

Radiological Anatomy of groin Region and radiological diagnosis of inguinal hernia.

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Abstract: Inguinal region diseases are distributed irrespective of sex, age group and socioeconomic status throughout the world. It some-times puts the life of the patient in such hazard, as to require one of the most delicate surgery; and it has in all times, from the most ancient down to the present, rendered those who labor under it subject to the most iniquitous frauds and in-positions. Thorough knowledge of the inguinal canal anatomy is must for a accurate radiological diagnosis of inguinal canal pathologies. Here we present a review article on the radiological anatomy of the inguinal region. Hernia is the most common pathology affecting the inguinal canal.

Key words: Inguinal canal anatomy, CT, USG, MRI, Hernia

I. Introduction

The anatomy of inguinal region is complex due to multiple vascular and muscular structures converging to enter upper thigh space. In this article we focus on the gross anatomy of groin and radiological tools that help in diagnosis of inguinal hernia.

Inguinal Canal Embryology^{1,2}

In a highly synergistic way the skin, the parietal peritoneum and the embryologic and anatomic entities between them produce the future pathway for the testes. The skin will form the scrotum in male and the labia in female.

The embryologic entities between the skin and peritoneum permit the processes vaginalis to penetrate them and form the inguinal canal. The downward journey of the testis to the scrotum is thus allowed and descent of the ovary outside the peritoneal cavity however is forbidden.

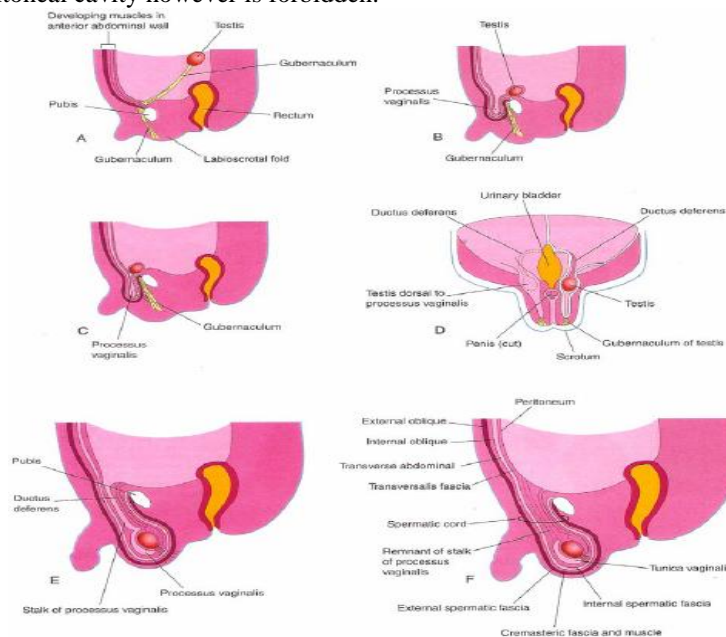


Fig1: Graphical representation of testis development and its descent through inguinal canal.

Inguinal Region

The testis originally lies on the posterior wall of the abdomen at the level of the upper lumbar vertebrae on the medial side of the mesonephrons attached by a peritoneal fold called mesorchism. Descent or migration of the testis into its corresponding scrotal chamber is accomplished by following the lead of the fibro muscular band- gubernaculum testis. It arises mainly within a peritoneal fold called the plica inguinalis, which stretches from the inguinal region to the lower end of mesonephrons, the gubernaculum attains the greatest development about the sixth month and is attached above to the lower end of the testis and below, it pierces through the abdominal wall in its passage to the bottom of the scrotal pouch, thereby forming the inguinal canal.

The processus vaginalis descends into the scrotum dragging with it thin fascial prolongations of the layers of the abdominal wall, thus the processus vaginalis receives covering from the aponeurosis of the external oblique and internal oblique and from fascia transversalis.

The blind extremity of the processus vaginalis gets invaginated for the reception of descending testis. As the migration of the testis proceeds, the gubernaculum shortens and eventually atrophies, but some trace of gubernaculum persists at the bottom of the scrotum, below tunica vaginalis forms the scrotal ligament fixing the testis to the bottom of scrotal pouch.

By the end of the eighth month the cavity of the upper part of the processus vaginalis disappears. The lower part of the processus vaginalis is entirely cut off from the general peritoneal cavity and consists of two layers, the parietal portion of the tunica vaginalis lining the scrotum, while visceral portion of that membrane is applied on to the surface of the testis.

In female, the gubernaculum extends from the lower poles of the ovaries to the labium majus through the inguinal canal. This part atrophies and is represented by the ligament of the ovary while the lower part which is developed is within the plica inguinalis is represented by the round ligament of the uterus, extending from the side of uterus to the labium majus.

A pouch of peritoneum is called the canal of nuck, similar to the processus vaginalis in the male, accompanies the gubernaculum along the inguinal canal into the labium majus. This is normally obliterated well before birth, the occasional persistence of the vaginal process after birth serves the genesis of induction of inguinal hernia in the female.

Anatomy^{3,4,5}

The groin is the portion of the anterior abdominal wall below the level of anterior superior iliac spines. The pelvic bones form an anchor for the muscles and aponeurosis of the groin. The pelvis is interposed in the axial skeleton in an inclined position. The angle of tilt is approximately 60 degree with regard to the shaft of the femur or the vertebral column. The superior aperture of the pelvis opens anteriorly as well as superiorly. The pubis and superior pubic (cooper's) ligament are medial. The epigastric vessels and transversalis fascia condensation at the internal ring are lateral. The anterior femoral sheath, ilio pubic tract and inguinal ligament are inferior and the transverse abdominis aponeurosis and its arch are superior.

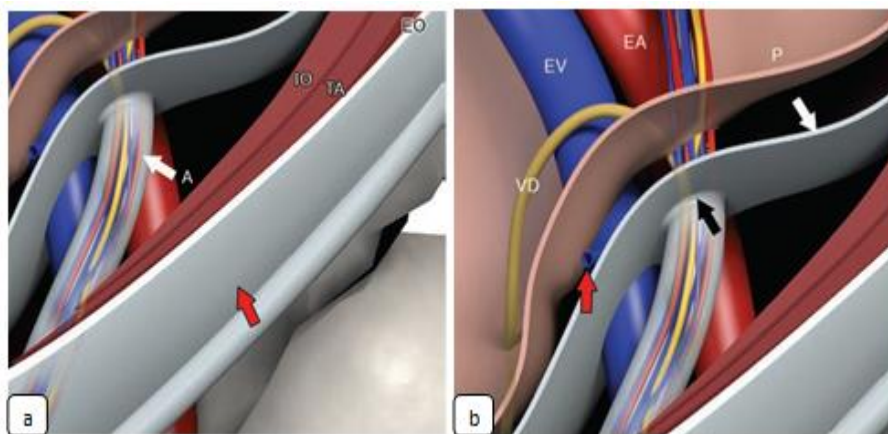


Fig2: Graphical representation inguinal canal anatomy. **a)** The inguinal ligament (red arrow) is the aponeurosis of the external oblique muscle. A = aponeurosis of the transversus abdominis muscle, EO = external oblique, IO = internal oblique, TA = transversus abdominis.

b) The deep inguinal ring (black arrow) is the site of an outpouching of the transversalis fascia and lies lateral to the inferior epigastric vessels. (Red arrow = inferior epigastric vein.) The transversalis fascia (white arrow) continues into the canal, forming the innermost covering of the structures traversing the IC. EA = external iliac artery, EV = external iliac vein, P = peritoneum,

VD = vas deferens ⁶.

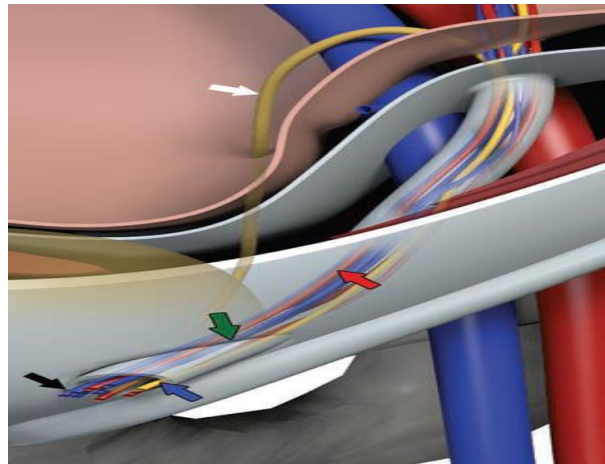


Fig 3: Coronal diagram of the male IC anatomy shows the vas deferens (white arrow), the testicular artery (red arrow), the superficial inguinal ring (green arrow), the pampiniform plexus (black arrow), and the genital branch of the genitofemoral nerve (blue arrow) ⁶.



Fig4: Dissected inguinal region showing origin of inferior epigastric artery and its relation to inguinal ligament.

Inguinal Region anatomy is made up of :

- 1.Skin
- 2.Subcutaneous tissues of the groin
- 3.Scarpa's fascia
- 4.In nominate fascia
- 5.Intercrural fibers
- 6.Musculoaponeurotic structures
 - a. External oblique muscle and aponeurosis
 - b. Internal oblique muscle and aponeurosis
 - c. Transversus abdominis muscle and aponeurosis
 - d. Transversalis fascia
 - e. Rectus sheath
 - f. Peritoneum
 - g.Conjoint tendon (Flax inguinalis)
 - h.Lacunar ligament (Gimbernat's Ligament)
 - i.Cooper's ligament (Iliopectineal ligament)
 - j.Inguinal ligament (Ligament of Poupart)
 - k.The cremaster muscle

Inguinal canal

It begins at the site of emergence of the spermatic cord through the transversus aponeurosis (internal ring), and ends at the pubic tubercle. It is oblique and 3.75 cm long slanting downwards and medially parallel

with and a little above the inguinal ligament. It extends from the deep to the superficial ring. The boundaries are: anteriorly throughout by the skin, superficial fascia, external oblique aponeurosis, in its lateral one third also by muscular fibers of the internal oblique. Posterior, the transversalis fascia reinforced medially by falx inguinalis (when present); above, arched fibers of internal oblique and transversus aponeurosis; below the inguinal ligament and its continuation, lacunar ligament.

Hasselbach's triangle:

it is bounded medially by the lateral border of then rectus sheath, laterally by inferior epigastric vessels and below by inguinal ligament.

Structures passing through inguinal canal

Spermatic cord

Originates at the deep ring and consists of

- a. Arteries: Testicular artery, cremasteric and artery to vas
- b. Veins: Corresponding veins mainly testicular (Pampiniform plexus)
- c. Nerves: Genital branch of genitor femoral nerve, cremasteric nerve, and Sympathetic plexus derived from Para aortic and pelvic plexus.
- d. Lymphatics of the testis
- e. Vas deferens and areolar connective tissue.

Coverings of spermatic cord from within are processus vaginalis, internal spermatic fascia (Transversalis fascia), Cremasteric fascia (Internal oblique muscle and fascia), and External spermatic fascia (External oblique muscle and fascia).

Contents Of Preperitoneal Space Of Inguinofemoral Region

I. vascular

1. Arteries

- External iliac artery and its branches
- Deep circumflex iliac artery
- Inferior epigastric artery

2. veins

- External iliac vein
- Deep circumflex iliac vein
- Inferior epigastric vein

3. nerves

- Ilioinguinal nerve
- Iliohypogastric nerve
- Genitofemoral N
- Femoral N
- Lateral cutaneous N of thigh
- L1, L2 & L3 ventral rami
- Spermatic plexus (sympathetic & sensory)

Pathophysiology Of Inguinal Hernia ⁷⁻¹¹

The cause of an inguinal hernia is multifactorial which includes: Patent processus vaginalis, incompetent shutter mechanism that is formed by internal oblique and transversus abdominis forming the myoaponeurotic roof of the inguinal canal which covers and protects the transversalis fascia, raised intra abdominal pressure due to various systemic causes, abdominal muscle weakness due to aging process.

Classification Of Inguinal Hernias ⁹⁻¹⁵

Anatomical classification ^{13, 14}

In this type of classification, the location of hernial sac in relation to certain anatomical structures is noted and accordingly the hernias are classified. In case of inguinal hernia the landmark taken is inferior epigastric artery. Hernia lying medial to this artery is called direct hernia and that lying lateral to it is indirect hernia.

Radiologic Investigations that aid in diagnosis of inguinal hernia

As described previously there are multiple etiology which cause Hernias in inguinal region. Inguinal hernia can be classified into direct and indirect inguinal hernia based on the location of neck of the hernial sac irrespective of contents in relation to inferior epigastric artery. In indirect inguinal hernia the sac arises from the deep inguinal ring which is lateral to the inferior epigastric artery. In direct inguinal hernia the origin of sac is from hesselbachs triangle which is medial to inferior epigastric artery. Dynamic USG and CT will help in locating the inferior epigastric artery and thus classifying the hernia into direct or indirect inguinal hernia.

First we illustrate the USG and CT anatomy of groin region with respect to inguinal canal and then we illustrate direct and indirect inguinal hernia in both USG and CT.

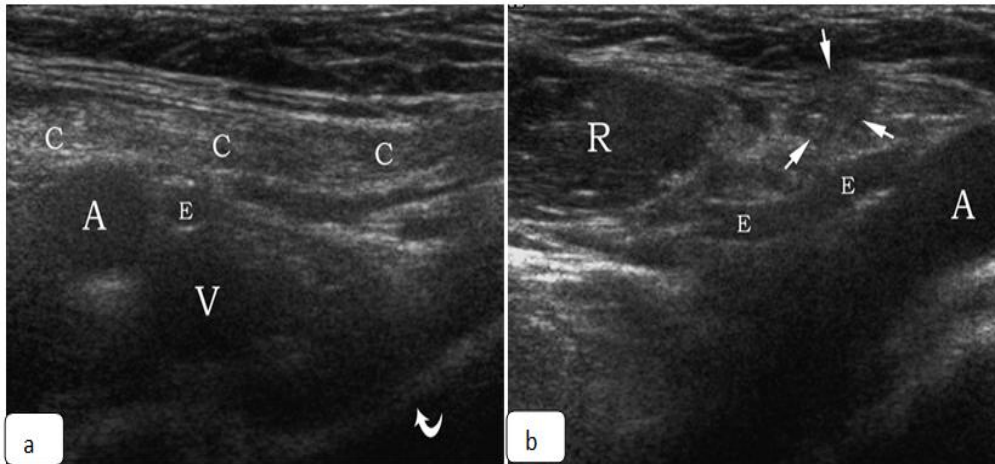


Fig. 5: 40-year-old man with healthy right inguinal anatomy. **a)** Sonogram of inguinal region parallel and cranial to inguinal ligament corresponding to transducer position 2 in Figure 4 shows spermatic cord (C), external iliac artery (A),inferior epigastric artery (E), femoral vein (V), and superior pubic ramus (*curved arrow*). **b),** Sonogram of inguinal region (transducer position not illustrated in Fig. 4) directly over and parallel to inferior epigastric artery (E), spermatic cord short axis (*arrows*), external iliac artery (A), and rectus abdominis (R)¹⁶.

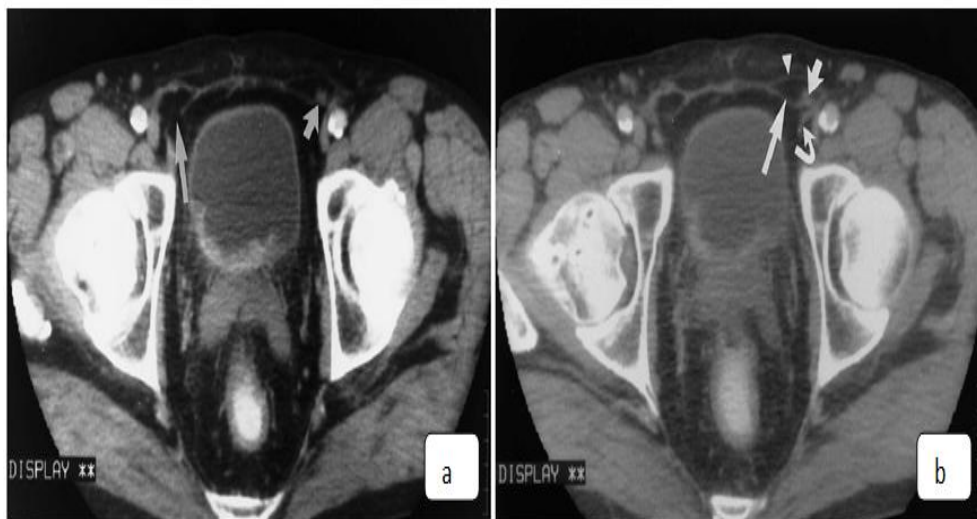


Fig.7: **a)** CT scan in a male patient clearly shows the location of the internalinguinal ring (annulus inguinalis internus) on the right side (largearrow); on the left side part of the deferent duct is seen within the inguinal canal (small arrow); **b)** slice obtained 5 mm lower demonstrating another part of the deferent duct (small arrow), as well as the epigastric vessels (curved arrow). At this level the anterior wall of the inguinal canal on the left side is formed by the aponeurosis of the external oblique (arrowhead), and the posterior wall by the transversus aponeurosis and transversalis fascia (arrow)¹⁷

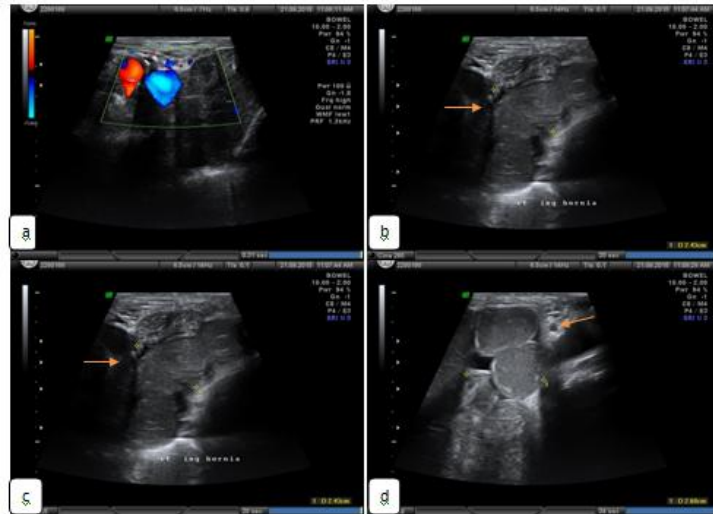


Fig 9: USG Image shows bilateral direct inguinal hernia with hernial sac containing bowel loops with their neck medial to inferior epigastric hernia. a,b,c) colour doppler image shows Common femoral artery(red), common femoral vein (Blue) with hernial sac containing bowel loops on right side. d) hernial sac on left side with bowel loops. (inferior epigastric artery)

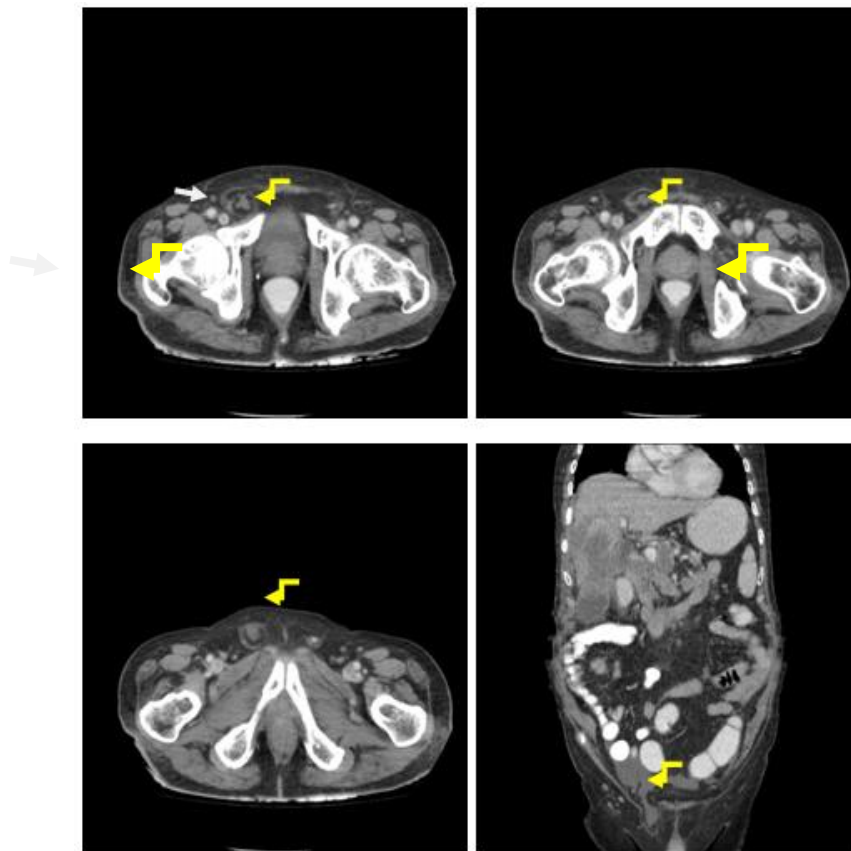


Fig. 10. A CTscan in a patient with a right-sided direct inguinal hernia (large curved arrow); the origin of the hernia medial to the inferior epigastric vessels (small arrow) is clearly seen

II. Conclusion

With brief knowledge of radiological anatomy of inguinal region one can easily diagnose various inguinal canal pathologies among which inguinal hernia stands out more obviously than other conditions.

Conflict of interest: None

Financial disclosure: None

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