

2. ABDOMINAL WALL AND HERNIAS

Contents

LAB OBJECTIVES.....	2
Knowledge objectives.....	2
Skills objectives.....	2
Preparation for lab.....	2
1.1 ORGANIZATION OF THE ABDOMINAL WALL.....	4
Organization of the trunk wall.....	4
Superficial layers of the trunk wall.....	5
Musculoskeletal layer of the anterolateral abdominal wall.....	7
T3/Deep fascia surrounding the musculoskeletal layer of the abdominal wall.....	11
Deeper layers of the trunk wall.....	12
1.2 ABDOMINAL WALL NEUROVASCULAR SUPPLY.....	13
Trunk wall innervation.....	14
Trunk wall blood supply.....	14
Trunk wall lymphatic drainage.....	14
1.3 INGUINAL REGION.....	15
Inguinal canal.....	16
Inguinal canal contents and coverings.....	16
1.4 INTERNAL SURFACE OF THE ANTEROLATERAL ABDOMINAL WALL.....	17
Triangles of doom and pain.....	19
1.5 FEMORAL SHEATH AND OBTURATOR CANAL.....	22
Femoral sheath.....	22
Obturator canal1 Umbilical hernia/Ventral hernia repair:.....	22
2 Component separation technique:.....	27
3. Femoral hernia:.....	28
4 Inguinal hernia: Indirect defect.....	36
5 Obturator hernia:.....	43
6 Inguinal hernia repair with mesh:.....	45

1. ABDOMINAL WALL AND HERNIAS

LAB OBJECTIVES

After successfully completing Laboratory 1, you will be able to do the following.

Knowledge objectives

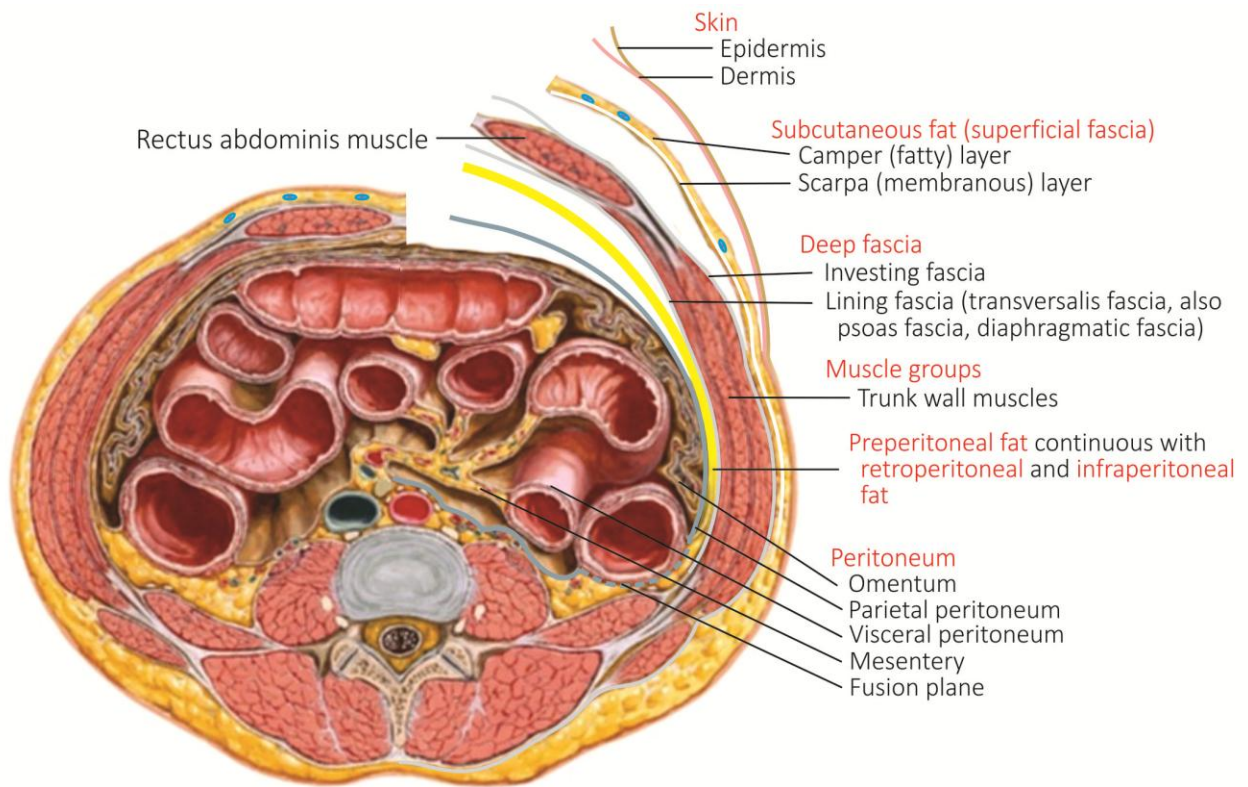
1. Describe the nine **layers of the abdominal wall**. Which layers consist of **connective tissue**? Which layers consist of **mesothelium**?
2. Describe the **three muscle layers of the trunk wall** and how their orthogonal muscle fiber orientations can be exploited in open muscle-splitting approaches.
3. Explain the **pattern of innervation** of the trunk wall. Which structures in the trunk wall receive visceral innervation rather than somatic innervation? Explain the **pattern of blood supply** to the trunk wall.
4. Describe the structure and position of the **inguinal ligament**, **shelving edge**, and **lacunar ligament**. Describe the structure and attachment of the **conjoint tendon**. Describe the structure and attachment of the **pectineal ligament**.
5. Describe the boundaries and contents of the **'triangle of doom'** and the position of the corona mortis. Describe the boundaries and contents of the **'triangle of pain'**.

Skills objectives

1. Complete the anatomy lab equivalent of an umbilical hernia/ventral hernia repair.
2. Complete the anatomy lab equivalent of a ventral hernia repair using component separation technique.
3. Complete the anatomy lab equivalent of a femoral hernia repair.
4. Complete the anatomy lab equivalent of an inguinal hernia repair, indirect defect
5. Complete the anatomy lab equivalent of an obturator hernia repair.
6. Complete the anatomy lab equivalent of an inguinal hernia repair with mesh:

PREPARATION FOR LAB

- Review this guide.
- Watch the SCORE videos listed at the end of some procedures.



ABDOMEN AT L3-4 INTERVERTEBRAL DISC LEVEL

Figure 2-1. Anatomical organization of the abdomen, axial view at the level of the L3-L4 intervertebral disk. (Modified from *Netter Atlas of Human Anatomy*, 5th Edition. Philadelphia: Elsevier, 2010.)

2. ABDOMINAL WALL AND HERNIAS

1.1 ORGANIZATION OF THE ABDOMINAL WALL

Organization of the trunk wall

The **nine layers of the anterolateral abdominal wall** include the following (Figure 2-1).

1. Skin
2. Subcutaneous fat
 - a. Fatty Camper fascia
 - b. Membranous Scarpa fascia
3. Investing deep fascia (external oblique fascia)
4. External abdominal oblique muscle
5. Internal abdominal oblique muscle
6. Transversus abdominis muscle
7. Lining deep fascia (transversalis fascia, iliacus fascia, psoas fascia, etc)
8. Preperitoneal fat
9. Parietal peritoneum

In the **central region of the anterior abdomen**, the rectus abdominis muscle and rectus sheath replace the three muscle layers of the anterolateral wall (Figure 2-1).

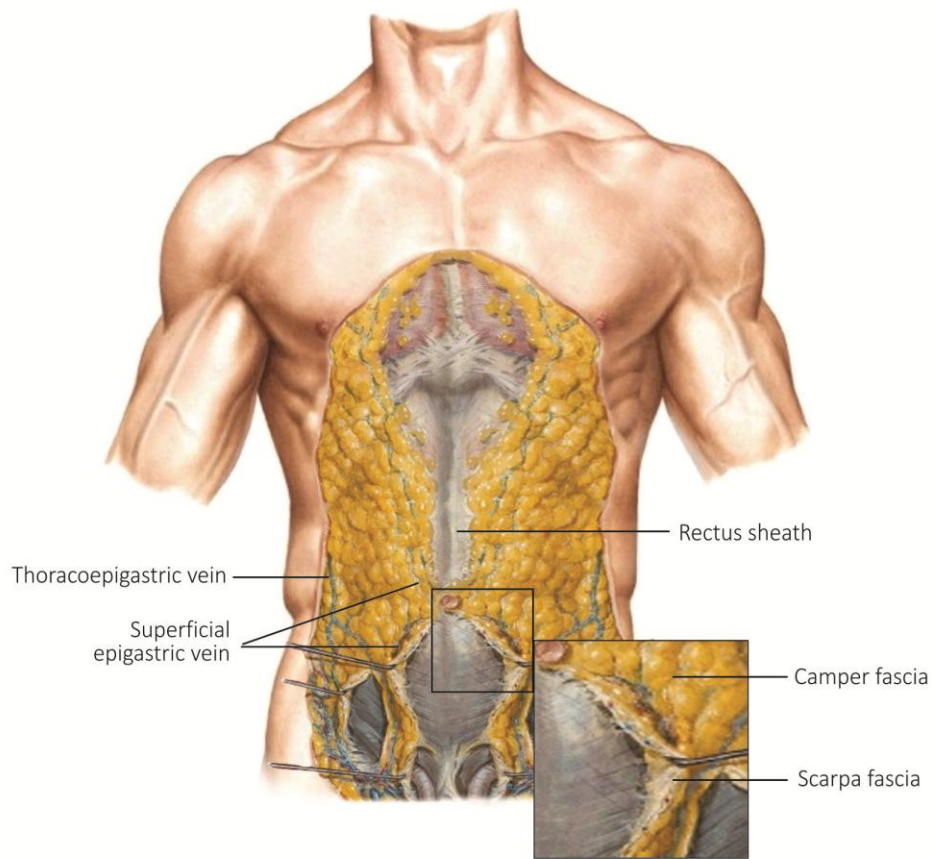
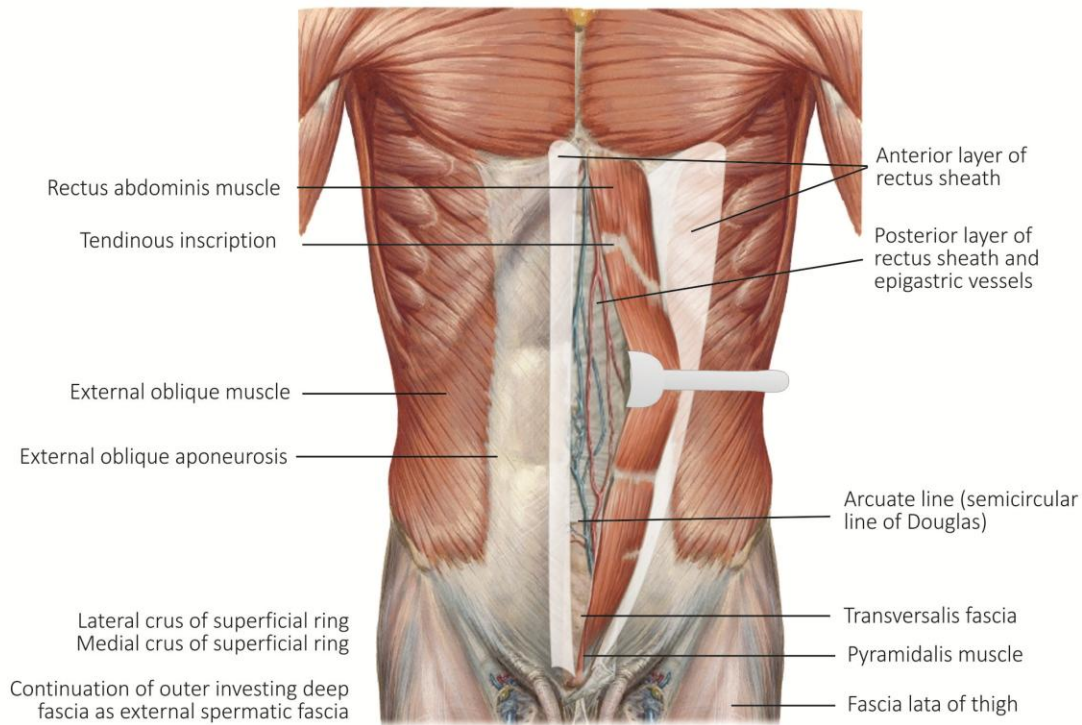


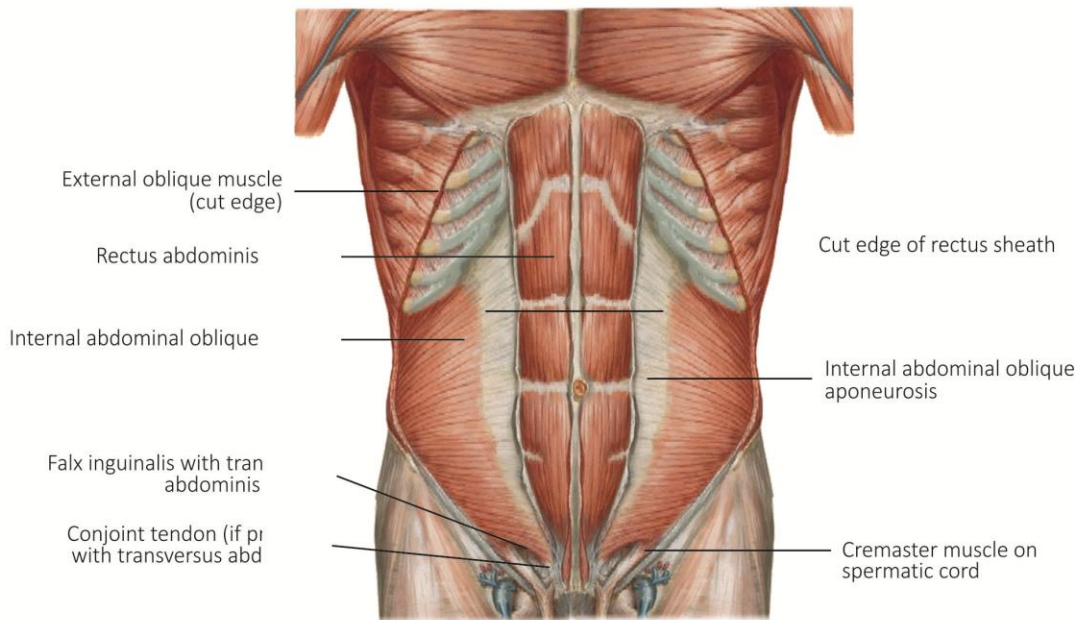
Figure 2-2. Superficial layers of the abdominal wall. (Modified from *Netter Atlas of Human Anatomy*, 5th Edition. Philadelphia: Elsevier, 2010.)

Superficial layers of the trunk wall

The superficial layers of the trunk wall consist of **skin** and **subcutaneous fat** (superficial fascia). As in all regions, the loose connective tissue of the subcutaneous fat consists of adipocytes and collagen strands. In the deeper portion of the subcutaneous fat, the collagen fibers coalesce to form an identifiable membranous or fibrous layer. The subcutaneous fat of the trunk is traditionally described as having an outer fatty **Camper fascia** and a deeper membranous or fibrous **Scarpa fascia** (Figure 2-2). A thin fatty layer typically intervenes between the Scarpa fascia and the underlying deep investing fascia. A network of superficial veins and cutaneous nerves run within the subcutaneous fat. Perforating branches of deeper vessels pass through the superficial fascia to reach the skin and its vascular plexuses.



External abdominal oblique muscle



Internal abdominal oblique muscle

Figure 2-3. External abdominal oblique, internal abdominal oblique, and rectus abdominis muscles. (Modified from *Netter Atlas of Human Anatomy*, 5th Edition. Philadelphia: Elsevier, 2010.)

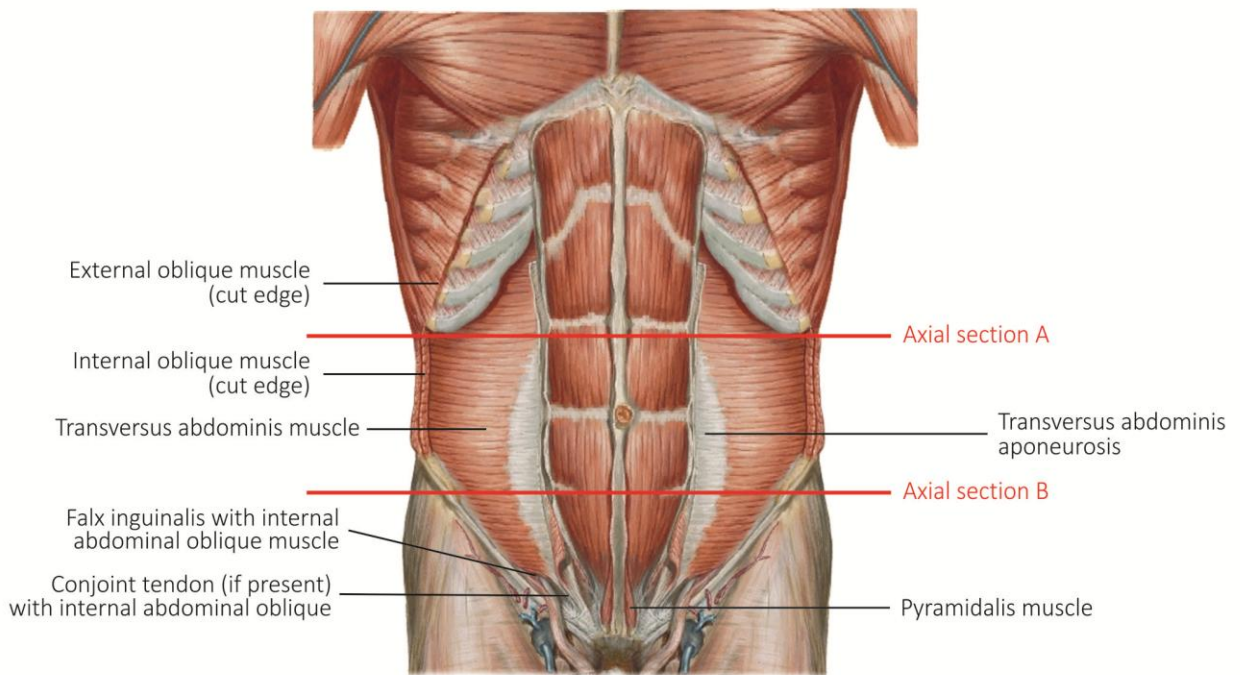
Musculoskeletal layer of the anterolateral abdominal wall

The **intrinsic muscles of the anterolateral abdominal wall** comprise a **trilaminar muscle plywood** (Figure 2-3). The external abdominal oblique, internal abdominal oblique, and transversus abdominis muscles of the abdominal wall each consist of a **muscular portion** laterally and a broad **aponeurosis** (flat tendon) medially. The aponeuroses of the external abdominal oblique, internal abdominal oblique, and transversus abdominis muscles extend toward the anterior midline, surrounding the rectus abdominis muscle and forming the rectus sheath.

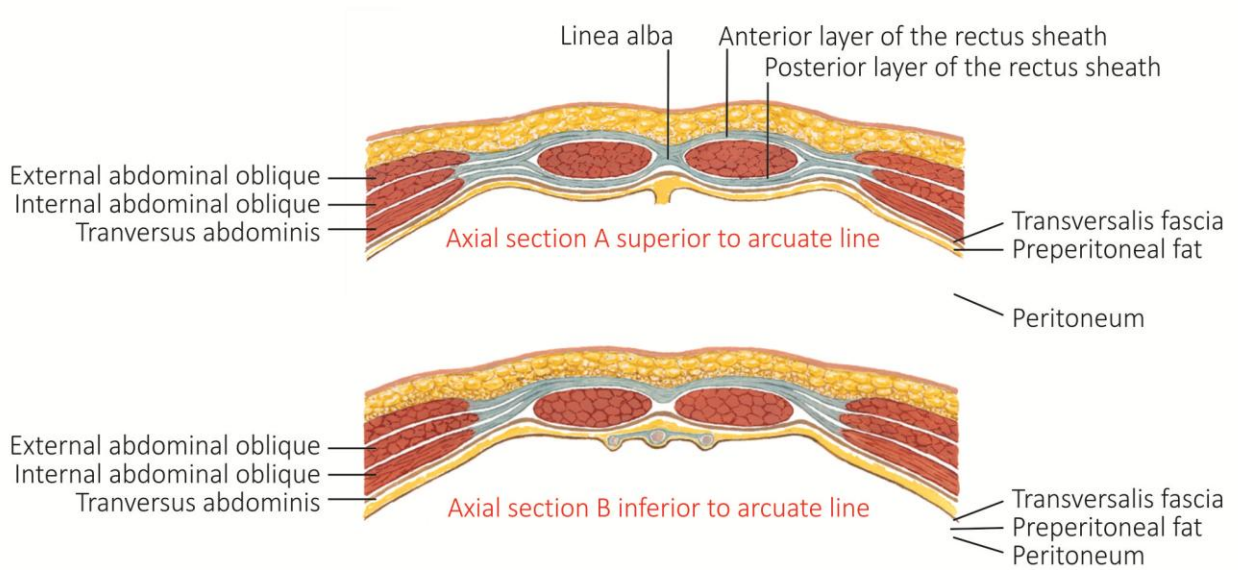
The **outermost layer** of trunk wall muscles consists of the **external intercostal muscles** in the intercostal spaces of the chest and the **external abdominal oblique muscles** in the anterolateral abdominal wall. Fibers in this muscle layer run **inferomedially** from back to front.

The **intermediate layer** of trunk wall muscles consists of the **internal intercostal muscles** in the intercostal spaces and the **internal abdominal oblique muscle** in the abdominal wall. Anteriorly, fibers in this muscle layer run **superolaterally** from back to front.

The **innermost layer** of trunk wall muscles is discontinuous in the thorax and continuous in the abdomen. In the thorax, the innermost layer consists of the **transversus thoracis muscle** anteriorly, the **innermost intercostal muscle** laterally, and the **subcostal muscles** posteriorly. In the abdomen, the innermost layer consists of the **transversus abdominis muscle**. Anteriorly, fibers of the transversus abdominis muscle run **transversely**, more or less.



Transversus abdominis muscle



Axial sections through the rectus sheath

Figure 2-4. Transversus abdominis muscle and axial views of the rectus sheath superior and inferior to the arcuate line. (Modified from *Netter Atlas of Human Anatomy*, 5th Edition. Philadelphia: Elsevier, 2010.)

In the abdomen, the abdominal wall is reinforced anteriorly by the paired **rectus abdominis muscles** (Figures 2-3 and 2-4), which extend from the ribs to the pubis. **Tendinous inscriptions** (intersections) divide the muscle into four or five segments. The small **pyramidalis muscle** lies at the inferior attachment of the rectus abdominis muscle.

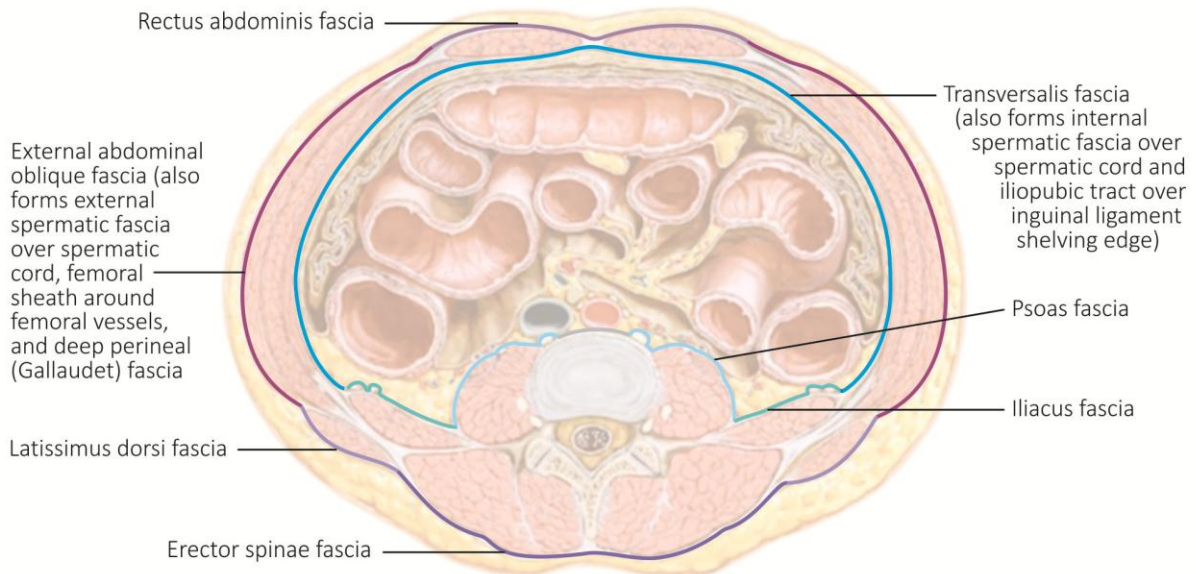
The aponeuroses of the three abdominal wall muscles surround the rectus abdominis muscles as the **rectus sheath**, then attach to their contralateral counterparts at a tough midline seam, the **linea alba**. The rectus sheath consists of an **anterior layer** fused to the tendinous intersections of the rectus abdominis muscle, and a **posterior layer**. The posterior layer is thicker superiorly and ends inferiorly at the arcuate line (semicircular line of Douglas).

The **aponeurosis of the external abdominal oblique** muscle contributes to the anterior layer of the rectus sheath throughout its length and makes no contribution to the posterior layer.

Superiorly, the **aponeurosis of the internal abdominal oblique** muscle splits into two lamellae; the anterior lamella contributing to the anterior layer of the rectus sheath and the posterior lamella contributing to the posterior layer of the rectus sheath. From the umbilicus to the arcuate line, the posterior lamella of the internal abdominal oblique muscle and the **aponeurosis of the transversus abdominis muscle** progressively abandon the posterior layer of the rectus sheath to join the anterior layer of the sheath. Inferior to the arcuate line, the posterior surface of the rectus abdominis muscle is covered by deep fascia only (Figures 2-3).

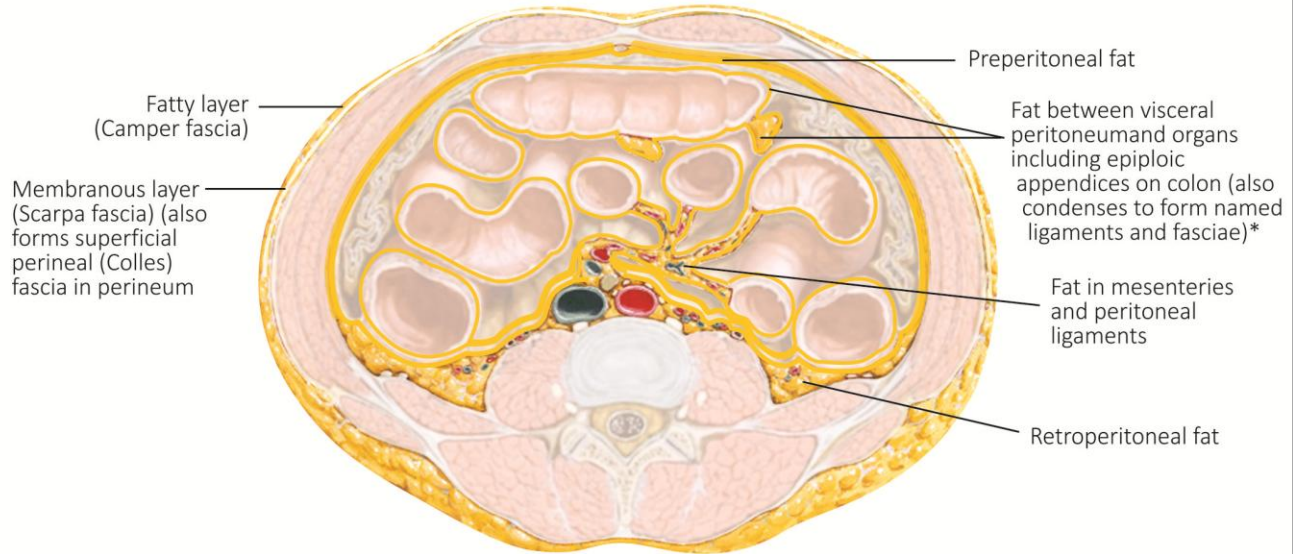
OUTER INVESTING DEEP FASCIA

INNER INVESTING DEEP FASCIA



SUBCUTANEOUS LOOSE CONNECTIVE TISSUE

VISCERAL LOOSE CONNECTIVE TISSUE



*Examples of named ligaments and fasciae formed by collagen condensations in visceral loose connective tissue include the ligament of Treitz, the phrenicosplenic ligament, the cardinal ligament of the uterus, and the renal (Gerota) fascia.

Figureb 2-5. Connective tissue continuities and synonyms in an axial section of the abdomen at the level of the T3/T4 intervertebral disc. (Modified from *Netter Atlas of Human Anatomy*, 5th Edition. Philadelphia: Elsevier, 2010.)

Deep fascia surrounding the musculoskeletal layer of the abdominal wall

A layer of **investing deep fascia** lies on the outer surface of the musculoskeletal layer and a layer of **lining deep fascia** lies on the inner surface of the musculoskeletal layer. The continuous layers of investing deep fascia and lining deep fascia acquire regional names according to adjacent muscle surfaces (Figure 2-5)

Deeper layers of the trunk wall

Just as a layer of loose connective tissue (subcutaneous fat) lies between the musculoskeletal layer and the skin, a deeper layer of loose connective tissue, the **preperitoneal/extraperitoneal fat** (aka endothoracic, endoabdominal, extraperitoneal, retroperitoneal, visceral fat) lies between the musculoskeletal layer of the trunk wall and the parietal pleura or parietal peritoneum lining the inner surface of the trunk wall (Figure 2-5). Again, regional names applied to regional thickenings, and haphazard use of the terms *ligament* and *fascia*, obscure the fundamental continuity of this layer. In the abdomen, this layer is continuous with the retroperitoneum; in the thorax, this layer is continuous with the mediastinum.

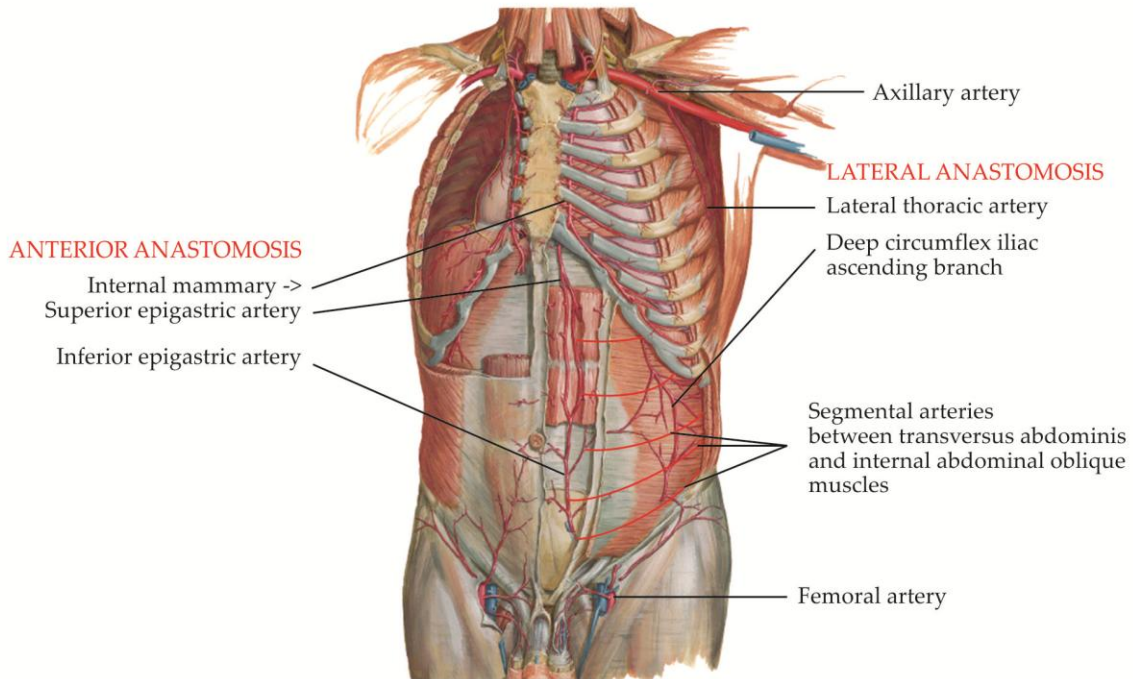
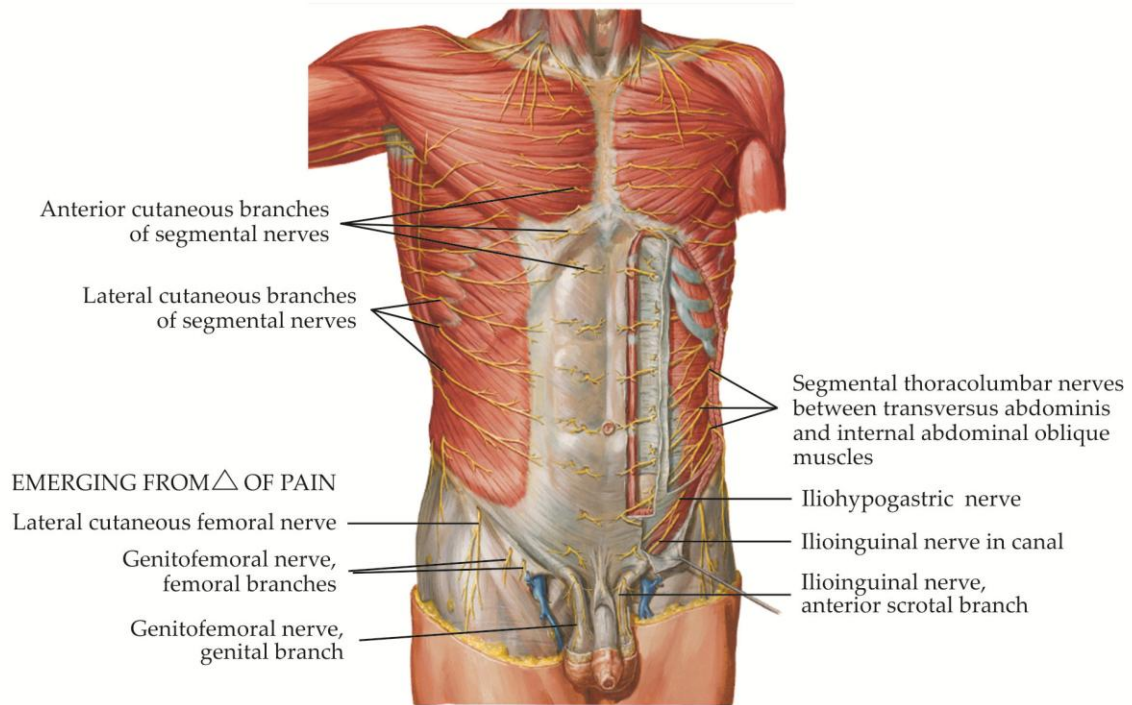


Figure 2-6. Trunk wall innervation and blood supply. (Modified from *Netter Atlas of Human Anatomy*, 5th Edition. Philadelphia: Elsevier, 2010.)

1.2 ABDOMINAL WALL NEUROVASCULAR SUPPLY

Trunk wall innervation

With the exception of skin glands and blood vessels, the entire thickness of the trunk wall develops from **embryonic somatic mesoderm**. The trunk wall muscles are **voluntary skeletal muscles** and receive **somatic motor fibers**. Sensation from the entire thickness of the trunk wall (skin to parietal pleura or parietal peritoneum), is conveyed in **somatic sensory fibers**. **Skin glands and vascular smooth muscle** receive **sympathetic visceral motor fibers** and sensation is conveyed from them in **visceral motor fibers**.

The **pattern of trunk wall innervation is entirely segmental** (Figure 2-6). Each intercostal or thoracoabdominal nerve supplies a strip of skin, muscle, fascia, and pleura or peritoneum based on the embryonic myotome and dermatome.

Thoracic and lumbar ventral rami innervate the trunk wall. The **intercostal nerves** supplying the thoracic wall run between the internal intercostal and innermost intercostal muscles. The **thoracoabdominal nerves** supplying the abdominal wall run in the corresponding plane between the internal abdominal oblique and the transversus abdominis muscles. **Anterior cutaneous** and **lateral cutaneous branches** leave the segmental nerves to pierce overlying layers and reach the skin.

Trunk wall blood supply

The **pattern of trunk wall blood supply includes both segmental horizontal and vertical anastomoses** (Figure 2-6). In any anastomosis, arterial or venous, interruption of flow from one source can be mitigated by partial reversal of flow from the other source.

Segmental horizontal anastomoses. Each **intercostal** or **lumbar artery** consists of a **posterior intercostal portion** from the aorta and an **anterior intercostal portion** from the internal mammary artery.

Vertical anastomoses. Medially, the **internal mammary artery**, a branch of the axillary artery, continues inferiorly as the **superior epigastric artery** and anastomoses with the **inferior epigastric artery**, a branch of the external iliac artery. Laterally, the **lateral thoracic artery**, a branch of the axillary artery, anastomoses with the ascending branch of the **deep circumflex iliac artery**, a branch of the external iliac artery. The **musculophrenic artery** communicates with both vertical anastomoses.

Corresponding venous anastomoses can serve as caval-caval shunts

Trunk wall lymphatic drainage

Superior to the umbilicus, the superficial layers of the anterolateral abdominal wall drain to the axillary lymph nodes and the deeper layers to the mediastinal nodes. **Inferior to the umbilicus**, the superficial layers of the anterolateral abdominal wall drain to the superficial inguinal lymph nodes and the deeper layers drain to the external iliac and para-aortic lymph nodes.

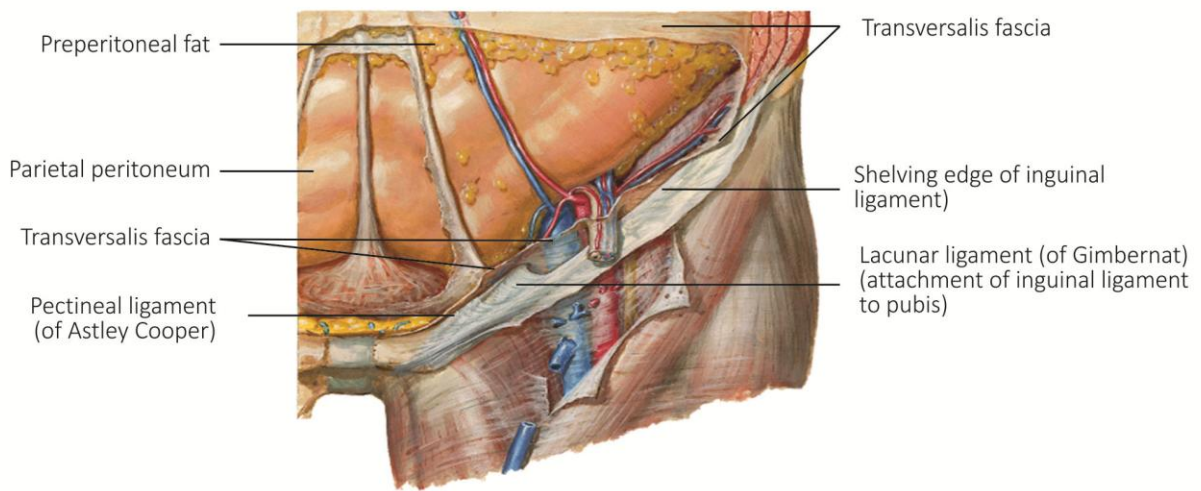
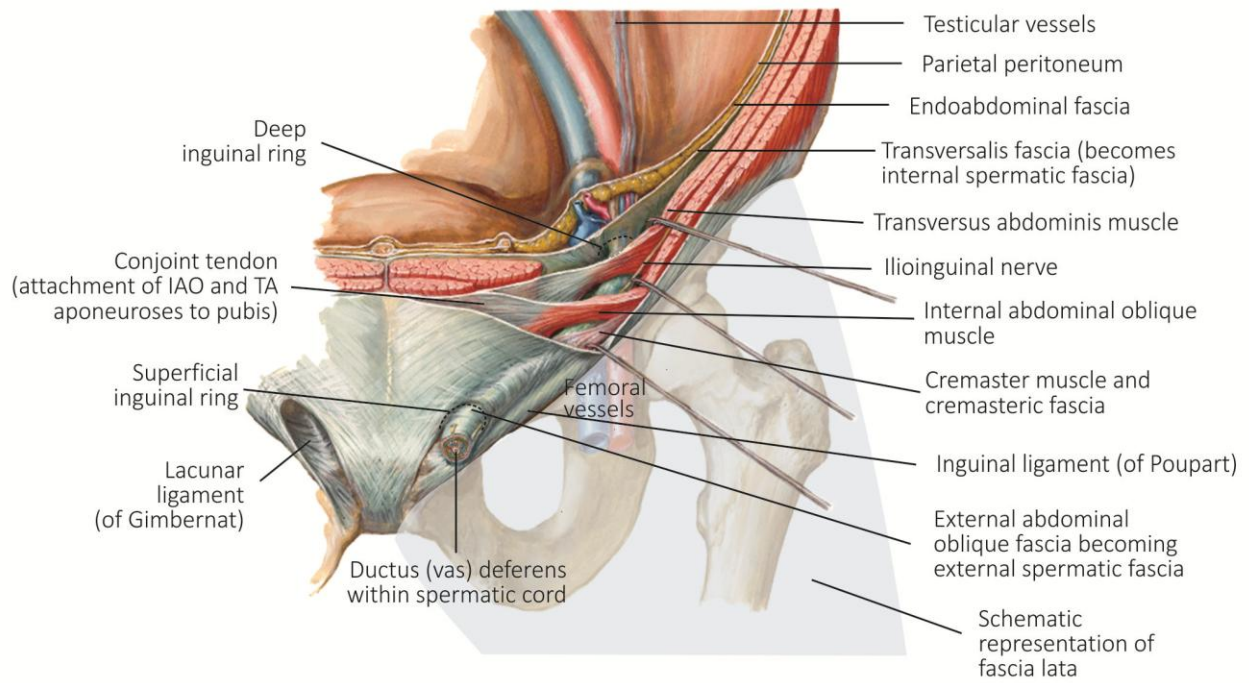


Figure 2-7. Inguinal anatomy, external aspect. (Modified from *Netter Atlas of Human Anatomy*, 5th Edition. Philadelphia: Elsevier, 2010.)

1.3 INGUINAL REGION

Inguinal canal

The **inguinal canal** is an oblique space between the anterolateral abdominal wall muscles (Figure 2-7).

The **aponeuroses** of the external abdominal oblique and internal abdominal oblique muscles form the **anterior wall** of the inguinal canal.

The **conjoint tendon**, the combined tendon of the internal abdominal oblique and transversus abdominis muscles, forms the medial portion of the **posterior wall** of the inguinal canal, and the **transversalis fascia** forms the lateral portion.

The inferior portion of the external abdominal oblique aponeurosis turns inward to form the **shelving edge (inward reflection) of the inguinal ligament** (of Poupart) and the **lacunar ligament** (of Gimbernat) medially. The shelving edge and lacunar ligament form the **floor** of the inguinal canal. Anteriorly, the inguinal ligament is continuous with the fascia lata, the deep investing fascia of the thigh. The deep surface of the shelving edge attaches to the **iliopubic tract**, the thickened inferior edge of the transversalis fascia.

The arching inferior margins of the **internal abdominal oblique** and **transversus abdominis muscles** form the **roof** of the inguinal canal. Contraction of the anterolateral abdominal wall muscles, for example during a Valsalva maneuver, narrows both the superoinferior and anteroposterior dimensions of the inguinal canal, decreasing the risk of herniation during increased intraabdominal pressure.

The **pectineal ligament** (of Astley Cooper) is a sturdy ligament located along the internal surface of the pecten pubis deep to the lacunar ligament.

Inguinal canal contents and coverings

In the **female**, the contents of the inguinal canal include the **round ligament of the uterus** and the **ilioinguinal nerve**. In the **male**, the contents of the inguinal canal include the **spermatic cord** and ilioinguinal nerve. The **spermatic cord** consists of the testis, vas deferences, and testicular nerves and vessels. As the round ligament or spermatic cord travels through the retroperitoneal fat to enter the inguinal canal, it prolongs successive layers of the anterolateral abdominal wall over its outer surface.

At the deep inguinal ring, a closed tube of peritoneum surrounds the spermatic cord structures as the **tunica vaginalis**, and a layer of transversalis fascia is prolonged over the spermatic cord and testis as the **internal spermatic fascia**. The deep inguinal ring is usually described as an *opening* in the transversalis fascia, but it is actually a reflection and prolongation of the transversalis fascia, rather than a hole in the fascia.

At its passage inferior to the arch of the internal abdominal oblique muscle, the spermatic cord annexes a portion of the internal abdominal oblique muscle as the **cremaster muscle** and prolongs a portion of the internal abdominal oblique fascia as the **cremasteric fascia**.

At its exit from the inguinal canal through the superficial inguinal ring, an opening in the external abdominal oblique aponeurosis, the spermatic cord acquires a layer of external abdominal oblique fascia prolonged as the **external spermatic fascia**.

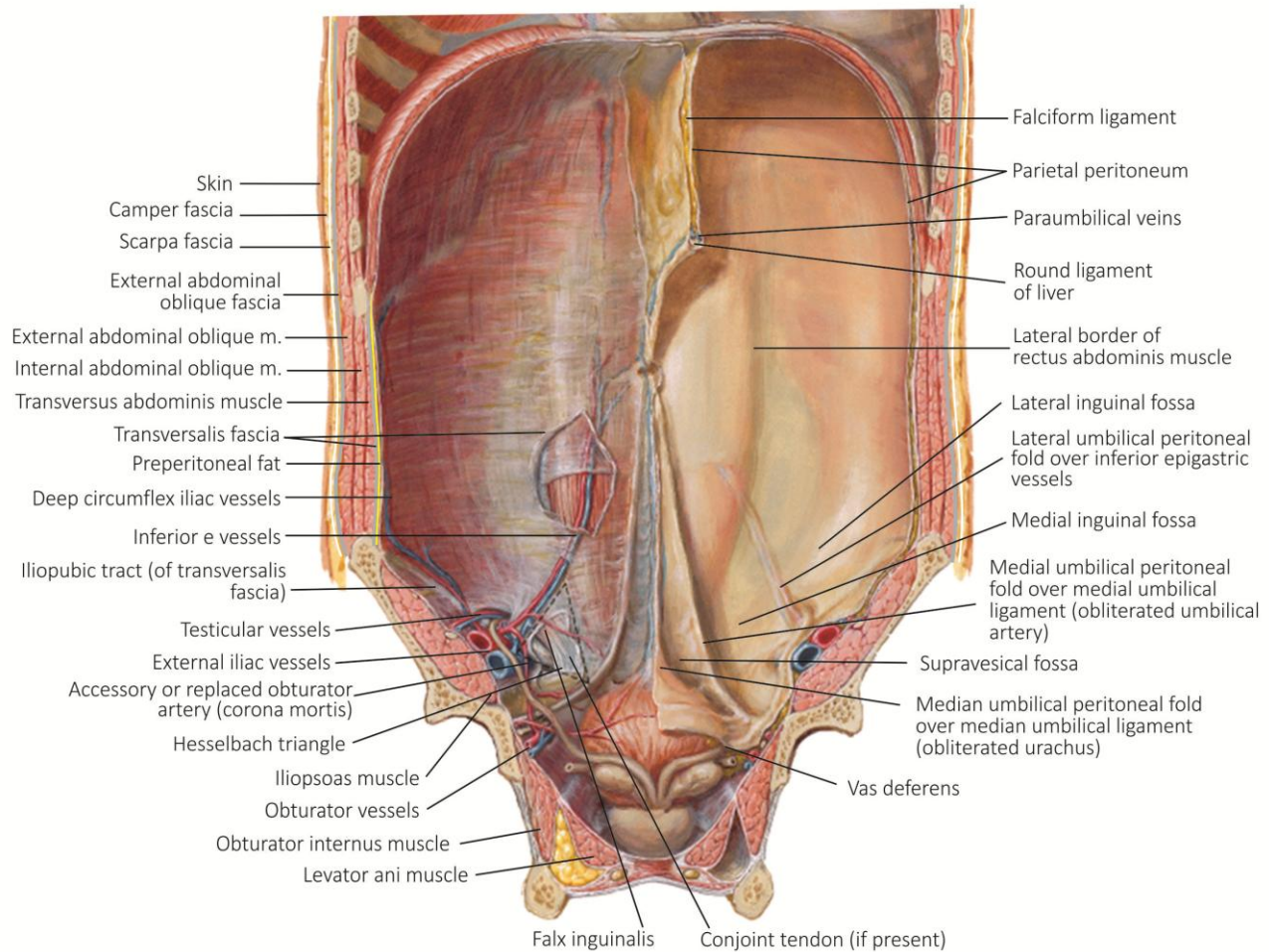


Figure 2-8. Internal surface of the anterior abdominal wall. (Modified from *Netter Atlas of Human Anatomy*, 5th Edition. Philadelphia: Elsevier, 2010.)

1.4 INTERNAL SURFACE OF THE ANTEROLATERAL ABDOMINAL WALL

Parietal peritoneum lines the abdominal surface of the anterior abdominal wall and rises to form **peritoneal folds** where it covers vessels or ligaments (in this case, obliterated embryonic structures) running superiorly on the deep surface of the anterior abdominal wall. (Figure 2-8, right side)

The **median umbilical fold of peritoneum** lies over the **median umbilical ligament**. This ligament represents the obliterated remnant of the embryonic urachus running from the bladder superiorly to the umbilicus.

The **medial umbilical fold of peritoneum** lies over the **medial umbilical ligaments**. These ligaments represent the obliterated remnants of the embryonic umbilical arteries distal to the superior vesical branches to the bladder and run from the superior surface of the bladder to the umbilicus..

The **lateral umbilical fold of peritoneum** covers the **inferior epigastric vessels**. The inferior epigastric vessels run superiorly on the internal surface of the rectus abdominis. Near the umbilicus, they anastomose with branches of the superior epigastric vessels, the inferior continuations of the internal mammary arteries.

The **lateral inguinal fossa**, **medial inguinal fossa**, and **supravesical fossa** are depressions between the umbilical ligaments (Figure 2-8, right side).

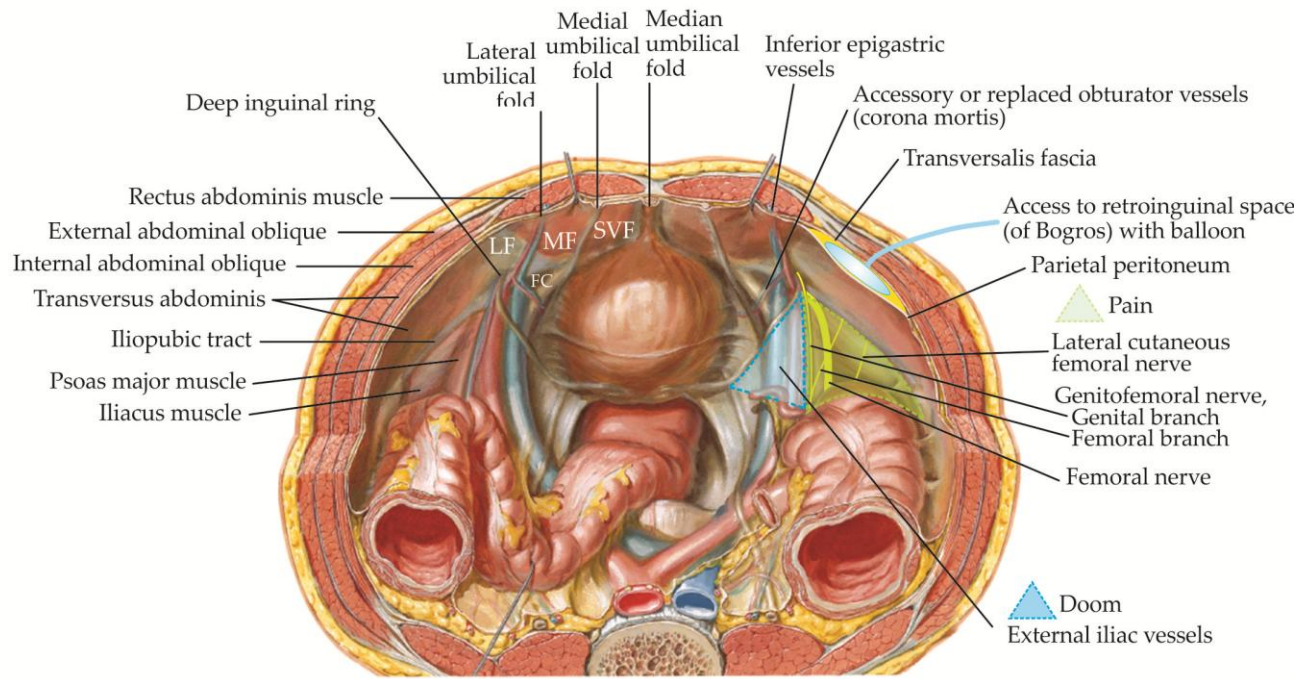


Figure 2-9. Inguinal anatomy, internal aspect. **LF** is lateral fossa, the site for indirect inguinal hernias. **MF** is medial fossa, the site for direct inguinal hernias. **SVF** is supravascular fossa. **FC** is femoral canal, a space within the femoral sheath medial to the femoral vessels. (Modified from *Netter Atlas of Human Anatomy*, 5th Edition. Philadelphia: Elsevier, 2010.)

Triangles of doom and pain

The **lumbosacral plexus** forms within the substance of the psoas major muscle. Important motor and sensory branches of the plexus leave the abdomen near the inguinal region to reach the thigh. The **'triangle of pain'** marks the location of these nerves and lies between the iliopubic tract laterally and the gonadal vessels medially (Figure 3-10).

The **femoral nerve** runs lateral surface to the psoas muscle and enters the femoral triangle inferior to the inguinal ligament, deep to the iliopsoas fascia, and lateral to the femoral sheath. The **anterior cutaneous branches** of the femoral nerve pierce the fascia lata to reach the superficial layers of the thigh.

The **lateral cutaneous nerve of the thigh** runs anteriorly on the iliacus muscle to pierce the fascia lata and gain the superficial layers of the thigh.

The **genitofemoral nerve** runs on the anterior surface of the psoas major muscle. Division of the genitofemoral nerve into its genital and femoral branches may occur almost anywhere along its intraabdominal course. The **femoral branches** of the genitofemoral nerve pierce the deep fascia to reach the thigh. The **genital branches** of the genitofemoral nerve leave the abdomen at the deep inguinal ring with the testicular vessels to enter the inguinal canal

The **ilioinguinal nerve** enters the inguinal canal anterior to the transversus abdominis muscle and does not lie within 'the triangle of pain'.

The **'triangle of doom'** encloses important structures and lies between the gonadal vessels laterally and the ductus deferens medially. The 'triangle of doom' encloses the **external iliac artery and vein**, and may enclose an **accessory obturator artery** or **replaced obturator artery** (corona mortis) from the external iliac or inferior epigastric artery.

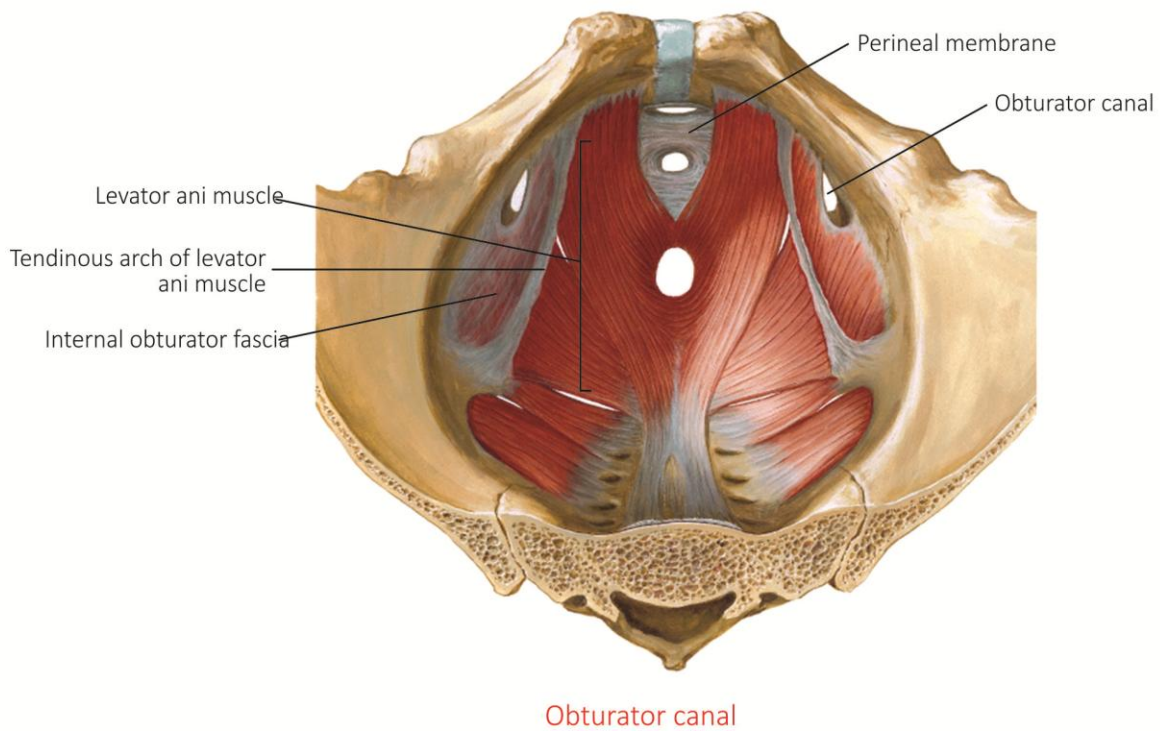
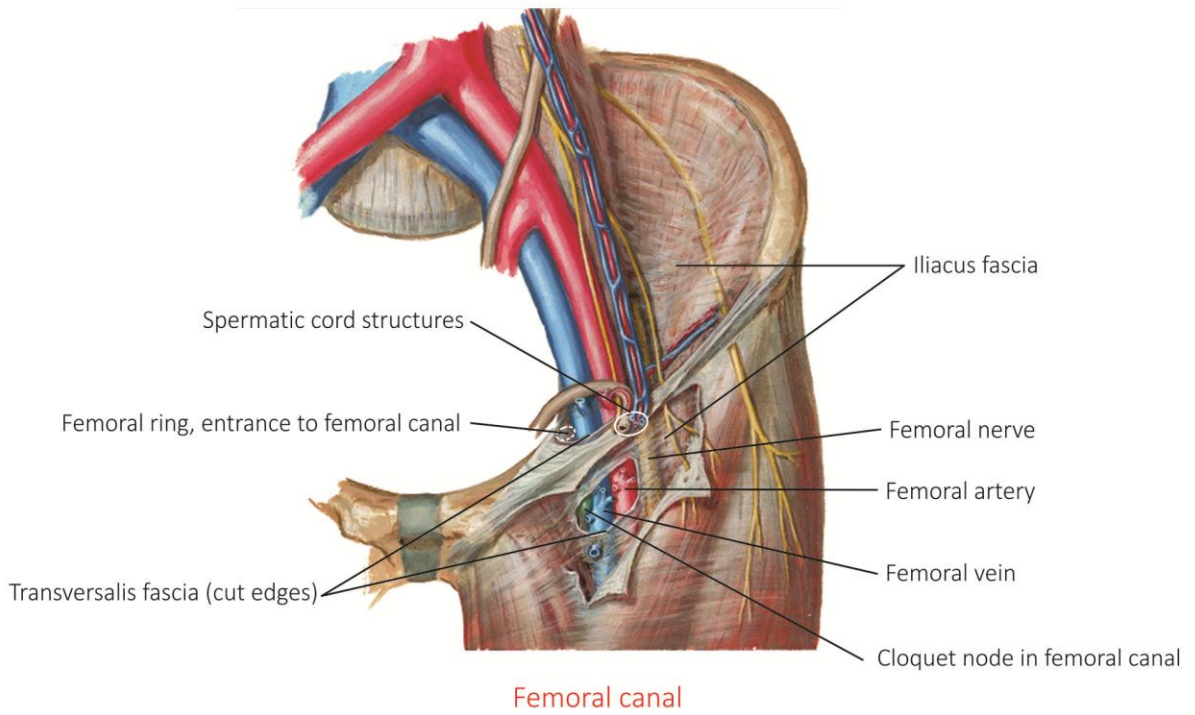


Figure 2-10. Femoral sheath and obturator foramen. (Modified from *Netter Atlas of Human Anatomy*, 5th Edition. Philadelphia: Elsevier, 2010.)

1.5 FEMORAL SHEATH AND OBTURATOR CANAL

Femoral sheath

The **deep lining fascia** of the abdominopelvic cavity forms a continuous layer lining the internal surface of the abdominal wall and surrounding the extraperitoneal connective tissue, peritoneal sac, and abdominopelvic viscera (Figure 2-1). The deep lining fascia of the anterolateral abdominal wall, the transversalis fascia, is continuous posteriorly with the iliacus fascia, psoas fascia, and quadratus lumborum fascia, superiorly with the diaphragmatic fascia, and inferiorly with the fascia of the pelvic diaphragm. Within the abdominopelvic cavity, the **femoral nerve** lies external to the deep lining fascia and the **femoral vessels and lymphatics** lie internal to the deep lining fascia within the extraperitoneal (visceral) fat.

As the femoral nerve, artery, and vein emerge onto the thigh, inferior to the inguinal ligament, a conical extension of the deep lining fascia follows surrounds the femoral vessels to form the **femoral sheath**, but excludes the femoral nerve (Figure 2-11). Inferiorly, the femoral sheath blends with the adventitia of the femoral vessels. The deep investing fascia of the thigh, the **fascia lata**, surrounds the femoral sheath, femoral vessels, and femoral nerve.

Two **vertical septa** subdivide the femoral sheath into three compartments. The **lateral compartment** contains the femoral artery. The **middle compartment** contains the femoral vein. The **medial compartment**, the **femoral canal**, contains lymphatic vessels and the deep inguinal lymph nodes including the node of Cloquet, the highest inguinal node. The **femoral ring** is the superior entrance to the femoral canal.

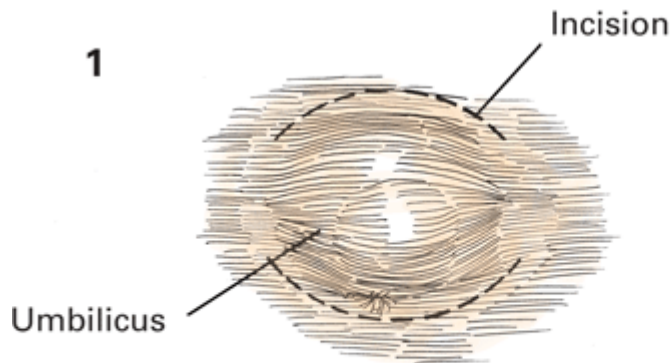
Obturator canal

The obturator foramen is closed by the **obturator membrane**, a sturdy dense connective tissue structure, except for an opening at its superomedial edge, the **obturator canal** (Figure 2-12). The **obturator internus and obturator externus muscles** of the lower limb attach to the internal and external surfaces of the obturator membrane respectively. The thick lining deep fascia over the internal obturator muscle thickens to form the **tendinous arch of the levator ani muscle**, providing attachment for the levator ani (pelvic floor) muscles between the pubic symphysis and ischial spine.

The **obturator canal** normally transmits only the **obturator nerve and vessels** as they leave the abdominopelvic cavity to enter the medial compartment of the thigh.

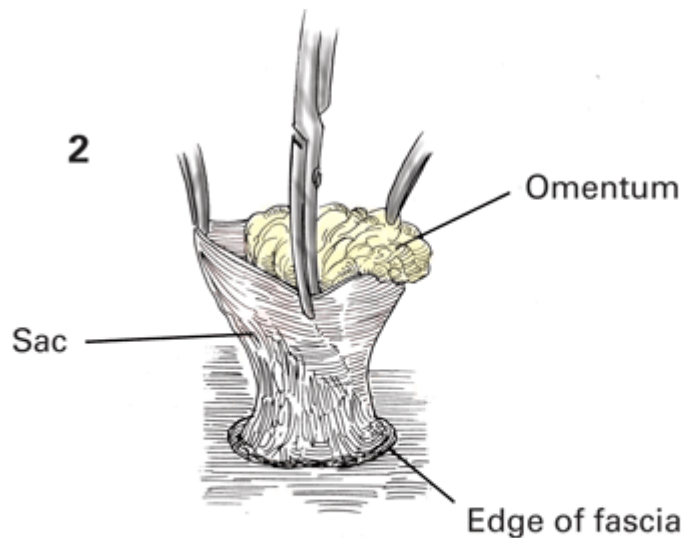
1 UMBILICAL HERNIA/VENTRAL HERNIA REPAIR:

- a. A curved incision is placed superiorly or inferiorly about the umbilicus, though a vertical incision that curves around the umbilicus may be necessary with umbilicus proper retained in the skin flap.



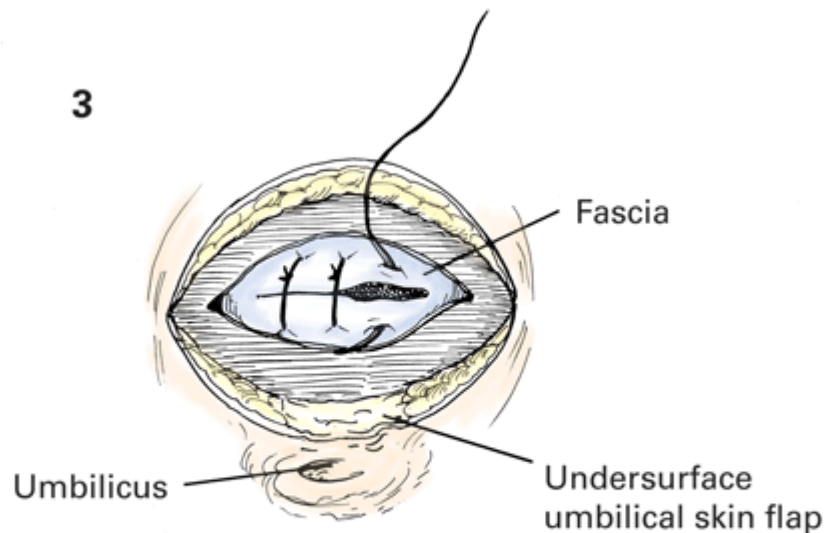
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- b. The hernia sac is easily mobilized except for its attachment to the back of the umbilical skin (do not buttonhole skin).
- c. Neck of the herniated sac is then dissected from adjacent tissues by a combination of blunt and sharp dissection which is carried down to the level of the linea alba and anterior sheaths of the rectus muscle.



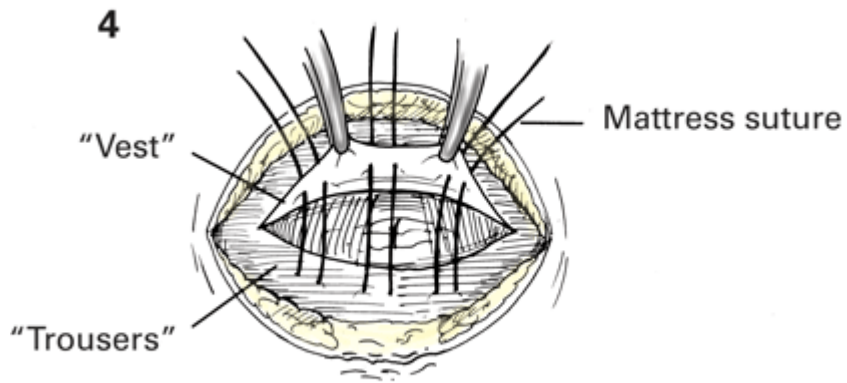
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- d. Sharp dissection is required to detach hernial contents from the sac as well as from the peritoneum around the neck of the sac as it joins the peritoneum. If the omentum cannot easily be freed and/or reduced, it is wise to resect it with sequential clamping and suture ligation placement.
- e. If defect is **less than 2cm in diameter**, the peritoneum is closed and the excess sac excised.
 1. Clean off perimeter of fascial defect and **primary repair** with 00 sutures of delayed absorbable or nonabsorbable nature.

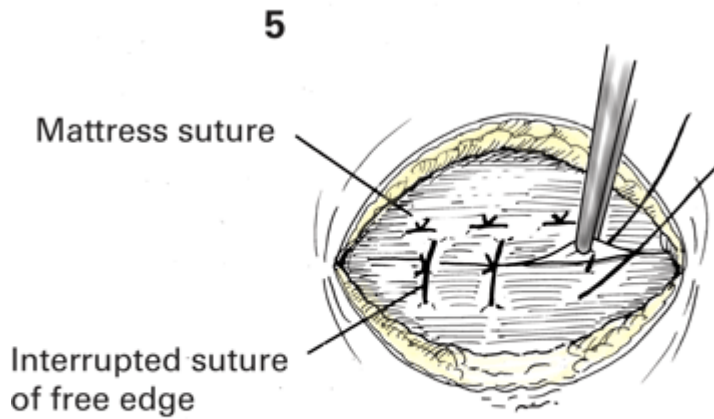


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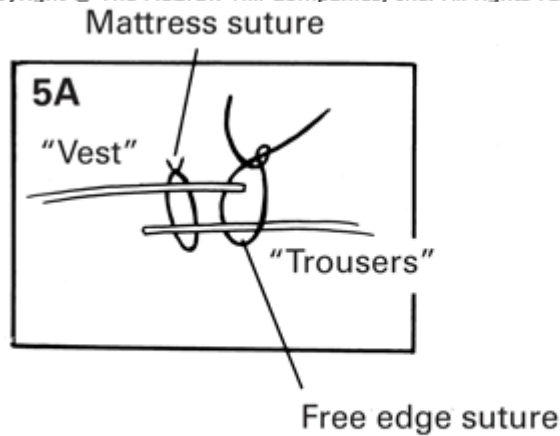
- f. If defect is intermediate defect – 2 to 4 cm – one can repair using two layer “vest-over-trouser (Mayo technique).
 1. The upper fascia is imbricated over the lower fascia with a row of interrupted 00 sutures. These begin and end on the vest (upper part) while the trousers are secured in a horizontal manner. When these sutures are secured, the free superior edge (vest) overhangs the inferior fascia (trousers) and a second layer of interrupted 00 sutures is used to secure the free edge.



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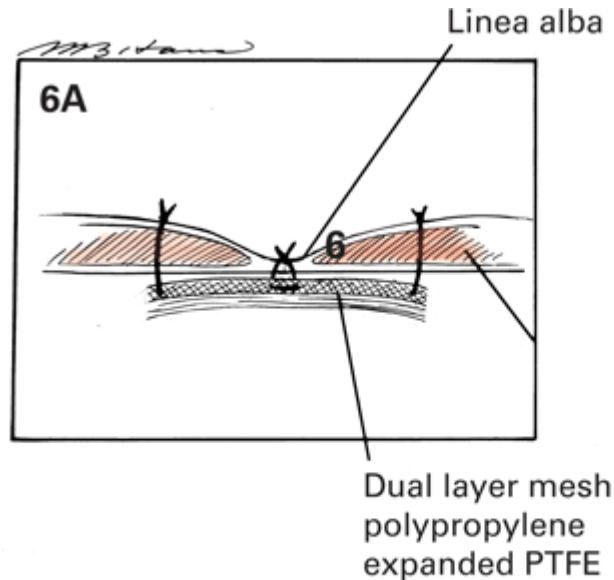


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- g. Medium to large defect – Mesh repair: Preferred site is posterior to the defect and posterior rectus sheath. If not, intra-peritoneal placement can be used using a dual-sided mesh wherein the smooth, nonadherent expanded polytetrafluoroethylene (PTFE) surface is posterior toward the omentum and bowel, while the polypropylene screen-like mesh is anterior against the peritoneum and posterior fascia.
1. Mesh should be sized to extend 3 to 5 cm beyond anticipated edges of the closed defect. Mesh secured with nonabsorbable 00 mattress sutures that are placed full-thickness through linea alba at 12 and 6 o'clock positions and through the rectus sheaths and muscle at 3 and 9 o'clock.

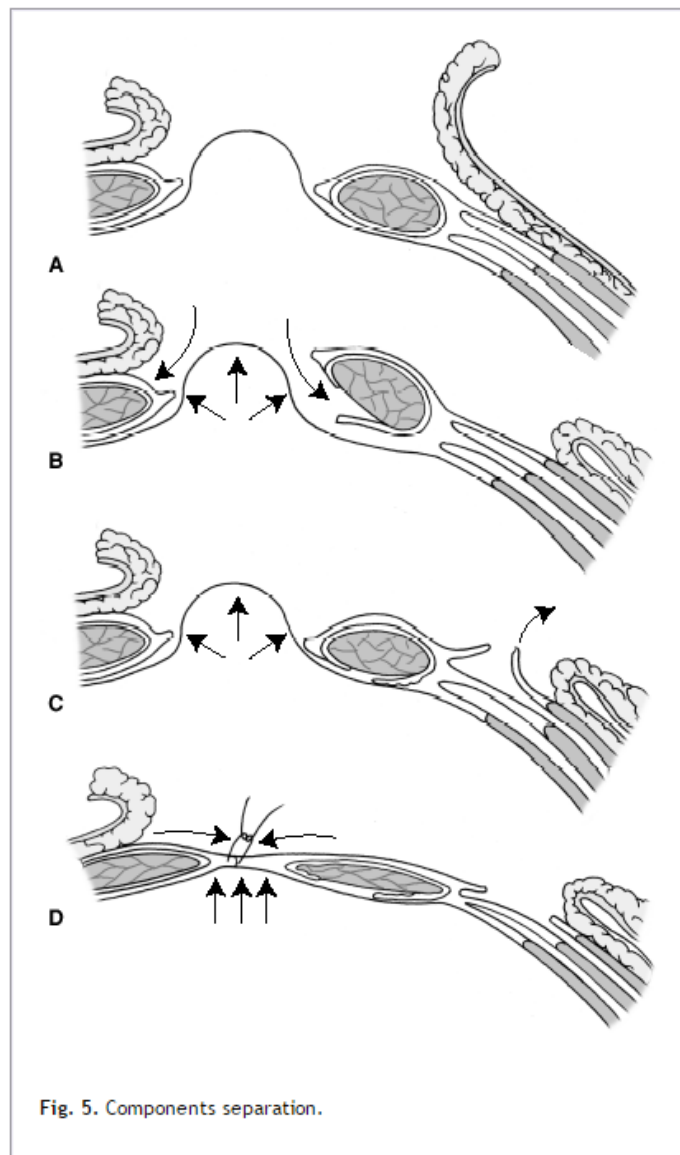


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- h. Skin is closed in layers, making note of apex of the subcutaneous tissue beneath the umbilicus is sutured down to the linea alba with 00 absorbable sutures (for ingoing bellybutton).

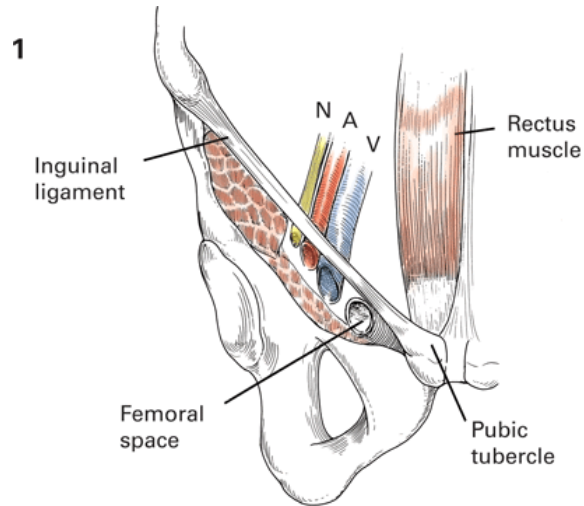
2 COMPONENT SEPARATION TECHNIQUE:

- Release of the external oblique muscle 1-2cm lateral to its insertion into the anterior rectus sheath allows medial advancement of the trimuscle complex composed of the rectus abdominis, internal oblique, and transverse abdominis muscles.
- Neurovascular bundle should be preserved as it travels in the layer between the internal oblique and transverse abdominis muscles.
- Typical mobility includes 5cm of unilateral advancement in the epigastric region, 10cm at the umbilicus, and 3cm in the suprapubic region.
- Allow at least 5cm of overlap between the fascia and mesh to promote good fibrous tissue ingrowth. Avoid large gaps between sutures to prevent bowel interposition (Richter's hernia).



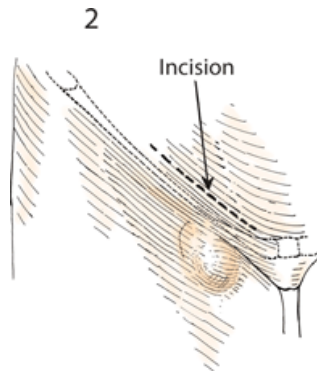
3. FEMORAL HERNIA:

- a. Patient is placed in a supine position with the knees slightly flexed to lessen the tension in the groin. Table tilted slightly with the patient's head down.

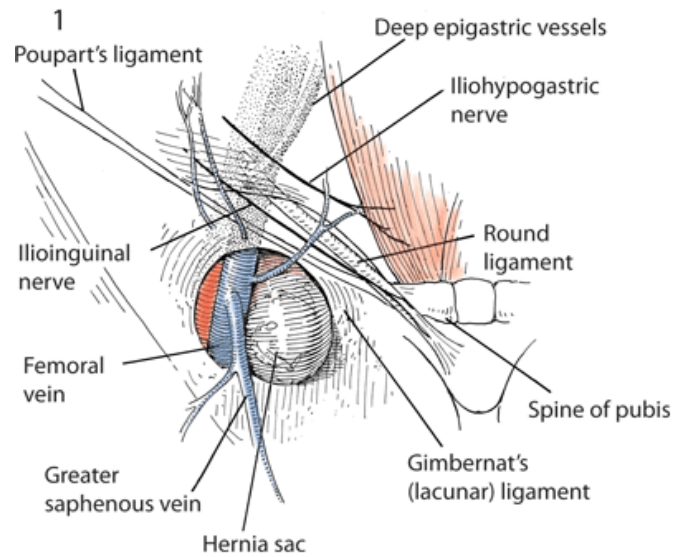


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- b. Incision is made just above inguinal ligament (it is above and parallel in general to the inguinal ligament with a more transverse medial extension) and gives the best exposure of the neck of sac and provides better exposure if bowel resection/anastomosis are necessary. This is carried down to the external oblique fascia, dissected free of the subcutaneous fat.

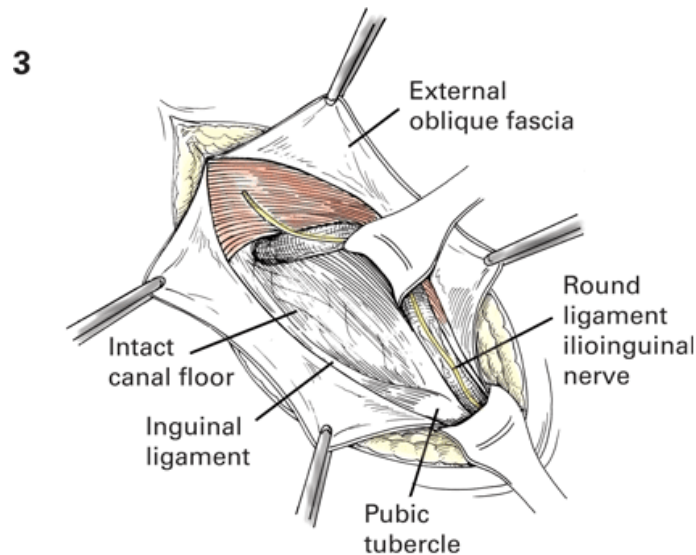


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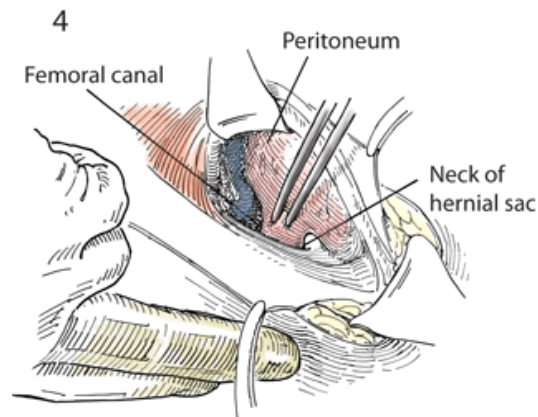
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- c. External oblique fascia is divided in the direction of its fibers.
- d. Spermatic cord or round ligament is retracted upward along with the margin of the conjoined tendon and the neck of the hernia sac is freed from surrounding tissues.



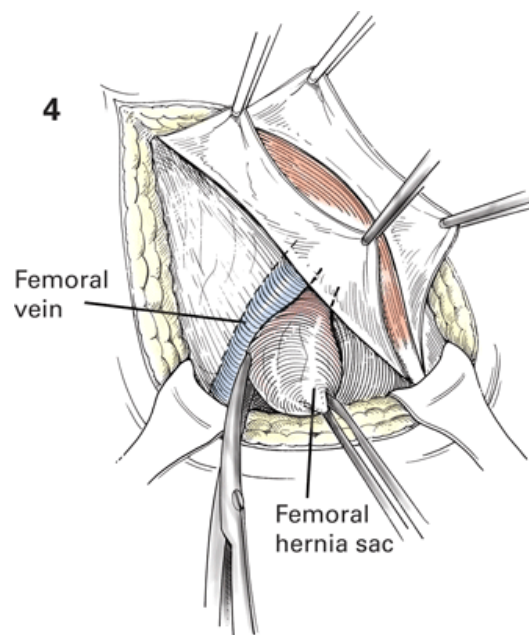
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- e. Reduce sac through femoral canal to the surface - retracting neck of the sac upward with forceps while applying counterpressure from below inguinal ligament.



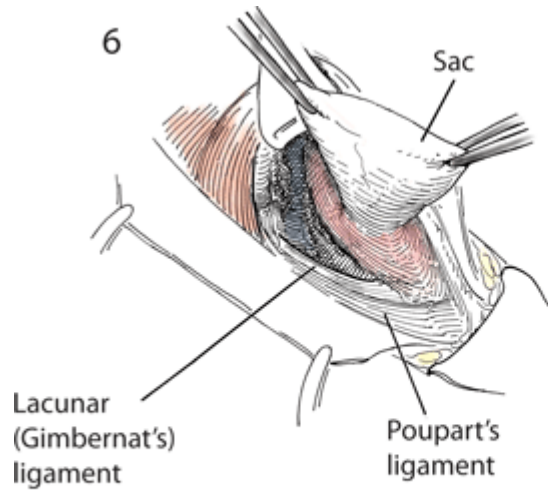
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- f. Alternatively, if the bowel cannot reduce then it becomes necessary to dissect the subcutaneous tissue from the lower leaf of the external oblique until the hernia sac is exposed as it appears in the femoral canal underneath inguinal ligament.



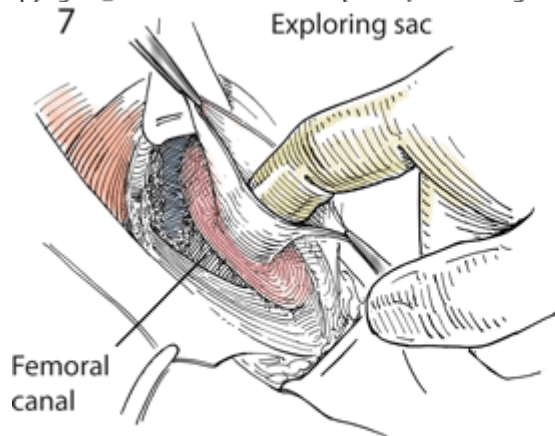
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- g. Sac is opened and a purse-string suture is placed (to include transversalis fascia and peritoneum) at the junction of the sac and peritoneal cavity.



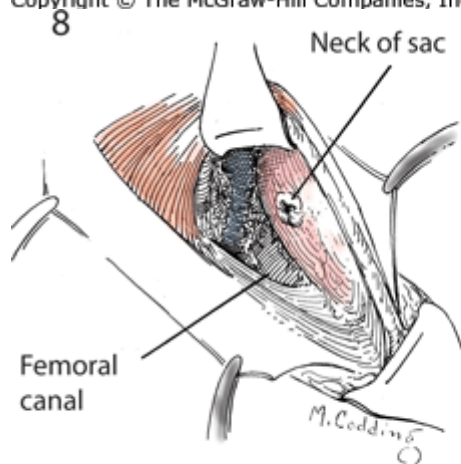
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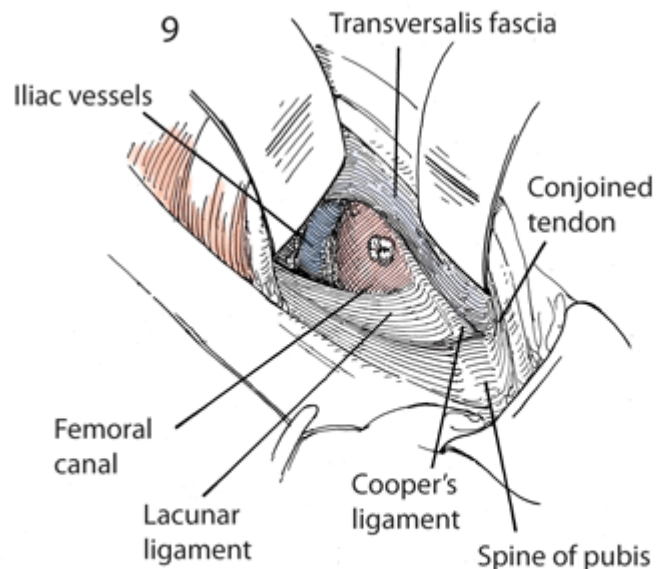


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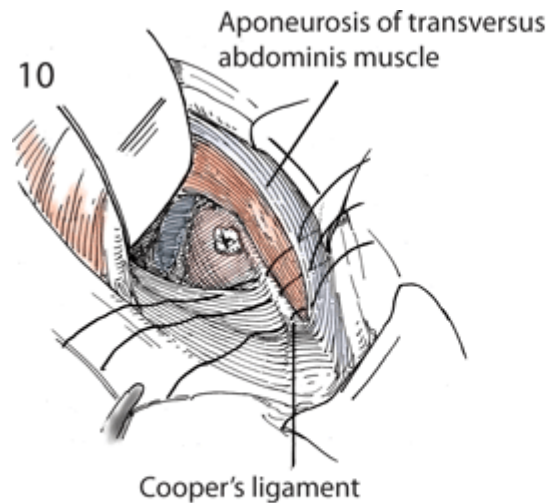
i. Tissue-based (primary repair): McVay (Cooper ligament repair)

- i. McVay/Cooper ligament repair– attaches the musculotendinous structures to Cooper's ligament and the lacunar ligament medially and the inguinal ligament laterally



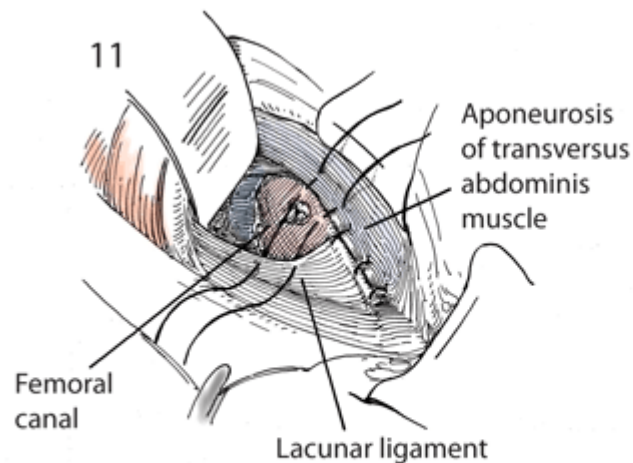
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- ii. Retract conjoined tendon upward and the cord downward, while the transversalis fascia adjacent to the pubic spine is freed from Cooper's ligament.
- iii. Identify Cooper's ligament and dissect free of its fibrous and fatty attachments
- iv. Prior to closure of the fascia to Cooper's ligament, a relaxing vertical incision (2-4cm) is made at the lateral border of the anterior rectus sheath beginning at the pubic tubercle and extending superiorly
- v. Using interrupted sutures, affix the upper border of the transversalis fascia to Cooper's ligament beginning medially at the pubic tubercle and continuing until the femoral sheath is reached



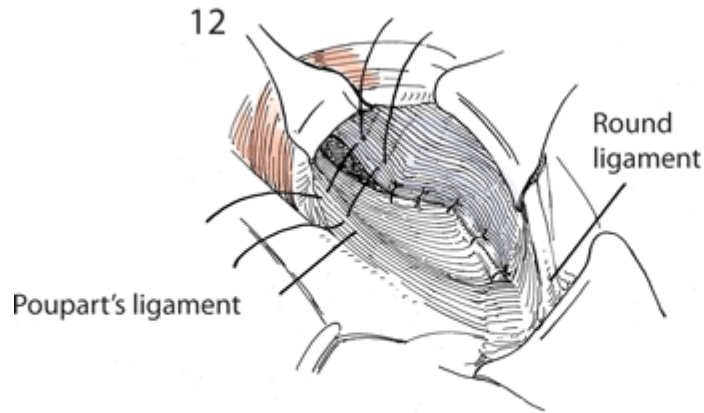
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- vi. The femoral canal is closed by carefully suturing Cooper's ligament to the femoral sheath



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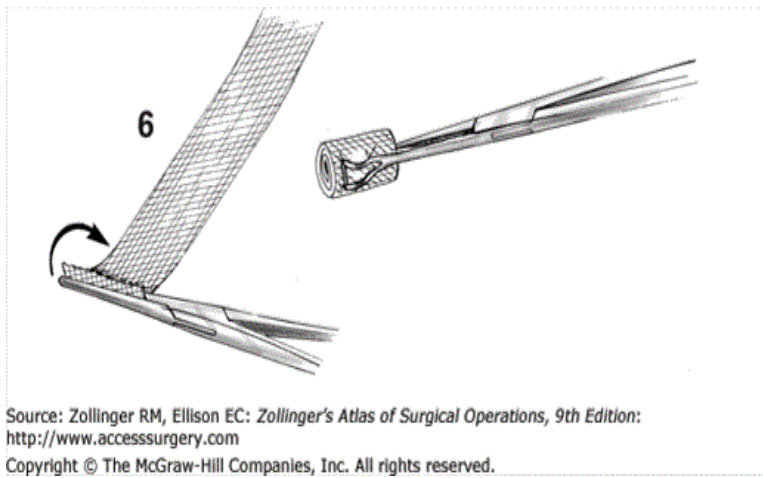
- vii. Continue repair with interrupted sutures between the transversalis fascia and the iliopubic tract laterally until the entrance point of the cord is reached



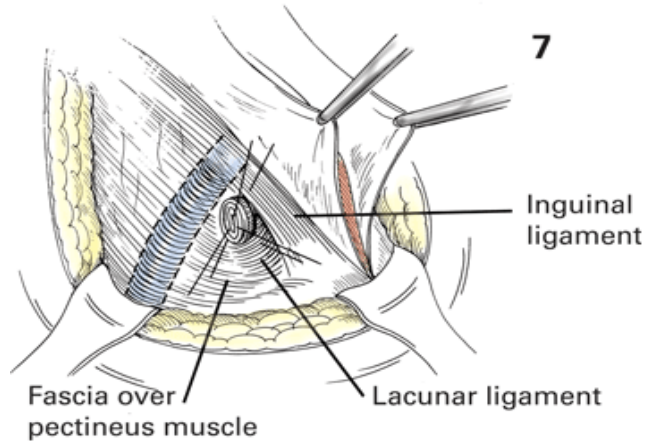
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ii. **Mesh (plug) repair**

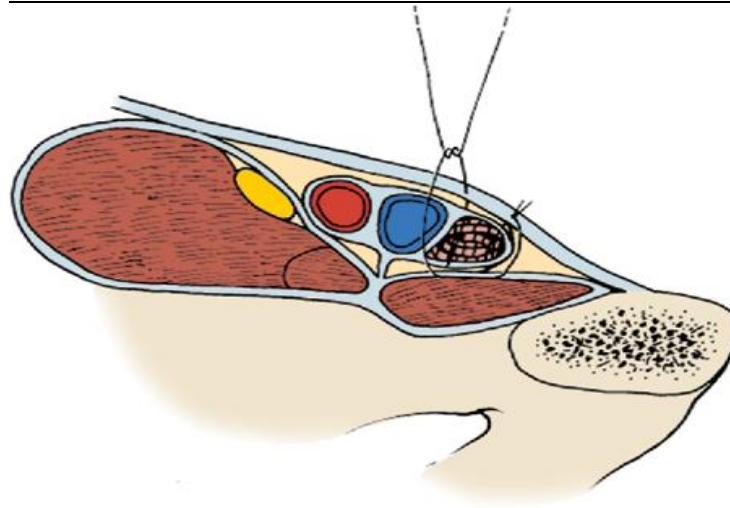
- i. Place mesh plug from cephalad to caudad to obstruct the femoral defect and promote scar tissue formation



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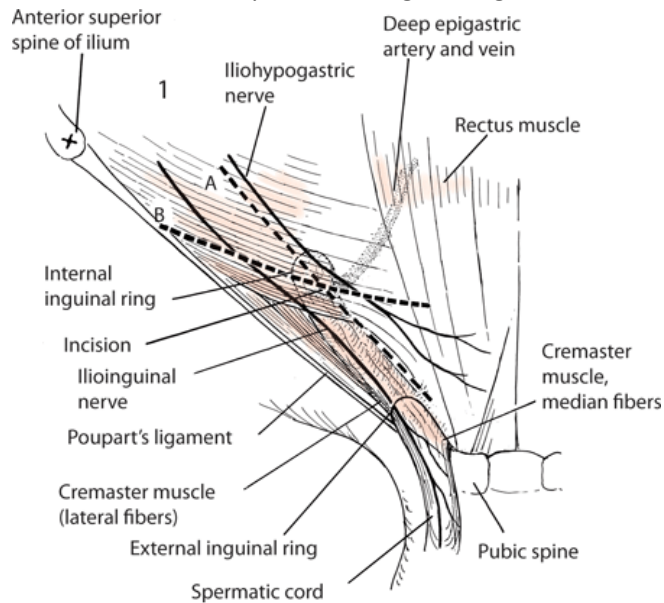
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iii. Simple suture repair

- viii. Tack the inguinal ligament anteriorly to Cooper's ligament posteromedially to close the defect

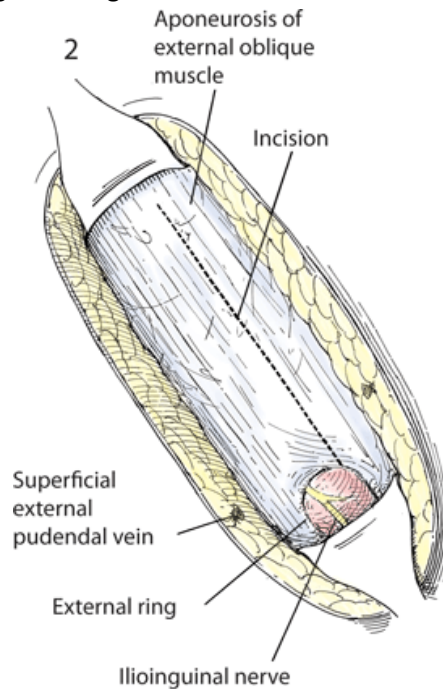
4 INGUINAL HERNIA: INDIRECT DEFECT

- a. Skin incision made 2 to 3 cm above and parallel to inguinal ligament



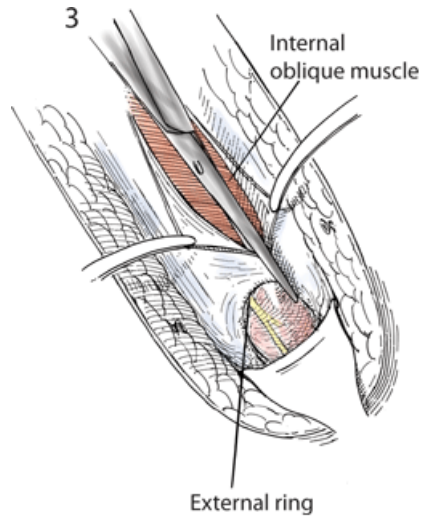
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- b. Dissection is carried down to external oblique aponeurosis (EOA) that is cleaned of all fat by sharp dissection throughout length of the wound. Self-retaining retractor may be placed.



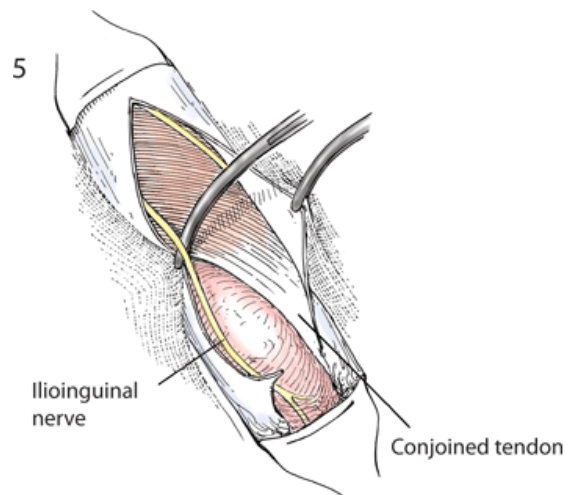
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- c. Small incision is made in the direction of fibers of the EOA extending to external inguinal ring with metzenbaum scissors taking care to avoid injury to underlying ilioinguinal nerve.



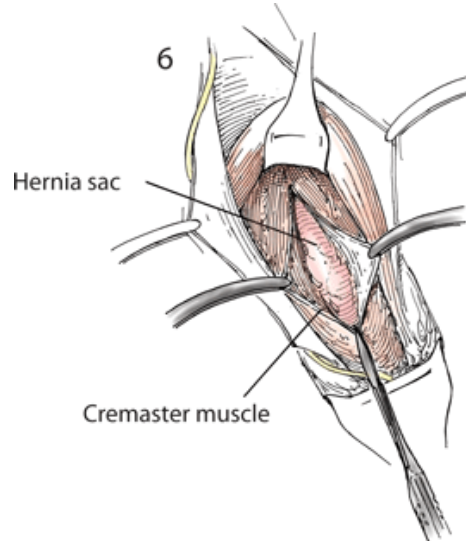
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- d. Clean off the preperitoneal tissue from the inguinal ligament and transversalis shelving edge to the pubic tubercle.
- e. Dissect down and isolate the cord. Identify sac (white membrane) – typically on the anterior medial to the cord.



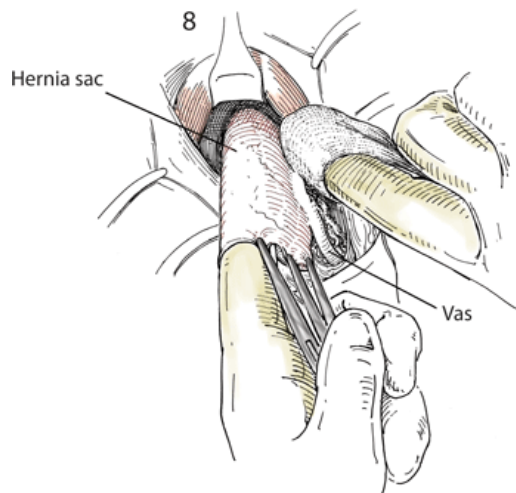
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f. Sac is opened within 2 to 3 cm of its neck and exploration carried out to rule out pantaloon, secondary



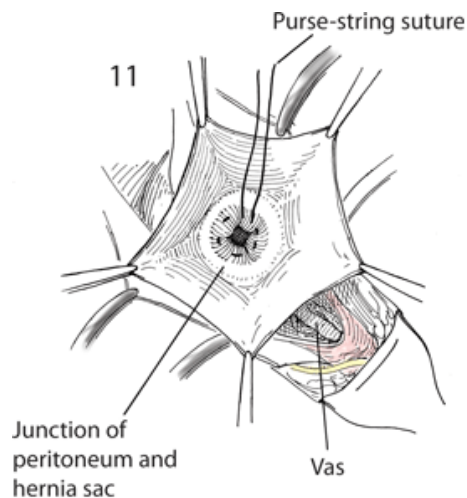
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g. Obliteration of the sac – purse-string suture at the inner side of neck. Excess sac amputated with scissors.

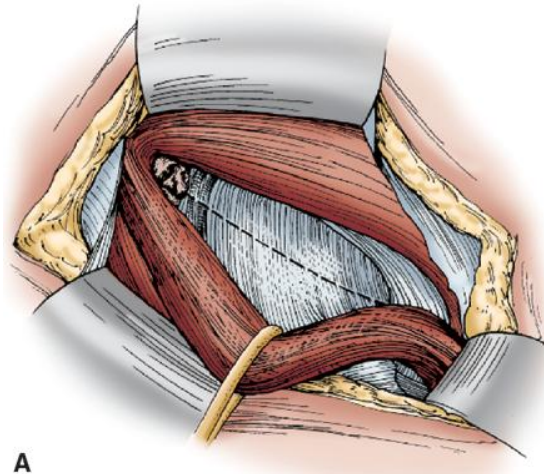


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h. **Primary tissue repair: Bassini** – approximate the inguinal ligament (ileopubic tract) to the conjoined tendon (aponeurosis of transversus muscle) and internal oblique musculature with interrupted non-absorbable 0-suture. **The initial suture should include the periosteum of the pubic spine and the medial portion of the conjoined tendon

i. **Primary tissue repair: Shouldice repair** – Primary tenants of hernia repair include: tightening of the internal ring and closure of the transversalis fascia to the inguinal ligament

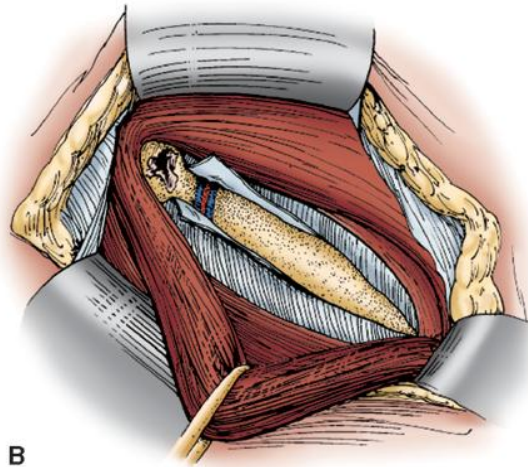
1. The original Shouldice repair used **continuous stainless steel wire suture for all four layers of repair. Permanent synthetic suture** is used today.
2. After suitable exposure and isolation of the cord, a pair of scissors is passed posterior to the transversalis fascia beginning at the medial pillar of the internal ring and extending inferomedially to the pubic tubercle.



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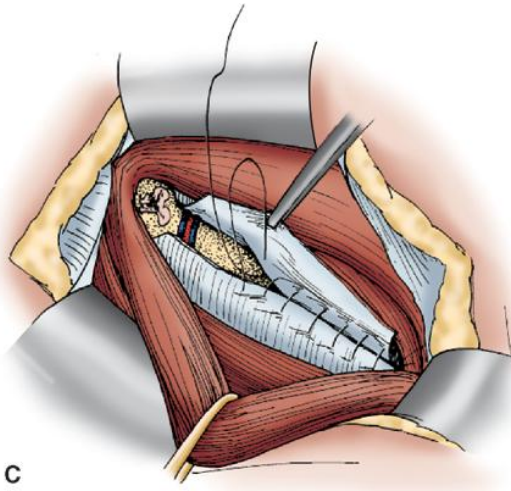
3. Transversalis fascia is separated from the preperitoneal fat plane



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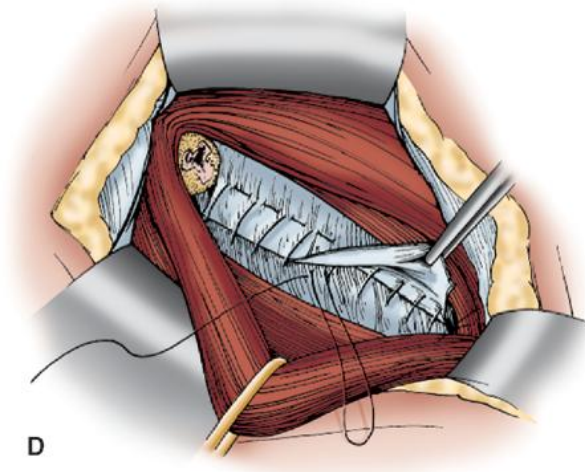
4. Identify and preserve inferior epigastric vessels that reside in the preperitoneal space
5. First layer of repair: Start medially at the pubic tubercle to and through the internal ring by suturing the free edge of the lower transversalis flap in a continuous, imbricated fashion behind the upper flap to the posterior surface of the upper transversalis fascia and the lateral component of the posterior rectus sheath



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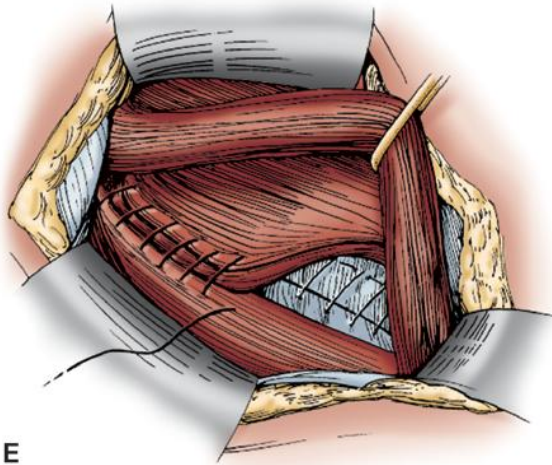
6. The first layer is not tied and continued as a second layer in a running fashion from lateral to medial closing the upper transversalis flap to the base of the lower edge as well as the inguinal ligament
7. The second layer is tied to the original tail that started the first layer



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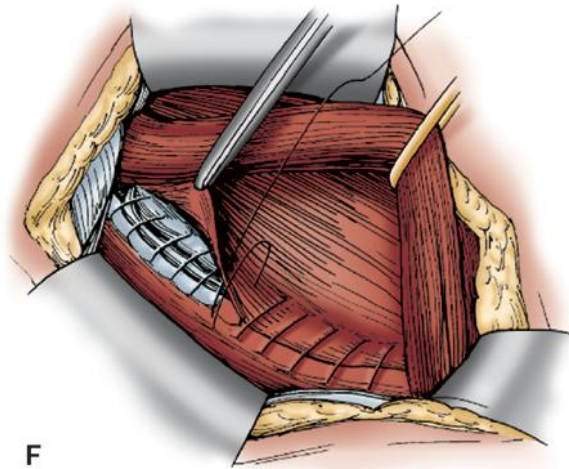
8. The third layer of continuous suture starts at the tightened internal ring and brings together the conjoined tendon (the internal oblique and transversus abdominis aponeuroses) medially with the inguinal ligament laterally



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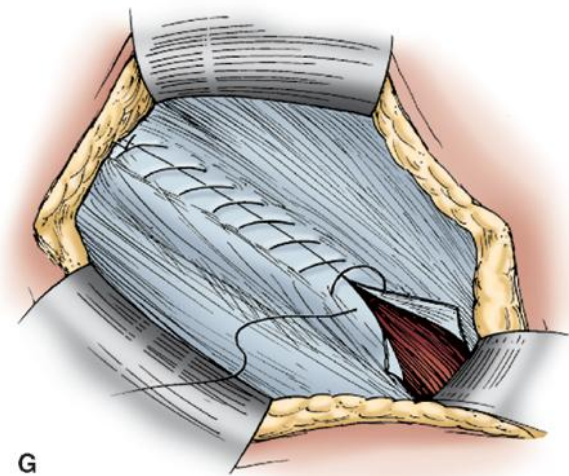
9. Continue continuous suture down to pubic tubercle and return to the internal ring as the fourth layer.
10. Fourth layer of repair: Starts at pubic tubercle and includes the anterior rectus sheath medially with the posterior aspect of the external oblique aponeurosis laterally.



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11. The cord can now be relaxed gently on the new inguinal floor, and the EOA is closed in one to two additional continuous layers extending down to the external ring.

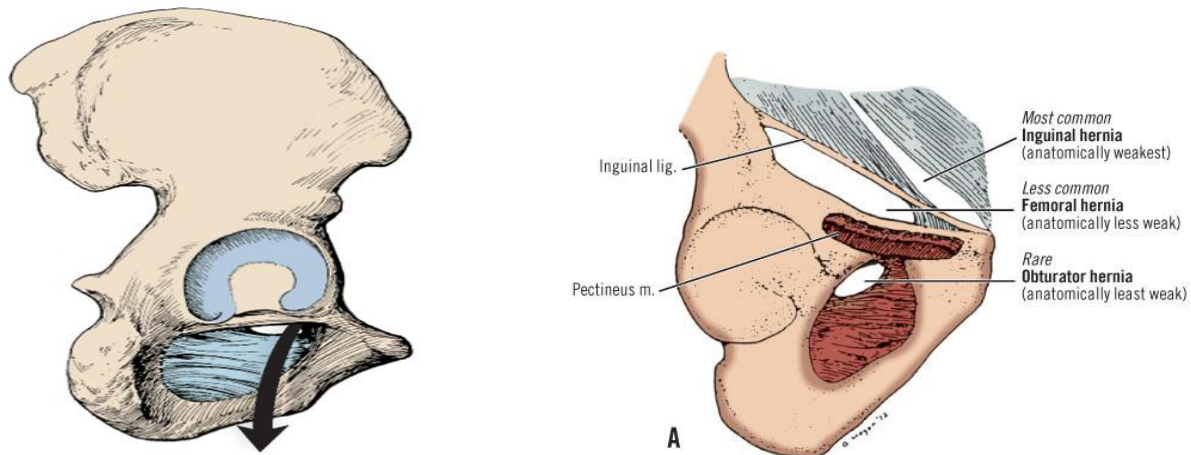


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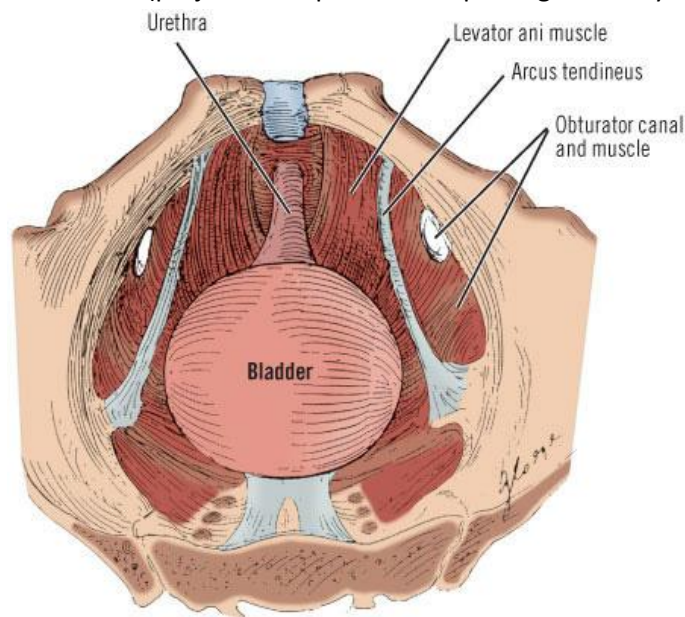
5 OBTURATOR HERNIA:



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a. Extraperitoneal approach:

- i. Lower midline incision
- ii. Enter preperitoneal plane, peel bladder from the peritoneum
- iii. Expose superior pubic ramus and the obturator internus muscle
- iv. Identify the hernia sac (projection of peritoneum passing inferiorly into the obturator canal)

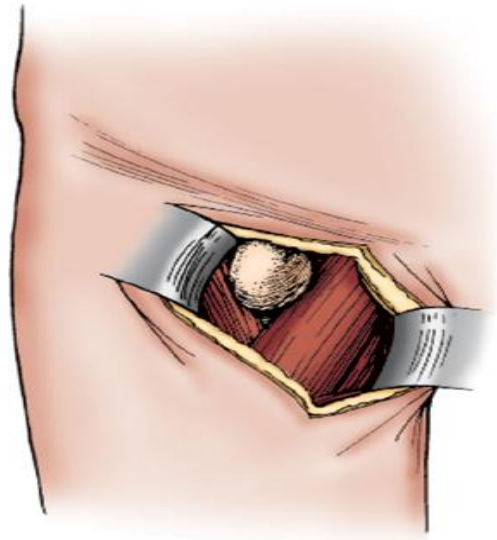


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- v. Reduce the hernia
- vi. Close the internal opening to the obturator canal (preperitoneal mesh may be placed)

b. Thigh approach:

- i. Vertical incision in the upper medial thigh along the adductor longus muscle
- ii. Retract the muscle medially to expose the pectineus muscle
- iii. Cut pectineus muscle across to expose the sac



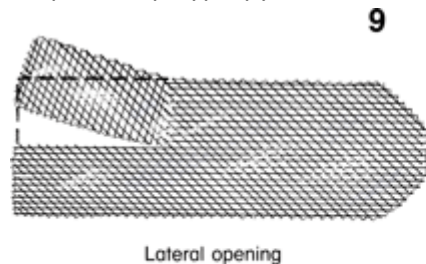
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- iv. Reduce hernia, excise the sac
- v. Close hernia opening
- vi. If bowel contents within the hernia sac do not appear viable, midline laparotomy is usually performed

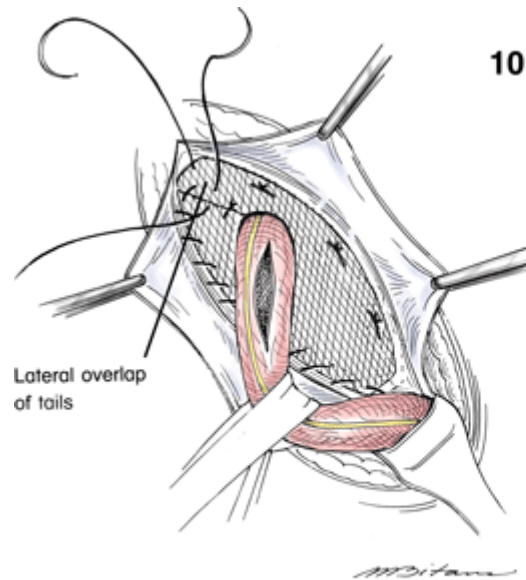
6 INGUINAL HERNIA REPAIR WITH MESH:

1. Skin incision 2 to 3 cm above and parallel to inguinal ligament
2. Dissection carried down through Scarpa's fascia to external oblique aponeurosis (EOA)
3. A self-retaining retractor is placed
4. A small incision is made in the direction of the fibers of EOA extending to external ring with Metzenbaum scissors
5. Identify and avoid injury to the underlying ilioinguinal nerve
6. Grasp the free edges of the external oblique fascia with hemostats medially and laterally
7. Use blunt dissection to clean off preperitoneal tissue from the internal oblique muscle superiorly and cord inferiorly
8. Dissect down and isolate the cord and encircle with penrose drain
9. Identify the hernia sac **anteromedial to the cord**, if indirect defect.
10. Open the cremaster muscle anteriorly and identify the vital cord structures
11. The indirect sac is freed from the cord using electrocautery and gentle traction
12. Sac is opened within 2 to 3 cm of its neck and exploration carried out to rule out pantaloon (**also acceptable**: hernia sac is NOT opened and returned to the preoperational space)
13. Obliterate the sac under direct vision – e.g., purse-string suture at the inner side of the neck and amputate excess sac
14. Cut a rectangular piece of polypropylene mesh with a lateral slit for the cord



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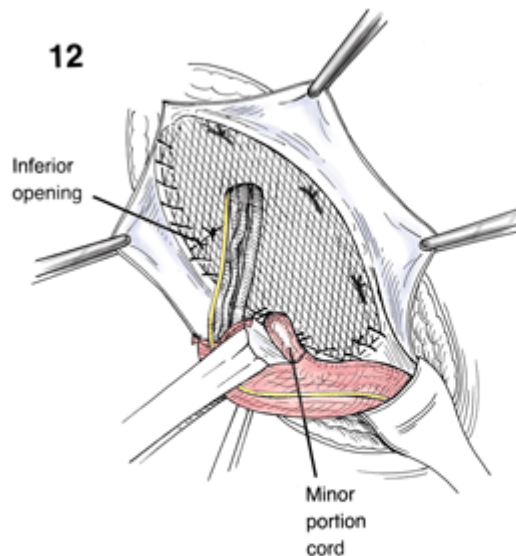
15. Position mesh on the floor of the canal with the tails overlapping lateral to the internal ring and cord



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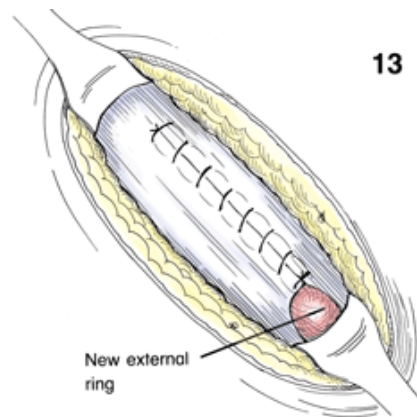
16. Using a non-absorbable (2-0) suture anchor the mesh to the pubic tubercle and run a continuous suture to secure the inferior edge of the mesh to the inguinal ligament
17. Use interrupted sutures to anchor the superior edge of the mesh to the internal oblique muscle. (**Care is taken to allow mesh to be loose and wrinkle longitudinally i.e., TENSION free**)



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18. Overlap the two tails of the mesh and sew together
19. External oblique fascia is reapproximated with a running suture of absorbable material creating snug external ring



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