The Inguinal Canal. Imaging of Common and Uncommon Pathology

Poster No.: C-0632
Congress: ECR 2014
Type: Educational Exhibit
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Keywords: Abdomen, Pelvis, CT, MR, Ultrasound, Education, Hernia, Neoplasia
DOI: 10.1594/ecr2014/C-0632

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Learning objectives

To describe and illustrate the imaging features of common and uncommon inguinal canal pathology.

Background

A variety of iatrogenic, traumatic, inflammatory, infectious and tumoral diseases can be found in the inguinal canal.

In this paper we will describe radiological findings of the inguinal canal pathology, including benign processes (hernia, abscess, hematoma, neurofibroma, varicocele, air, oral contrast, hydrocele, prosthesis) and malignant lesions (liposarcoma, testicular carcinoma, sarcoma, metastasis).

The combination of clinical evaluation, laboratory testing and imaging findings helps the radiologist make an accurate diagnosis of the inguinal canal pathology.

Findings and procedure details

We have retrospectively identified several patients with benign and malignant inguinal pathology who underwent various imaging procedures for primary diagnosis and for determining extension and complications.

We have reviewed the inguinal canal pathology diagnosed at our institution in the past two years by performing different imaging techniques (sonography, CT and MR). 68% of the patients were male. The mean age was 52 years. Benign pathology is more common than malignant diseases. The most frequent benign entity is inguinal hernia and sarcomas are the most common malignant processes.

ANATOMY:

The inguinal canal is a passage in the anterior and inferior abdominal wall that measures approximately 4cm in length and contains the spermatic cord in males and the round ligament of the uterus in females.

The inguinal canal is formed by four walls:
- Anterior wall: aponeurosis of the external and internal oblique muscles.
- Posterior wall: transversalis fascia and conjoint tendon.
- Superior wall: internal oblique and transverses abdominis muscles.
- Inferior wall: inguinal ligament.

It has **two openings**:
- Deep inguinal ring: oval gap in the transversalis fascia.
- Superficial inguinal ring: triangular opening in the aponeurosis of the external oblique muscle.

**Benign pathology in the inguinal canal:**

**INGUINAL HERNIA:**

They are classified as direct and indirect hernias:

- **Indirect:** they are congenital as a result of a failure of obliteration of the processus vaginalis peritonei. They are lateral to the inferior epigastric artery and anteromedial to the spermatic cord.

- **Direct:** it is a noncongenital hernia that passes through a defect in the Hesselbach triangle medially to the inferior epigastric artery.

Marfan syndrome, elevated maternal estrogen levels or collagen degeneration are some predisposing factors.

Inguinal hernias can contain bowel loops, colon, appendix, bladder, ovaries or fat (Figs. 1-7). Hernias containing fat are the most common. When bowel is present in a hernia is essential to look for signs that suggest strangulation.

Hernias containing ovaries occur commonly in children under the age of 5 years. They can associate torsion or salpingitis.

Cryptorchidism is a common congenital anomaly. The testicle can be localized anywhere in the usual path of descent. 80% will be located in the inguinal canal (Fig.8-10). Treatment is orchiopexy.
We can confirm that the visualized structure in the inguinal canal is the ovary or the testis by following the gonadal vessels

**LIPOMA:**

Spermatic cord lipomas are usually incidentally found during surgery, commonly in inguinal hernia repair.

They are considered true lipomas only if they are confined to the inguinal canal and don't connect with the retroperitoneal fat.

Lipomas have the appearance of fatty masses located lateral and inferiorly to the spermatic cord (hernias are anterior and medial to the cord). 50% measure more than 4cm and they are usually asymptomatic, sometimes associated to discomfort or pain. Symptomatic patients undergo surgery as treatment of choice.

At CT, lipomas have fat attenuation (less than 20HU). At MR imaging they show high signal intensity on T1 and T2-weighted images, similar to that of subcutaneous fat (Figs. 11-14)

**HEMATOMA:**

Inguinal hematomas are secondary to anticoagulant therapy, trauma, surgery, catheter placement or tumor.

They manifest as pain.

They are high attenuation masses at CT (greater than 30HU) and have variable signal intensity on MR images.

Resolution is usually spontaneous without surgery. Treatment includes drainage and antibiotics in symptomatic patients.

**ABSCESS:**

Some of its causes are incarcerated inguinal hernias, diverticulitis or Meckel diverticulum.

They produce fever, local pain and swelling and irreducible mass.
They appear as low attenuation masses on CT images with ring enhancement (Fig. 15). Their signal intensity at MR is low on T1-weighted images and high on T2 images, with a rim of peripheral enhancement.

Treatment includes drainage and antibiotic therapy.

**VARICOCELE:**

It’s a dilatation of the pampiniform plexus in the spermatic cord. There are two types:

- **Primary:** as a result of valvular incompetence and impaired venous drainage. It is more common on the left side.

- **Secondary:** because of a pressure increase in testicular veins produced by pathological processes as hydronephrosis, cirrhosis, abdominal neoplasms and the so called nutcracker syndrome (a compression of the left renal between the superior mesenteric artery and the abdominal aorta).

It can cause pain, palpable mass and infertility. The prevalence of varicocele among men with infertility is about 40%.

Non-compressible varicocele raises suspicion for a retroperitoneal neoplasm.

At US, varicoceles appear as a group of anechoic serpiginous structures that represent dilated veins. The normal diameter is variable, between 2 and 3mm. Varicoceles have low flow on Doppler studies and maintained flow inversion during Valsalva maneuver (Fig. 17-18). At CT it manifests as tubular structures with contrast enhance (Fig. 16). Varicocele has variable appearance at MR imaging depending on the rate of flow. In general there is intermediate signal intensity on T1 weighted images and high signal intensity on T2 weighted images. If the flow rate is high, we can see flow voids.

Treatment consists in embolization or surgery. When varicocele is secondary, the underlying cause must be treated.

**AIR AND BOWEL CONTRAST MATERIAL:**

It is secondary to gastrointestinal perforation.
Air in the canal produces crepitating. It has attenuation values of -1000 HU at CT and low signal intensity on T1 and T2 weighted images at MRI.

Underlying cause must be treated.

**HYDROCELE:**

Hydrocele is a fluid collection in the inguinal secondary to an incomplete closure of the processus vaginalis.

It also can occur as a secondary process due to trauma, infection or neoplasm. In these cases treatment should be that of the underlying cause.

Congenital hydrocele has two described types:

- **Encysted**: has no communication with the peritoneum or tunica vaginalis of the scrotum.

- **Funicular**: communicates with the peritoneum.

Symptoms include swelling and groin palpable mass.

At imaging, hydrocele appears at US as an anechoic fluid collection, or with fine echoes and thin septa. At CT, they have fluid attenuation and are situated in the inguinal canal anterior and medial to the spermatic cord (Fig. 20). At MR hydrocele shows low signal intensity on T1 weighted images and high signal intensity on T2 images and don't enhance with gadolinium contrast material.

**PROSTHESES:**

Penile prostheses are a treatment for erectile dysfunction, which can be caused by diabetes, surgery, trauma, Peyronie disease and others.

They are composed of three fundamental parts:

- Reservoir, placed in the lower anterior pelvis (Fig. 22).

- Bulb, placed in the scrotum.

- Cylinders, placed in the penile shaft (Fig. 21).
These components show high attenuation at CT.

There are other types of prostheses, as the penile urinary-sphincter prostheses for urinary incontinence from sphincter dysfunction (Fig. 23). They can be made of solid silicon, which is associated with a signal void at MR imaging.

**Malignant pathology in the inguinal canal:**

**LIPOSARCOMA:**

Liposarcoma of the spermatic cord is a malignant neoplasm of mesenchymal origin and one of the most common soft tissue sarcomas.

Liposarcomas occur in people with a wide age range. Mean age at diagnosis is 56. 20% of these tumors arise from the retroperitoneum, just 0.1% manifest as incidental inguinal hernia.

Most of the cases are low grade, well differentiated tumors with local extension. High grade tumors can have hematogenous and lymphatic spread.

Treatment consists of surgery with or without chemotherapy or radiotherapy. The percentage of local recurrence is 25% of cases.

**Imaging:**

- US: Solid lesion, predominantly hyperechoic, although it has variable appearance.

- TC: Big masses with fat attenuation (>75% of the lesion) with thick septa or soft-tissue attenuation nodules.

- RM: High signal intensity on T1 and T2 weighted images, similar to that of subcutaneous fat with little enhance after gadolinium contrast material administration (Figs. 24-25).

Dedifferentiation manifests as non-fatty components that enhance, with calcification. Imaging findings are very unspecific, with a high grade of overlapping between lipoma and liposarcoma appearance. Biopsy is mandatory. Findings suggesting malignancy: elderly people, big size of tumor, thick septa, soft-tissue nodularity and low percentage of fatty tissue.

**TESTICULAR CARCINOMA:**
Testicular carcinoma constitutes only 1% of all malignant neoplasm in men. Peak prevalence of testicular tumors occurs in the 25-35 age group. The most common manifestation is a painless scrotal mass. 95% of cases are germ cell tumors (seminomatous or nonseminomatous).

Testicular carcinoma affects the spermatic cord due to vascular invasion or direct tumor extension. This occurs more frequently with embryonal carcinoma and is seen in 15% of cases.

At CT, they are solid tumors with enhancement and cystic-necrotic component. At MR, these lesions demonstrate heterogeneous signal intensity on T1 and T2 weighted images.

Radiotherapy, chemotherapy and orchiectomy are the treatments of choice.

**SARCOMA:**

Rhabdomyosarcoma is the most common sarcoma in the inguinal canal and spermatic cord. Prevalence has a bimodal distribution, being 5 and 16 the peak ages. It usually manifests as painless groin mass.

It is a very aggressive tumor with local, hematogenous and lymphatic spread. 26-71% metastasizes to lymph nodes and 25% have distant metastases. There are three histological types: embryonal, alveolar and pleomorphic. The alveolar type has the worst prognosis.

Surgery and chemotherapy are the treatments of choice.

At imaging, they are heterogeneous masses with unspecific imaging findings due to necrosis and hemorrhage. CT allows pelvic staging for surgery planning.

**METASTASES:**

They occur principally in the lymph nodes or bone tissue. The first, are most frequently from tumors arising in lower extremities or pelvic structures: vagina, vulva, penis, rectum and anus.

Imaging of metastases is unespecific (Fig. 26).
Fig. 1: Axial contrast enhanced CT image shows fat herniated in the left inguinal canal.
Fig. 2: Axial contrast-enhanced CT image demonstrates the cecal pole herniated in the right inguinal canal.
Fig. 3: Axial contrast-enhanced CT image demonstrates the appendix herniated in the right inguinal canal of the same patient as in fig. 2.
**Fig. 4:** Axial contrast-enhanced CT image shows bladder herniated in the right inguinal canal.

**Fig. 5:** Axial contrast-enhanced CT image shows left inguinal hernia containing small bowel loops.
Fig. 6: Axial contrast-enhanced CT image shows inflamed appendix herniated in the right inguinal canal.

Fig. 7: Axial contrast-enhanced CT image performed to the same patient of fig. 6, showing a right inguinal hernia containing a fluid collection with gas secondary to complicated appendicitis with appendix perforation.
**Fig. 8:** Cryptorchidism. US image of the inguinal canal shows a well-defined mass with homogeneous medium-level echotexture, similar to that of the normal testis.
**Fig. 9:** Cryptorchidism. Coronal T1-weighted image shows a nondescended testis in the right inguinal canal of a child. It has uniform intermediate signal intensity, as in the normal testis.
**Fig. 10:** Coronal T2-weighted fat suppressed image taken in the same patient of fig.9. The right testis shows normal high signal intensity.
Fig. 11: Axial T2-weighted image of the right scrotum shows a mass with high signal intensity. It has a small posterior nodule with intermediate signal intensity. Surgery confirmed that this lesion was a spermatic cord lipoma.
**Fig. 12**: Coronal T2-weighted image shows the same lipoma with high and homogeneous signal intensity.
**Fig. 13:** Axial T1-weighted image shows high signal intensity of the lipoma, similar to that of the subcutaneous fat.
**Fig. 14:** Axial T1-weighted fat-suppressed and contrast enhanced image shows low signal intensity of most of the tumor (the same of figs 11-13) demonstrating fat composition. We also can see enhancement of the posterior nodule, a finding that should raise suspicion of malignancy. In this case, after surgery of the mass, no signs of malignancy were present.
Fig. 15: Axial contrast-enhanced CT image shows fluid collection with gas in the right scrotum, corresponding to an abscess.
**Fig. 16:** Axial contrast-enhanced CT image shows right inguinal tubular structures with contrast enhancement corresponding to a varicocele.
**Fig. 17:** US image shows varicocele as serpiginous anechoic/isoechoic tubules, some of them with a diameter of more than 2mm.

**Fig. 18:** Color Doppler US image shows slow venous flow in the varicocele.
**Fig. 19:** Color Doppler US image during Valsalva maneuver. Maintained increase in venous flow is observed.
**Fig. 20:** Axial contrast-enhanced CT image shows a right fluid inguino-scrotal collection corresponding to hydrocele.
**Fig. 21**: Penile prosthesis. Axial contrast-enhanced CT image shows cylinders placed in the penile shaft.
**Fig. 22:** Penile prosthesis. Axial contrast-enhanced shows the reservoir implanted in the anterior left pelvis.
**Fig. 23:** Penile urinary-sphincter prosthesis. Axial contrast-enhanced CT image shows an inflate-deflate cuff placed at the penile urethra.
Fig. 24: Liposarcoma. Coronal T2-weighted (a), axial T2-weighted (b), axial T1-weighted (c) and T2-weighted fat-suppressed images show right inguino-scrotal mass with heterogeneous signal intensity. Important amount of fat component is present and shows high signal intensity on T1 and T2-weighted images and low signal intensity on fat-suppressed image. Red star in (a) is marking the right testicle.
Fig. 25: Liposarcoma. Axial T1-weighted fat-suppressed and contrast-enhanced image shows enhancement of the solid non-fatty components of the tumor.
Fig. 26: Axial contrast-enhanced CT image shows bilateral inguinal cystic metastases of epidermoid carcinoma of the penis.
Conclusion

The radiologist plays a key role in the diagnosis and monitoring of inguinal canal pathology. Definitive diagnosis can be made by careful interpretation of the radiological findings, although biopsy is necessary sometimes. It is important to be familiarized with the imaging features and patient's clinical history to make a correct diagnosis.

Personal information

References


