

Surgical Anatomy of Anterior Abdominal Wall and Pelvis

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INTRODUCTION

Understanding the anatomy of abdomen and pelvis is very essential for a gynaecological surgeon. A thorough knowledge of anatomy will help avoid complications, improve surgical outcomes, and thus provide a safe and effective management.

ANTERIOR ABDOMINAL WALL

Anterior abdominal wall is bounded above by the xiphoid process of the sternum and the costal margins; below by the upper border of pubic symphysis, pubic crest, pubic tubercle, inguinal ligament and iliac crest and laterally by midaxillary line. The layers of anterior abdominal wall include the skin, subcutaneous tissue, muscles and their aponeurosis, fascia transversalis, extraperitoneal fat and parietal peritoneum. Knowledge of the abdominal wall is essential for the safe access in laparoscopic surgery.

Layers of Anterior Abdominal Wall

Skin and Subcutaneous Tissue

In the anterior abdominal wall, the dermal fibres are primarily oriented in a transverse direction. In the lower part it has a gentle curvature with concave upward. These are connected to the distribution of collagen and elastic fibers in the skin and are referred to as Langer's lines (Fig. 6.1). The incisions which are parallel to the Langer's line, i.e. transverse incisions have less tension and heal with a narrow and more cosmetic scar while the vertical incisions across Langer's lines heal with a wider scar.

At the umbilicus, the skin is securely affixed to underlying tissue. The skin of the rest of the abdomen is loosely attached to its underlying

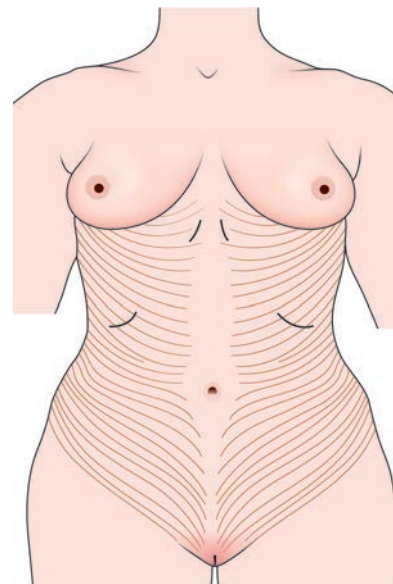


Fig. 6.1: Langer's line

structures. It is for this reason that the primary port is usually made at the level of umbilicus. The subcutaneous tissue is mainly made of fat globules which are supported by branching fibrous septa. It is separated into Camper's fascia (superficial fatty layer) and Scarpa's fascia (deep membranous layer). Clinically Scarpa's fascia is identified in the lateral portion of low transverse incisions and is rarely identified during midline vertical incision.

Musculoaponeurotic Layer

The anterior abdominal wall is comprised of the internal and external oblique muscles, transversus abdominis and two strap like muscles: The rectus abdominis, and pyramidalis. The aponeurosis of the transversus abdominis, internal oblique, and external oblique muscles form the rectus sheath. The external oblique and internal oblique aponeurosis form the anterior layer of rectus sheath and the internal oblique and transversus abdominis aponeurosis forms the posterior layer. Below the arcuate line, at about the level of anterior superior iliac spine, the aponeurosis of muscles passes only anterior to the rectus muscle (Fig. 6.2). Therefore, the rectus muscle is in direct touch with the transversalis fascia inferior to the arcuate line and lacks a posterior fascial sheath.

Transversalis Fascia

A thin layer of connective tissue between the deep surface of transversus abdominis and extraperitoneal fat, is known as the transversalis fascia. During extraperitoneal entry into the retropubic space, it is the last layer to be penetrated.

Parietal Peritoneum

The inside of the abdominal and pelvic cavity is lined by a thin serous membrane known as the parietal peritoneum. Below the umbilicus, peritoneum presents fivefolds. All folds converge towards umbilicus and are known as umbilical ligaments.

1. Median umbilical fold contains the median umbilical ligament, which is a remnant of fetal urachus and runs from umbilicus to bladder (Fig. 6.3).

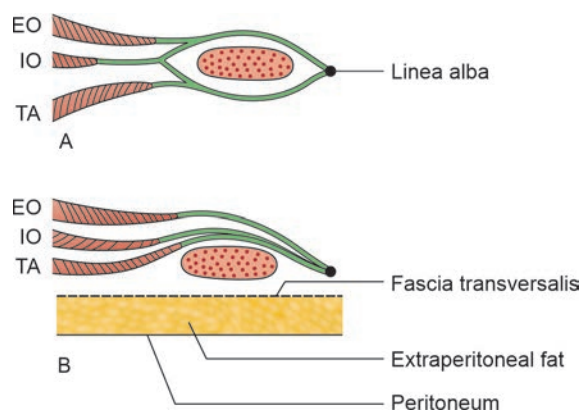


Fig. 6.2: Rectus sheath above the arcuate line (A) and below the arcuate line (B)

2. Pair of medial umbilical fold/ligament containing the obliterated umbilical artery (Fig. 6.3).
3. Pair of lateral umbilical fold/ligament containing peritoneal fold covering the inferior epigastric vessels (Fig. 6.4).

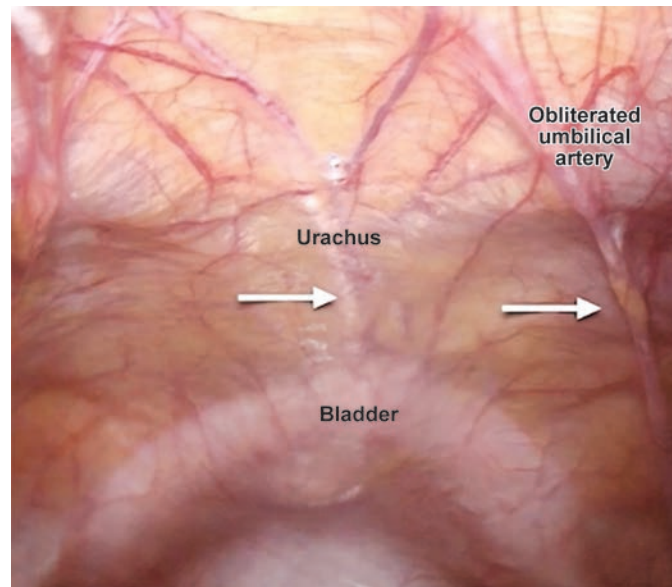


Fig. 6.3: Median and medial umbilical ligament

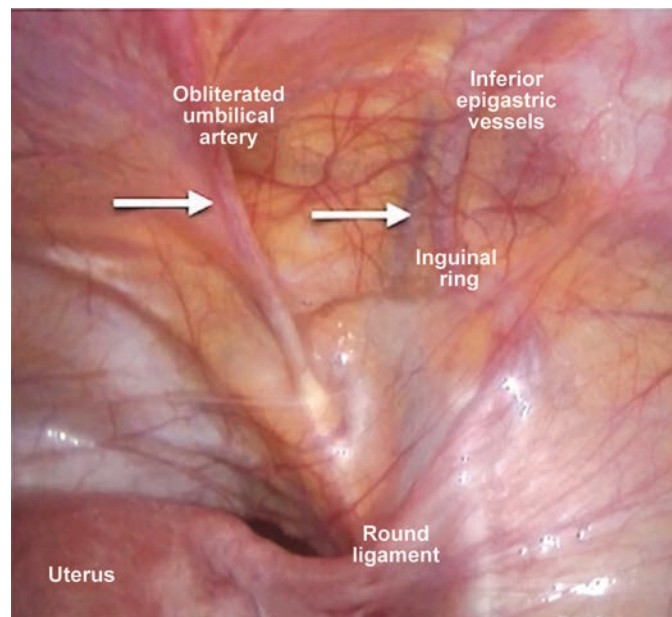


Fig. 6.4: Medial and lateral umbilical ligament. Inferior epigastric vessels lie just medial to the attachment of the round ligament into the deep inguinal ring

The peritoneum has six fossae, or depressions, in and surrounding these folds. Two of them (supravesical fossae) are located between the median and medial umbilical ligaments; two (medial inguinal fossae) are located between the medial and lateral umbilical ligaments; and two (lateral inguinal fossae) are located outside the lateral umbilical ligament, covering the region of the deep inguinal ring.

Vessels of Anterior Abdominal Wall

The abdominal wall is supplied by the superficial and the deep arteries. They include:

1. Superior epigastric artery: It is a branch of internal thoracic artery
2. Inferior epigastric artery: It is a branch of external iliac artery
3. Deep circumflex iliac artery: A branch of external iliac artery
4. Superficial epigastric artery: A branch of femoral artery
5. Superficial circumflex iliac artery: A branch of femoral artery

From the medial aspect of the external iliac artery just proximal to the inguinal ligament and lateral to the rectus muscle, arises the inferior epigastric artery. It curves forward in the anterior extraperitoneal tissue and ascends obliquely along the medial margin of the deep inguinal ring. After piercing the transversalis fascia, it enters the rectus sheath by passing anterior to the arcuate line. Here it is visible through the parietal peritoneum of anterior abdominal wall and forms the lateral umbilical fold and runs forward towards the umbilicus and finally anastomoses with the superior epigastric artery (Fig. 6.5).

Superficial epigastric artery is a branch of the femoral artery and runs diagonally towards the umbilicus. It is seen between the skin and the musculofascial layer.

The superficial circumflex iliac vessels run laterally from the femoral vessels towards the flank. Placing the lateral laparoscopic trocars may at times injure the superficial and inferior epigastric vessels. So, one has to be very careful while inserting the trocars. The superficial epigastric and inferior epigastric vessels run similar courses towards umbilicus (Fig. 6.5). The vessels are roughly 5.5 cm from the midline just above the pubic symphysis and 4.5 cm from the midline at the level of the umbilicus. Therefore, ports can be placed either medial or lateral to the line connecting these points. Transillumination in thin patients allows identification of the superficial epigastric vessels. When performing a laparoscopic procedure, the inferior epigastric arteries are frequently directly visible through the peritoneal layer. The inferior epigastric vessels lie just medial to the point of entry of the round ligament into the deep inguinal ring (Fig. 6.6). Disruption of the artery at this site may result in large hematoma. Retraction of the vessels under the transversalis fascia makes achieving hemostasis difficult.

Nerve Supply

The sensory innervation of the anterior abdominal wall is from the intercostal nerves, subcostal nerve, iliohypogastric nerves and ilioinguinal nerves.

The lower abdominal wall is supplied by the ilioinguinal nerve and a branch of it through the inguinal canal supplies the upper portion of the labia majora and medial portion of the thigh.

Iliohypogastric nerve passes medial to the anterior superior iliac spine in the abdominal wall. It innervates the skin of the suprapubic area.

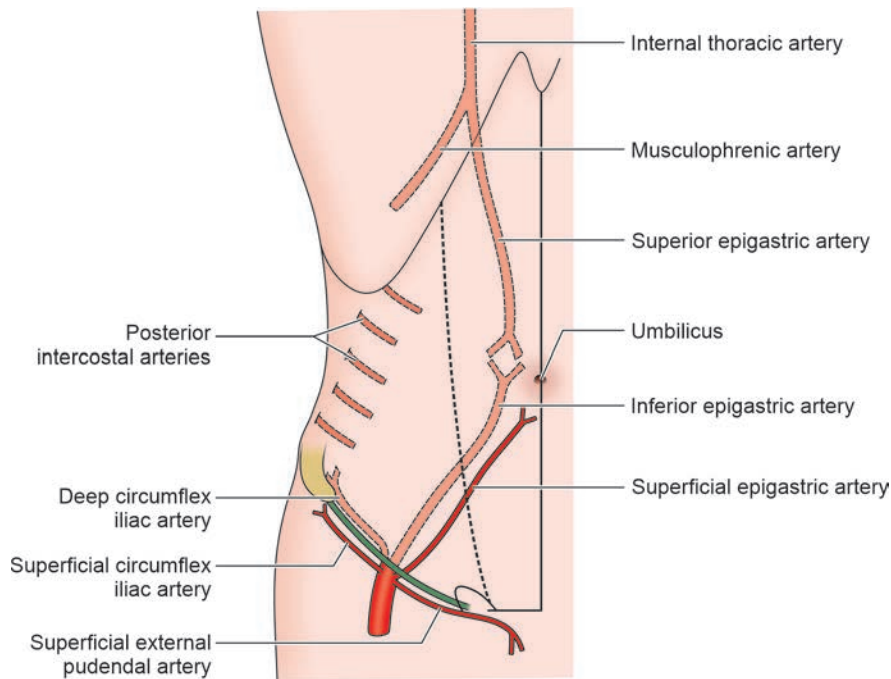


Fig. 6.5: Blood supply of anterior abdominal wall

The insertion of accessory trocars in lower abdomen can cause entrapment and cutting of the ilioinguinal and iliohypogastric nerves. Placing the lateral trocars superior to the anterior superior iliac spine can minimize the risk of injury.

Umbilicus

During laparoscopic surgery, the umbilicus is the most often used port of entry. The skin, the fascia and the peritoneum are fused together with minimum fat at this level. The umbilicus lies between the third and fourth lumbar vertebrae. The abdominal aorta bifurcates and the inferior vena cava is formed from the common iliac veins at this level. The median umbilical ligament, paired medial umbilical ligament join at the inferior crease of the umbilicus to form a tough layer (Figs 6.6 and 6.7). Ligamentum teres which forms part of the free edge of the falciform ligament of the liver gets attached to the upper part of umbilicus. Based on the patient's level of obesity, the position of umbilicus might change. The thinnest region of anterior abdominal wall, however, is the base of the umbilicus.

SURGICAL ANATOMY OF PELVIS

Pelvic Blood Supply

The common iliac vessels divide into internal iliac and external iliac vessels, at the level of sacral promontory. The internal iliac vessels are the main source of blood supply to the pelvis and its organs.

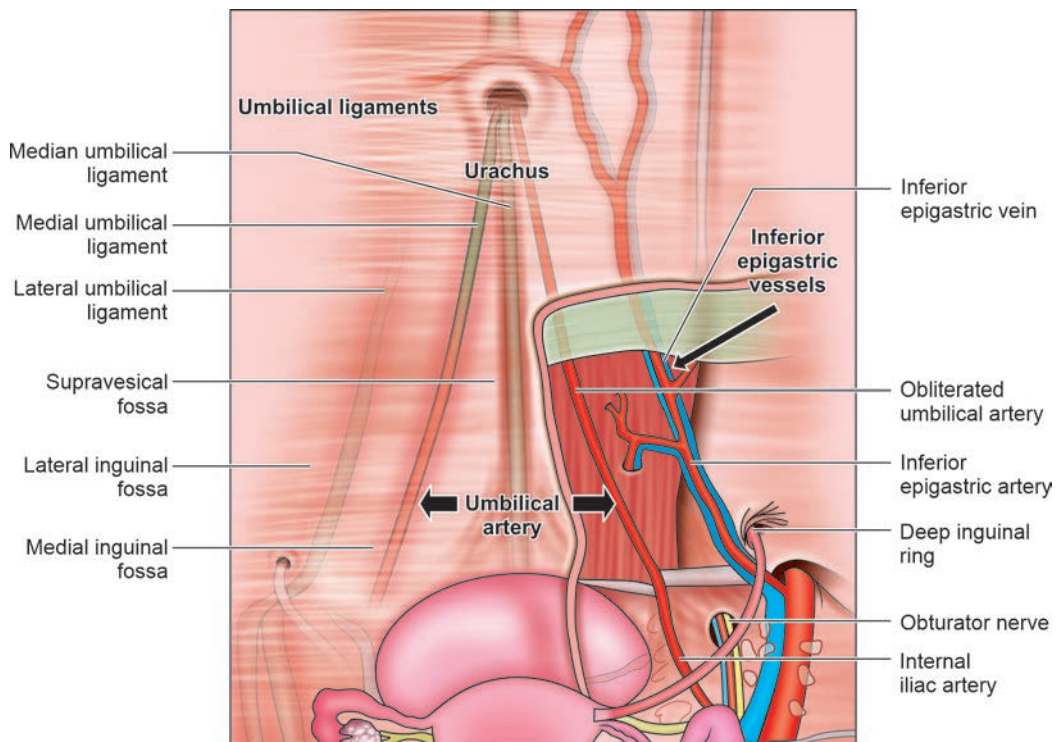


Fig. 6.6: Anatomy of the umbilicus

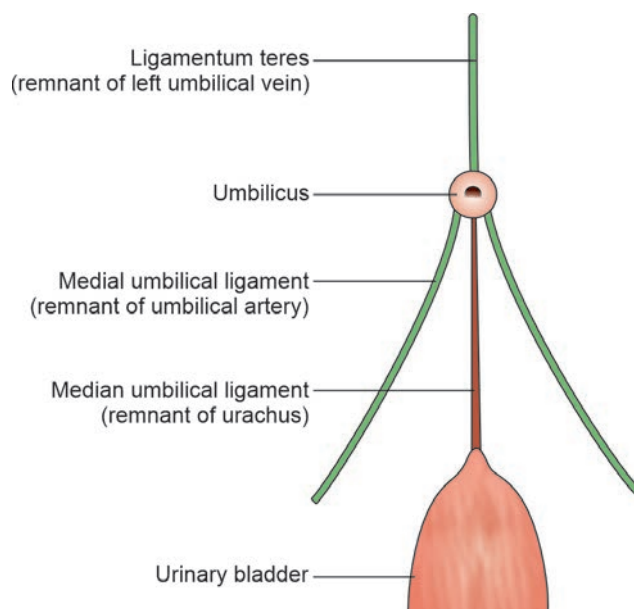


Fig. 6.7: Attachment of peritoneal folds to umbilicus

External Iliac Artery

It arises from the common iliac artery at the level of sacroiliac joint and runs on the medial surface of the psoas major muscle and continues as the femoral vessels (Fig. 6.8). Just before it passes under the inguinal ligament to become the femoral vessels, it branches into the inferior epigastric and the deep circumflex iliac branches. Both of these are important branches and have a role in the blood supply of the inferior portion of anterolateral abdominal wall. The anteromedial part of the external iliac artery lacks branching, making pelvic lymph node dissection safer and simpler.

Internal Iliac Artery

The internal iliac artery (IIA) originates from the common iliac artery at the level of the sacral promontory. After that, it splits into two divisions: anterior and posterior. The three branches of the posterior division: Iliolumbar, lateral sacral and the superior gluteal artery, supplies the gluteal region. The parietal and visceral branches of the anterior division supply the vital organs of the pelvis. The visceral branches are the uterine, middle rectal, superior vesical and vaginal artery. The uterine artery arises approximately 5–6 cm from the origin of IIA and it is the first branch of its anterior division (Figs 6.9 and 6.10). After giving the superior vesical branch, it then continues as obliterated hypogastric artery to the anterior abdominal wall. As the anterior division of IIA is devoid of any branches for about 5–6 cm, this area is taken for its ligation. The internal iliac vein lies parallel to the artery and utmost care should be taken to avoid the ligation of the vein. It is important to ligate the artery after it gives off the posterior division. After IIA ligation the pulse pressure is reduced but flow is maintained to the organs by active collateral circulation between systemic and pelvic vessels. The parietal branches are the obturator artery, internal pudendal artery, and inferior gluteal artery. The obturator artery is the only lateral branch of IIA. It lies in the lateral paravesical space underneath the obturator nerve.

Uterine Artery

The first branch of the anterior division of IIA is the uterine artery. It crosses over the ureter horizontally and anteriorly and before entering the uterus it divides into ascending

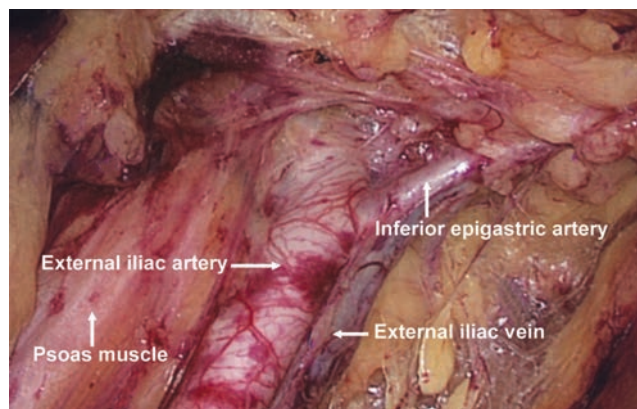


Fig. 6.8: Inferior epigastric artery arising from external iliac artery

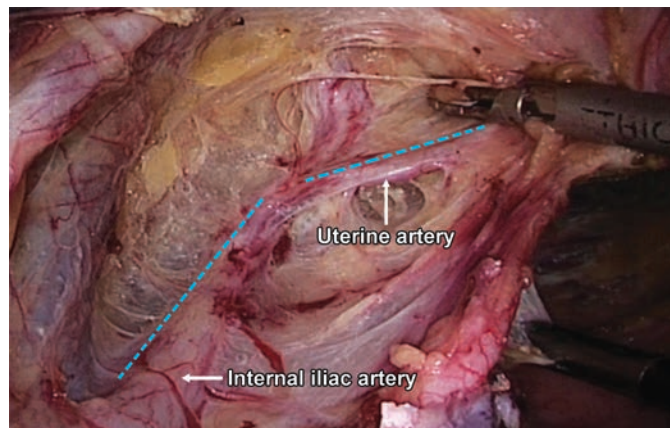


Fig. 6.9: Uterine artery is the first branch of anterior division of internal iliac artery

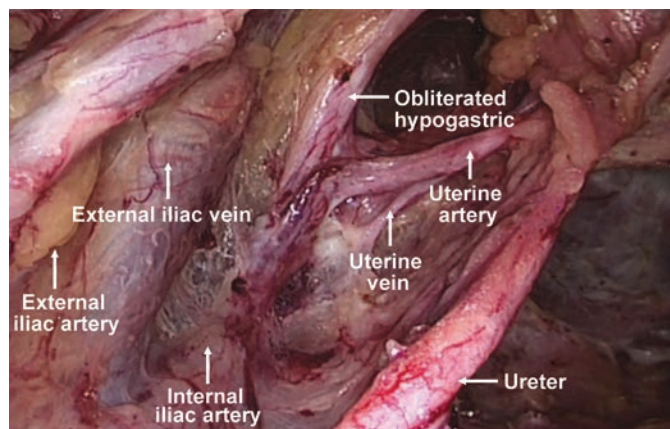


Fig. 6.10: Relations and branches of the internal iliac artery

and descending branches (Fig. 6.11). It lies anterior to the ureter while uterine vein lies posterior to the ureter (Fig. 6.12). Uterine artery is best seen in the pararectal space.

Pelvic Innervation

Both the somatic and autonomic nervous systems innervate the pelvis. The autonomic nerves include both the sympathetic and the parasympathetic fibres and innervates the visceral organs.

Somatic Nerves

The lumbosacral plexus provides sensory and motor innervation to the lower abdominal wall and pelvis. These include

1. **Femoral nerve (L2, L3, L4):** It emerges from the inferolateral surface of the psoas muscle, passes beneath the inguinal ligament and provides motor innervation to the anterior compartment thigh muscles and sensory innervation to anterior thigh and

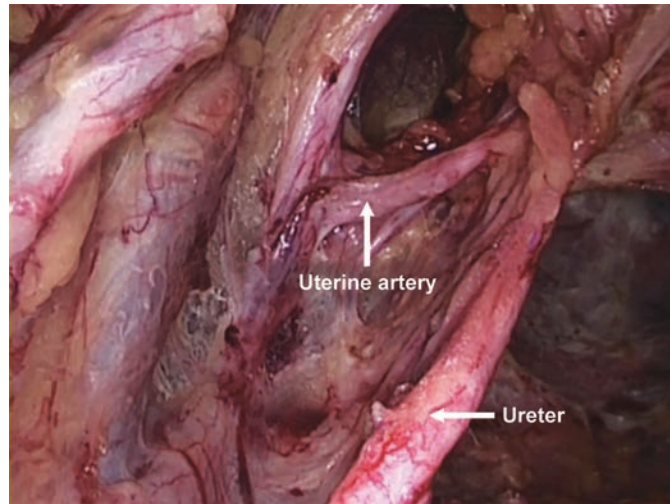


Fig. 6.11: Uterine artery crosses over the ureter horizontally

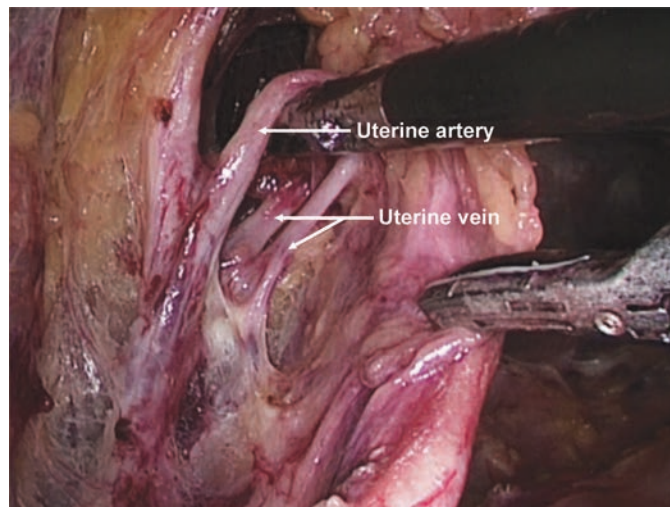


Fig. 6.12: Uterine artery lies anteriorly and uterine vein posterior to ureter

medial leg. Lithotomy positioning (thigh hyperflexion or excessive hip abduction) can compress the femoral nerve against the inguinal nerve. The nerve injury manifests as both motor (inability to flex the thigh and extend the knee) and sensory (sensory loss over anterior thigh and medial aspect of leg) disability.

2. **Obturator nerve (L2, L3, L4):** The obturator nerve leaves the obturator canal. It then enters the thigh and supplies the adductor muscles and skin over medial thigh. Procedures like pelvic lymphadenectomy, Burch colposuspension or pelvic support procedures can injure the obturator nerve. The injury manifests as inability to adduct the thigh and sensory loss over medial thigh.

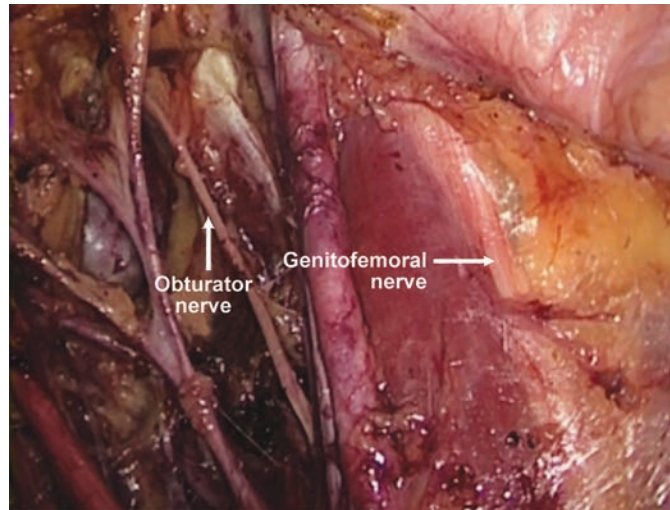


Fig. 6.13: Genitofemoral nerve along the psoas muscle

3. **Genitofemoral nerve (L1, L2):** The genitofemoral nerve lies on the anterior surface of the psoas muscle (Fig. 6.13). Procedures like pelvic lymphadenectomy or psoas hitch, can injure the nerve. Damage to this nerve can cause anaesthesia over the superomedial part of thigh and lateral labia.
4. **Lateral cutaneous nerve of thigh (L2, L3):** The lateral cutaneous nerve runs over the iliacus muscle and passes beneath the inguinal ligament just medial to the anterior superior iliac spine. The injury to the nerve can occur during excessive flexion of the hip in the lithotomy position and it causes sensory loss over the anterior and lateral thigh.
5. **Pudendal nerve:** The motor fibres supply muscles of the perineal body, levator ani and external anal sphincter. The sensory supply is to the skin of the vulva, external urethral meatus, clitoris, perineum, and lower vagina.

Autonomic Nerves

The visceral organs like uterus, adnexa, vagina, bladder, urethra, and rectum are innervated by the autonomic nervous system. In the pelvis the two main components of the autonomic nervous system include the superior and inferior hypogastric plexuses. The superior hypogastric plexus (presacral nerve) is an extension of aortic plexus and is seen below the aortic bifurcation. It contains the sympathetic fibres and sensory afferent fibres from the uterus. It terminates by dividing into hypogastric nerves which provides the sympathetic nerves (Fig. 6.14). These nerves join with the pelvic splanchnic nerves (parasympathetic fibres) to form the inferior hypogastric plexus. The inferior hypogastric plexus accompanies the branches of the internal iliac artery to the pelvic viscera and divides into three portions representing distribution of innervation of viscera. These include the vesical plexus along vesical vessels, middle rectal plexus along middle rectal artery, uterovaginal plexus (Frankenhauser ganglion) along uterine vessels and through the cardinal and uterosacral ligaments.

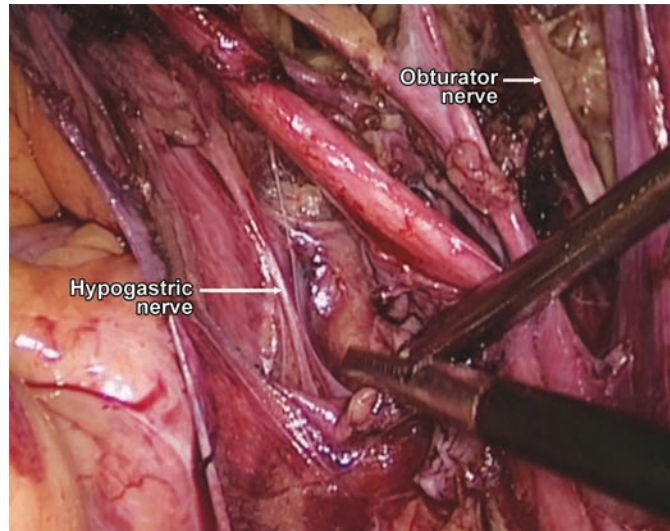


Fig. 6.14: Hypogastric nerve in the pararectal space

Superior hypogastric plexus carries sensory sympathetic fibres concerned with pain from the body of uterus, urinary bladder, and other pelvic organs. Hence presacral neurectomy is a treatment option for chronic pelvic pain, spasmodic dysmenorrhea and inoperable cases of cancer of bladder or rectum.

Injury to the inferior hypogastric plexus can lead to sexual, voiding or defecatory dysfunction.

Pelvic Ureter

The ureter is a long smooth muscle structure 25–30 cm long that courses down the retroperitoneum, from the renal pelvis to the bladder. It is generally divided into abdominal part and pelvic part of equal lengths. The intravesical part of the ureter lies within the bladder wall. The pelvic ureter extends from the point the ureter crosses over the iliac vessels at the pelvic brim up to its opening into the urinary bladder. The external iliac artery on the right and the common iliac artery on the left are crossed by the ureter at the pelvic brim (Fig. 6.15). It forms the posterior boundary of the ovarian fossa as it descends, passing behind the ovary and anterior to the internal iliac artery. The ureter is the first structure seen medial to the infundibulopelvic ligament. As it courses forward and medially, the uterine artery crosses it anteriorly (water under the bridge) at the base of the broad ligament and it then enters the ureteric tunnel and lies close to the supravaginal part of the cervix, about 1.5 cm lateral to it (Fig. 6.16). The uterosacral ligaments are medial to the ureter (Fig. 6.17). It then traverses a short distance on the anterior vaginal wall. It travels obliquely through the bladder wall and enters the bladder trigone, which forms the basis of antireflux mechanism. The ureter is supplied by the renal, ovarian, common iliac, internal iliac and vesical arteries. The branches of the arteries supplying the ureter form a convoluted network of vessels which runs longitudinally along its outer surface.

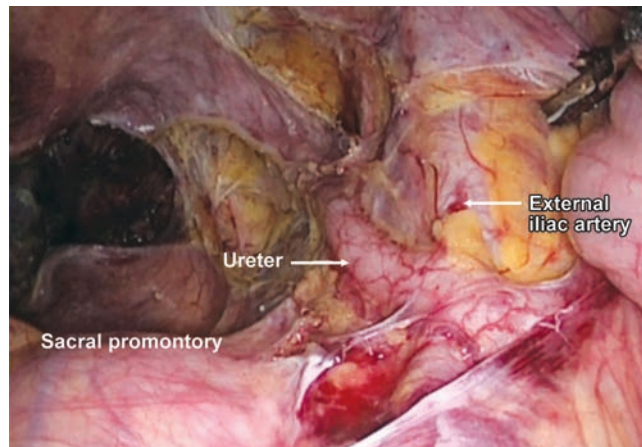


Fig. 6.15: Ureter crosses the external iliac artery on the right side

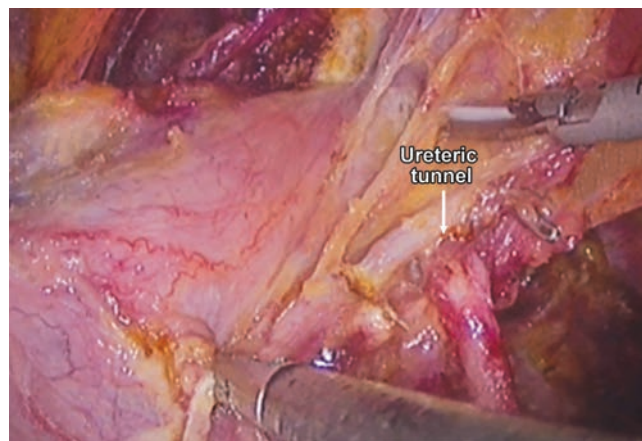


Fig. 6.16: Ureteric tunnel

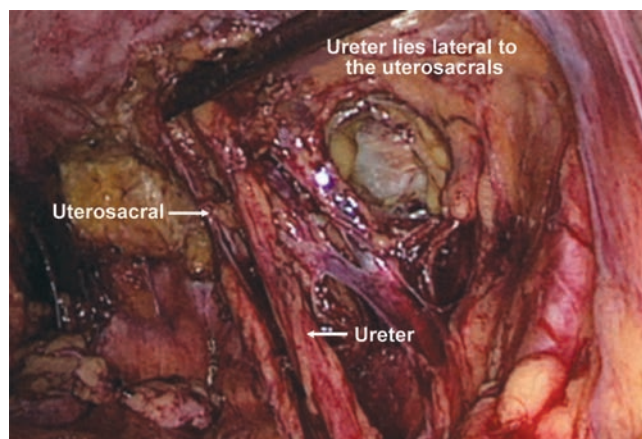


Fig. 6.17: Ureter lies lateral to the uterosacral ligament

AVASCULAR SPACES OF PELVIS

The peritoneal depressions formed by reflections of the peritoneum between the pelvic walls and the organs, form the retroperitoneal spaces of pelvis. These are virtual spaces and are developed by dissection and are useful anatomical landmarks for pelvic surgery for both benign and malignant conditions.

The retroperitoneal spaces of pelvis are classified as:

1. Lateral spaces
Pararectal, paravesical, Yabuki space (fourth space)
2. Midline spaces
Retropubic (Retzius space), rectovaginal, presacral, vesicovaginal

Pararectal Space

The pararectal space is the retroperitoneal space lying lateral to the rectum. It is bounded medially by the rectum, laterally by the internal iliac artery, dorsally by the sacrum and pre-sacral fascia, ventrally by the cardinal ligament including the parametrium over the ureter and paracervix below the ureter. The roof is formed by the posterior leaf of broad ligament and floor is formed by levator ani. The pararectal space is further divided by the ureter into the lateral Latzko space and medial Okabayashi space. The nerve fibres of the superior hypogastric plexus which are present in the Okabayashi space, forms the hypogastric nerve (Fig. 6.18). The uterine artery can be identified in the Latzko space (Fig. 6.19).

Paravesical space

The retroperitoneal space lying lateral to the urinary bladder is the paravesical space. It lies anterior and superior to the pararectal space. It is bounded medially by the bladder, laterally by the obturator internus fascia/muscle, external iliac artery/vein, ventrally by the superior pubic ramus and dorsally by the cardinal ligament including the parametrium above ureter and paracervix below the ureter. The anterior leaf of broad ligament covers it and the iliococcygeus muscle forms the floor. It contains the obliterated umbilical artery, superior vesical artery, obturator neurovascular bundle and accessory obturator vessels. The space is divided into lateral and medial

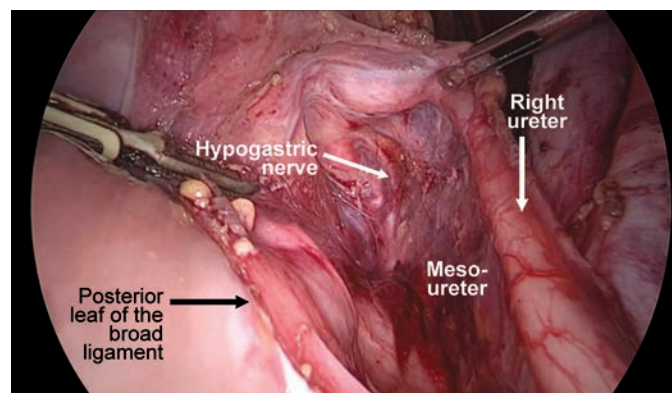


Fig. 6.18: Hypogastric nerve in Okabayashi space

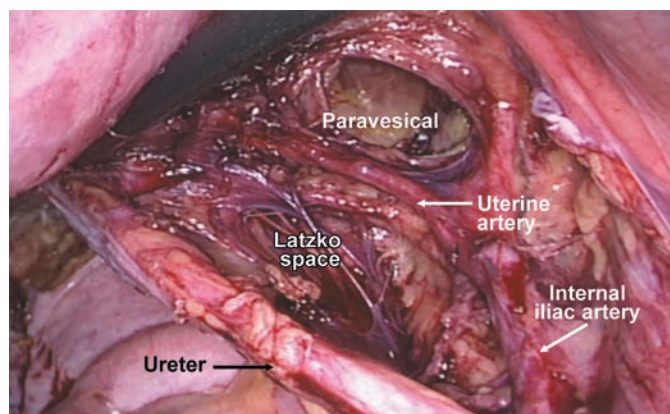


Fig. 6.19: Latzko space

paravesical space by the obliterated umbilical artery. The obturator space is the lateral paravesical space and it contains the obturator nerve, artery, vein, and lymph nodes. The limit of dissection of lateral paravesical space is the obturator nerve. The floor formed by the levator ani muscle forms the limit of dissection of medial paravesical space.

Yabuki Space

This small retroperitoneal space is confined to the anterior surface of uterus and the ureter inserting into the bladder. The dissection of the cranial portion of vesicouterine ligament exposes this space. The parasympathetic pelvic splanchnic nerves innervating the bladder are present in this space. Nerve sparing radical hysterectomy requires careful dissection at this space.

Prevesical/Retropubic Space of Retzius

Prevesical space (Fig. 6.20) is bounded ventrolaterally by the bony pelvis and muscles of pelvic wall, dorsally by proximal urethra and bladder and cranially by the abdominal wall. The attachment of the bladder to the cardinal ligament and attachment of the endopelvic fascia to the inner surface of the obturator internus, pubococcygeus and puborectalis muscle, forms the dorsal limit of this space. The dorsal vein of clitoris, obturator nerve and vessels, lie within this space. The anterior surface of the retropubic space which is formed by the upper border of the pubic bone has a ridge like fold of periosteum called the pectineal line. In Burch colposuspension for stress urinary incontinence, sutures are anchored to the pectineal line.

Presacral Space/Retrorectal Space

Presacral space lies behind rectum and is covered anteriorly by the mesorectum and posteriorly by the Waldeyer fascia. Since the presacral veins lie posterior to the Waldeyer fascia, one should carefully dissect this space. If these veins are injured, it can cause severe bleeding. Dissection of this space helps in excision of rectal endometriosis, presacral neurectomy, and sacrocolpopexy.

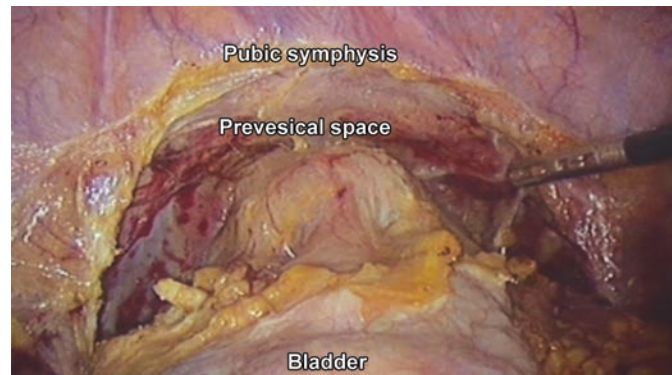


Fig. 6.20: Retropubic space of Retzius

Rectovaginal Space

Rectovaginal space (Fig. 6.21) is bounded ventrally by the posterior vaginal wall, dorsally by the anterior rectal wall, laterally by the uterosacral and rectovaginal ligament. The peritoneal reflection of pouch of Douglas forms the roof and the floor is formed by the levator ani muscle. The two layered fascia between the rectum and vagina, is the Denonvilliers fascia. The rectum is covered by one layer, and the vagina is covered by the other. Dissection of the rectovaginal space requires creating an avascular plane between the two layers of Denonvilliers fascia. This space is developed during radical hysterectomy, sacrocolpopexy, excision of deep endometriosis or rectovaginal fistula repair.

Vesicovaginal Space/Vesicouterine Space

Vesicovaginal space (Fig. 6.22) is bounded ventrally by the trigone of bladder, dorsally by the pubocervical fascia, laterally by the vesicouterine ligament, cranially by the peritoneal reflection between dome of bladder and the low uterine segment, caudally by the junction of proximal and middle third of urethra. This space is developed during laparoscopic hysterectomy, laparoscopic sacrocolpopexy and other urogynaecological procedures. The space is developed by pulling up the bladder.

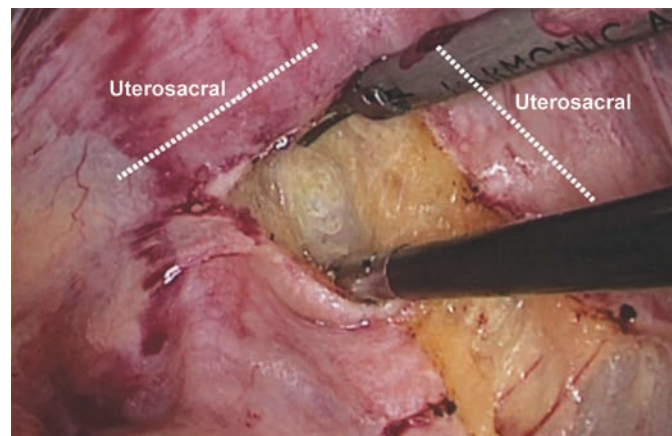


Fig. 6.21: Rectovaginal space

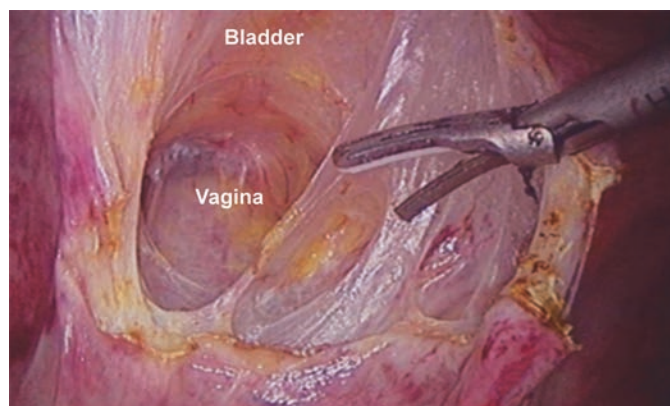


Fig. 6.22: Vesicovaginal space

Key Points

1. The skin incisions which are parallel to the Langer's line have less tension and heal with a narrow and more cosmetic scar.
2. The inferior epigastric vessels arise just medial to the point where the round ligament enters into the deep inguinal ring.
3. Injury to the ilioinguinal and iliohypogastric nerves can be avoided by placing lateral trocars above the anterior superior iliac spine.
4. Uterine artery is the first branch of anterior division of internal iliac artery.
5. Ureter crosses the external iliac artery on the right side and common iliac artery on the left.
6. The first structure medial to the infundibulopelvic ligament is the ureter.
7. The uterine artery crosses over the ureter horizontally at the base of broad ligament.
8. The pelvic organs are innervated by the autonomic nervous system: Superior hypogastric plexus and hypogastric nerve carry the sympathetic fibres and pelvic splanchnic nerves carry the parasympathetic fibres.
9. Ureter divides the pararectal space into lateral Latzko space and medial Okabayashi space. Uterine artery at origin is best identified at the Latzko space and Okabayashi space contains the superior hypogastric plexus and hypogastric nerve.
10. Obliterated umbilical artery divides the paravesical space into lateral paravesical (obturator) space and medial paravesical space. Lateral paravesical space contains the obturator nerve and arteries.

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