Anatomy and pathological conditions of the inguinal region: a pictorial essay

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Learning objectives

The purpose of our educational exhibit is:

- to illustrate normal anatomy and normal appearance of inguinal region;

- to analyse the most common pathological conditions encountered in inguinal regions, showing their main imaging features depicted using Ultrasound (US), Computed Tomography (CT) and Magnetic Resonance Imaging (MRI).

To better understand the anatomic and pathological findings, some radiological images are related to schematic drawings.
Background

Anatomy

Inguinal region comprises two main anatomical areas: the inguinal canal (IC) and the femoral triangle.

The first, in adults, is an interfascial space measuring about 4 cm in length, which runs obliquely lateral to medial and from the depths to the surface. The anterior wall of the IC is formed by the aponeurosis of the external oblique muscle; the posterior wall is formed by the trasversalis fascia, the aponeurosis of the trasversus abdominis and the internal oblique muscles - which creates the conjoint tendon. The latter also forms the roof, whereas the floor is limited by the inguinal ligament - which is a U-shaped structure between anterior superior iliac spine and pubic tubercle (Fig. 1 on page 8) [1-4].

Fig. 1: Anatomy of inguinal region. The illustration (a) shows the structures that form the IC: aponeurosis of the external oblique muscle (A), internal oblique muscle (B), trasversus abdominis muscle (C), trasversalis fascia (D), inguinal ligament (white arrow heads), vas deferens (VD), testicular artery (TA) and vein (TV), inguinal ring (red asterisk), inferior epigastic artery (IEA) and vein (IEV). Caudally to the inguinal ligament the lacunar and pectineal ligaments form the medial margin of the femoral ring (blue asterisk). Coronal MIP (b) shows the most important anatomical landmarks to recognize the IC: deep inguinal ring (red asterisk), inguinal ligament (white arrow head), spermatic cord (SC), external iliac artery (EIA), inferior epigastic artery (IEA) and vein (IEV), deep circonflex iliac artery (DCIA), femoral artery (FA) and vein (FV).
The IC shows two orifices placed at the extremities: the deep inguinal ring (by an outpouching of the trasversalis fascia) and the superficial inguinal ring (an opening in the context of the oblique external aponeurosis). In males, IC contains the spermatic cord; in females, it carries the uterine round ligament and the genital branch of the ilioinguinal nerve [1-4].

The spermatic cord contains:

- the vas deferens and its artery;
- the testicular artery and the pampiniform venous plexus;
- the genital branch of the genitofemoral nerve;
- the lymphatic vessels and sympathetic nerve fibers;

These structures are surrounded by fat and connective tissue and covered by the cremaster muscle, the cremaster fascia and the internal spermatic fascia. The ilio-inguinal nerve runs anteriorly along the spermatic cord [1-4].

The Femoral triangle is a pyramid-shaped structure - located below the IC. The inguinal ligament forms its superior border, whereas the lateral and medial borders are limited respectively by the sartorius muscle and the adductor longus muscle; the floor is formed by the ilio-psoas, the pectineal and the long adductor muscles. The fascia lata constitutes the anterior wall. The triangle contains, from lateral to medial, the femoral nerve, the femoral sheet, the femoral artery, the femoral vein and the femoral canal (Fig. 2 on page 8) [1-4].
Fig. 2: Anatomy of inguinal region. Volume Rendering CT image shows the borders of the Femoral Triangle (blue triangle). Inguinal ligament represents the superior border, lateral and medial border are delimited respectively by the sartorius muscle (S) and the adductor longus muscle (AL). Femoral canal (white asterisk) is located medial to femoral vein (FV) and femoral artery (FA).

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Some anatomical structures may be used as landmarks to better understand the three-dimensional anatomy of IC. The most important anatomical landmark - to localize the deep inguinal ring - is given by the origin of the inferior epigastric vessels and the deep circumflex iliac artery (DCIA). The deep inguinal ring is placed lateral to the origin of the Inferior Epigastric Artery (IEA). The pubic tubercle is the landmark to localize the superficial inguinal ring (Fig. 1 on page 8, Fig. 3) [2-5].

Ultrasonography provides the initial assessment to study the inguinal region using a high-frequency linear transducer (10-12 MHz). Images are generally obtained in oblique planes, parallel (long axis) and perpendicular (short axis) to the inguinal ligament - which is depicted as an echogenic structure. The
contents of the IC should be examined using both gray-scale and color Doppler US. In males, the spermatic cord is slightly hypoechoic compared to the adipose tissue; the vas deferens appears as a "cord-like" hypoechoic structure, limited by echogenic walls; Doppler-US may differentiate artery and pampiniform plexus [9 - 11].

On axial contrast enhanced CT images - at the level of hip joints - the testicular vessels and vas deferens are well visualized entering into the IC through the deep inguinal ring, lateral to the origin of IEA. The inguinal ligament is better appreciated on coronal images. Inside the IC, these structures are surrounded by a variable amount of adipose tissue(Fig. 3a - c)[2 - 5].

**Fig. 3**: Anatomy of the inguinal region. Contrast-enhanced CT images (a-c) show the most important landmarks to recognize the deep inguinal ring (red asterisk) - moving from the hip joint (a) to the pubic tubercle (c). Contrast enhanced 3D GRE T1-weighted image and power-Doppler US image show origin of the inferior epigastric artery (IEA) from the external iliac artery (EIA). Vas deferens (VD) passes around the IEA, running medially through the deep inguinal ring (red asterisk). Spermatic cord (SC), external
iliac vein (EIV), inferior epigastic veins (IEV), deep circonflex iliac artery (DCIA), rectus abdominis muscle (RA)

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Inguinal region is a frequent site of pathology; considering the presence of several anatomical structures, the etiology may be varied. A differential diagnosis is required, due to non-specific clinical findings revealed by clinicians (pain and swelling are in fact commonly described). Inguinal pathologies include hernias, congenital conditions, infections or inflammatory diseases, benign and malignant tumors.
Fig. 1: Anatomy of inguinal region. The illustration (a) shows the structures that form the IC: aponeurosis of the external oblique muscle (A), internal oblique muscle (B), trasversus abdominis muscle (C), trasversalis fascia (D), inguinal ligament (white arrow heads), vas deferens (VD), testicular artery (TA) and vein (TV), inguinal ring (red asterisk), inferior epigastic artery (IEA) and vein (IEV). Caudally to the inguinal ligament the lacunar and pectineal ligaments form the medial margin of the femoral ring (blue asterisk). Coronal MIP (b) shows the most important anatomical landmarks to recognize the IC: deep inguinal ring (red asterisk), inguinal ligament (white arrow head), spermatic cord (SC), external iliac artery (EIA), inferior epigastic artery (IEA) and vein (IEV), deep circonflex iliac artery (DCIA), femoral artery (FA) and vein (FV).

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Findings and procedure details

1. Hernias

Hernia is the commonest pathological finding encountered in inguinal regions. It represents the protrusion of an organ through a defect in the muscle-aponeurotic layer. Hernias can be congenital or acquired diseases; based on their location, they may be classified as inguinal hernias (more frequent) or femoral hernias. US represents the first imaging modality to investigate hernias; dynamic imaging, especially during provocative maneuvers, provide a direct visualization of the protruding structures - in case of reducible hernias - compared with cross-sectional imaging features, that can fail to diagnose hernias because of static imaging acquisition. CT is generally required for diagnosis and management of complications.

1.1. Inguinal hernias could be "direct" or "indirect". In the first type of hernias, the protrusion of abdominal viscera is located medially and inferiorly to the course of the IEA; in case of indirect hernias, the protrusion is observed postero-laterally and superiorly to the course of vessels [3 - 5].

The former are more generally acquired - increasing their incidence with age. They bulge out of the anterior abdominal wall through a weakening area of the Hesselbach triangle. They are recognizable laterally to the rectus muscle, superiorly to the inguinal ligament - displacing the canal contents sideways; on CT images the normal adipose tissue of the IC is pushed laterally, appearing like a crescent moon (crescent sign) (Fig. 4 on page 21). If hernia extends more inferiorly the crescent sign may disappear [3 - 5].

Indirect type is the most frequent inguinal hernia observed. In young patients, it is generally due to a congenital defect of the processus vaginalis, whereas in older patients is caused by weakness of deep inguinal ring. Hernia protrudes through the deep inguinal ring and runs lateral to medial into the IC (Fig. 5 on page 22) [3 - 5]. On US, this hernia appears as tissue of variable echogenicity moving through the deep inguinal ring that moves medially parallel to the skin surface (Fig. 6 on page 23) [8 - 11]. On axial CT, the inguinal canal contents are not compressed - being very difficult to distinguish from hernia (they may also seem to be a part of the hernia) [3 - 5].
Fig. 4: Direct inguinal Hernia. Contrast-enhanced CT images (with free-hand drawings) show a left fat-containing hernia, which protrudes medially to the origin of the Inferior Epigastic Artery (IEA) (a-b); the Spermatic Cord (SC - pink) and fat are compressed laterally. Image obtained at a lower level (c-d) show a lateral crescent of compressed inguinal canal contents, including fat (in yellow), and spermatic cord (in pink). Coronal oblique reformatted image from contrast-enhanced CT (e) shows the mesenteric fat protruding medially to the origin of IEA. External iliac artery (EIA), femoral artery (FA) and vein (FV), rectus abdominis muscle (RA).

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Fig. 5: Indirect inguinal hernia. Contrast-enhanced CT images show a left hernia, containing small bowel loop and mesenteric fat, and protruding superiorly and laterally.
to the course of the Inferior Epigastic Artery (IEA) (a-b). Image and drawing obtained at a lower level (c-d) show the herniated mesenteric fat in the context of spermatic cord creating a ‘target ring’ appearance; spermatic cord is not separable from the hernia content. Sagittal reformatted contrast-enhanced CT image (e) shows the mesenteric fat protruding in the IC. External iliac artery (EIA) and vein (EIV), femoral artery (FA) and vein (FV).

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1.2. Femoral hernias develop into the femoral canal, and are localized medially to the common femoral vein - which may be compressed (Fig. 7 on page 23). These hernias have a female prevalence. Both contrast enhanced-CT and Doppler US may detect the presence of femoral vein compression, and the engorgement of small distal collateral veins around the hernia sac [3 - 5, 8 - 11].
Fig. 7: Femoral Hernia, two cases. Contrast-enhanced CT image (a) and coronal oblique reconstruction (b) show a femoral hernia, containing small bowel loops (red asterisks), on both sides; they protruding medially to the femoral vein (FV) and laterally to IC (white arrow heads). In the second case, a left femoral hernia is depicted. The hernia contains a small amount of fluid, located medially to the FV, in the context of femoral canal fat. FV appears slightly compressed by the narrow hernia neck (blue asterisk). Femoral arteries (FA).

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Different organs, in varying degrees, may be contained in inguinal and femoral hernias: small and large bowel, omentum, bladder (Fig. 8 on page 24) or incarcerated appendix (Amyand hernia) (Fig. 9 on page 25) [7]. Complications are represented by strangulation (Fig. 10 on page 26) - namely in femoral hernias, incarceration, obstruction, perforation. In these conditions, CT could demonstrate the involved bowel loop collapsed, with a sudden change in caliber; other imaging features revealed on CT images include thickened walls, mesenteric edema (due to venous congestion), and dilatation of afferent loops; bowel enhancement may be normal, increased or poorly appreciated. In case of perforation, air bubbles may be detected [3-5, 8-11].

2. Congenital deseases

Congenital diseases in inguinal regions include hydrocele and cryptorchidism. Abnormalities in the regression of processus vaginalis - which remains patent - leads to the development of congenital indirect hernias, hydrocele in males or canal of Nuck hydrocele in females [3-4, 8].

2.1. Hydrocele is a fluid collection in the IC, located antero-medially to the spermatic cord in males (Fig. 11 on page 27). There are two types of Hydrocele: "communicating" and "encysted". In the first type, there is a communication between the abdominal cavity and scrotum through the deep inguinal ring; in the second type, fluid collection shows no communication with the peritoneal cavity or tunica vaginalis. In female encysted hydrocele is known as canal of Nuck cyst (Fig. 12 on page 27). Hydrocele can also be secondary to traumas, infection, malignancy or an increase of abdominal pressure due to cirrhotic/malignant ascites (Fig. 11 on page 27). US shows an anechoic fluid collection - with no vascular flows. Valsalva maneuver increases the volume of fluid collection, and this finding help the differential diagnosis among the two subtypes. On MR images, fluid collection have low signal intensity on T1-weighted images and high signal intensity on T2-weighted images, with no contrast enhancement [3-4, 8-12].
2.2. **Cryptorchidism** represents a developmental arrest of the normal descent of the testes into the scrotum. Undescended testes may be located anywhere along the course of their descent, even if IC is the most frequent site. A differential diagnosis from retractile testis and ectopic testes are required. Undescended testes causes abnormal spermatogenesis and increases the risk of cancer. US is the first imaging modality used to validate suspicion of non-palpable undescended testes: the spermatic cord should be identified, in order to find the testes. Testis appears as an oval mass hypo- or hyperechoic, smaller in size compared to the normal one (Fig. 13 on page 28). In cases of neoplastic degeneration, US show inhomogenous appearance of testicular parenchyma. On MR images, testes have low signal intensity on T1-weighted images and high signal intensity on T2-weighted images, with homogeneous contrast enhancement after gadolinium (Fig. 14 on page 29). At CT, testes are iso or hypopattenuating to the soft tissue, exhibiting homogeneous contrast enhancement [8 - 12].

3. Varicocele

*Varicocele* is an abnormal dilatation of the pampiniform venous plexus, which can be primary or secondary. It is often cause of infertility. Primary varicocele is a result of valvular incompetence of the spermatic vein, and it is common on the left side; the secondary form is due to increased pressure in testicular veins, which can be caused by hydronephrosis, spleno-renal shunts in portal hypertension, abdominal and retroperitoneal tumours or vascular compression of renal vein. US can appreciate tortuous anechoic vessels with a diameter of 2-3 mm. Color Doppler US is the imaging technique, most frequently used to assess varicoceles; during the Valsalva maneuver, the varicocele enlarges and reversal flows become evident; reflux may be intermittent or continuous (Fig. 15 on page 29) [8 - 13]. The most widely used classifications are those developed by Sarteschi and by Dubin [14 - 15]. On CT and MR images, varicocele represents an incidental finding, with several tubular vessels which are increased in size after contrast enhancement. On unenhanced MR acquisitions, low-flow varicocele produces an intermediate-intensity signal in T1-weighted sequences and hyperintensity in T2-weighted sequences; high flow varicocele produces flow void signal [3, 4, 8].

4. Hematomas and Inflammatory Conditions

4.1. **Hematomas** may occur at the level of the IC. They may be related to traumatic or iatrogenic injuries, or may develop during anticoagulant therapy. On US examination it appears as a fluid collection in the acute phase; in the subacute and chronic phase, they have a mixed echogenicity [8 - 11]. At CT, hematomas generally appear as hyperattenuating masses in the IC, with ROI (Region of Interest) value greater than 30
HU (Fig. 16 on page 30) [3-4]. On MRI images they reproduce a variable appearance depending on time of bleeding and type of hemoglobin degradation products [3-4].

4.2. After surgical procedures, it is possible to find a seroma, which represents a sterile fluid collection with thin smooth wall, or a lymphocele, which on CT images appears as a cystic low-attenuating mass, rarely with calcifications (Fig. 17 on page 30) [3-4].

4.3. Inguinal abscesses may be related to complicated hernias, lymphadenitis and soft tissue infections. Common sonographic findings and CT imaging features include the presence of a uni- or multilocular inhomogeneous fluid collection, with irregular wall and peripheral enhancement ("rim enhancement"); surrounding tissues may show edematous appearance. Gas bubbles are specific signs of abscess; air-fluid levels could be found. On MR images, abscesses show typically low signal intensity on T1-weighted images and high signal intensity on T2-weighted images, with rim of peripheral enhancement after gadolinium administration. Diffusion weighted images are useful to differentiate abscesses, which show central restriction, from necrotic tumours that show peripheral restriction (Fig. 18 on page 31) [3-4, 8, 16].

4.4. The inflammation of spermatic cord - known as funiculitis or vasitis - represents a complication of epididymitis or lower urinary tract infections. On US images, spermatic cord appears thickened, with echogenic appearance and increased vascularization that doesn't change during Valsalva maneuver. Spermatic cord abscess should be considered when a cystic tubular mass is detected. CT and MR images may reveal spermatic cord asymmetry with variable thickening and enhancement of vessels after contrast administration (Fig. 19 on page 32). At MR imaging an increased T2 signal intensity could be depicted [16].

5. Benign Neoplasms

5.1. Among benign lesions, lipoma is the most frequently encountered; it may be associated with an inguinal hernia. These lesions are considered as "true lipomas" if no relationship with the peritoneal fat is demonstrable. They are typically arranged laterally or below the spermatic cord, unlike the fat content in hernias that protrudes anterior-medially [3, 4, 6, 8].

5.2. Neurofibromas may arise from genitofemoral and ileum-inguinal nerves, particularly when associated with neurofibromatosis type 1 or 2; secondary involvement of the IC can be found in case of bulky abdominal masses. On TC examinations, they appear as low
attenuating masses, enhancing after contrast medium administration. On MR sequences, the plexiform neurofibromas show low signal intensity on T1-weighted images and high signal intensity on T2-weighted images, with central hypointense area (target sign) (Fig. 20 on page 33). Malignant transformation can be suspected in case of rapid growth, T2-signal inhomogeneity, no target sign and infiltration of adjacent structures [3 - 4, 17].

Other benign tumours are represented by desmoids, leiomyomas (rarely deriving from round ligament of uterus) and lymphangiomas.

6. Malignant Neoplasms

Malignant tumours of the inguinal region may be primary or secondary.

Primary neoplasms can arise from any structures, such as connective and adipose tissues, nerve sheaths, muscles, blood vessels, and lymphatic nodes. They are rare and consist mainly of sarcomas - due to the fact that inguinal structures originate from the mesoderm [3 - 4, 17]. Sonographic findings are variable and non-specific [8 - 11].

6.1. The liposarcoma is one of the most common tumour depicted. CT images show the pathognomonic presence of low attenuation due to the abundant presence of adipose tissue and thicker, irregular, and/or nodular septa of solid tissue that show reticular enhancement after contrast medium administration. Necrosis or pseudocystic degeneration may be observed on CT and MR images. In less differentiated forms, the fat areas become less evident, and differential diagnosis is needed from other sarcomas (Fig. 21 on page 34).

Other types of sarcoma, such as leiomyosarcoma, fibrosarcoma, rhabdomyosarcoma, may appear as heterogeneously enhancing soft tissue masses infiltrating adjacent structures [3 - 4, 17].

6.2. Secondary neoplasms may be found in inguinal regions due to direct invasion from malignant lesions of adjacent organs, or metastatic lymphadenopathy involvement (from external genitalia, lower part of the rectum, anus, and lower limbs) [19 - 21]. Superficial and deep lymph nodes are arranged in a T-shape with a superior group, below the inguinal ligament and a lower group, along the course of the great saphenous vein [1, 3 - 4, 19 - 21]. On US normal lymph node is usually seen as an oval mass with a hypoechoic peripheral zone and an echogenic hylum. Pathological lymph nodes appear generally round in shape, and are greater to 12-15 mm on transverse axis. On gray-scale US, metastatic lymph nodes present irregular borders, appear hypoechoic or heterogeneous - with possible disappearance of normal echogenic hylum. Using color and power Doppler, it is possible to recognize an increased vascularization, even with multiple vascular poles (Fig. 22 on page 35) [8, 11, 22]. On unenhanced CT images, metastatic
lymphadenopathy may be indistinguishable from normal or reactive lymph nodes. After contrast administration, the enhancement can be more or less intense; the evidence of central low attenuated areas may indicate the presence of necrosis (Fig. 23 on page 36) [18, 20, 21]. On MR heterogeneous signal intensity of the lymph nodes on T2-weighted images may indicate malignant infiltration [18, 23, 24].

In lymphoproliferative disorders lymph nodes involved may be multiple, confluent, with irregular margins, can surround and dislocate nearby vessels and structures, showing moderate enhancement after contrast medium administration (Fig. 24 on page 36) [23 - 25]. Diffusion weighted images may help the diagnosis both in case of metastatic involvement and in lymphoma: restriction is in relation to their hypercellularity. Very low ADC values were found in case of lymphomatous localizations; whereas higher values are found in localization of well-differentiated solid tumours (Fig. 25 on page 37) [24 - 25].
Fig. 1: Anatomy of inguinal region. The illustration (a) shows the structures that form the IC: aponeurosis of the external oblique muscle (A), internal oblique muscle (B), trasversus abdominis muscle (C), trasversalis fascia (D), inguinal ligament (white arrow heads), vas deferens (VD), testicular artery (TA) and vein (TV), inguinal ring (red asterisk), inferior epigastic artery (IEA) and vein (IEV). Caudally to the inguinal ligament the lacunar and pectineal ligaments form the medial margin of the femoral ring (blue asterisk). Coronal MIP (b) shows the most important anatomical landmarks to recognize the IC: deep inguinal ring (red asterisk), inguinal ligament (white arrow head), spermatic cord (SC), external iliac artery (EIA), inferior epigastic artery (IEA) and vein (IEV), deep circonflex iliac artery (DCIA), femoral artery (FA) and vein (FV).

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Fig. 3: Anatomy of the inguinal region. Contrast-enhanced CT images (a-c) show the most important landmarks to recognize the deep inguinal ring (red asterisk) - moving from the hip joint (a) to the pubic tubercle (c). Contrast enhanced 3D GRE T1-weighted image and power-Doppler US image show origin of the inferior epigastric artery (IEA) from the external iliac artery (EIA). Vas deferens (VD) passes around the IEA, running medially through the deep inguinal ring (red asterisk). Spermatic cord (SC), external iliac vein (EIV), inferior epigastric veins (IEV), deep circonflex iliac artery (DCIA), rectus abdominis muscle (RA)

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**Fig. 4:** Direct inguinal Hernia. Contrast-enhanced CT images (with free-hand drawings) show a left fat-containing hernia, which protrudes medially to the origin of the Inferior Epigastic Artery (IEA) (a-b); the Spermatic Cord (SC - pink) and fat are compressed laterally. Image obtained at a lower level (c-d) show a lateral crescent of compressed inguinal canal contents, including fat (in yellow), and spermatic cord (in pink). Coronal oblique reformatted image from contrast-enhanced CT (e) shows the mesenteric fat protruding medially to the origin of IEA. External iliac artery (EIA), femoral artery (FA) and vein (FV), rectus abdominis muscle (RA).

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Fig. 5: Indirect inguinal hernia. Contrast-enhanced CT images show a left hernia, containing small bowel loop and mesenteric fat, and protruding superiorly and laterally to the course of the Inferior Epigastic Artery (IEA) (a-b). Image and drawing obtained at a lower level (c-d) show the herniated mesenteric fat in the context of spermatic cord creating a 'target ring' appearance; spermatic cord is not separable from the hernia content. Sagittal reformatted contrast-enhanced CT image (e) shows the mesenteric fat protruding in the IC. External iliac artery (EIA) and vein (EIV), femoral artery (FA) and vein (FV).

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Fig. 6: Indirect inguinal hernia. Gray-scale longitudinal US images obtained during Valsalva manoeuvre. The images show the hernia sac, containing a bowel loop that increase its representation after dynamic activation.

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Fig. 7: Femoral Hernia, two cases. Contrast-enhanced CT image (a) and coronal oblique reconstruction (b) show a femoral hernia, containing small bowel loops (red asterisks), on both sides; they protruding medially to the femoral vein (FV) and laterally to IC (white arrow heads). In the second case, a left femoral hernia is depicted. The hernia contains a small amount of fluid, located medially to the FV, in the context of femoral canal fat. FV appears slightly compressed by the narrow hernia neck (blue asterisk). Femoral arteries (FA).

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Fig. 8: Multiple examples of hernia, showing different content. Axial scans and coronal reformatted images (a-b) show a right inguinal hernia with bowel loops extending until the scrotum. Axial and sagittal MPR CT images (c-d) show a right inguinal hernia containing urinary bladder. Axial and coronal MPR CT images (e-f) show the ureter of transplanted kidney - protruding into the right IC.

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Fig. 9: Amyand hernia. Axial images (a-b) and coronal MPR images (c) show the appendix within a right femoral hernia. The hernia sac emerges into the femoral canal medial to the femoral vein; the appendix shows an increased diameter (a-c). Edema and fat stranding may be appreciated in the subcutaneous tissues (b-c); some small air bubbles are also visible within the hernia sac (b).

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Fig. 10: Two cases of complicated hernias. Axial scan and coronal MPR show an incarcerated right femoral hernia (a-b) that causes small bowel obstruction. The neck of the hernia is narrow, the hernia sac emerges into the femoral canal medial to the femoral vein, which appears slightly compressed (b); the involved small bowel loop appears collapsed. In the second case, oblique coronal image (c) and coronal MPR (d) shows
an incarcerated inguinal hernia that causes bowel obstruction. The herniated bowel loop shows a change of caliber - at the level of hernia’s neck, with edema of mesenteric fat.

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**FIG. 11:** FIG. 11 - Idrocele. Axial contrast-enhanced CT image (a) shows a large amount fluid which surround the spermatic cord; fluid distension is better appreciated on figures b and c. These figures show a secondary idrocele, due to cirrhotic ascite. In the second case, gray-scale longitudinal US images (d-f) show scrotal anechogenic fluid collection on both sides.

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**Fig. 12:** Canal of Nuck cysts. Axial FRFSE (a), SSFSE (b) T2-W and 3D GRE T1-W (c) MR images show two cystic structures at the level of right deep inguinal ring and inguinal canal - with no communication with peritoneal cavity.

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**Fig. 13:** Three cases of non-descended testes. In the first case, US images show the left testis into the IC associated with a fat-containing indirect inguinal hernia(a); the right testis (b) is detected at the level of deep inguinal ring, between bowel loops. In the second (c) and third case (d), the left testis, appearing as oval hypoechoic structure - is located in the IC, close to the deep inguinal ring.
**Fig. 14:** Non-descended testis. Axial (a), coronal (d) and sagittal (e) FRFSE T2-weighted images show an ovoid mass with high signal intensity in the right IC. Testis has a relatively low signal intensity on axial 3D GRE T1-W image (b), with poor enhancement after gadolinium administration (c).

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Fig. 15: Varicocele. Power Doppler longitudinal scans show enlarged left pampiniform plexus veins (a-b) whose calibers increase during the Valsalva maneuver (d-f).

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Fig. 16: Inguinal hematoma. Axial image (a) and coronal MRP image (b) show an high-attenuating mass in the right femoral region; it represent a consequence of a femoro-femoral bypass placement. Contrast enhanced image (c) shows increased attenuation, caused by active bleeding.

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Fig. 17: Lymphocele. Axial image (a) and coronal MPR CT images (b) show two fluid collections on both inguinal and femoral regions, as complications of an aorto-bifemoral bypass placement.

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Fig. 18: Abscess. Axial and coronal FRFSE T2-W images show a pelvic fluid collection, extending into the right IC, with heterogeneous intermediate signal intensity; air bubbles are clearly visible in both collections. Diffusion weighted image (c) (b value = 800) shows restriction of the central portion - whereas axial 3D GRE T1-W image after gadolinium demonstrates the presence of a typical rim enhancement.

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Fig. 19: Funiculitis. A 63 year old man with right inguinal pain, fever and hematospermia; FRFSE T2-weighted axial images (a,b,d - scans at different level) and sagittal acquisitions show a thickened right spermatic cord, with low signal intensity. On 3D GRE T1-W images, the affected spermatic cord shows high signal intensity (e), with increased enhancement after gadolinium administration (f).

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Fig. 20: Plexiform neurofibromas, in patient with type 1 neurofibromatosis. Coronal and axial FRFSE T2-weighted images - obtained with (a-b) and without (c-d) fat saturation - show multiple lesions with high signal, located in the context of left trasversus abdominis muscle, internal oblique muscle and rectus abdominis muscle. Lesions reach the left IC, as well depicted on axial and coronal images. Similar lesions are also appreciable in the pelvis.

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**Fig. 21:** Liposarcoma. Axial MR images show a right inguinal mass involving the spermatic cord. On SSFSE (a) and SSFP (b) T2-weighted images, liposarcoma have heterogeneous intermediate signal intensity - with some central high signal intensity areas due to necrosis; on contrast-enhanced T1 3D GRE image (c), the mass shows enhancement of the solid peripheral portions, whereas the central area maintains low signal intensity. On axial CT images, the mass has soft-tissues attenuation without intra-lesional adipose tissue (d); it shows progressive peripheral enhancement during the various phases (e-g). Reticular enhancement is better appreciable in delayed phase.

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Fig. 22: Lymphatic metastases from sarcoma. On gray-scale US image (a), metastatic nodes are enlarged, with irregular borders. On color Doppler image (b) is possible to recognize an increased sonographic pattern of vascularization. On MR images, right inguinal lymphadenopathy are enlarged, with moderate/high signal intensity on T2-W images (c-d), low signal intensity on T1-W images (e), and of enhancement after gadolinium administration (f).

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Fig. 23: Metastatic nodes from penile carcinoma. Axial CT image (a) shows a large and confluent lymphoadenopathy with central necrosis in the left femoral region; the mass also infiltrates the pectineus muscle. After contrast administration (b), peripheral enhancement is well depicted.

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Fig. 24: Inguinal lymphoma. Axial contrast enhanced CT images (a-b) and oblique coronal MPR (c) show involvement of left iliac and inguinal lymphnodes; they show enhancement of solid portions, with heterogeneous appearance due to the intralesional necrosis.

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**Fig. 25:** Lymphatic metastases due to melanoma. Axial (a-b) and coronal (c) FRFSE T2-weighted images show two masses, respectively, in right femoral and inguinal region with high signal intensity. Diffusion weighted image (d) (b value = 800) and ADC maps (e) show restriction. On axial (f) and coronal (g) contrast-enhanced 3D GRE T1-W images, both masses show inhomogeneous enhancement.

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Conclusion

Knowledge of the anatomy is crucial to localize diseases occurring in the inguinal region. Radiologists should be able to identify the most frequent pathologies, in order to obtain a correct clinical and therapeutic approach.
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