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Ultrasound of the scrotum

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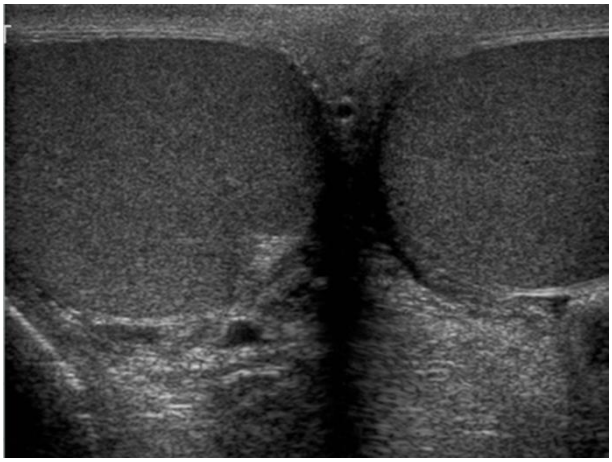
Introduction

Imaging the contents of the scrotum remains firmly within the realm of ultrasonography despite the introduction and extensive use of more sophisticated imaging techniques. Ultrasonography is the first-line, and frequently the only imaging modality, employed in the assessment of scrotal abnormalities. Technical advances in transducer design and image processing has further improved the quality of diagnosis of diseases of the scrotal contents. Colour Doppler imaging (CDI) has added important information and newer techniques (contrast-enhanced ultrasound and elastography) are improving the diagnostic capabilities (1-4). This chapter will deal with aspects related to the testis and epididymis, detailing both normal sonographic features and those related to the disease processes.

Sonographic examination technique

Private surroundings are essential for the examination, which should be conducted in the presence of a chaperone and the examiner should use a gloved hand for the examination. The sonographic gel should be warm and ample amounts should be applied. The scrotal sac may be stabilized by placing a towel beneath the sac with the penis held against the abdominal wall by the patient. A high-frequency linear array transducer should be used, which has colour and spectral Doppler capabilities. An adequate transducer length (>5cm) is required to allow accurate longitudinal length measurements of the testis. The “spectacle” view of both testes in the transverse direction allows comparison of testicular parenchyma features, which is important if a unilateral global testicular problem is suspected [Figure 1]. The entire scrotal sac should be examined to include both the transverse and longitudinal planes. Testicular volume may be calculated and colour Doppler ultrasound will confirm vascular supply. If the examination fails to detect the “lump”, the patient should find the lesion and hold this between two fingers to be re-examined.

Figure 1 Normal testis. A transverse view through both the testes, the “spectacle view” allows comparison of the reflectivity of the two testes, which is of particular importance in infiltrative lymphoma and leukaemia.



Gross anatomy

Embryology

After the seventh month of fetal development the testes descend into the scrotal sac with a dense layer of fibrous connective tissue that covers the testis, called the tunica albuginea. The testis is also covered by a fold of the processes vaginalis, which becomes the visceral layer of the tunica vaginalis. The remainder of the peritoneal sac forms the parietal layer of the tunica vaginalis. The visceral layer of the tunica vaginalis covers the testes and the epididymis, whereas the parietal reflection covers the anterior and lateral parts of the testes and the epididymis leaving a “bare area” to which the mesentery of the testis is attached this is important as the “bell-clapper” deformity in spermatic cord torsion (5). A reflection of the tunica albuginea forms the mediastinum testis, within which the rete testis forms (6).

Scrotal sac and testicular anatomy

The layers of the scrotal sac consist of skin, dartos muscle, external spermatic fascia, the cremasteric fascia and the internal spermatic fascia. The scrotum is divided into two separate chambers by the median raphe, which is continuous with the dartos muscle. Beneath the internal spermatic fascia is the parietal layer of the tunica vaginalis. A potential space exists between the parietal and visceral layers of the tunica vaginalis allowing fluid accumulation. The visceral layer of the tunica vaginalis covers the inelastic tunica albuginea, which gives rise to multiple thin septations that extend to the mediastinum testis dividing the testis into 200–

250 lobules containing the seminiferous tubules. The seminiferous tubules form the tubuli recti that enter the mediastinum as the rete testis which eventually drain into the epididymis and then into the vas deferens. The epididymis consists of three segments: the head, body and the tail. The head is formed of efferent ductules from the rete testis that form a single convoluted duct, the ductus epididymis, up to 6m in length. The ductus epididymis has a very tortuous route from the head to the tail of the epididymis, where it turns around to exit into the spermatic cord from the epididymal head.

Vascular anatomy

The arterial supply to the scrotal sac and content arises from three sources: the testicular artery, (arising from the aorta and supplying the testis), the cremasteric artery(a branch of the inferior epigastric artery, supplying the scrotal sac and the coverings of the spermatic cord) and the artery to the ductus deferens(arising from the superior vesicle artery). The testicular artery branches into the testis and pierces the tunica albuginea in a layer termed the tunica vasculosa. These branches course along the septum to converge on the mediastinum and then form recurrent rami through the parenchyma. The veins exit the testes at the mediastinum and join the veins draining the epididymis to form the pampiniform plexus at the superior aspect of the testes. The cremasteric plexus (mainly draining extra-testicular blood) lies posterior to the pampiniform plexus. The right testicular vein drains directly into the inferior vena cava below the level of the right renal vein, whereas the left testicular vein drains into the left renal vein. These three arteries and the veins are loosely held together by connective tissue along with nerves, lymph vessels and the vas deferens in the spermatic cord. The spermatic cord runs from the deep inguinal ring into the scrotum. Although it is not possible to identify a named artery within the spermatic cord, CDI is able to demonstrate the three individual arteries within the spermatic cord. Despite anastomoses existing between the testicular, deferential and cremasteric arteries, one of the arteries will consistently show a significantly lower resistive index than the other two arteries (7).

Sonographic appearances

The scrotal wall appears as three layers: an outer hyper-reflective layer, a hypo-reflective intermediate and a hyper-reflective inner layer corresponding to the tunica albuginea. The

testes are homogenous and of medium level reflectivity. At birth the testis measures approximately 1.5cm in length and 1.0cm in width. Before 12 years of age the testicular volume is 1–2ml. In adults, testicular length may be up to 5cm. Volume measurement is calculated using the formula:

Length × Width × Height × 0.51

A total volume (both testis) of more than 30ml is indicative of normal function (8). Testicular volume of more than 2mls allows a reliable appreciation of intratesticular colour Doppler flow (9). The mediastinum testis is seen as a highly reflective linear structure at the posterior-superior aspect of the testicle and drains the seminiferous tubules of the testes into the rete testis [Figure 2]. The rete testis is a low reflective area at the hilum of the testis with finger-like projections into the parenchyma [Figure 3] (10). The appendix testis (a vestigial remnant of the Müllerian duct) is present in the majority of patients at the superior testicular pole (11). There is marked variation in the size and appearance of an appendix testis; it is usually oval, although a stalk-like cystic structure (cyst of Morgagni) is occasionally seen [Figure 4].

Figure 2 Mediastinum testis. The mediastinum testis is seen as a highly reflective linear structure at the posterior-superior aspect of the testicle (arrows).

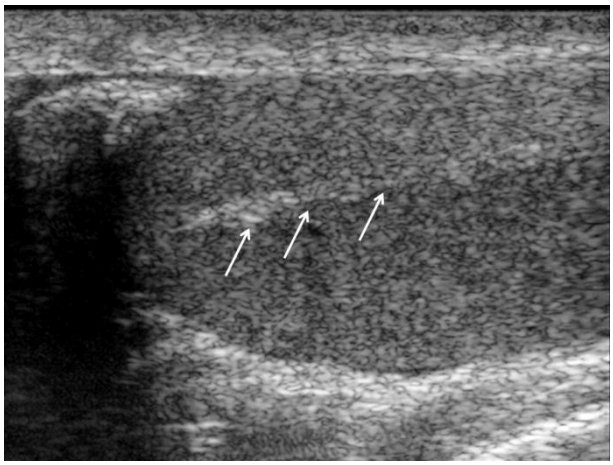


Figure 3 Normal rete testis. The rete testis is a low reflective area at the hilum of the testis with finger-like projections into the parenchyma (arrows).

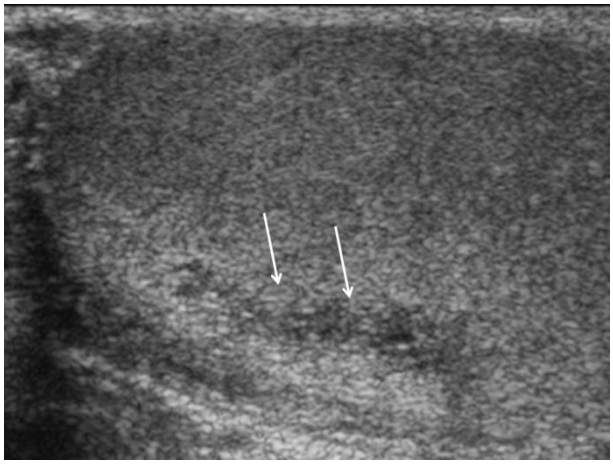
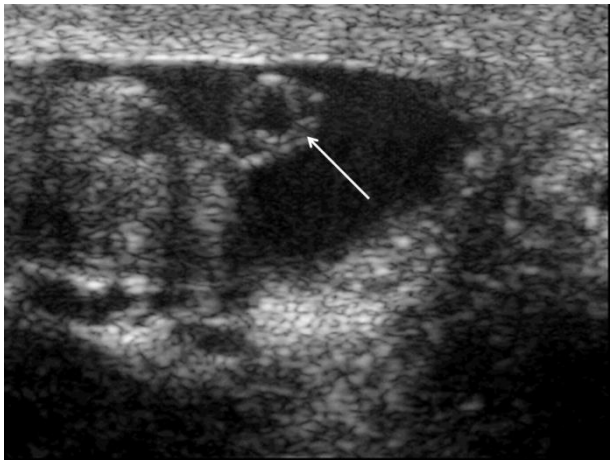
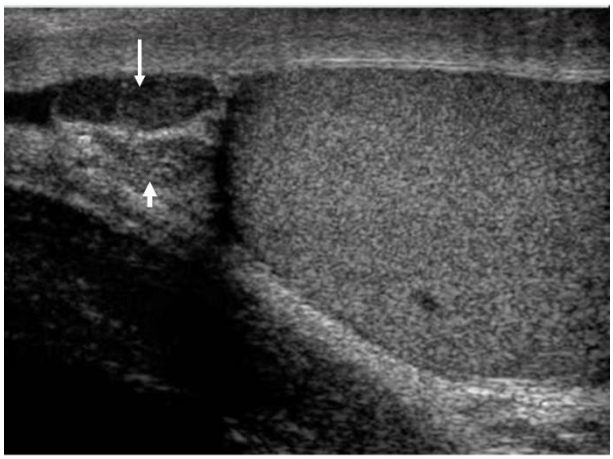


Figure 4 Appendix testis and epididymis. There is marked variation in the size and appearance of an appendix testis and epididymis, usually oval, although a stalk-like cystic structure is referred to as the "cyst of Morgagni" (arrow).



The epididymal head is a pyramid shaped structure lying superior to the upper pole of the testis. The body courses along the posterolateral aspect of the testicle. The epididymal tail is thicker than the body and is a curved structure at the inferior aspect of the testicle. The body and tail are of slightly lower reflectivity when compared with the testis, while the head is of slightly higher reflectivity [Figure 5]. Colour Doppler signal may be identified in the normal epididymis (12). The appendix epididymis is not seen as frequently as the appendix testis (13). It is part of the mesonephric (Wolffian duct) and projects from the epididymis to different sites, most commonly the head. The epididymal head measures 10–12mm in diameter, the body is less than 4mm (average 1–2mm) in diameter (14).

Figure 5 Normal epididymal head. The normal triangular shaped epididymal head. The changes in reflectivity of the epididymis are demonstrated; the low reflectivity of the body (long arrow) alters in the head of the epididymis (short arrow) to a higher reflectivity.

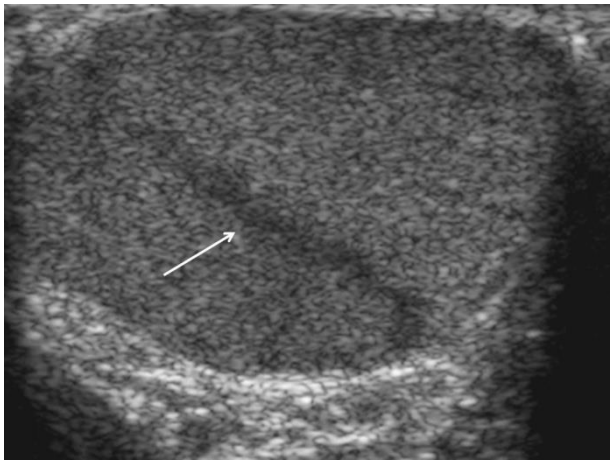


Normal variants

Transmediastinal artery

A transmediastinal artery is a large branch of the testicular artery, which splits off and traverses the testis to form capsular branches at the opposite aspect. It has been reported in 52% of patients and is unilateral in half of these (15). The artery is freely identified with colour Doppler sonography and normally returns a low-resistance spectral Doppler waveform. The transmediastinal is often accompanied by the transmediastinal vein [Figure 6].

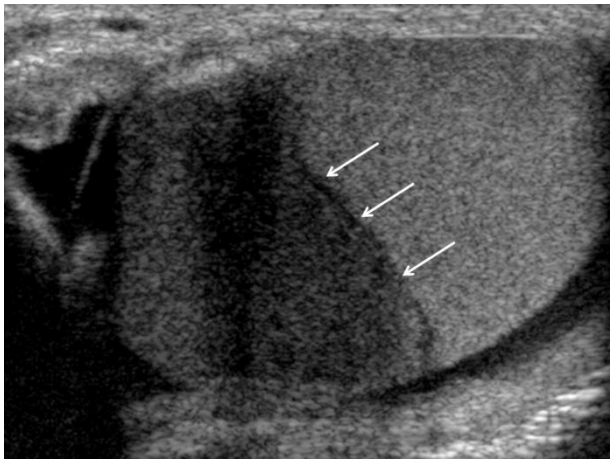
Figure 6 Trans-mediastinal artery and vein. The linear low reflective structures traverse the testis (arrow).



Two-tone testis

The term “two-tone” describes the appearance of an artefact where the transmediastinal artery produces acoustic shadowing resulting in a discreet uniform area of decreased reflectivity posterior to the artery [Figure 7]. This artefact is caused by refractive shadowing at both edges of the intratesticular artery (16). The reflectivity of the remainder of the testis is normal. The use of colour Doppler ultrasound confirms the presence of the intratesticular artery as the source of the artefact (17).

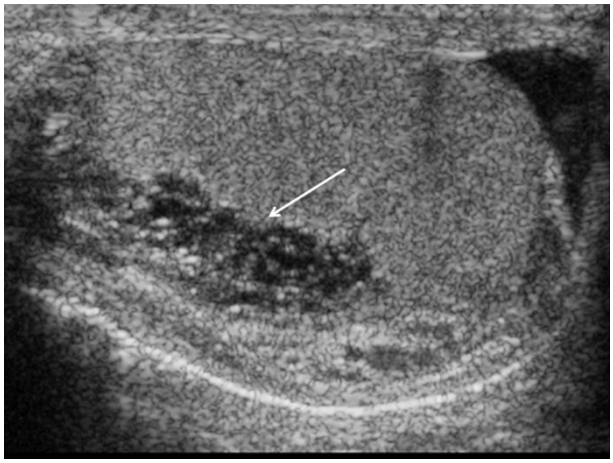
Figure 7 “Two-tone” testis. There is a well-demarcated low reflective appearance generated through the testis (arrows) that does not appear to be related to a pathological cause.



Rete testis

The rete testis is contained within the mediastinum testis. On ultrasound, the rete testis has a spectrum of appearance ranging from a faintly visible ill-defined area of decreased reflectivity (18% of patients) at the testicular hilum to a coarse tubular appearance with finger-like projections into the parenchyma (10) [Figure 8].

Figure 8 Rete testis. An example of a rete testis with a number of cysts of varying size present adjacent to the mediastinum of the testis (arrow).



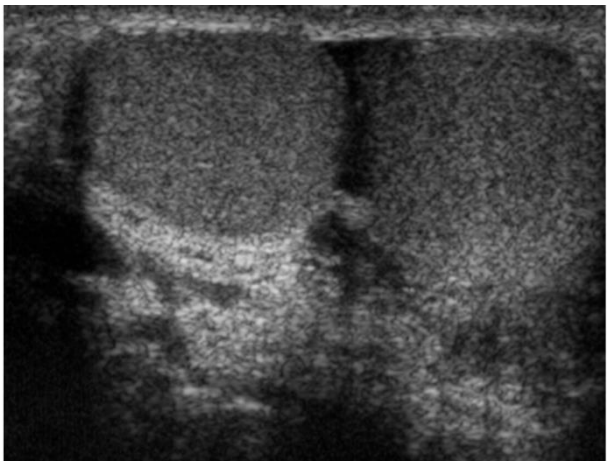
Appendix testis

A remnant of the paramesonephric and mesonephric ducts may remain to form the appendix testis (hydatid of Morgagni) and appendix epididymis, respectively. The appendix testis may be present in up to 92% of patients and is bilateral in 69% (18) The appendix testis is usually of similar reflectivity to the head of the epididymis; this is best seen in the presence of a hydrocoele. They are commonly oval-shaped and sessile but may appear “stalk-like” and pedunculated, cystic or calcified (11). The stalk-like and cystic appendices are linked with an increased possibility of appendiceal torsion recognized as a cause of acute scrotal pain (19). The epididymal appendix is seen less frequently (6%), more frequently stalked and, less commonly, may undergo torsion (18). On occasion both an epididymal and testicular appendage may be seen in the same patient.

Polyorchidism

Polyorchidism (more than two testes) is a rare condition and most commonly involves a bifid or duplicated testis with a single epididymis and a uniform surrounding tunica albuginea (20;21) [Figure 9]. Polyorchidism, usually presents as a painless mass and occurs more often on the left. The supernumerary testes may or may not have reproductive potential depending on the attachment to a draining vas deferens and epididymis: Type 1 has reproductive potential and Type 2 has no reproductive potential (20). Based on the embryological development, polyorchidism may be classified into four types (21): Type A, the supernumerary testis lacks either an epididymis or vas deferens; Type B, the supernumerary testis has an epididymis but no vas deferens and there may be no connection (Type B1) or the epididymis may be connected to the normal ipsilateral testis (Type B2); Type C, the supernumerary testis has a separate epididymis but shares the vas deferens with the ipsilateral testes either in a parallel or longitudinal fashion; Type D, the supernumerary testis may have a completely separate epididymis and vas deferens and is the least common.

Figure 9 Polyorchidism. The left testis is divided into two components both of normal reflectivity of a testis.



The sonographic features are those of a well-defined rounded lesion occurring either superior or inferior to the ipsilateral testicle with identical reflectivity and colour Doppler signal as the ipsilateral testis (22). The length of the two ipsilateral testes added together equates to the length of the contralateral testicle. Polyorchidism has been reported in association with rete

testis and microlithiasis (23). Various malignancies have been reported in the supernumerary testes (24;25). Management is conservative, and multiparametric ultrasound may be useful (26).

Acute painful scrotum

Acute scrotal pain is a common urological emergency for which epididymo-orchitis is the commonest cause, but the most important diagnostic distinction to be made is between acute spermatic cord torsion and the other causes of acute scrotal pain (27;28). The treatment for acute spermatic cord torsion is urgent surgical exploration to maintain viability of the testis and avoid testicular infarction. Diagnostic accuracy is important to identify patients who require immediate surgical intervention and to avoid unnecessary surgery in patients with a non-surgical cause for acute testicular pain. Clinical examination can be particularly inaccurate in distinguishing the causes of acute scrotal pain; in particular, the clinical discrimination between acute epididymo-orchitis and spermatic cord torsion can be practically unattainable. In an emergency setting, the ready availability of greyscale and CDI allows ultrasound to remain the imaging modality of choice. Familiarity with the sonographic features of common causes of acute scrotal pain is therefore a necessity for the emergency on-call sonographers to provide complementary information for the clinical team to aid accurate diagnosis in these patients.

The following are the causes of acute scrotal pain:

Acute epididymo-orchitis

Chronic epididymo-orchitis

Acute spermatic cord torsion

Intermittent torsion of the spermatic cord

Acute testicular trauma

Acute segmental testicular infarction

Henoch Schonlein purpura

Patent processes vaginalis with acute appendicitis

Intratesticular tumours

Inflammatory disease

Epididymo-orchitis and epididymitis

Epididymo-orchitis and epididymitis predominantly affects sexually active males under 40 years of age, older patients with urological disease and pre-pubertal boys with an associated urogenital anomaly (29). The main causative organisms for those with sexual transmitted diseases are Chlamydia trachomatis and Neisseria gonorrhea, whereas in pre-pubertal boys and in men over the age of 40 years the organisms responsible are Escherichia coli and Proteus mirabilis. Epididymitis causes acute scrotal pain of varying intensity, pyuria with fever and at clinical examination the epididymis may be palpated as a thickened tender structure separate from the testis.

The epididymis may be involved in focal areas (often the lower is affected first) or in a global pattern, with enlargement, decreased reflectivity and increased colour Doppler flow on sonography (30;31) [Figure 10]. The increased colour Doppler flow to the inflamed epididymis is the mark for hyperaemia and conveniently aids the diagnosis of epididymitis. There is often a reactive hydrocoele with septations if a pyocoele develops and scrotal wall thickening [Figure 11]. The infection may spread to the adjacent testis (epididymo-orchitis), which is seen as patchy areas of low reflectivity and increased colour Doppler signal. This appearance that may persist for several months following treatment and it is sometimes difficult to exclude a malignant lesion (32) [Figure 12]. It is important that diffuse heterogeneous hyper-reflectivity and focal changes of the testes in suspected orchitis are followed-up to ensure complete resolution and to rule out neoplasm (33).

Figure 10 Epididymitis. The epididymis is enlarged and of mixed reflectivity (arrows).