US features of scrotal disorders: A pictorial essay

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Learning objectives

1. To review the anatomy of the scrotal contents and the indications for scrotal ultrasonography (US)
2. To describe the US features of various types of scrotal pathology
3. To highlight the utility of US in differentiating among the types of scrotal lesions

Background

A variety of disorders may affect structures within the scrotum. Gray-scale US is widely available, noninvasive and inexpensive imaging modality for evaluating these disorders, and is valuable for differentiating between extra-testicular from intra-testicular lesions. The supplement use of color Doppler US and knowledge of patient's clinical details further help improve the diagnostic accuracy.

Findings and procedure details

I. Indication for scrotal US:

1. Evaluation of palpable scrotal mass
2. Evaluation of scrotal trauma
3. Evaluation of scrotal pain
4. Evaluation of infertile
5. Evaluation of occult primary tumours in patients with metastatic disease
6. Searching for undescended testis
7. Follow up of patients with prior testicular neoplasm, leukemia, lymphoma, and infection

II. Normal anatomy of the scrotal contents:

The scrotum is divided by a midline septum into two separate pouches. Each half of the scrotum consists of a testis, epididymis, and the intrascrotal portion of the spermatic cord (Fig. 1).

A normal testis measures 5 × 3 × 2 cm in size. In healthy young men the ovoid testis measures 15 to 25 mL in volume. The testicular parenchyma consists of multiple lobules, each of which is composed of many seminiferous tubules that lead via the tubuli recti to dilated spaces, called the rete testis within the mediastinum (Fig. 2).
The epididymis, which overlies the superolateral aspect of the testis, comprises a head, body, and tail. The epididymal head is a 5-12-mm pyramidal structure. The body of the epididymis is 2-4 mm thick.

The spermatic cord contains the vas deferens, testicular artery, cremasteric artery, deferential artery, pampiniform venous plexus, lymphatic ducts and genitofemoral nerve (Fig 3).

III. Normal scrotal US and technique of examination:

Scrotal US is performed with the patient lying in a supine position and with the scrotum supported by a towel placed between the thighs.

The superficial location of the testis allows the use of a high-frequency transducer (7 - 14 MHz), which produces excellent spatial resolution.

The testes are evaluated in longitudinal and transverse planes(Fig 3, 4). The size and echogenicity of each testis and epididymis should be compared with those of the controlateral testis and epididymis.

Transverse scrotal imaging to depict both the testes is extremely important, allowing a comparison of their gray-scale and color Doppler appearances (Fig 5).

At US, the epididymis appears isoechoic or hypoechoic when compared with the testis. The normal epididymis shows no flow on color Doppler sonograms. (Fig 4).

At the upper pole of the testis is the appendix testis, a small pedunculated or sessile body similar in appearance to the appendix of the epididymis (Fig 6).

The addition of color Doppler sonography provides simultaneous display of morphology and blood flow. Normal intratesticular arterial blood flow is consistently detected with power or color Doppler. Power Doppler ultrasound yields a higher gain and is therefore more sensitive for detecting low flow. Pulsed Doppler is used to quantify blood flow.

IV. SCROTAL PATHLOGY

1. Congenital anomalies: Anomaly of closure of the processus vaginalis:
Anomaly of closure of the processus vaginalis may result in a communicating hydrocele (7a), hydrocele (7b), cyst of the cord (7c) and (fig 8), a congenital inguinal hernia (7d) or congenital inguinoscrotal hernia (7e).

Hydrocele is an abnormal fluid collection in the tunica vaginalis and may be either congenital or acquired. It is the most common cause of painless scrotal mass. Congenital hydrocele results from incomplete obliteration of processus vaginalis, allowing communication between the peritoneal cavity and scrotum (Fig 9).

Acquired hydrocele may be idiopathic or associated with trauma, infection and tumors. Although processus vaginalis completely closes, it remains as a potential mechanical weak point. With straining, it can open and allow the herniation of abdominal contents such as omentum or bowel into the scrotum.

2. Inflammatory Disease :

Primary epididymitis is generally caused by a bacterial infection. Orchitis is representing a direct extension of the inflammation. Isolated orchitis is unusual and generally is viral or posttraumatic.

The US finding of acute epididymitis is enlargement of the epididymis with hypoechogenicity and increased vascularity on color doppler study (Fig 10, 11, 12, 13). It may be focally or diffusely involved. When orchitis is also present, the testis appears enlarged with decreased echogenicity. Reactive hydroceles and scrotal wall thickening are often found with epididymoorchitis.

The inflammed epididymis and testis display increased flow and low-resistance pattern (RI< 0.5). It may be difficult to differentiate focal orchitis or abscess from testicular tumour. Associated epididymal involvement and scrotal skin thickening are suggestive of infection rather than tumour. Advanced or untreated cases of epididymo-orchitis may result in abscess formation, pyocele and testicular ischemia (Fig 14, 15). In the chronic stage, The echogenicity of the epididymis and testis may be increased with or without calcifications.

3. Testicular torsion:

Testicular torsion is a surgical emergency. Occlusion of the testicular artery causes necrosis of the testis after approximately 6 h.

US appearances of testicular torsion are variable, depending on the duration of torsion. In the first few hours, the testis often appears normal. After 4 hours, the testis is enlarged with diffuse hypoechogenicity and absent or decreased vascularity on color doppler study (Fig 16). After that, appears hemorrhage and necrotic lesions.
Flow within the torsed testis is reduced or absent. In missed torsion, lack of intratesticular flow and increase of blood flow in the peritesticular tissues are seen (Fig 17). The presence of Doppler signal in a patient with clinical suggestion of testicular torsion does not exclude torsion (incomplete torsion!) (Fig 18). Diagnosis of spontaneous detorsion should be considered in a patient with acute scrotal pain and resolves spontaneously with hyperaemia of the testis. It can simulate epididymo-orchitis.

4. Vascular pathology:

Varicocele is a Dilatation of veins of pampiniform plexus> 2-3 mm in diameter.

US findings : Tortuous anechoic tubular structures adjacent to the testis, expand with Valsalva manoeuvre and upright position (Fig 19, 20). Colour Doppler Reflux in the spermatic vein, which increases with Valsalva manoeuvre, may be identified.

Doppler sonography grading venous reflux :
- physiological (grade I) <2sec
- intermittent (grade II) 4-5sec
- continuous (grade III) >6sec

5. Testicular Trauma

It varies from a small hematocele requiring conservative management to a testicular rupture demanding immediate surgical intervention.

Intratesticular Hematoma: Hyperacute and acute hematomas are sometimes difficult to identify, as they may appear isoechoic to the surrounding testicular parenchyma or may have a diffusely heterogeneous echotexture. Suspected acute hematomas must be reexamined within 12-24 hours after the initial US evaluation. Traumatic epididymitis may also be revealed as enlargement and hyperemia of the affected epididymis on color Doppler images.

Testicular rupture: heterogeneous echotexture within the testis, testicular contour abnormality, and disruption of the tunica albuginea (Fig 21).

Testicular Fracture: identified at US as a linear hypoechoic and avascular area within the testis. May or may not be associated with a tunica albuginea rupture.
6. Testicular and epididymal cysts:

Simple epididymal cyst: Well-defined and anechoic cyst containing clear fluid, it may be seen throughout epididymis.

Differential diagnosis: Tubular Ectasia of Rete Testis.

Tunica albuginea cyst

7. Scrotal calcifications:

Testicular microlithiasis (TM) corresponds to intratubular calcifications resulting from degenerating cells within the seminiferous tubules.

The typical US appearance of TM is of multiple non-shadowing echogenic foci measuring 2-3 mm and randomly scattered throughout the testicular parenchyma (Fig 24).

While microcalcifications do exist in roughly 50% of germ cell tumors.

Men with testicular microlithiasis must have regular US and Tests for tumor markers.

8. Testicular solid tumors:

Benign tumors:

Adenomatoid tumors are the most common epididymal tumors; they comprise about 30% of paratesticular neoplasms. They are frequently well defined and can range from 3 mm to 5 cm in size. The lesion will show an echotexture similar to, or slightly greater than, the testis without increased flow on Doppler imaging (Figure 25, 26).

Congenital adrenal hyperplasia (CAH) refers to a group of inherited disorders that cause defects in the adrenal glands' ability to produce cortisol from cholesterol, leading to increased levels of adrenocorticotropic hormone (ACTH). In patients with CAH, ectopic adrenal rest tissue is frequently identified within the testicles. In response to elevated levels of ACTH, this rest tissue enlarges and can present as a palpable mass. On ultrasound, these lesions are typically bilateral, hypoechoic, predominantly located peripherally, and show minimal mass effect (Figure 27). Additionally, a spoke-like pattern of vascularity may be present within the mass on color Doppler, but many of the masses will appear hypovascular or avascular.
Testicular malignancy

Testicular cancers are relatively rare, but are the most common solid tumor in males aged 15-35.

Seminomas are usually well-defined, hypoechoic, solid ± lobulation. They don’t have calcification nor tunica invasion. Most seminomas demonstrate increased flow on color Doppler examination (Fig 28, 29, 30).

The nonseminomatous germ-cell neoplasms demonstrate a heterogeneous echotexture with irregular or ill-defined margins. Echogenic foci within the substance of the tumors represent areas of hemorrhage, calcification, or fibrosis. They frequently have cystic components, consistent with regions of necrosis.

Embryonal cell carcinomas tend to distort the testicle and frequently invade the tunica albuginea.

Approximately 10% of the patients may present testicular tumor with acute scrotal pain, it may mimic epididymo-orchitis.

Lymphoma is the most common secondary tumor of the testes. It most commonly occurs in patients >60 years, with non-Hodgkin's lymphoma being the most frequent. It may appear on ultrasound as a diffuse, hypoechoic enlargement of the testis or as an avascular, hypoechoic, and intratesticular mass (Figure 31, 32).

Leukemic involvement is also common, as the blood-gonad barrier shields the testis from systemic chemotherapy. The ultrasound appearance often shows diffusely enlarged, hypoechoic testicles, frequently indistinguishable from lymphoma.

The testis is occasionally the site of metastatic lesions from tumours involving the prostate, kidney, lung, gastrointestinal tract, skin, myeloma, plasmacytoma, and other primary sites. Patients usually have a known malignancy.

Images for this section:
Fig. 1: Cross section through the midpoint of scrotum and testis
Fig. 2: Longitudinal section of the testis and epididymis
Fig. 3: Longitudinal section of spermatic cord showing its content: vas deferens, testicular artery, cremasteric artery, deferential artery, pampiniform venous plexus, lymphatic ducts and genitofemoral nerve.
Fig. 4: Longitudinal USG of scrotum; the epididymis appears isoechoic or hypoechoic when compared with the testis.
Fig. 5: Transverse ultrasound section of both testis: The size and echogenicity of each testis and epididymis should be compared with those of the contralateral testis and epididymis.
Fig. 6: At the upper pole of the testis is the appendix testis, a small pedunculated or sessile body similar in appearance to the appendix of the epididymis.
Fig. 7: Anomaly of closure of the processus vaginalis may result in a communicating hydrocele (a), hydrocele (b), cyst of the cord (c), a congenital inguinal hernia (d) or congenital inguinoscrotal hernia (e).

Fig. 8: longitudinal US of right inguinal canal: cord cyst
Fig. 9: Longitudinal US of left inguino scrotal region: congenital inguino scrotal hernia with communicating hydrocele.

Fig. 10: Transverse color doppler US scan through both testis demonstrating hypervascularity of right testis compared to the left.
**Fig. 11:** Longitudinal US of right testis: hypervascularity of right epididymis and testis. Right epididymo orchitis.
Fig. 12: Longitudinal scrotal US: epididymal thickening with decreased echogenicity

Fig. 13: US demonstrates hypervascularity of the head of epididymis.
**Fig. 14:** US shows left epididymal abscess with marked enlargement of epididymis.

**Fig. 15:** Power doppler study demonstrates intratesicular avascular lesion representing testicular abscess.
**Fig. 16:** Comparative color doppler study of both testis showing no vascularity in the the torsed testis compared with the normal vascularized testis.

**Fig. 17:** Transverse color doppler scan of left testis showing increased testicular peripheral vascularity in a case of missed torsion.
Fig. 18: Power doppler study demonstrate mild parenchymal vascularity in left testis. Incomplete torsion.

Fig. 19: B mode and power doppler study of left testis showing increased diameter of pampiniform plexus veins during valsalva.
Fig. 20: (a and b) Grayscale and color Doppler ultrasound images of the left spermatic cord demonstrate multiple tubular, serpiginous anechoic structures with flow on the Doppler images. The diameter of the vessels is up to 3.5 mm with Valsalva, consistent with testicular varices.
**Fig. 21:** Grayscale ultrasound image of the right testicle shows disruption of the tunica albuginea with extrusion of the testicle through the defect, consistent with testicular rupture.

**Fig. 22:** Grey scale US demonstrates epididymal cyst with thin wall and clear content.
Fig. 23: Color Doppler ultrasound image of the left testicle showing multiple anechoic structures located near the mediastinum testis. These structures demonstrate little mass effect and appear avascular on Doppler imaging. The appearance is consistent with ectasia of the rete testis.
Fig. 24: Grayscale ultrasound image of the left testicle shows multiple punctate areas of increased echogenicity throughout the testicle, consistent with microlithiasis. There is no posterior acoustic shadowing.

Fig. 25: Grayscale ultrasound image show relatively well-defined, mobile paratesticular lesion, which have similar to slightly increased echogenicity relative to the testicle.
**Fig. 26:** Color Doppler ultrasound image show relatively well-defined, mobile paratesticular lesion, which have similar to slightly increased echogenicity relative to the testicle. The lesions show minimal internal flow on Doppler imaging. Appearance is consistent with adenomatoid tumors.
**Fig. 27:** Grayscale ultrasound image of the left testis shows hypoechoic masses within the peripheral portion of the testis with more normal appearing testicular tissue centrally, suggestive of adrenal rests. The patient has a history of congenital adrenal hyperplasia.
Fig. 28: Grayscale ultrasound image of the right testicle shows hypoechoic mass with some internal echos. No internal calcifications are identified. Pathology confirmed seminoma.
Fig. 29: Grayscale ultrasound image of the right testicle show multiple hypoechoic masses throughout the testicle. No internal calcifications are identified. Pathology confirmed seminoma.
Fig. 30: Color Doppler ultrasound image of the right testicle show multiple hypoechoic masses throughout the testicle with some internal flow. Pathology confirmed seminoma.
Fig. 31: Grayscale ultrasound image of the left testicle show multiple ill-defined hypoechoic masses within the testicle. Biopsy confirmed non-Hodgkin’s lymphoma.

Fig. 32: Color Doppler ultrasound image of the left testicle show multiple ill-defined hypoechoic masses within the testicle with internal flow. Biopsy confirmed non-Hodgkin’s lymphoma.
Conclusion

Ultrasound is the preferred imaging modality for the scrotum because of its low cost, lack of ionizing radiation, and ability to image in real time. The clinical history and examination of patients presenting with scrotal symptoms frequently overlap among multiple etiologies, and a thorough understanding of the usual findings to aid in differentiating surgical from medical, and benign from malignant, etiologies is required to accurately guide patient care.

Personal information

References