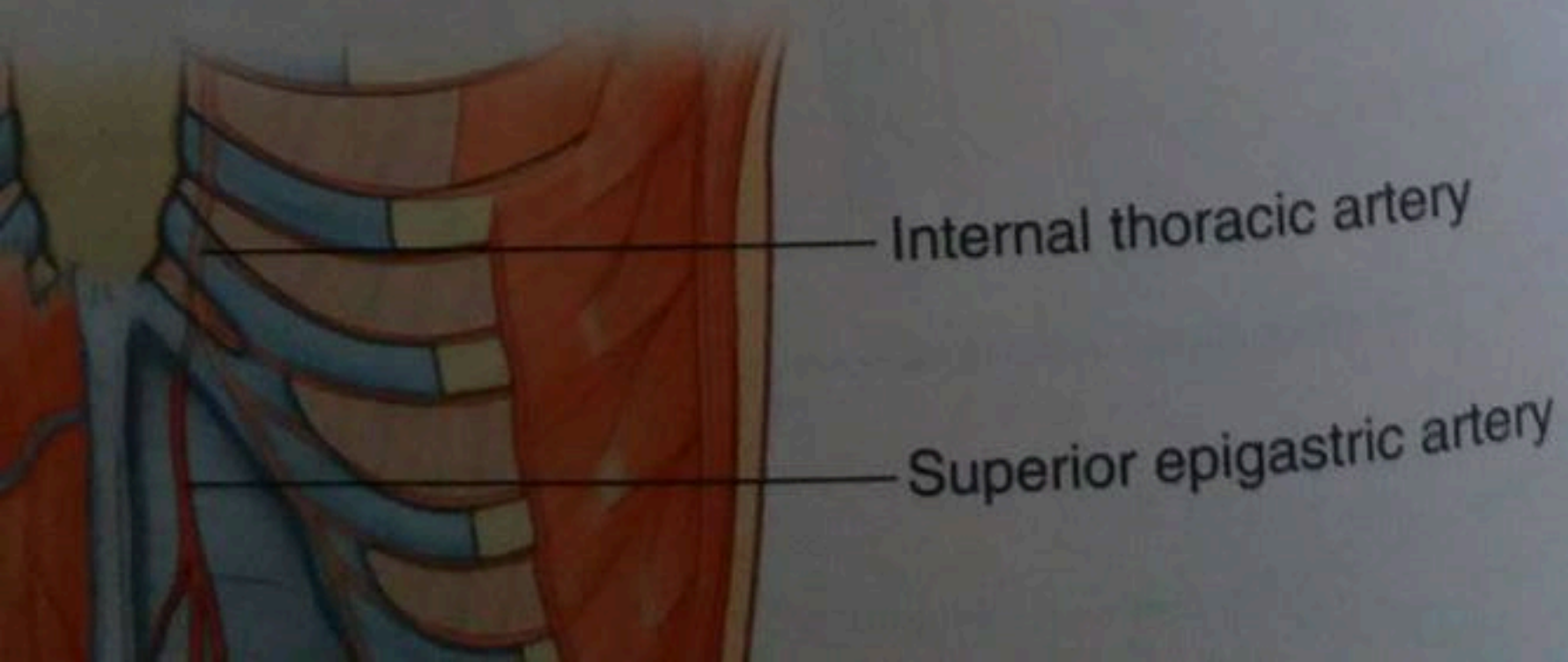


- Deep lymphatic drainage follows the deep arteries back to **parasternal nodes** along the internal thoracic artery, lumbar nodes along the abdominal aorta, and external iliac nodes along the external iliac artery.

GROIN

The groin (inguinal region) is the area of junction between the anterior abdominal wall and the thigh. In this area, the abdominal wall is weakened from changes that occur during development and a peritoneal sac or diverticulum with or without abdominal contents, can therefore protrude through it, creating an inguinal hernia. This type of hernia can occur in both sexes, but it is most common in males.



The inherent weakness in the anterior abdominal wall in the groin is caused by changes that occur during the development of the gonads. Before the descent of the testes and ovaries from their initial position high in the posterior abdominal wall, a peritoneal outpouching (the processus vaginalis) forms (Fig. 4.41), protruding through the various layers of the anterior abdominal wall and acquiring coverings from each:

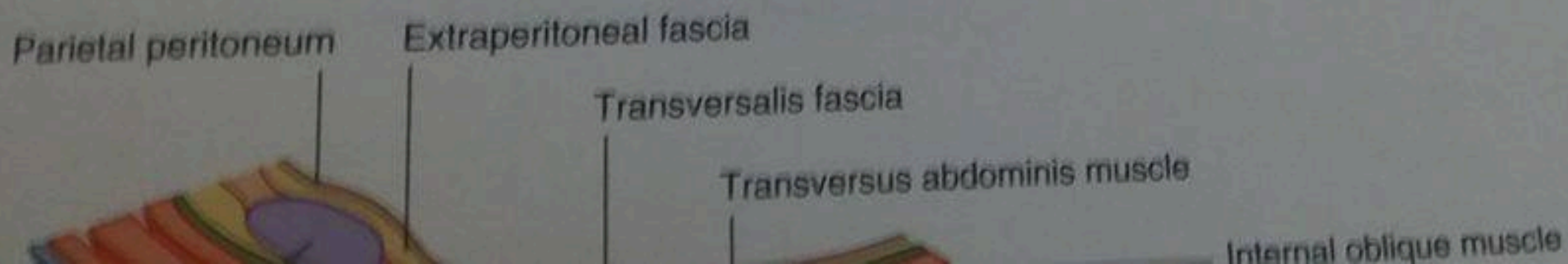
- The transversalis fascia forms its deepest covering.
- The second covering is formed by the musculature of the internal oblique (a covering from the transversus abdominis muscle is not acquired because the processus vaginalis passes under the arching fibers of this abdominal wall muscle).
- Its most superficial covering is the aponeurosis of the external oblique.

As a result the processus vaginalis is transformed into a tubular structure with multiple coverings from the layers of the anterior abdominal wall. This forms the basic structure of the **inguinal canal**.

The final event in this development is the descent of the testes into the scrotum or of the ovaries into the pelvic cavity. This process depends on the development of the gubernaculum, which extends from the inferior border of the developing gonad to the labioscrotal swellings (Fig. 4.41).

The processus vaginalis is immediately anterior to the gubernaculum within the inguinal canal.

In men, as the testes descend, the testes and their accompanying vessels, ducts, and nerves pass through the inguinal canal and are therefore surrounded by the same fascial layers of the abdominal wall. Testicular descent completes the formation of the spermatic cord in men.



Abdomen

In women, the ovaries descend into the pelvic cavity and become associated with the developing uterus. Therefore, the only remaining structure passing through the inguinal canal is the round ligament of the uterus, which is a remnant of the gubernaculum.

The development sequence is concluded in both sexes when the processus vaginalis obliterates. If this does not occur or is incomplete, a potential weakness exists in the anterior abdominal wall and an inguinal hernia may develop. In males, only proximal regions of the tunica vaginalis obliterate. The distal end expands to enclose most of the testis in the scrotum. In other words, the cavity of the tunica vaginalis in men forms as an extension of the developing peritoneal cavity that becomes separated off during development.

Inguinal canal

The inguinal canal is a slit-like passage that extends in a downward and medial direction, just above and parallel to the lower half of the inguinal ligament. It begins at the

deep inguinal ring and continues for approximately 4 cm. The contents of the canal are the genital branch of the genitofemoral nerve, the spermatic cord in men, and the round ligament of the uterus in women. Additionally, in both sexes, the ilio-inguinal nerve passes through part of the canal, exiting through the superficial inguinal ring, with the other contents.

Deep inguinal ring

The deep (internal) inguinal ring is the beginning of the inguinal canal and is at a point midway between the anterior superior iliac spine and the pubic symphysis (Fig. 4.43). It is just above the inguinal ligament and immediately lateral to the inferior epigastric vessels. Although sometimes referred to as a defect or opening in the transversalis fascia, it is actually the beginning of the tubular evagination of transversalis fascia that forms one of the coverings (the internal spermatic fascia) of the spermatic cord in men or the round ligament of the uterus in women.

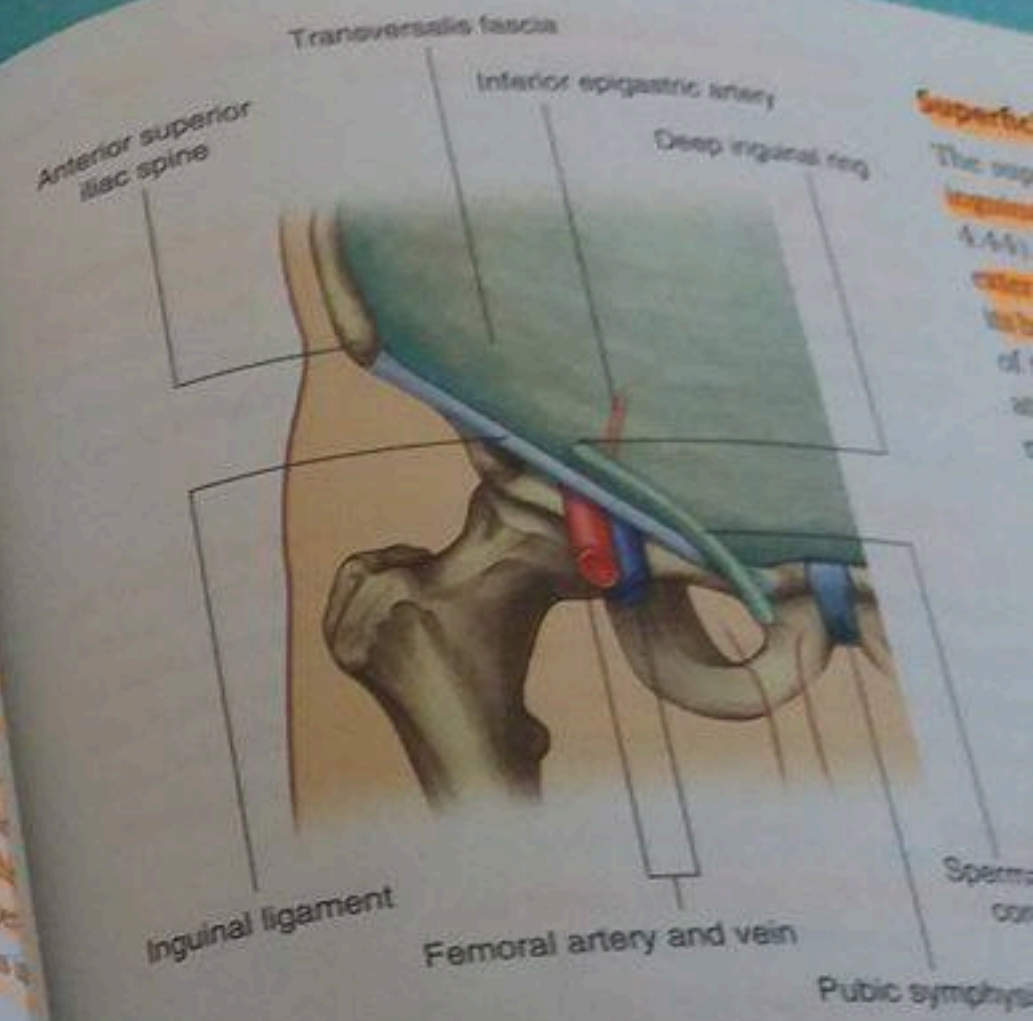
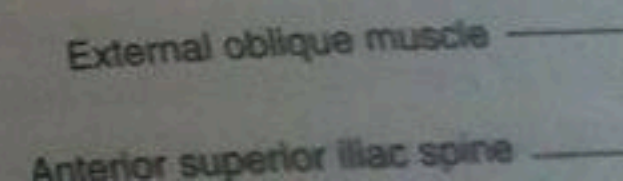


Fig. 4.43 Deep inguinal ring and the transversalis fascia.



Superficial inguinal ring

The superficial (external) inguinal ring is the end of the inguinal canal and is superior to the pubic tubercle (Fig. 4.44). It is a triangular opening in the aponeurosis of the external oblique, with its apex pointing superolaterally and its base formed by the pubic crest. The two remaining sides of the triangle (the **medial crus** and the **lateral crus**) are attached to the pubic symphysis and the pubic tubercle, respectively. At the apex of the triangle the two crura are held together by crossing (intercrural) fibers, which prevent further widening of the superficial ring.

As with the deep inguinal ring, the superficial inguinal ring is actually the beginning of the tubular evagination of the aponeurosis of the external oblique onto the structures traversing the inguinal canal and emerging from the superficial inguinal ring. This continuation of tissue over the spermatic cord is the **external spermatic fascia**.

Aponeurosis of external oblique

Anterior wall

The anterior wall of the inguinal canal is formed along its entire length by the aponeurosis of the external oblique muscle (Fig. 4.44). It is also reinforced laterally by the lower fibers of the internal oblique that originate from the lateral two-thirds of the inguinal ligament (Fig. 4.45). This adds an additional covering over the deep inguinal ring, which is a potential point of weakness in the anterior abdominal wall. Furthermore, as the internal oblique muscle covers the deep inguinal ring, it also contributes a layer (the **cremasteric fascia** containing the **cremasteric muscle**) to the coverings of the structures traversing the inguinal canal.

Posterior wall

The posterior wall of the inguinal canal is formed along its entire length by the **transversalis fascia** (see Fig. 4.43). It is reinforced along its medial one-third by the **conjoint tendon (inguinal falx)** (Fig. 4.45). This tendon is the combined insertion of the transversus abdominis and internal oblique muscles into the pubic crest and pectineal line.

As with the internal oblique muscle's reinforcement of the area of the deep inguinal ring, the position of the conjoint tendon posterior to the superficial inguinal ring

provides additional support to a potential point of weakness in the anterior abdominal wall.

Roof

The roof (superior wall) of the inguinal canal is formed by the arching fibers of the transversus abdominis and internal oblique muscles (Figs. 4.45 and 4.46). They pass from their lateral points of origin from the inguinal ligament to their common medial attachment as the conjoint tendon.

Floor

The floor (inferior wall) of the inguinal canal is formed by the medial one-half of the inguinal ligament. This rolls under, free margin of the lowest part of the aponeurosis of the external oblique forms a gutter or trough on which the contents of the inguinal canal are positioned. The lacunar ligament reinforces most of the medial part of the gutter.

Contents

The contents of the inguinal canal are:

- the spermatic cord in men, and
- the round ligament of the uterus and genital branch of the genitofemoral nerve in women.

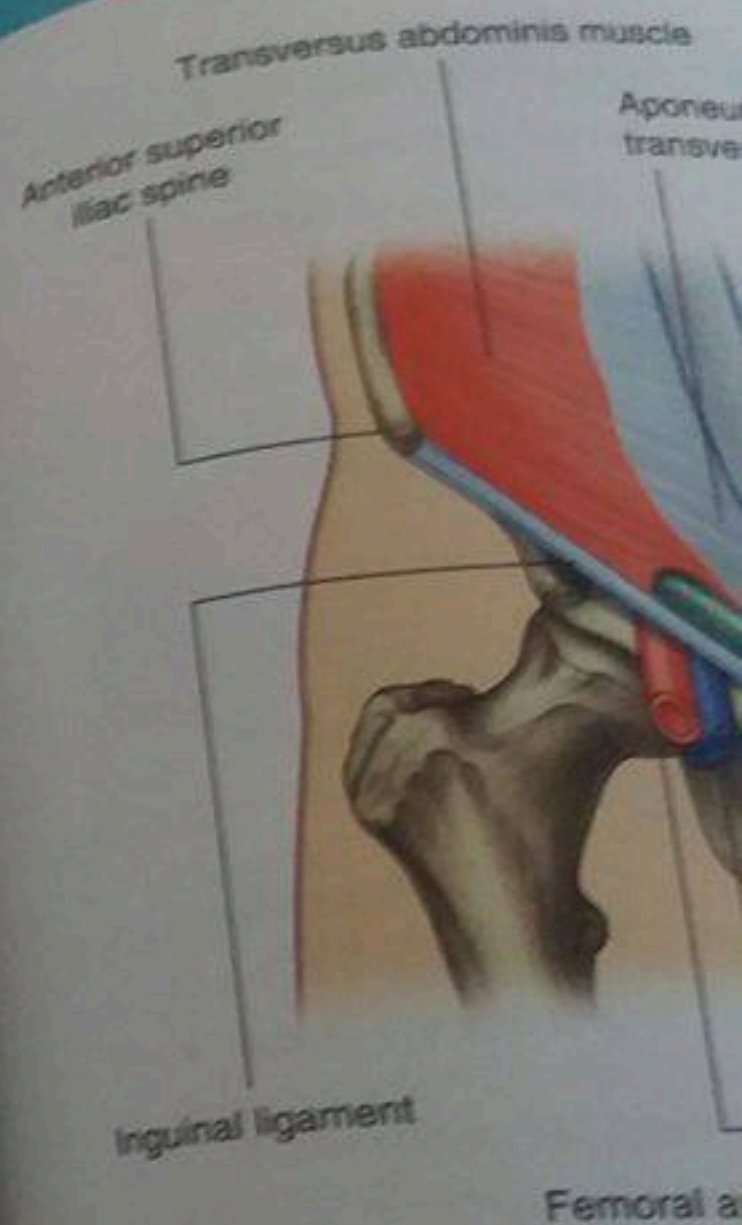


Fig. 4.46 Transversus abdominis muscle

These structures enter the deep inguinal ring and exit the superficial inguinal ring.

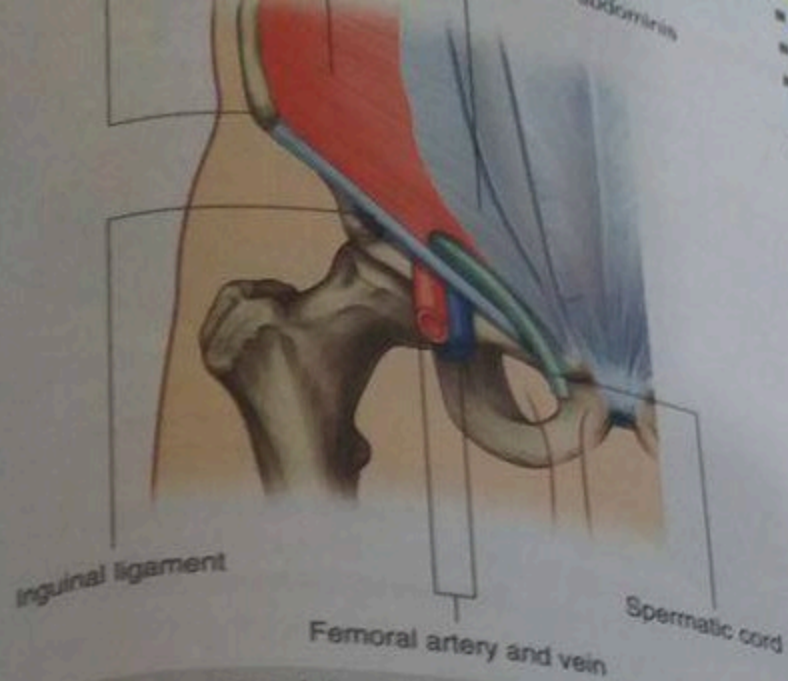


Fig. 4.46 Transversus abdominis muscle and the inguinal canal.

These structures enter the inguinal canal through the deep inguinal ring and exit it through the superficial inguinal ring.

Additionally, the ilio-inguinal nerve (L1) passes through part of the inguinal canal. This nerve is a branch of the lumbar plexus, enters the abdominal wall posteriorly by piercing the internal surface of the transversus abdominis muscle, and continues through the layers of the anterior abdominal wall by piercing the internal oblique muscle. As it continues to pass inferomedially, it enters the inguinal canal. It continues down the canal to exit through the superficial inguinal ring.

Spermatic cord

The spermatic cord begins to form proximally at the deep inguinal ring and consists of structures passing between the abdominopelvic cavities and the testis, and the three fascial coverings that enclose these structures (Fig. 4.47).

The structures in the spermatic cord include:

- the ductus deferens,
- the artery to the ductus deferens (from the inferior vesical artery),

- the testicular artery (from the abdominal aorta)
- the pampiniform plexus of veins (testicular vein)
- the cremasteric artery and vein (small vessels with the cremasteric fascia)
- the genital branch of the genitofemoral nerve (union to the cremasteric muscle)
- sympathetic and visceral afferent nerve fibers
- lymphatics, and
- remnants of the processus vaginalis.

These structures enter the deep inguinal ring down the inguinal canal, and exit from the superficial inguinal ring, having acquired the three fascial coverings during their journey. This collection of fascias continues into the scrotum where they connect with the testes and the fascias of the spermatic cord.

- The internal spermatic fascia, which arises from the transversalis fascia at the margins of the deep inguinal ring.
- The cremasteric fascia with the cremasteric muscle, which is the middle fascial covering of the spermatic cord.
- The external spermatic fascia, which is the superficial covering of the spermatic cord, arising from the aponeurosis of the external oblique muscle attached to the margins of the superficial inguinal ring (Fig. 4.47).

Round ligament of the uterus

The round ligament of the uterus is a ligament that passes from the uterus to the labia majora. It enters the inguinal canal through the deep inguinal ring and exits through the superficial inguinal ring. At this point, it has changed to a few strands of tissue, which are associated with the labia majora. After passing through the inguinal canal, it acquires the three fascial coverings of the spermatic cord in men.

The round ligament of the uterus is the remnant of the original gubernaculum of the ovary that develops from the ovary to the labia majora. The gubernaculum of the ovary continues to the labia majora, and the gubernaculum of the uterus continues to the labia majora that develop from the gubernaculum.

aponeurosis of
transversus abdominis



Spermatic cord

vein

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include:

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- the testicular artery (from the abdominal aorta),
- the pampiniform plexus of veins (testicular veins),
- the cremasteric artery and vein (small vessels associated with the cremasteric fascia),
- the genital branch of the genitofemoral nerve (innervation to the cremasteric muscle),
- sympathetic and visceral afferent nerve fibers,
- lymphatics, and
- remnants of the processus vaginalis.

These structures enter the deep inguinal ring, proceed down the inguinal canal, and exit from the superficial inguinal ring, having acquired the three fascial coverings during their journey. This collection of structures and fascias continues into the scrotum where the structures connect with the testes and the fascias surround the testes.

Three fascias enclose the contents of the spermatic cord:

- The internal spermatic fascia, which is the deepest layer, arises from the transversalis fascia and is attached to the margins of the deep inguinal ring.
- The cremasteric fascia with the associated cremasteric muscle, which is the middle fascial layer, arises from the internal oblique muscle.
- The external spermatic fascia, which is the most superficial covering of the spermatic cord, arises from the aponeurosis of the external oblique muscle and is attached to the margins of the superficial inguinal ring (Fig. 4.47).

Round ligament of the uterus

The round ligament of the uterus is a cord-like structure that passes from the uterus to the deep inguinal ring where it enters the inguinal canal. It passes down the inguinal canal and exits through the superficial inguinal ring. At this point, it has changed from a cord-like structure to a few strands of tissue, which attach to the connective tissue associated with the labia majora. As it traverses the inguinal canal, it acquires the same coverings as the spermatic cord in men.

The round ligament of the uterus is the long distal part of the original gubernaculum in the fetus that extends from the ovary to the labioscrotal swellings. From its attachment to the uterus, the round ligament of the uterus continues to the ovary as the ligament of the ovary that develops from the short proximal end of the gubernaculum.

In the clinic

Cremasteric reflex

In men, the cremaster muscle and cremasteric fascia form the middle or second covering of the spermatic cord. This muscle and its associated fascia are supplied by the genital branch of the genitofemoral nerve (L1/L2). Contraction of this muscle and the resulting elevation of the testis can be stimulated by a reflex arc. Gently touching the skin at and around the anterior aspect of the superior part of the thigh stimulates the sensory fibers in the ilio-inguinal nerve. These sensory fibers enter the spinal cord at level L1. At this level, the sensory fibers stimulate the motor fibers carried in the genital branch of the genitofemoral nerve, which results in contraction of the cremaster muscle and elevation of the testis.

The cremasteric reflex is more active in children, tending to diminish with age. As with many reflexes, it may be absent in certain neurological disorders. Although it can be used for testing spinal cord function at level L1 in men, its clinical use is limited.



Fig. 4.48 Indirect

Inguinal hernias

An inguinal hernia is the protrusion or passage of a peritoneal sac, with or without abdominal contents, through a weakened part of the abdominal wall in the groin. It occurs because the peritoneal sac enters the inguinal canal either:

- indirectly, through the deep inguinal ring, or
- directly, through the posterior wall of the inguinal canal.

Inguinal hernias are therefore classified as either indirect or direct.

Indirect inguinal hernias

The indirect inguinal hernia is the most common of the two types of inguinal hernia and is much more common in men than in women (Fig. 4.48). It occurs because some

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An inguinal hernia is the passage of a peritoneal sac, with or without abdominal contents, through a weakened part of the abdominal wall in the groin. It occurs because the peritoneal sac enters the inguinal canal either:

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Inguinal hernias are therefore classified as either indirect or direct.

Indirect inguinal hernias

The indirect inguinal hernia is the most common of the two types of inguinal hernia and is much more common in men than in women (Fig. 4.48). It occurs because some

part, or all, of the embryonic processus vaginalis remains open or patent. It is therefore referred to as being congenital in origin.

The protruding peritoneal sac enters the inguinal canal by passing through the deep inguinal ring, just lateral to the inferior epigastric vessels. The extent of its excursion down the inguinal canal depends on the amount of processus vaginalis that remains patent. If the entire processus vaginalis remains patent, the peritoneal sac may traverse the length of the canal, exit the superficial inguinal ring, and continue into the scrotum in men or the labia majus in women. In this case, the protruding peritoneal sac acquires the same three coverings as those associated with the spermatic cord in men or the round ligament of the uterus in women.

Abdomen

Direct inguinal hernias

A peritoneal sac that enters the medial end of the inguinal canal directly through a weakened posterior wall is a direct inguinal hernia (Fig. 4.49). It is usually described as acquired because it develops when abdominal musculature has been weakened, and is commonly seen in mature men. The bulging occurs medial to the inferior epigastric vessels in the inguinal triangle (Hesselbach's triangle), which is bounded:

- laterally by the inferior epigastric artery,
- medially by the rectus abdominis muscle, and
- inferiorly by the inguinal ligament (Fig. 4.50).

Internally, a thickening of the transversalis fascia (the iliopubic tract) follows the course of the inguinal ligament (Fig. 4.50).

This type of inguinal hernia does not traverse the entire length of the inguinal canal but may exit through the superficial inguinal ring. When this occurs, the peritoneal sac acquires a layer of external spermatic fascia and can extend, like an indirect hernia, into the scrotum.

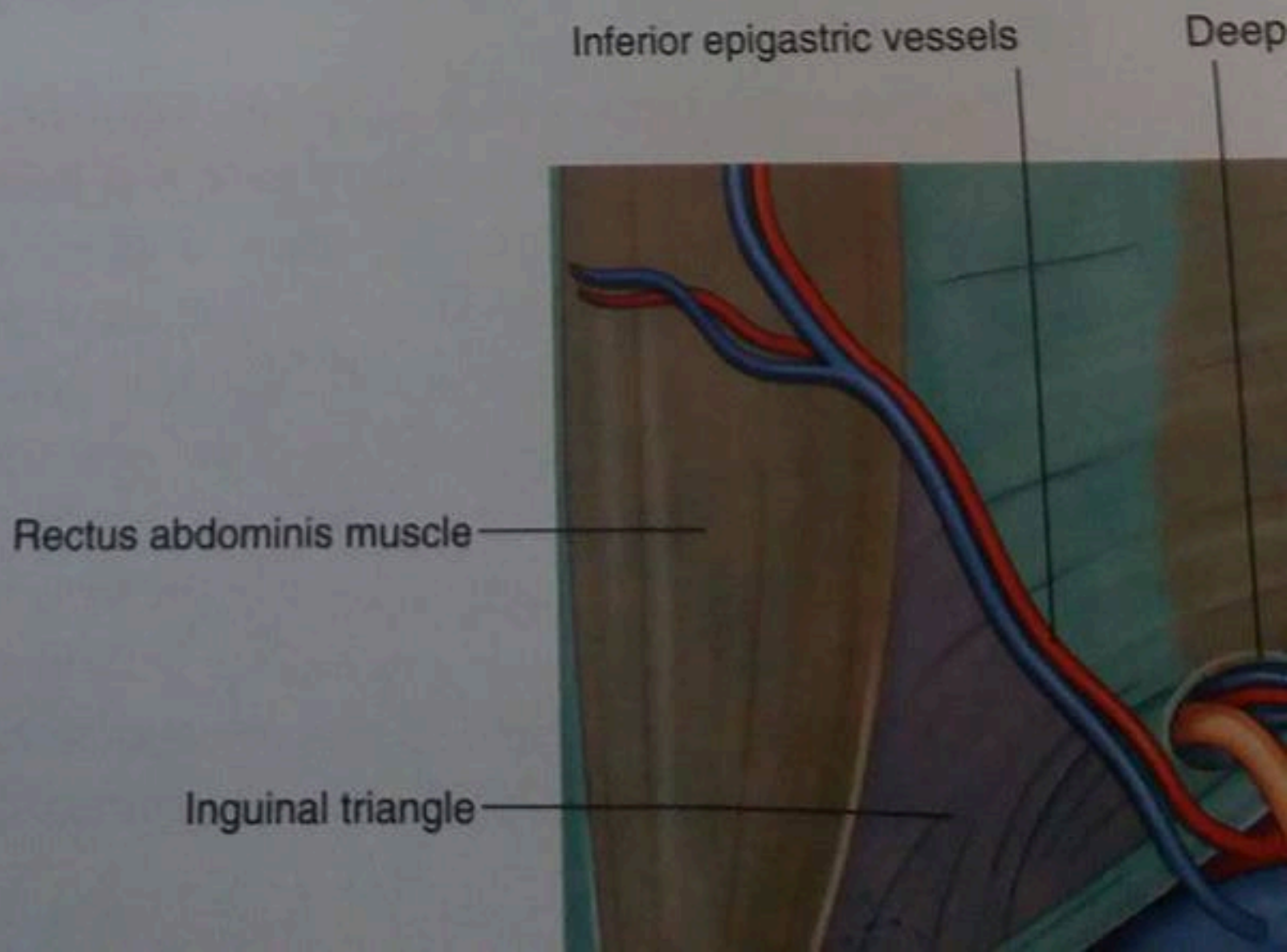


Fig. 4.

In the clinic

Masses around the groin

Around the groin there is a complex confluence of anatomical structures. Careful examination and good anatomical knowledge allows determination of the correct anatomical structure from which the mass arises and therefore the diagnosis. The most common masses in the groin are hernias.

The key to groin examination is determining the position of the inguinal ligament. The inguinal ligament passes between the anterior superior iliac spine laterally and the pubic tubercle medially. Inguinal hernias are above the inguinal ligament and are usually more apparent on standing. A visual assessment of the lump is necessary, bearing in mind the anatomical landmarks of the inguinal ligament.

In men, it is wise to examine the scrotum to check for a lump. If an abnormal mass is present, an inability to feel its upper edge suggests that it may originate from the inguinal canal and might be a hernia. By placing the hand over the lump and asking the patient to cough, the lump bulges outward.

An attempt should be made to reduce the swelling by applying gentle, firm pressure over the lump. If the lump is reducible, the hand should be withdrawn and careful observation will reveal recurrence of the mass.

The position of an abnormal mass in the groin relative to the pubic tubercle is very important, as are the presence of increased temperature and pain, which may represent early signs of strangulation or infection.

As a general rule:

- An inguinal hernia appears through the superficial inguinal ring above the pubic tubercle and crest.

- A femoral hernia (see below) appears through the femoral canal below and lateral to the pubic tubercle.

A hernia is the protrusion of a viscus, in part or in whole, through a normal or abnormal opening. The viscus usually carries a covering of parietal peritoneum, which forms the lining of the hernial sac.

Inguinal hernias

Hernias occur in a variety of regions. The commonest site is the groin of the lower anterior abdominal wall. In some patients, inguinal hernias are present from birth (congenital) and are caused by the persistence of the processus vaginalis and the passage of viscera through the inguinal canal. Acquired hernias occur in older patients and causes include raised intraabdominal pressure (e.g., from repeated coughing associated with lung disease), damage to nerves of the anterior abdominal wall (e.g., from surgical abdominal incisions), and weakening of the walls of the inguinal canal.

One of the potential problems with hernias is that bowel and fat may become stuck within the hernial sac. This can cause appreciable pain and bowel obstruction, necessitating urgent surgery. Another potential risk is **strangulation** of the hernia, in which the blood supply to the bowel is cut off at the neck of the hernial sac, rendering the bowel ischemic and susceptible to perforation.

The hernial sac of an **indirect inguinal hernia** enters the deep inguinal ring and passes through the inguinal canal. If the hernia is large enough, the hernial sac may

(continues)

In the clinic—cont'd

emerge through the superficial inguinal ring. In men, such a hernia may extend into the scrotum (Fig. 4.51).

The hernial sac of a **direct inguinal hernia** pushes forward through the posterior wall of the inguinal canal immediately posterior to the superficial inguinal ring. The hernia protrudes directly forward medial to the inferior epigastric vessels and through the superficial inguinal ring.

The differentiation between an indirect and a direct inguinal hernia is made during surgery when the inferior epigastric vessels are identified at the medial edge of the deep internal ring:

- An indirect hernial sac passes lateral to the inferior epigastric vessels.
- A direct hernia is medial to the inferior epigastric vessels.

Inguinal hernias occur more commonly in men than in women possibly because men have a much larger inguinal canal than women.

Femoral hernias

A **femoral hernia** passes through the femoral canal and into the medial aspect of the anterior thigh. The femoral

Right indirect
inguinal hernia

Corpora cavernosa

Corpus spongiosum



Right testis

Left testis

canal lies at the
contains the fe
The neck of th
prone to trap
type of hernia
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