in identifying the borders of the bladder. The median umbilical ligament can then be grasped with downward traction and transected with monopolar cautery in order to enter the retropubic space.

- The paravesical space is most commonly accessed during Burch retropubic colposuspension or a paravaginal defect repair. However, endometriosis can also infiltrate the paravesical space and may need to be excised.

- The paravesical space is also accessed at the time of radical hysterectomy. For cervical cancer, the majority of cervical lymphatic drainage to the pelvic lymph nodes travels through the parametria and adequate central dissection of the parametria with tumor-free margins is essential. Once the round ligament is transected, the surgeon develops the anterior leaf of the broad ligament inferiorly, then turning medially in order to create the bladder flap. The paravesical space can then be developed lateral to the medial umbilical ligament until the levator ani muscle is reached. The anterior cardinal ligament can also be assessed at this point for gross tumor invasion into the parametria. (See "Radical hysterectomy".)

**Pararectal space —** The pararectal spaces are located on either side of the cardinal ligaments. The borders of the pararectal space are defined anteriorly by the cardinal ligament, medially by the rectum, posteriorly by the sacrum, and laterally by the internal iliac artery or pelvic sidewall.

- During laparotomy or laparoscopy, the most likely scenario necessitating access to this space is an obliterated posterior cul-de-sac from endometriosis, where the rectum is adhered to the posterior cervix. In that case, the surgeon must first perform a bilateral ureterolysis of the pelvic ureter and dissect the pararectal space in order to safely dissect the rectovaginal space and the rectum off the posterior cervix and vagina. (See

"Endometriosis: Treatment of rectovaginal and bowel disease", section on 'Surgical treatment'.)

- The pararectal space is also developed at the time of radical hysterectomy. It is accessed by opening the posterior leaf of the broad ligament cephalad posterolateral to the infundibulopelvic ligament. Retraction of the uterus medially helps expose the pararectal space. The ureter must be identified and the space between the ureter and internal iliac artery developed with careful blunt dissection in order to avoid the small veins in this area. (See "Radical hysterectomy".)

- During sacrospinous ligament suspension, the pararectal space is accessed to identify the sacrospinous ligament. The posterior vaginal epithelium is dissected off the underlying rectum then the pararectal space is entered lateral to the rectum using blunt dissection until the ischial spine is palpated. (See "Pelvic organ prolapse in women: Surgical repair of apical prolapse (uterine or vaginal vault prolapse)", section on 'Sacrospinous ligament suspension'.)

**Rectovaginal space** — The rectovaginal space starts caudally at the superior margin of the perineal body (2 to 3 cm above the hymenal ring) and extends superiorly between the posterior vagina and the rectum through the posterior cul-de-sac. Its most cephalad border is the posterior cul-de-sac just inferior to the cervix. It contains loose areolar tissue that can bluntly be dissected. Its lateral boundaries are the rectal pillars, which are fibers from the cardinal-uterosacral ligament complex that connect to the lateral rectum then to the sacrum. They divide the rectovaginal space from the pararectal spaces.

- Occasionally the surgeon may need to enter the rectovaginal space during a hysterectomy when the patient has altered anatomy due to an obliterated cul-de-sac from endometriosis or due to the presence of a posterior lower uterine segment, broad ligament, or cervical fibroid [13].

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## SUMMARY

- **General** – Pelvic surgery in women requires a comprehensive knowledge of the pelvic anatomy to safely attain access, maximize exposure, ensure hemostasis, and avoid injury to viscera, blood vessels, and nerves. (See 'Introduction' above.)

- **Uterus –** The uterus includes the uterine corpus and uterine cervix ( figure 2). In reproductive age women, the corpus is much larger than the cervix while, during the prepubertal and postmenopausal stages, they are of similar sizes. However, the size of the uterus can vary considerably, depending upon hormonal levels, previous parturition, or the presence of uterine pathology (eg, fibroids, adenomyosis). (See 'Uterus' above.)

- **Uterus support –** Support of the uterus is provided by the uterosacral/cardinal ligament complex, round ligament, and broad ligament. Loss of this support contributes to prolapse of the uterus and/or vaginal apex. (See 'Uterine support structures' above.)

- **Uterine vasculature –** The uterine arteries originate from the anterior division of the internal iliac arteries in the retroperitoneum and travel through the cardinal ligament and pass over the ureter. They then join the uterus near the level of the internal cervical os and give off branches that run superiorly towards the uterine corpus and inferiorly towards the cervix ( figure 9). The uterine corpus branches anastomose with vessels that derive from the ovarian arteries, thus providing collateral blood flow. (See 'Blood supply to the uterus, tubes, and ovaries' above.)

- **Ovarian vasculature –** The ovarian arteries arise from the abdominal aorta. The right ovarian vein returns to the inferior vena cava while the left ovarian vein returns to the left renal vein. The ovarian vessels travel through the infundibulopelvic ligaments in close proximity to the ureter, along the medial aspect of the psoas muscle. (See 'Blood supply to the uterus, tubes, and ovaries' above.)

- **Lymphatic drainage –** The lymphatic drainage follows the pelvic vessels, with the nodes located anterior, posterior, or lateral to the vessels. The pelvic lymphatic system is located retroperitoneally, like the pelvic vasculature. The pelvic lymphatics include the common iliac, external iliac, internal iliac, medial sacral, and pararectal lymph nodes ( figure 10 and figure 11). (See 'Lymphatics' above.)

- **Innervation –** The ovaries and fallopian tubes are innervated by a nerve plexus that originates in the renal plexus with fibers from T10 and parasympathetic fibers from the vagus nerve that run along the ovarian vessels ( figure 12). The nerve supply to the pelvis runs through the superior hypogastric plexus ( figure 12), a ganglionic plexus that lies over the bifurcation of the aorta in the presacral space. (See 'Nerves' above.)

- **Avascular planes –** The pelvis contains several potential spaces and connective tissue planes that allow the urinary, reproductive, and gastrointestinal systems to function independently of each other ( figure 13). They lack blood vessels and nerves and are filled with loose areolar tissue, allowing blunt dissection without disruption of these structures. (See 'Avascular planes' above.)



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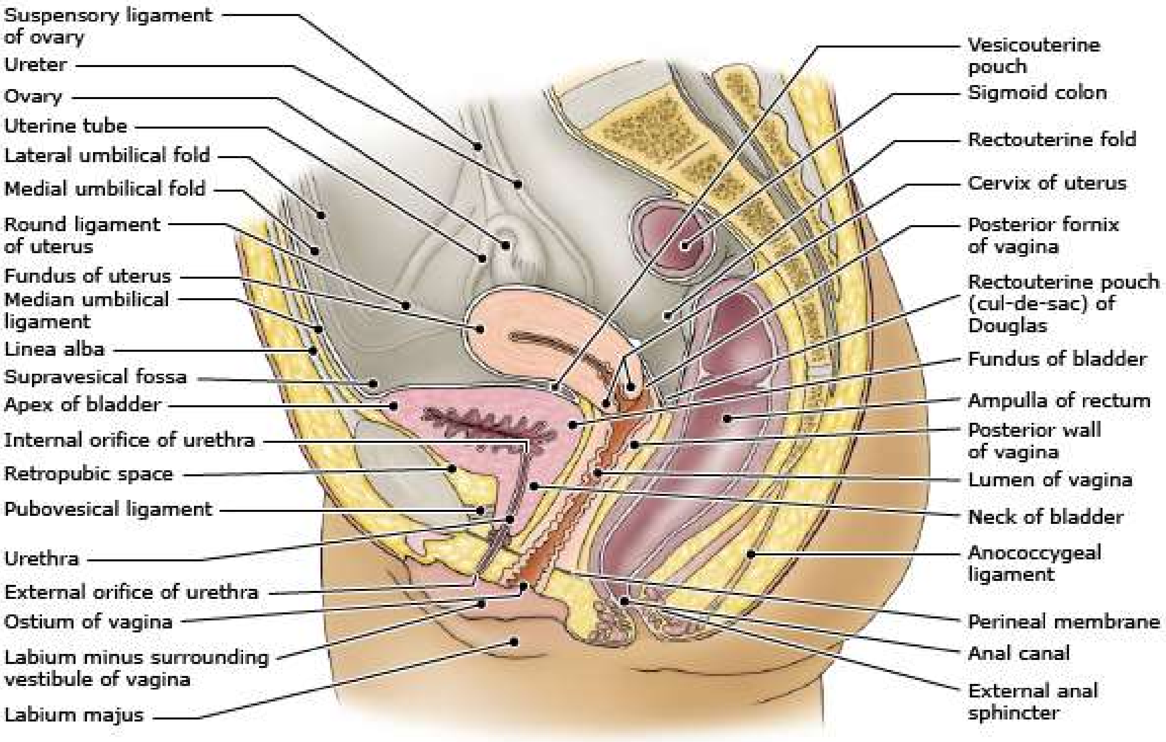
Topic 14185 Version 21.0

GRAPHICS

## Sagittal view of female pelvis




Sagittal view of the female pelvis. The peritoneal sac drapes over the ovary, reproductive organs, and rectum. The thick body of the uterus transitions to the vagina through a cervix. An archway, or fornix, at the upper end of the vaginal canal surrounds the cervix and brushes into contact with the peritoneum posteriorly.

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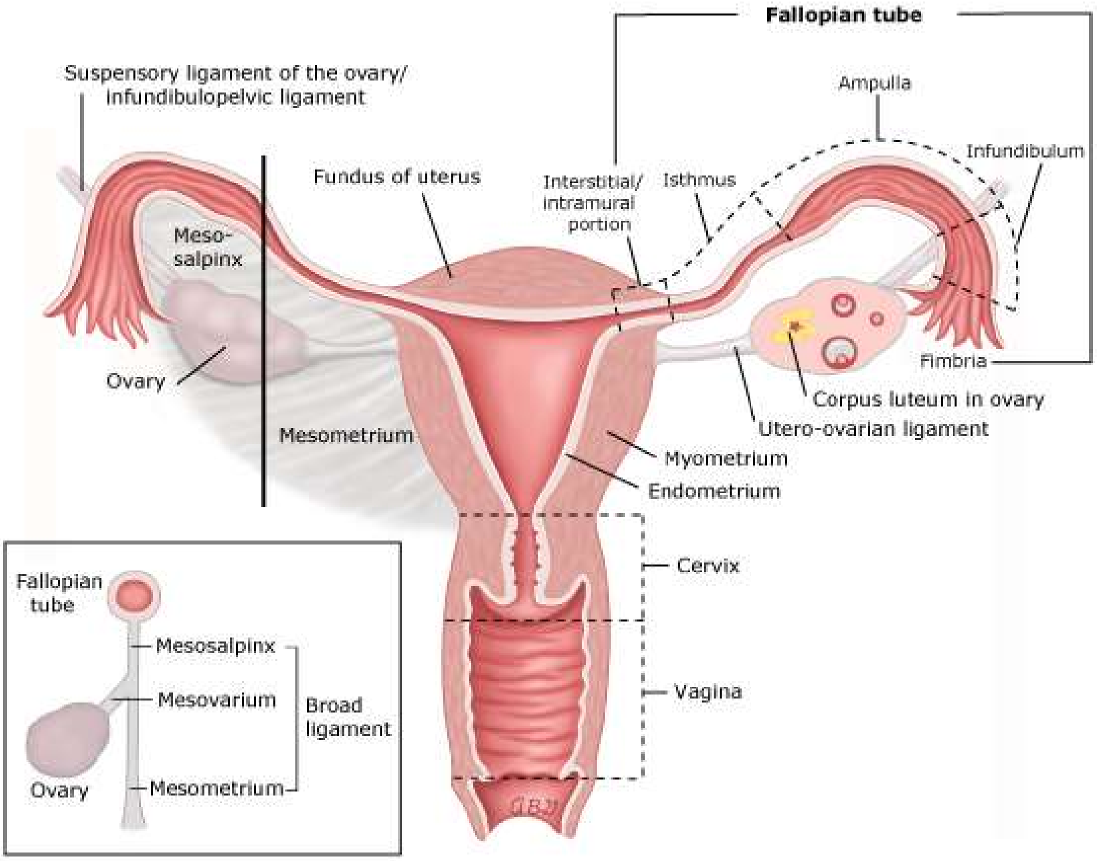
Graphic 82998 Version 1.0

# Normal female reproductive anatomy

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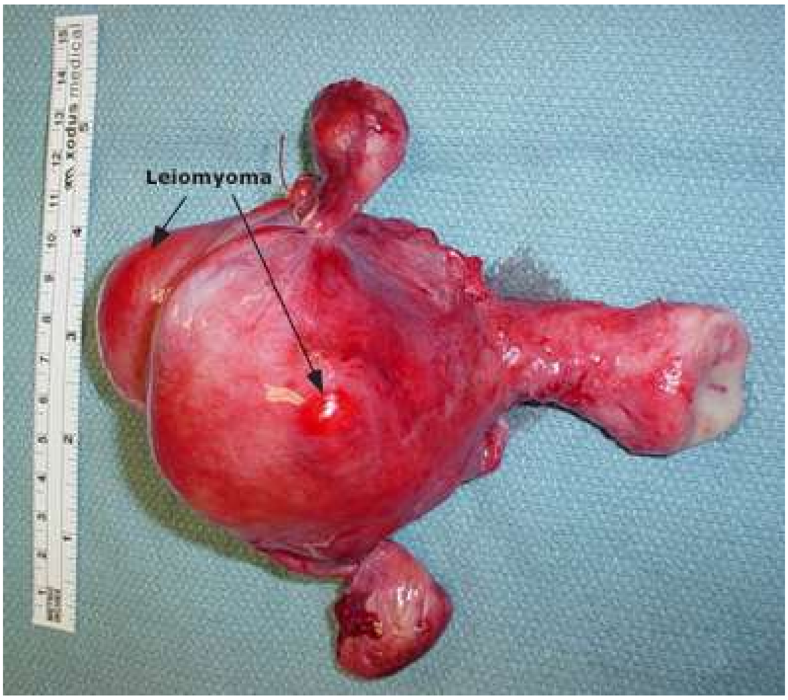
# Hysterectomy specimen showing multiple leiomyomas

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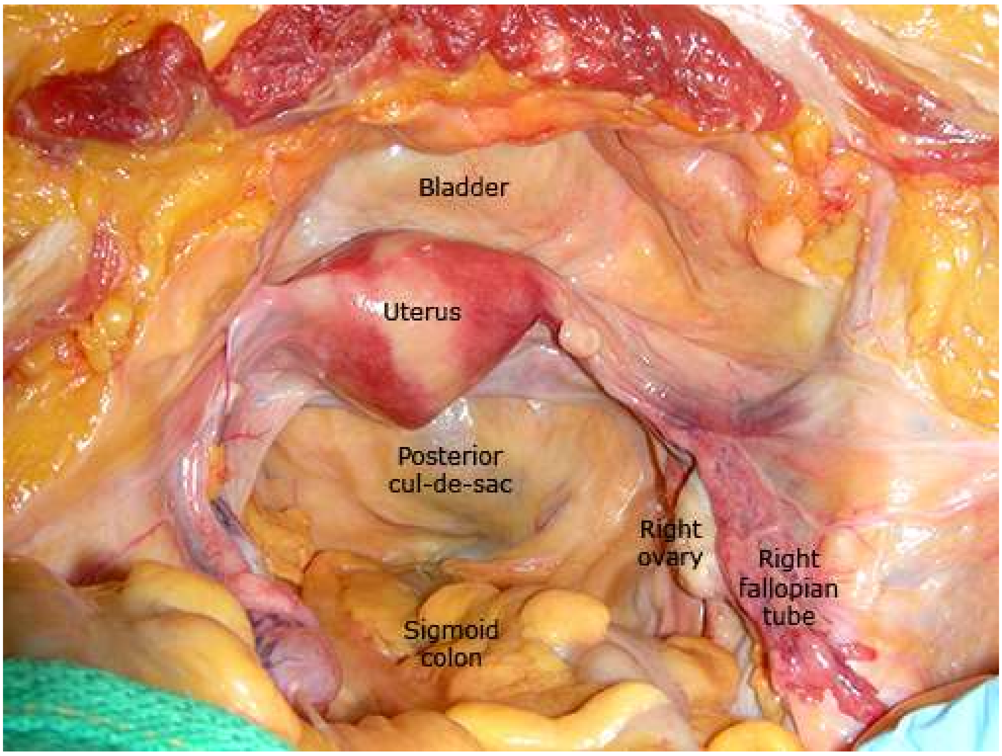
Graphic 80897 Version 1.0

## Superior view of the female pelvis




View of female pelvis during laparotomy. Pelvic posterior cul-de-sac (pouch of Douglas) is well visualized.

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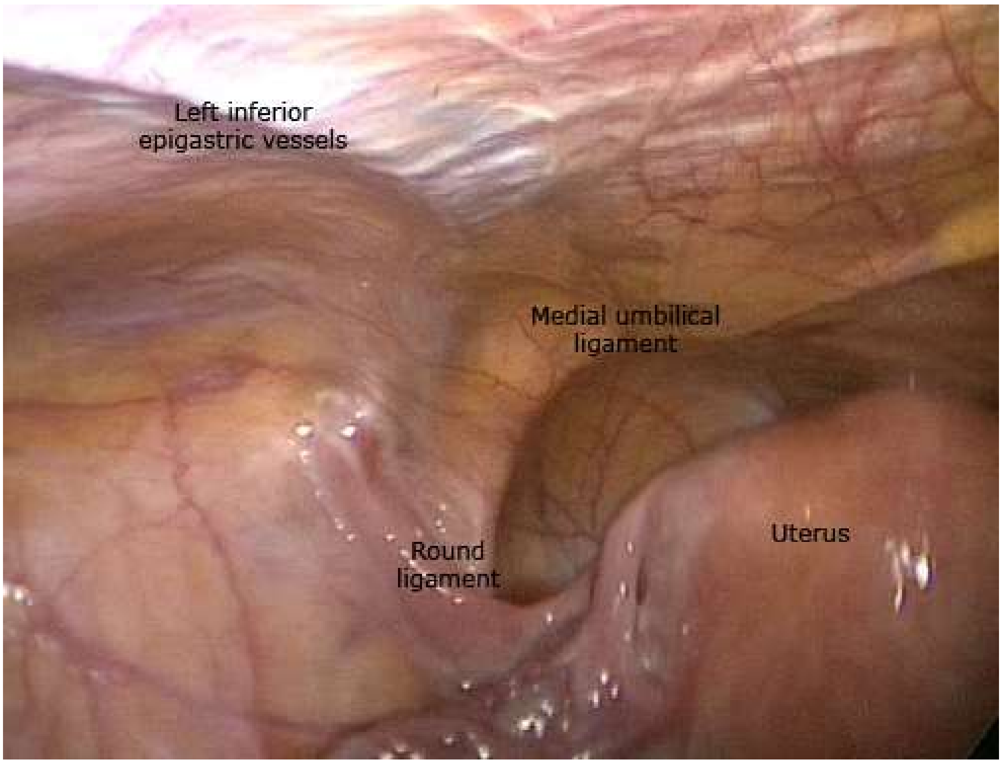
Graphic 82997 Version 2.0

# Laparoscopic view of inferior epigastric vessels and round ligament




Laparoscopic view of the inferior epigastric vessels, located lateral to the medial umbilical ligaments (obliterated umbilical ligaments), and the round ligament entering the inguinal canal. It is important during placement of the lower abdominal trocars during laparoscopy to avoid the inferior epigastric vessels.

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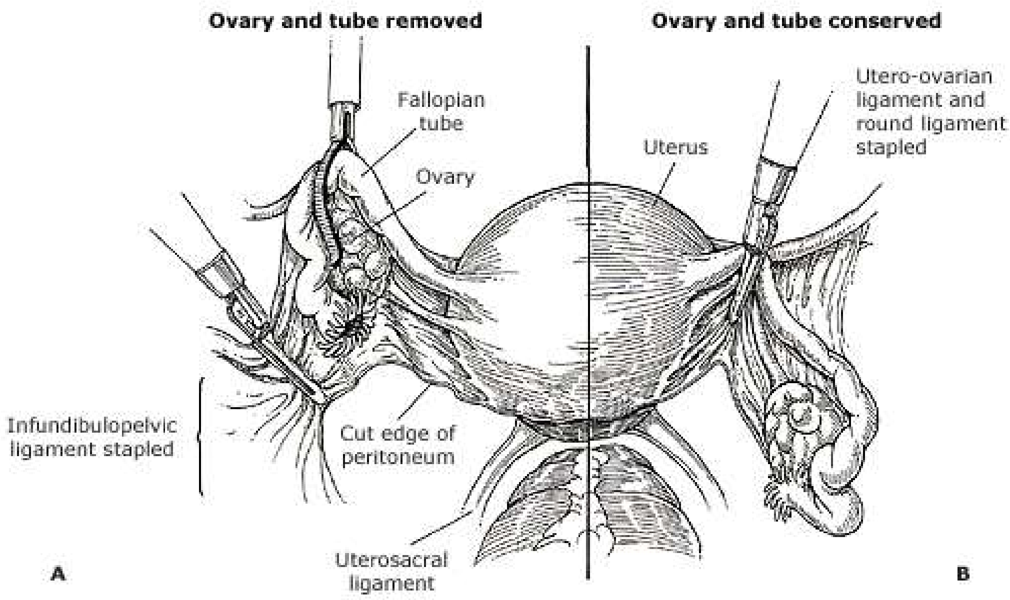
Graphic 83000 Version 2.0

# Removal or conservation of adnexa at hysterectomy




(A and B) Placement of stapling device for ligation of utero-ovarian or infudibulopelvic ligaments.

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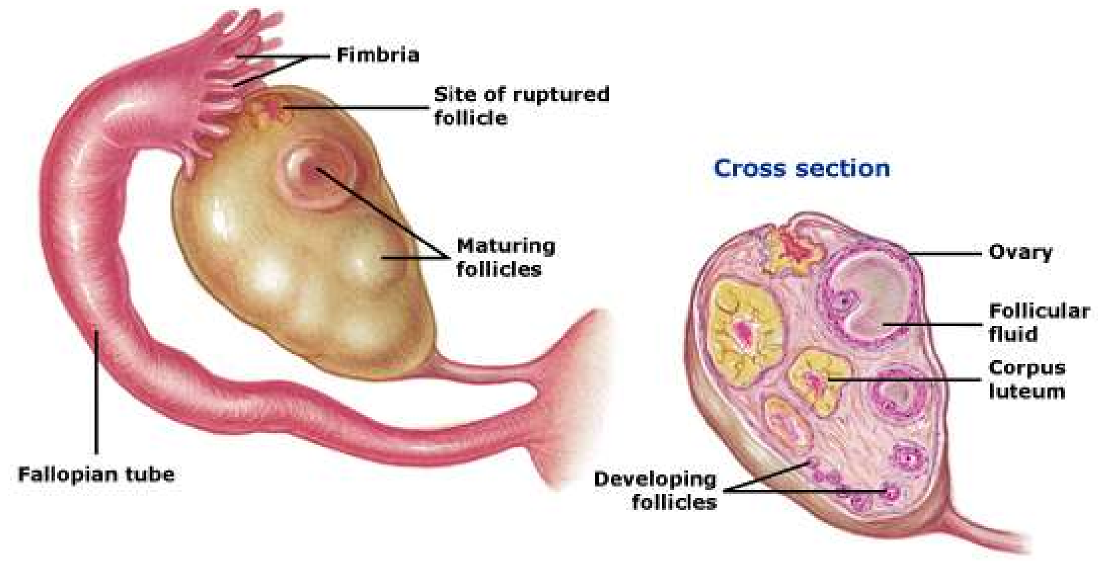
Graphic 63463 Version 1.0

## Ovarian anatomy




This figure shows the ovary, fallopian tube, and follicles (cysts).

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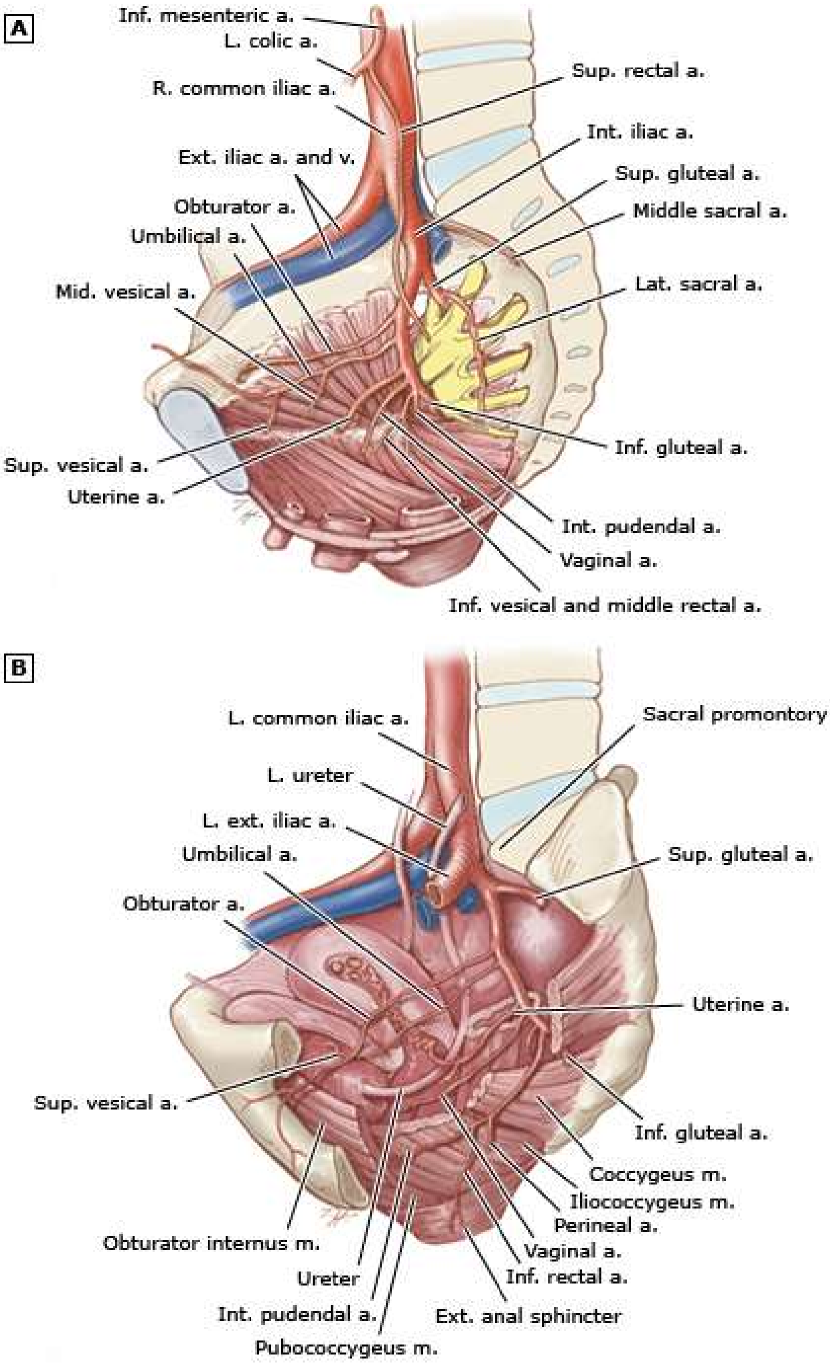
Graphic 77045 Version 6.0

# Female pelvic blood supply




The blood supply to the pelvis.

(A) The sagittal view of the pelvis without the viscera.

(B) The blood supply to one pelvic viscera.

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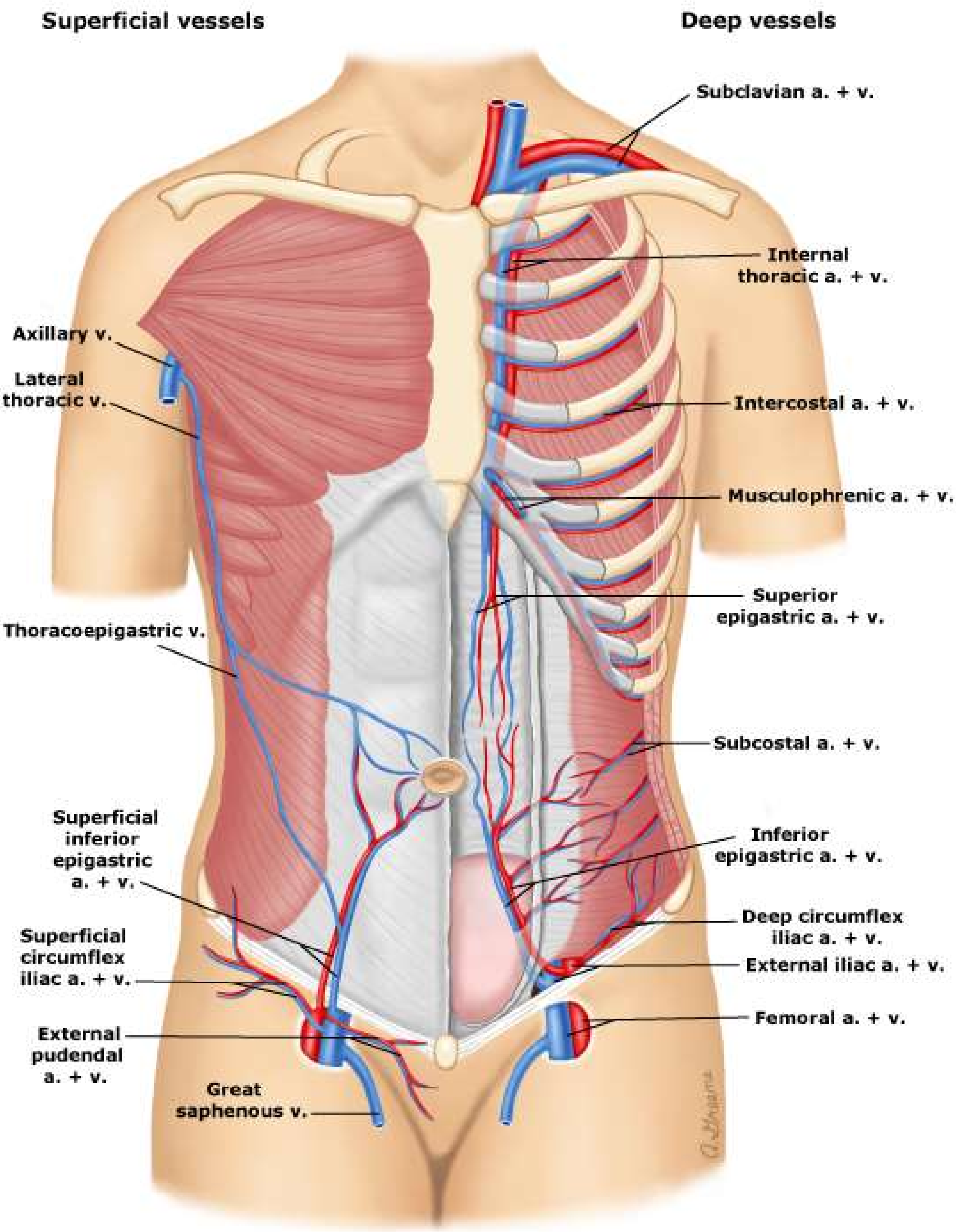
Graphic 83008 Version 1.0

## Blood vessels of the anterior abdominal wall




The superior and inferior epigastric arteries provide a rich arcade arising from the internal thoracic artery superiorly and the external iliac artery inferiorly. The musculophrenic artery, deep circumflex iliac artery, and subcostal arteries supply the lateral abdominal wall. The superficial epigastric veins and the superficial iliac veins can arise from the great saphenous vein.

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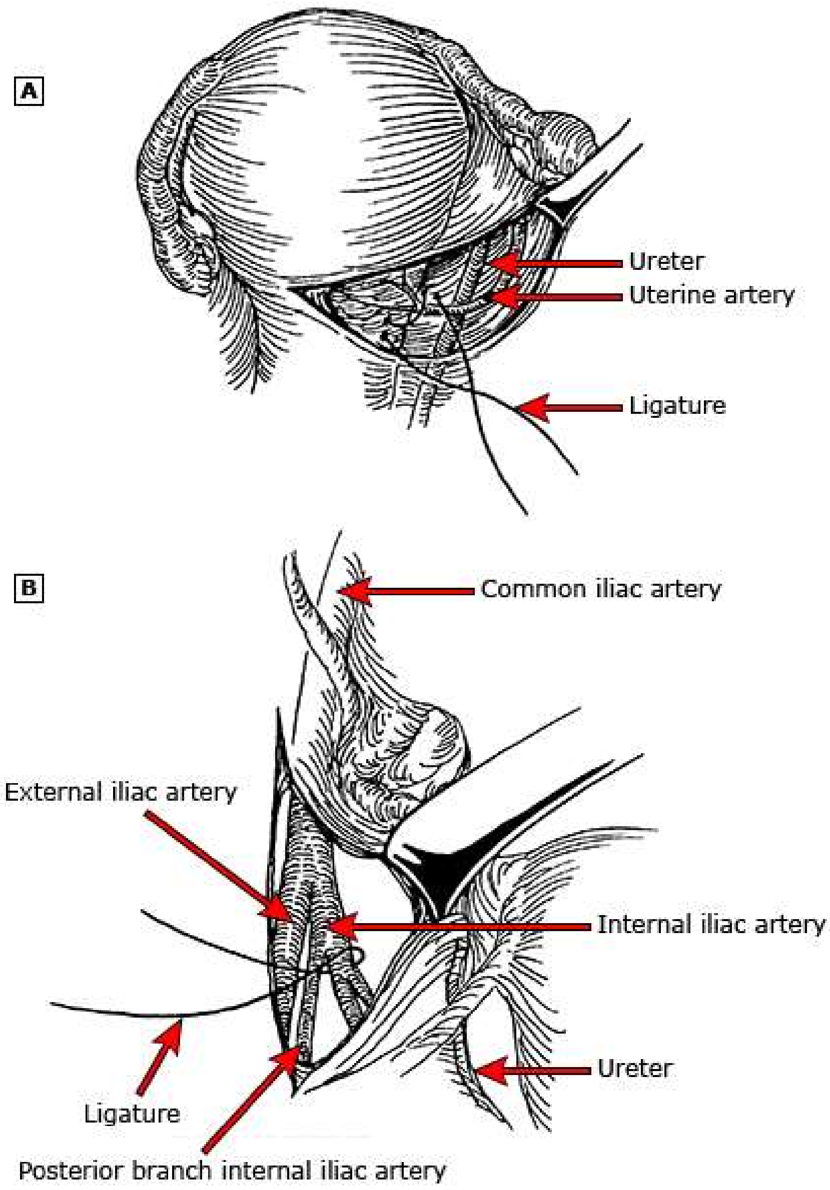
Graphic 81343 Version 6.0

## Uterine and hypogastric artery ligation




Surgical treatment of atonic uterine hemorrhage.

(A) Ligation of the uterine artery. The artery crosses over the ureter and is ligated beyond this point at the uterine corpus.

(B) Hypogastric artery ligation. Ligation of the anterior division of the internal iliac artery is performed after careful identification and retraction of the ureter, which usually overlies the bifurcation of the iliac artery into the external and internal iliac branches.

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*Reproduced with permission from: Beckmann CRB, Ling FW, Laube DW, et al. Obstetrics and Gynecology, 4th ed, Lippincott Williams & Wilkins, Baltimore 2002.* 

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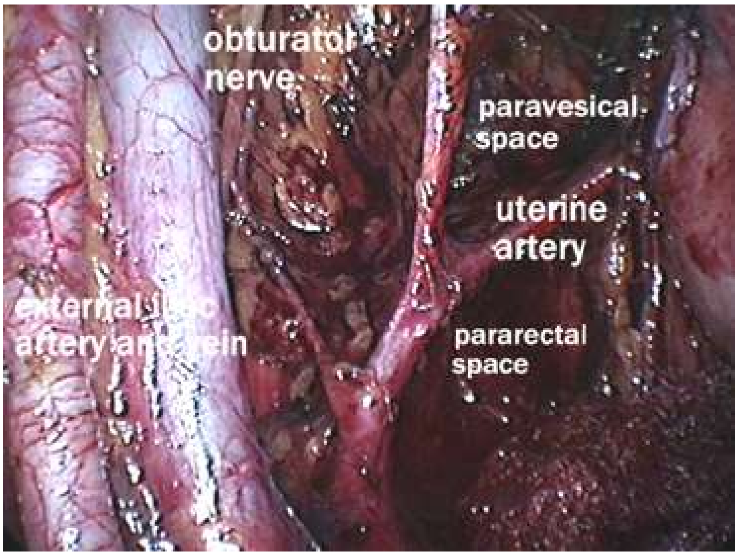
## Anatomy of left pelvic vessels




*Courtesy of Ken Hatch, MD.*

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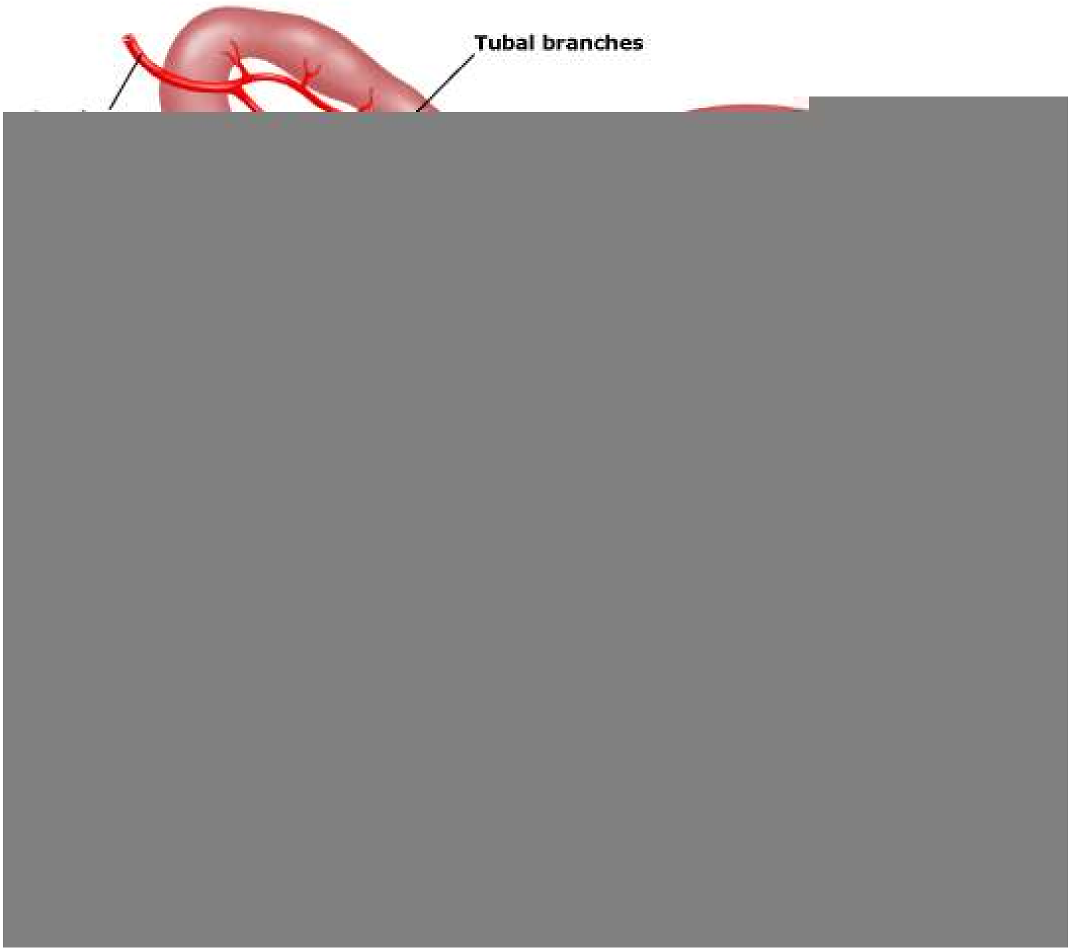
Graphic 58377 Version 1.0

# Uterine blood supply

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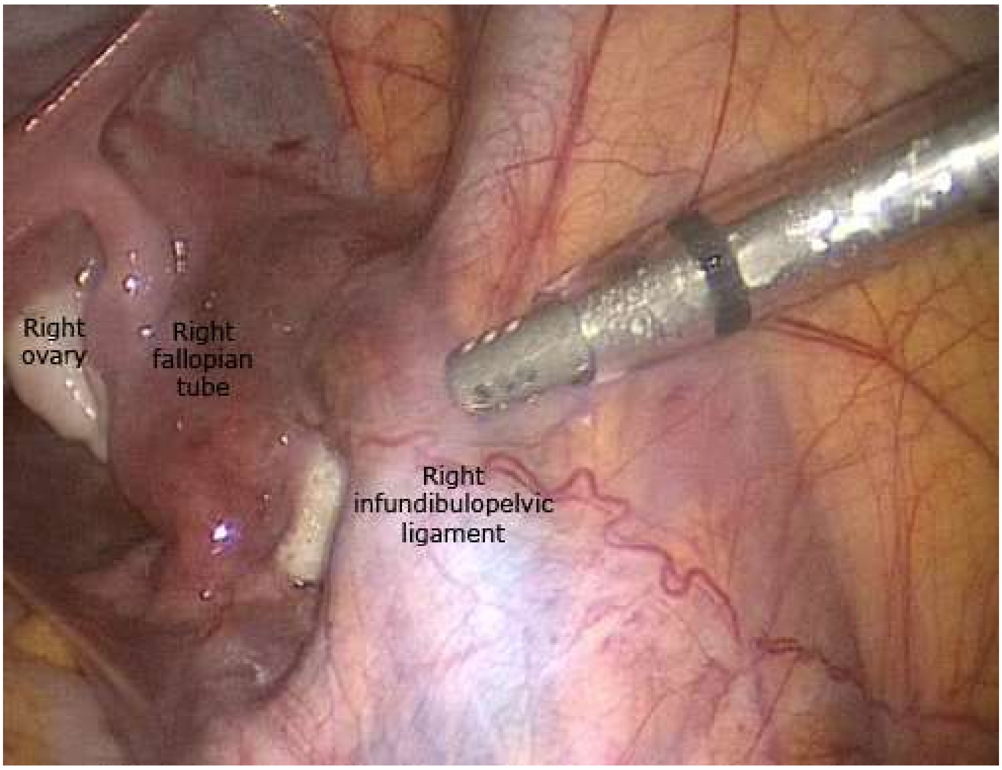
## Ovarian vessels at pelvic brim




Laparoscopic view of the ovarian vessels at the pelvic brim. The ovarian vessels supply the right ovary and tube, crossing over the pelvic brim and the bifurcation of the external and internal iliac vessels.

Graphic 83002 Version 1.0

# Ureter at female pelvic brim

The ureters are most easily identified at the pelvic brim, where they cross the bifurcation of the common iliac into the external and internal iliac vessels.

Graphic 83005 Version 1.0

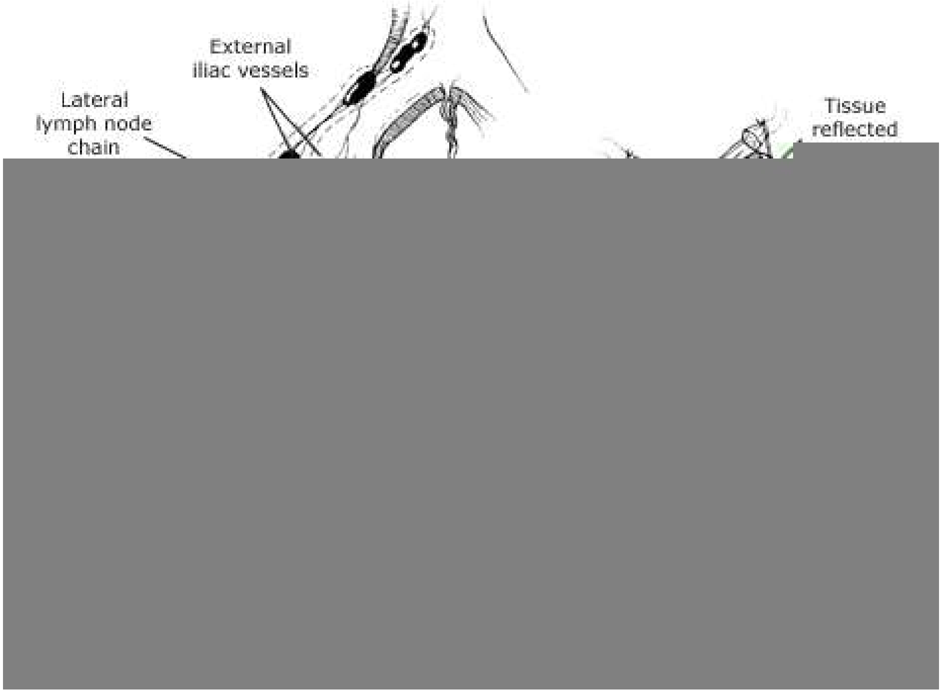
# Female pelvic lymph vessels and nodes


Lymphatic vessels and nodes. Posterior wall of abdomen and inguinal region.



Graphic 83003 Version 1.0

# Female pelvic lymphadenectomy




Lymph node dissection is begun by sharply and bluntly mobilizing the tissue lateral to the external iliac artery and vein and moving this tissue until the external iliac artery can be identified. The dissection should be kept close to the artery to facilitate the resection. Using Metzenbaum scissors and forceps, the lymphatic tissue is then sharply dissected off the surface of the external and common iliac arteries and reflected medially. With lateral traction at this time, the external iliac vein and obturator fossa can be identified.

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*Courtesy of William J Mann, Jr, MD.*

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Graphic 75242 Version 4.0

## Nerve plexus of the pelvis

Autonomic nerves are demonstrated. The superior hypogastric plexus is a continuation of the aortic (intermesenteric) plexus. It divides into left and right hypogastric nerves as it enters the pelvis. The hypogastric and pelvic splanchnic nerves merge to form the inferior hypogastric plexuses, which thus consist of both sympathetic and parasympathetic fibers. Autonomic (sympathetic) fibers also enter the pelvis via the sympathetic trunks and periarterial plexuses.

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Graphic 56679 Version 11.0

## Avascular spaces of the female pelvis

Schematic sectional drawing of the pelvis shows the firm connective tissue covering. The bladder, cervix, and rectum are surrounded by a connective tissue covering. The Mackenrodt ligament extends from the lateral cervix to the lateral abdominal pelvic wall. The vesicouterine ligament originating from the anterior edge of the Mackenrodt ligament leads to the covering of the bladder on the posterior side. The sagittal rectum column spreads both to the connective tissue of the rectum and the sacral vertebrae closely nestled against the back of the Mackenrodt ligament and lateral pelvic wall. Between the firm connective tissue bundles is loose connective tissue (paraspaces).

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*Von Peham H, Amreich JA. Gynaekologische Operationslehre. S Karger, Berlin, Germany 1930.*

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Graphic 83011 Version 2.0

## Contributor Disclosures

**Matthew D Barber, MD, MHS** Other Financial Interest: Elsevier book royalties [Hysterectomy, Walters & Karram Urogynecology and Reconstructive Pelvic Surgery]. All of the relevant financial relationships listed have been mitigated. **Amy J Park, MD** No relevant financial relationship(s) with ineligible companies to disclose. **Howard T Sharp, MD** No relevant financial relationship(s) with ineligible companies to disclose. **Kristen Eckler, MD, FACOG** No relevant financial relationship(s) with ineligible companies to disclose.

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