EFSUMB Course Book, 2nd Edition

Editor: Christoph F. Dietrich

Ultrasound of the scrotum

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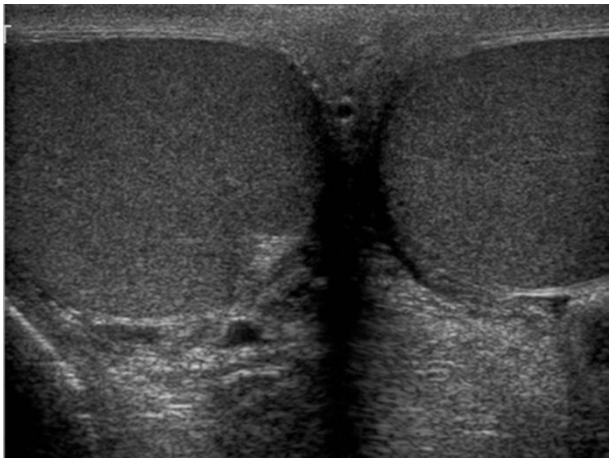
Introduction

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).

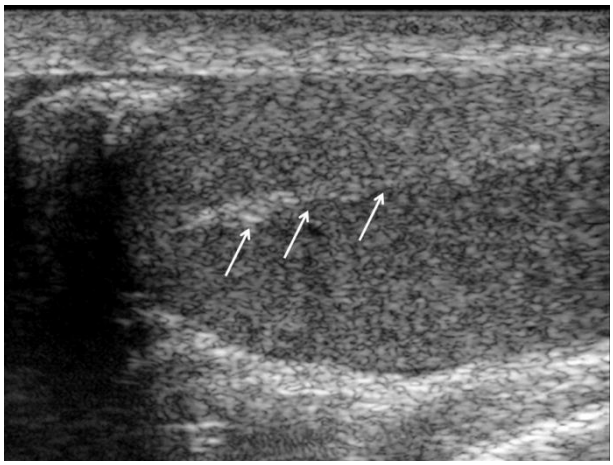


Figure 3 Normal rete testis. The rete testis is a low reflective area at the hilum of the testis with finger-like projections into the parenchyma (arrows).

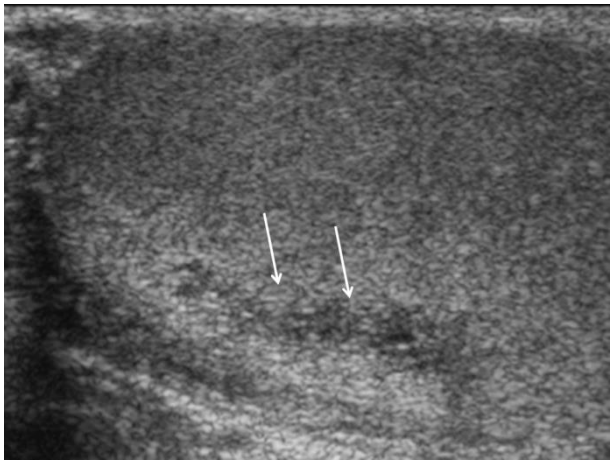
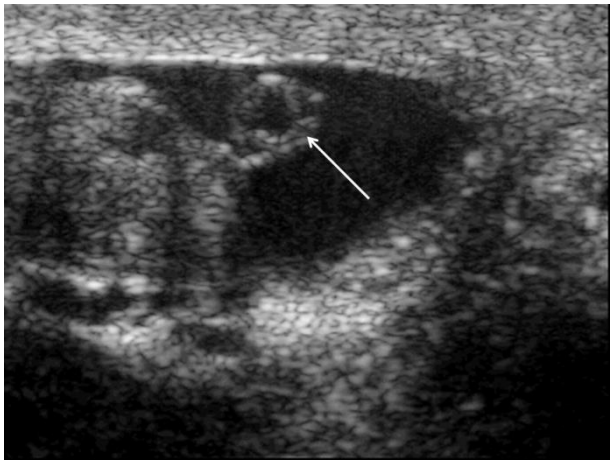
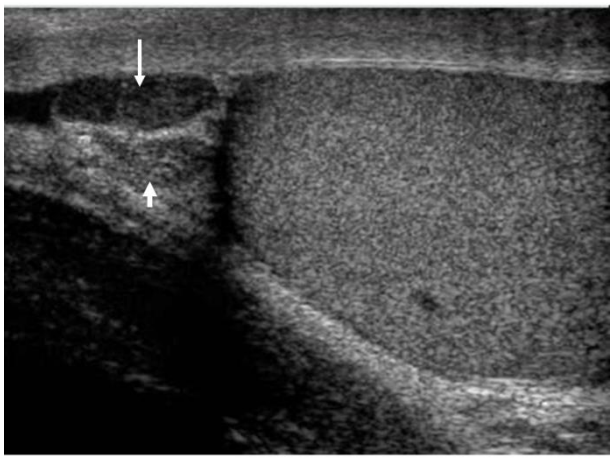


Figure 4 Appendix testis and epididymis. There is marked variation in the size and appearance of an appendix testis and epididymis, usually oval, although a stalk-like cystic structure is referred to as the "cyst of Morgagni" (arrow).



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.

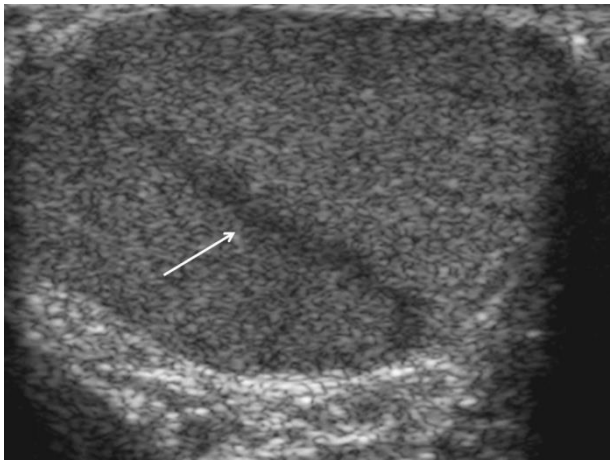


Normal variants

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].

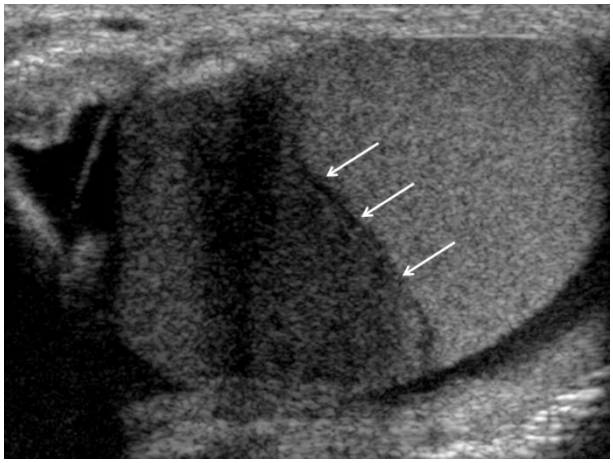
Figure 6 Trans-mediastinal artery and vein. The linear low reflective structures traverse the testis (arrow).



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).

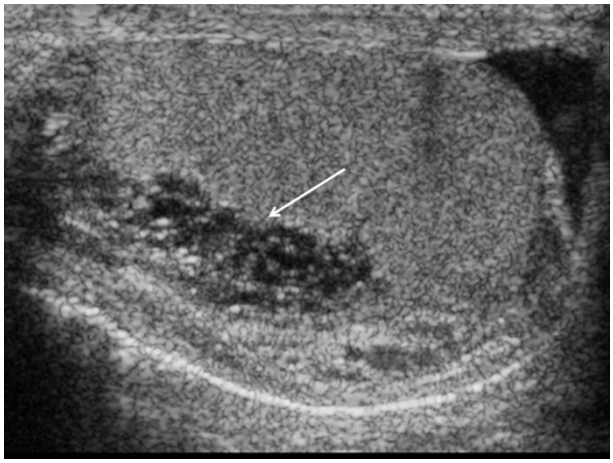
Figure 7 “Two-tone” testis. There is a well-demarcated low reflective appearance generated through the testis (arrows) that does not appear to be related to a pathological cause.



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).



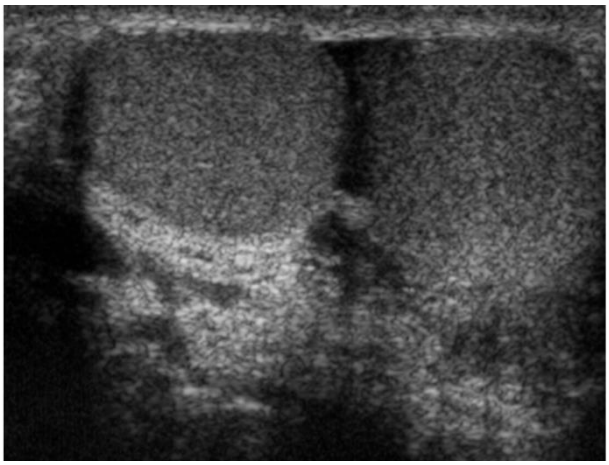
Appendix testis

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).

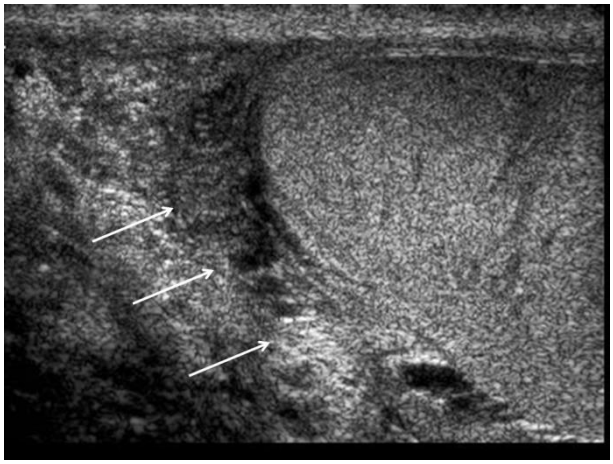


Figure 11 Pyocoele. There is a septated, mixed reflective hydrocoele (short arrow) with thickening of the overlying scrotal skin (long arrows).

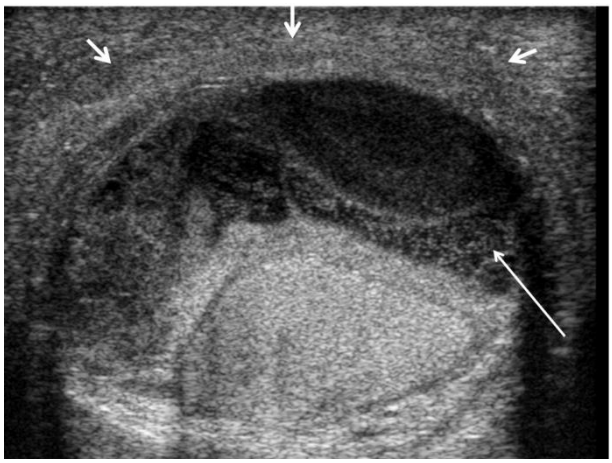
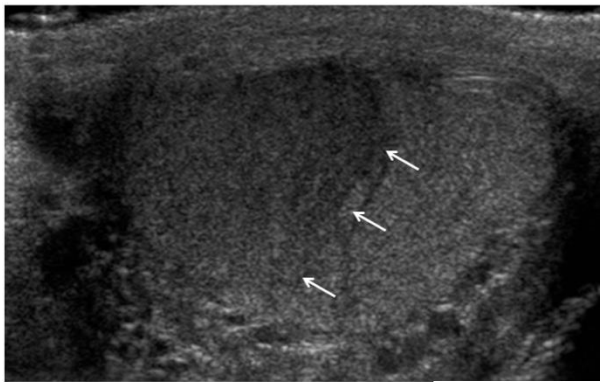


Figure 12 Epididymo-orchitis. A focal area of orchitis in a patient with epididymo-orchitis mimicking a focal testicular mass (arrows).



Venous infarction of the testis may occur in patients with severe epididymo-orchitis where localized oedema occludes the venous drainage of portions of the testis or the entire testis (34) [Figure 13]. Contrast enhanced ultrasound will demonstrate areas of infarction clearly, aiding diagnosis and management (35). Other complications include abscess formation (low reflective area surrounded by increased colour Doppler signal, [Figure 14), testicular atrophy and chronic pain (36). An extra-testicular abscess will be better delineated with a contrast enhanced ultrasound examination (37).

Figure 13a Venous infarction. There is an area of irregularity and mixed reflectivity present in the testis (arrow) in a patient with severe epididymitis.

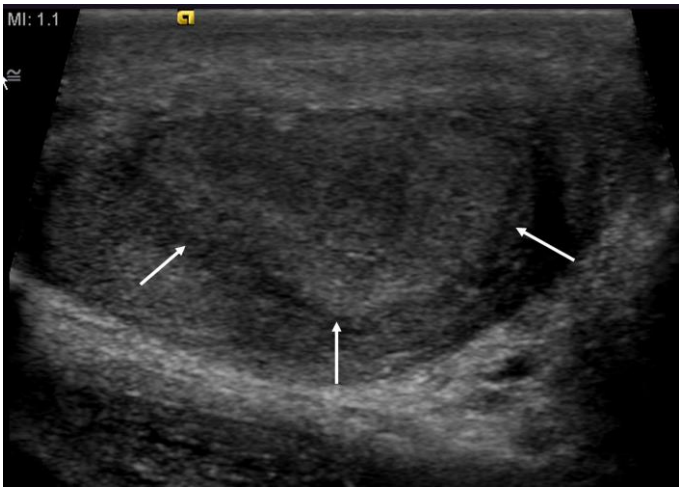


Figure 13b Venous infarction on contrast enhanced ultrasound. There is an area of irregularity and mixed reflectivity present in the posterior aspect of the testis (arrow) in a patient with severe epididymitis.

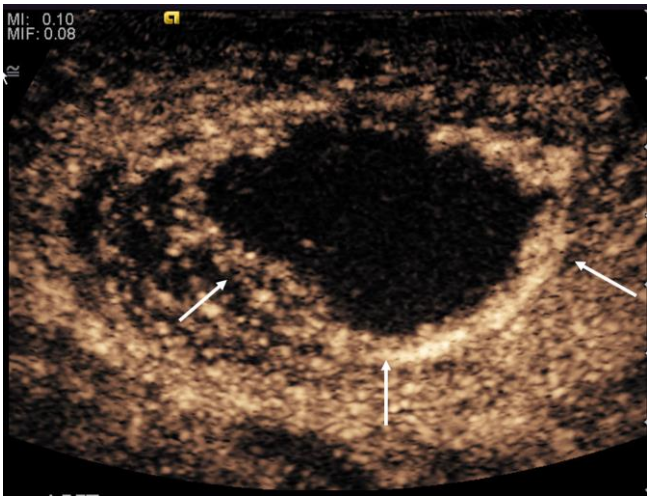


Figure 14a Epididymal abscess. There is a focal area of mixed reflectivity (arrows) containing debris in the tail of the epididymis in a patient with acute epididymitis not responding to antibacterial therapy.

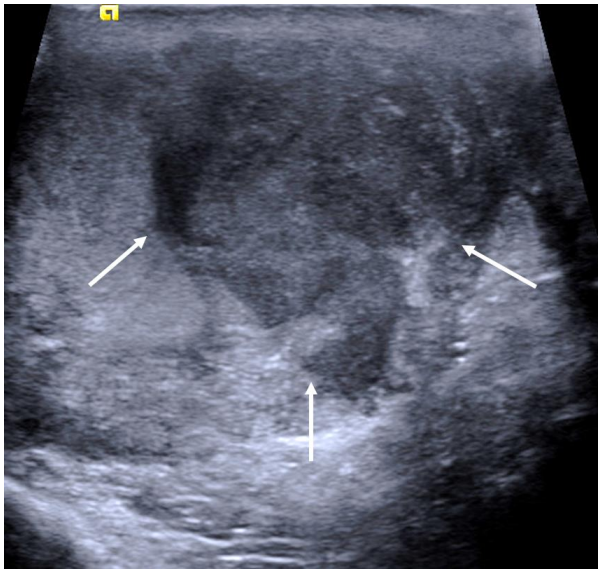
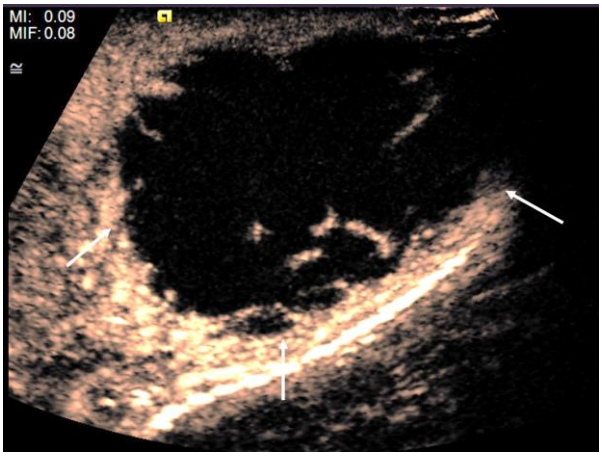


Figure 14b Epididymal abscess. There is a focal area of mixed reflectivity (arrows) containing debris in the tail of the epididymis well demonstrated as an avascular area with contrast enhanced ultrasound.



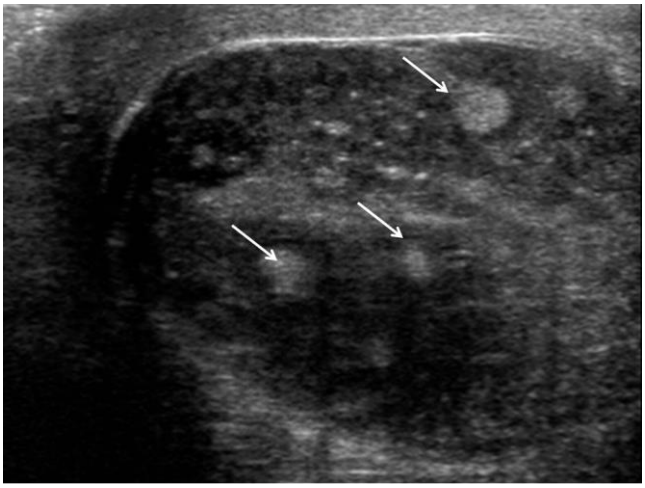
Chronic epididymitis

Chronic epididymitis results in persistent pain and on sonography an enlarged epididymis with increased reflectivity and calcification is often present. Tuberculosis epididymitis may present in a similar manner to bacterial epididymitis but will not respond to standard antibiotic treatment (38). Sonographic features are not specific, although chronic disease with calcification and indolent abscess formation discharging onto the skin may be present.

Orchitis

Commonly there is involvement from acute epididymitis resulting in a combination of epididymitis and orchitis. Primary orchitis without associated epididymitis is comparatively rare but may be caused by human immunodeficiency virus (HIV) or the mumps virus (31;32). An inordinate array of appearances can be seen on sonography in acute orchitis. Initially oedema of the testis arises with associated pain; sonographic appearances are those of a diffuse low reflective pattern. The appearance then develops to an area of low reflectivity with an increase in colour Doppler flow (39). As the condition progresses, areas of venous infarction occur with associated haemorrhage, which gives rise to areas of mixed or increased reflectivity (40). Complications include abscess formation, infarction and necrosis (Figure 15). Following treatment and healing, changes may resolve completely, but often there is loss of volume of the testis with fibrosis giving a heterogeneous sonographic pattern.

Figure 14 Complicated orchitis. There are multiple areas of high reflectivity (arrows) in this mixed but predominantly low reflective testis in a patient with severe orchitis.



Trauma

Testicular trauma is usually seen following motor vehicle accidents, athletic injury or a straddle injury. The mobility and elasticity of the scrotal tissues provides protection for the testis in the event of trauma. However, forceful compression of the scrotal contents against the pubic ramus or impact with objects moving at high velocity can result in serious injury. Blunt scrotal trauma may result in a variety of injuries including testicular rupture, torsion, dislocation, haematoma or contusion. Epididymal, scrotal wall and urethral injury may also be seen. Pain and swelling of the scrotum following trauma makes clinical examination extremely difficult. Ultrasonography is useful in the context of trauma and can help to exclude or confirm testicular rupture and differentiate testicular haematoma from haematocoele. Testicular rupture is a surgical emergency, which on sonography is manifest by discontinuity of the tunica albuginea, irregular heterogeneous testicular margins, a haematocoele and diminished colour Doppler flow to the affected area (36;41). Direct visualization of a fracture site is unusual, more often parenchyma heterogeneous areas are seen [Figure 16]. A haematoma will initially be seen as a high reflective area but progression of the haematoma over time will subsequently manifest as a low reflective complex cystic structure. The ability to add contrast enhanced ultrasound to the examination helps identify devascularized tissue (42), identifies testicular rupture and haematoma formation (43). Using tissue elastography is helpful when

an intratesticular haematoma is present, to distinguish from and intratesticular tumor, in combination with contrast enhanced ultrasound (2;4;44).

Figure 156a Testicular trauma. Ultrasonography of the testis following trauma demonstrating a fracture line (arrow) through the mid-aspect of the testis.

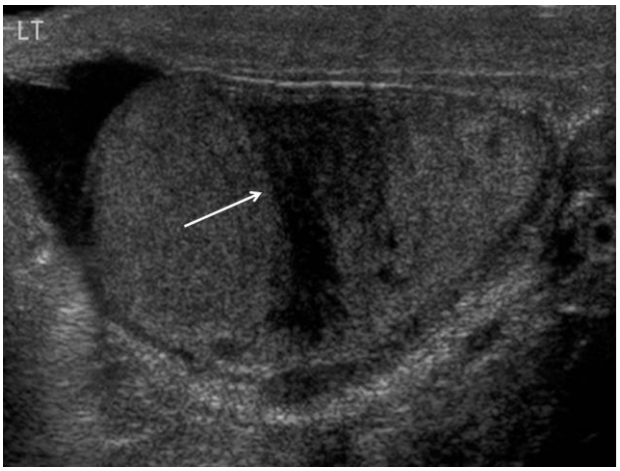


Figure 16b Testicular trauma. Ultrasonography of the testis following trauma demonstrating enhancing remaining viable tissue (arrows).

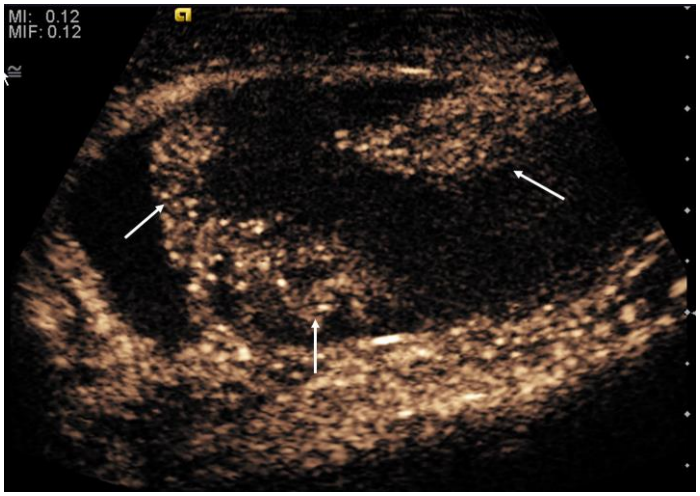
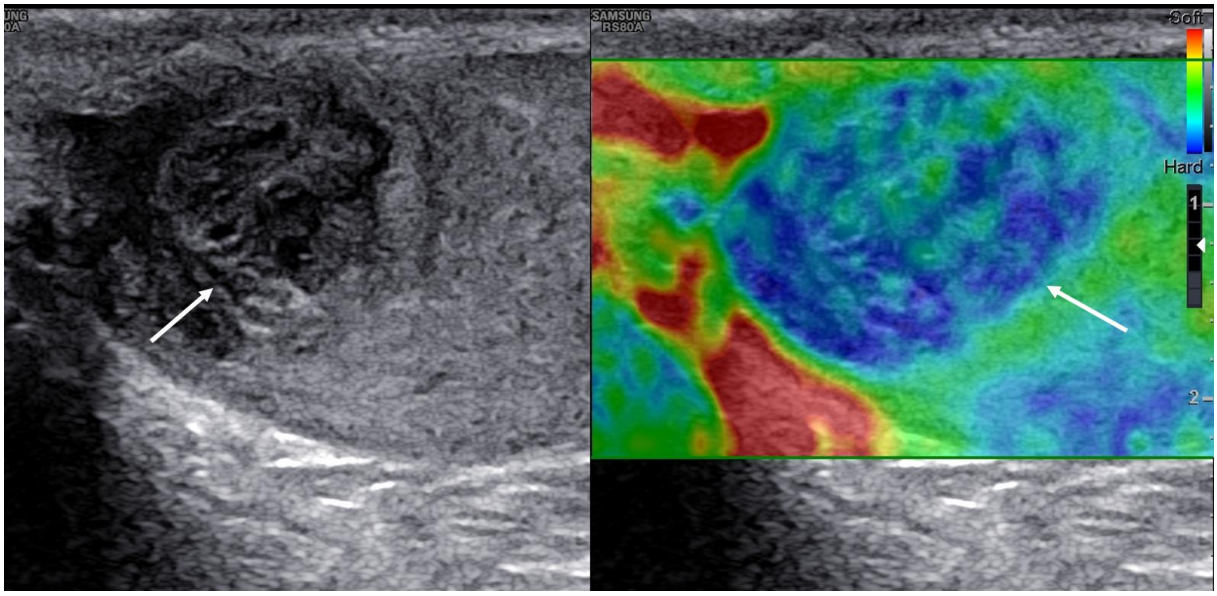


Figure 16c Testicular trauma. Ultrasonography of the testis following trauma demonstrating a haematoma (arrow) through the upper-aspect of the testis, which is initially stiff (arrow) on elastography but eventually resolves.



Torsion

Spermatic cord torsion

Testicular infarction occurs when the spermatic cord is twisted, termed spermatic cord torsion (27;45). A narrow mesenteric attachment from the spermatic cord to the testes and epididymis is regarded as the main cause, allowing the testes to fall forward within the cavity of the tunica vaginalis and then to rotate like a “bell-clapper”, known as the “intravaginal” type of torsion (46). In neonates the entire testes, epididymis and the tunica vaginalis twist in a vertical axis on the spermatic cord, termed “extravaginal” torsion. Neonatal torsion is rare and occurs in the prenatal period and is associated with an inguinal hernia (47).

Two factors are important in spermatic cord torsion: the extent of the spermatic cord twist and the duration of the torsion, with the initial disruption to the venous and lymphatic drainage, rather than to the arterial supply of the testes, and venous infarction occurs earlier (35;48). Scrotal oedema is an early feature, and areas of testicular infarction appear within 2h of complete occlusion of the testicular artery, irreversible ischaemia occurs after 6h and complete infarction by 24h (49;50). Intravaginal torsion most commonly occurs from 12–18 years old, with a reported incidence of 1 in 4000 males (51). Torsion commonly arises as puberty approaches, when testicular volume increases.

Clinically intravaginal torsion presents with pain of sudden or insidious onset and is followed by swelling of the ipsilateral scrotum; the clinical dilemma is the difference between spermatic

cord torsion and acute epididymo-orchitis. Establishing the diagnosis is important. In acute epididymo-orchitis resolution with minimal intervention is the rule unless complications occur, whereas surgery is mandatory for torsion. The diagnostic dilemma is compounded by the similarity in clinical presentation because fever and pyuria may occur in both conditions (52).

The sonographic appearances of the testis following spermatic cord torsion are variable depending on the time elapsed from the onset of symptoms. With the development of congestion and infarction, the testes appear enlarged with decreased reflectivity (50) [Figure 17]. As infarction is established, haemorrhage may increase reflectivity and heterogeneity, particularly in missed torsion and “chronic” torsions (where symptoms present for more than 10 days). There may be an abrupt change in caliber of the spermatic cord below the point of torsion, which can result in an enlarged twisted spermatic cord superior and posterior to the epididymal head, containing round anechoic structures representing veins resembling a “whirl-pool” first shown with MR imaging (53;54).

Figure 17a Spermatic cord torsion. The testis is enlarged and heterogeneous (arrow).

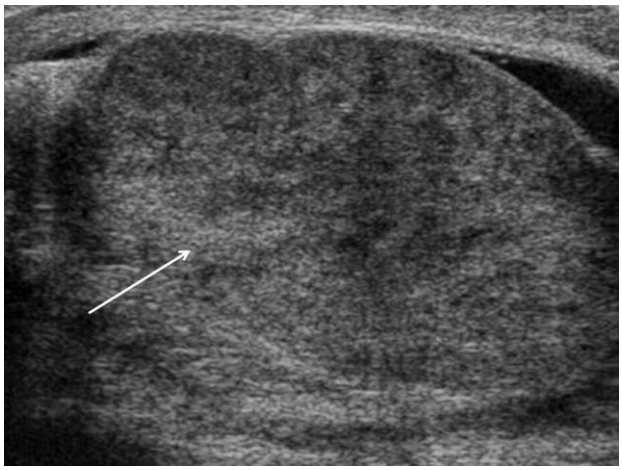


Figure 16b Spermatic cord torsion. No colour Doppler flow is present in the testis.

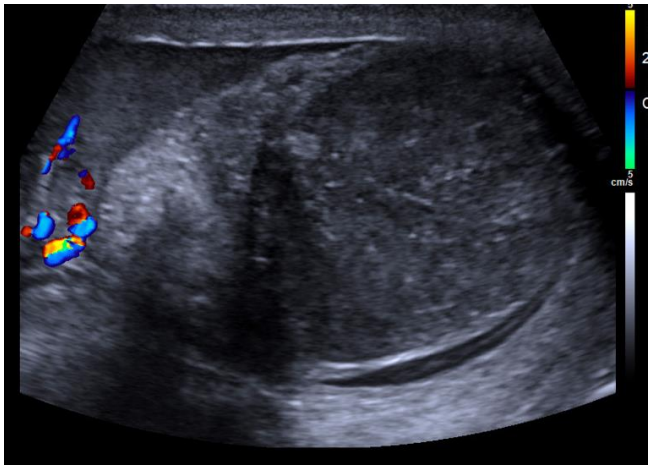
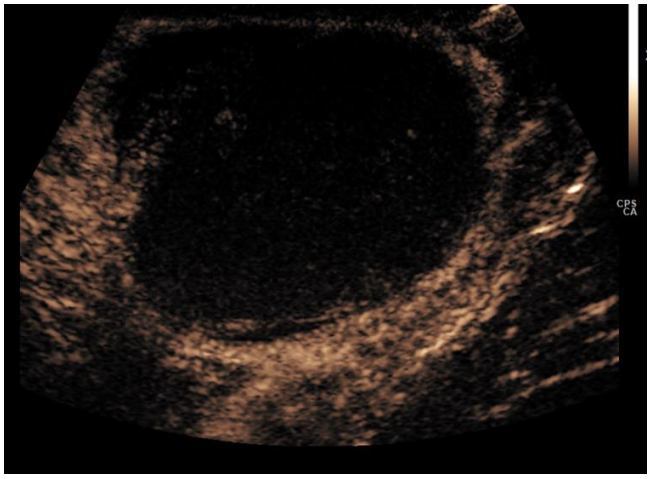


Figure 17c Spermatic cord torsion. Absence of enhancement on the contrast enhanced ultrasound examination confirms infarction.



The basis for the sonographic analysis of spermatic cord torsion is the absence of colour Doppler flow in the symptomatic testis compared with the asymptomatic testis, whereas it may be increased in epididymo-orchitis (39;55). Colour Doppler ultrasound is useful in promptly differentiating acute spermatic cord torsion from epididymo-orchitis. Although colour Doppler is of useful in the adult testes, it is less sensitive for the detection of blood flow in children because symmetry of blood flow is dependent on testicular size (9;56;57). A drawback of colour Doppler ultrasound is the entity of severe epididymo-orchitis complicated by testicular infarction (48;58). A reversal of diastolic flow in the testicular artery is thought to be characteristic of venous thrombosis, and when combined with the greyscale and colour Doppler appearance of the inflamed epididymis, it should allow a correct analysis to be

reached (27;59;60). However, there is no single clinical feature or imaging examination that can reliably distinguish torsion from other causes of testicular pain.

A pitfall of colour Doppler ultrasound in the assessment of the acute scrotum, and in the desire to exclude the presence of spermatic cord torsion, is the entity of a spontaneous detorsion. The susceptible testis undergoes torsion and then spontaneously untwists, which results in hyperaemia of the previously ischaemic testis. On sonography, B-mode appearance can be unexceptional, but an increase in colour Doppler flow may resemble acute epididymo-orchitis, which can result in a misinterpretation.

Contrast enhanced ultrasound is very useful for the distinction of areas of non-perfusion, and would be ideal to identify the infarcted testis (3;35;48;61). The application is useful for confirmation of an infarcted testis in ‘missed’ torsion, with surgical based decision for operative management, but is an adjunct to the clinical care, as it will clearly identify the inflamed and vascularized testis (62;63). The application in segmental areas of infarction is more useful, and areas of application are detailed in guidelines (64).

Torsion of an appendage

Torsion of the testicular (or epididymal) appendage is more common than spermatic cord torsion and is an important differential diagnosis in boys under the age of 13 years with an acutely painful scrotum. Although it most frequently presents in patients under the age of 13 years, torsion of a testicular appendage can occur at any age and may present in adulthood. Onset may be associated with trauma or exercise; pain, erythema, tenderness and scrotal swelling common presenting symptoms. In light-skinned patients the palpable, infracted, tender appendage may be visible at the upper pole of the testis, known as the “blue-dot” sign (65).

With torsion of a testicular appendage, the testis itself usually appears normal on sonography. There is an upper pole hydrocoele and an inflammatory reaction in the epididymis, which is often enlarged. The appendage can have a variable appearance, commonly there is increased homogenous reflectivity, but not infrequently there is low reflectivity surrounded by an area of increased colour Doppler flow (55) [Figure 18]. In time the appendix becomes increasingly of higher reflectivity, indicating the onset of calcification, and eventually completely detaches itself [Figure 19].

Figure 18 Torsion of the appendix testis. A hydrocoele surrounds the upper aspect of the testis, with a prominent appendix testis (arrow) seen; appearances are those of torsion of an appendix in a patient with the appropriate symptoms of sudden onset of testicular pain.

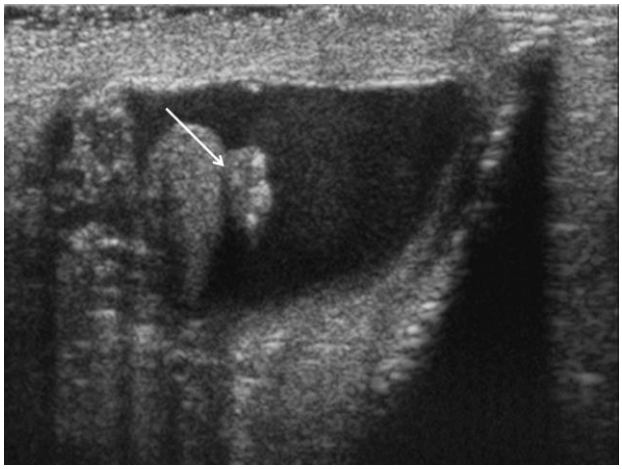
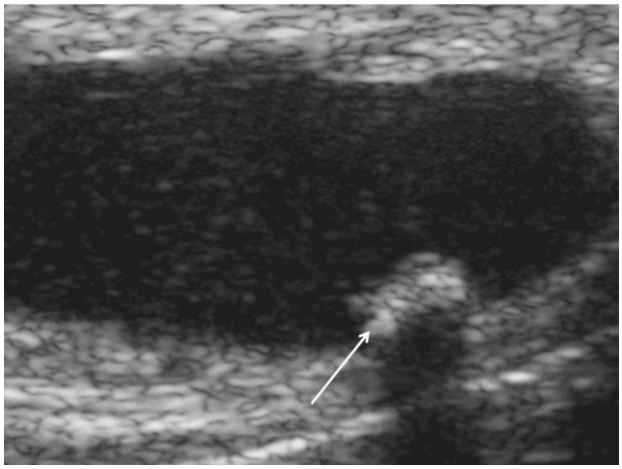


Figure 19 Detached appendix testis (arrow). In time the appendix becomes increasingly of higher reflectivity, indicating the onset of calcification, eventually completely detaching itself.

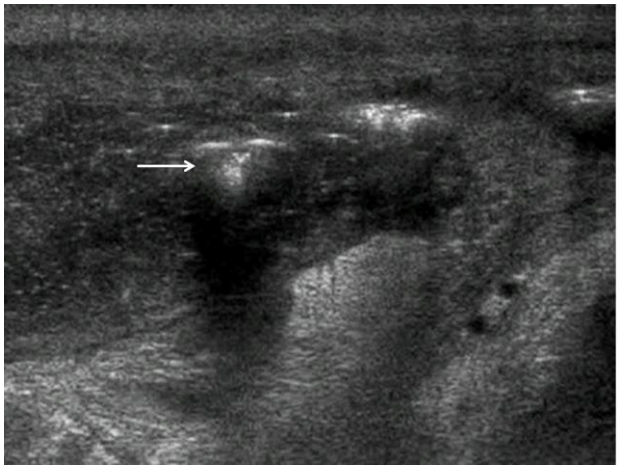


Fournier's gangrene

Fournier's gangrene is an aggressive necrotizing fasciitis of the perineum. It occurs in males aged from 50–70 years and is associated with diabetes mellitus (66). Fournier's gangrene arises secondary to local infection with multiple, different organisms, such as Klebsiella, Streptococcus, Proteus and Staphylococcus, which have all been frequently described (67). Immediate surgical resection of the devitalized tissues is needed as the condition carries a

high morbidity and mortality rate. Prompt diagnosis is vital because mortality rate increases to 11.5% at 24h diagnostic delay and then to 75% at 6 days diagnostic delay (68). Anaerobic bacterial metabolism produces soft-tissue gas that can be detected clinically as crepitus, and on sonography much earlier (69). Sonographic features of Fournier's gangrene are scrotal wall thickening containing multiple pockets of gas, which appear as high reflective foci causing "dirty shadowing" with normal underlying testes (70) [Figure 20].

Figure 170 Fournier's gangrene. Ultrasound of the scrotal wall demonstrates multiple pockets of gas, which appear as high reflective foci causing "dirty shadowing" (arrow).



Testicular Massess

Intratesticular masses: benign focal lesions

Epidermoid cyst

Epidermoid cysts are benign lesions with no malignant potential and account for 1% of intratesticular lesions (71). An epidermoid cyst arises either from mono-dermal development of a teratoma or as a result of squamous metaplasia of surface mesothelium. Epidermoid cysts are true cysts, which contain a cheesy laminated material. Patients present at 20–40 years of age with a mass, but they are often an incidental finding on a sonographic examination. Classically epidermoid cysts are well-circumscribed with a high reflective border and internal laminations giving an "onion-ring" appearance (72) [Figure 21]. There is no colour Doppler flow detected within the lesion. Four sonographic types are documented: classic onion ring

configuration, densely calcified mass, peripheral rim or central calcification, and mixed pattern (71). Management is either by enucleation or orchidectomy and because the sonographic findings are frequently non-specific, orchidectomy is often performed.

Using the newer technology, in particular contrast enhanced ultrasound, there is no vascularity demonstrated within the epidermoid cyst, and the elastography will demonstrate the lesion to be 'stiff', a manifestation of the densely packed material (73).

Figure 18a Epidermoid cyst. An epidermoid cyst demonstrating a well-circumscribed low reflective appearance with a high reflective border and internal laminations (arrows) giving an "onion-ring" appearance.

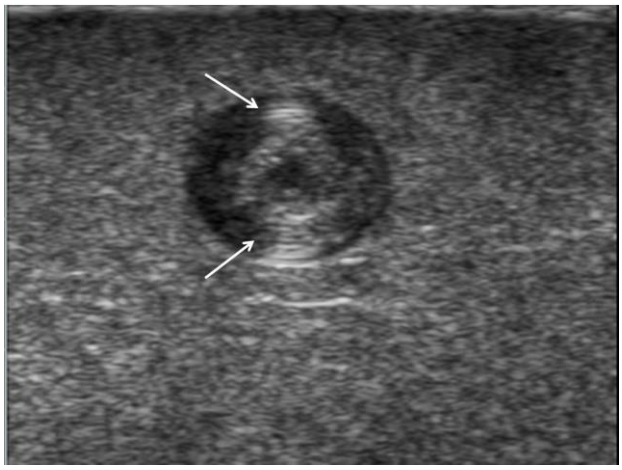


Figure 22b Epidermoid cyst. Two epidermoid cysts demonstrating a well-circumscribed non-enhancing avascular appearance, following a contrast enhanced ultrasound examination.

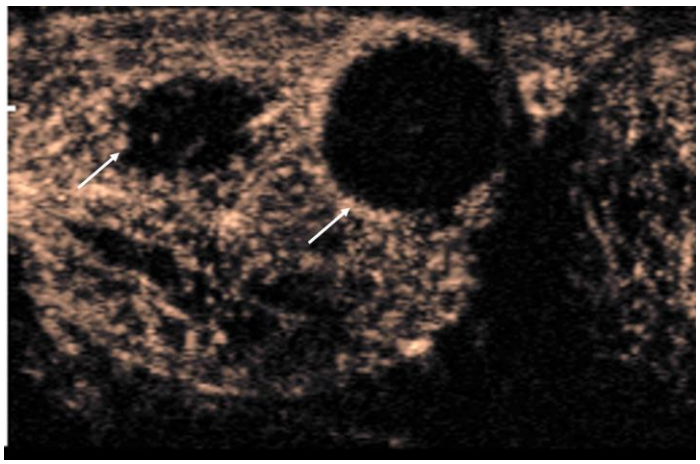
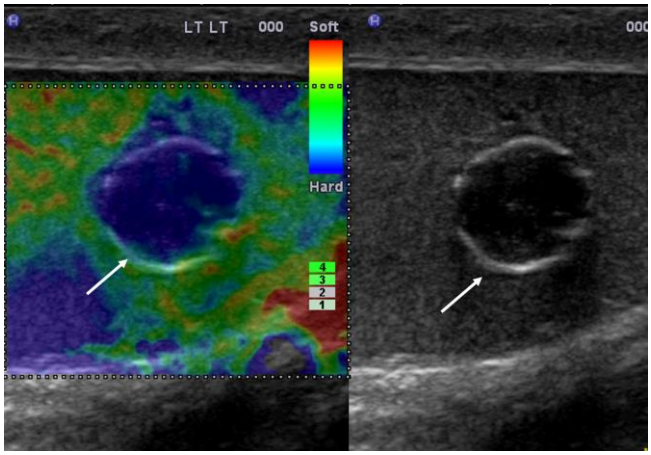


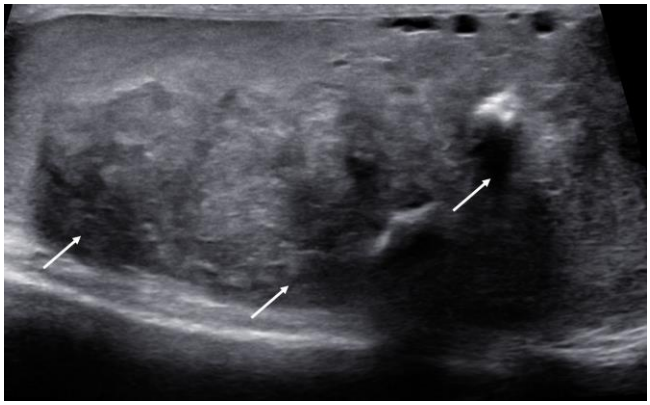
Figure 23c Epidermoid cyst. The cyst is 'stiff' on the strain elastography examination (arrows).



Adrenal rest cells

Testicular adrenal rest tumours are benign adeno-cortico-trophic hormone (ACTH)-dependent lesions that are asymptomatic and occur in patients with congenital adrenal hyperplasia. Increased ACTH levels prevent involution of aberrant adrenal cortical cells that migrate with gonadal tissues in fetal life. The testicular adrenal rests are usually less than 5mm, and these ectopic adrenal rest cells within the testis only develop as a tumour-like abnormality in response to elevated circulating ACTH. Furthermore, the intratesticular nodules of adrenal rests can gradually expand and destroy the testicular parenchyma, which results in low testosterone production and infertility. Treatment with steroid therapy can stabilize or regress these lesions and aids diagnosis. These tumours usually appear as focal low reflective abnormalities with abnormal colour flow and are often bilateral (74;75) [Figure 24].

Figure 19 Adrenal rest cells (arrows), with chronic changes and areas of calcification.



Segmental infarction

Global testicular infarction is well-recognized, usually as a result of torsion of the spermatic cord. However, segmental testicular infarction is unusual, and previously usually diagnosed following orchidectomy (76), but with the advent of multiparametric ultrasound (1), imaging diagnosis allows for watchful waiting and testis sparing surgery (35;63). The majority of cases are idiopathic in origin (34;77). Patients with segmental infarction tend to be older than those with testicular infarction arising from spermatic cord torsion, usually from 20–40 years old. Segmental testicular infarction is characterized by poor or absent flow on colour Doppler ultrasound in a focal low reflective wedge-shaped or rounded area with no posterior acoustic enhancement [Figure 25]. Focal expansion of the testis may mimic a primary testicular tumour and colour Doppler ultrasound provides a useful discriminatory tool (78). Serial sonographic examination of an area of infarction will demonstrate reduction in size of the lesion.

The advent of contrast enhanced ultrasound allows for a much better appreciation of areas of infarction in the testis, and has established the higher prevalence of segmental infarction than previously recognized (35;63). Importantly the differentiation from tumour prevents an unnecessary orchidectomy.

Figure 25a Segmental infarction. A focal wedge-shaped area of low reflectivity (arrows) in a testis of a patient complaining of acute testicular pain with no evidence of inflammatory disease.

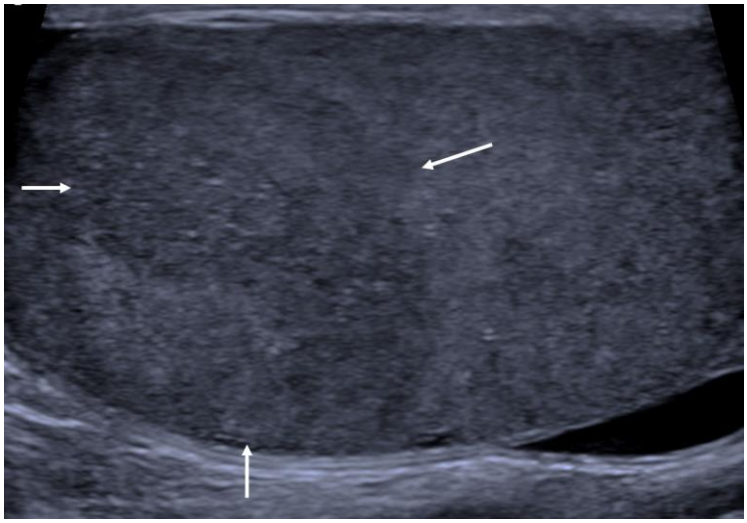


Figure 25b Segmental infarction. The focal wedge-shaped area of low reflectivity demonstrates no colour Doppler flow.

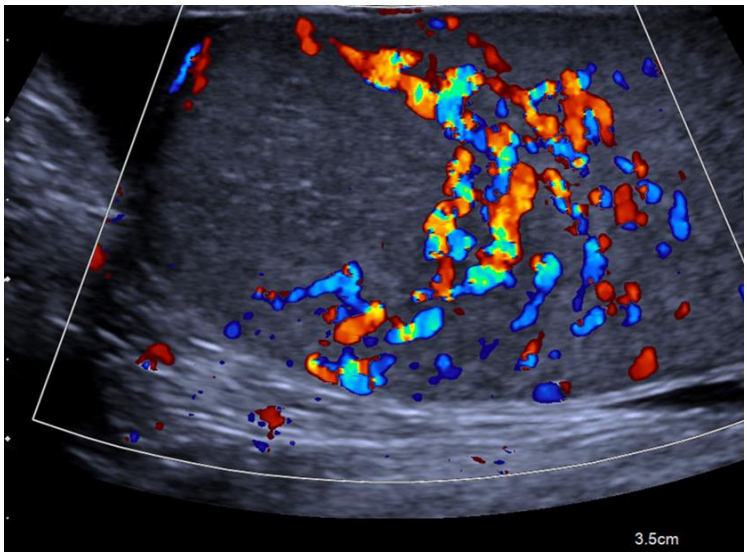
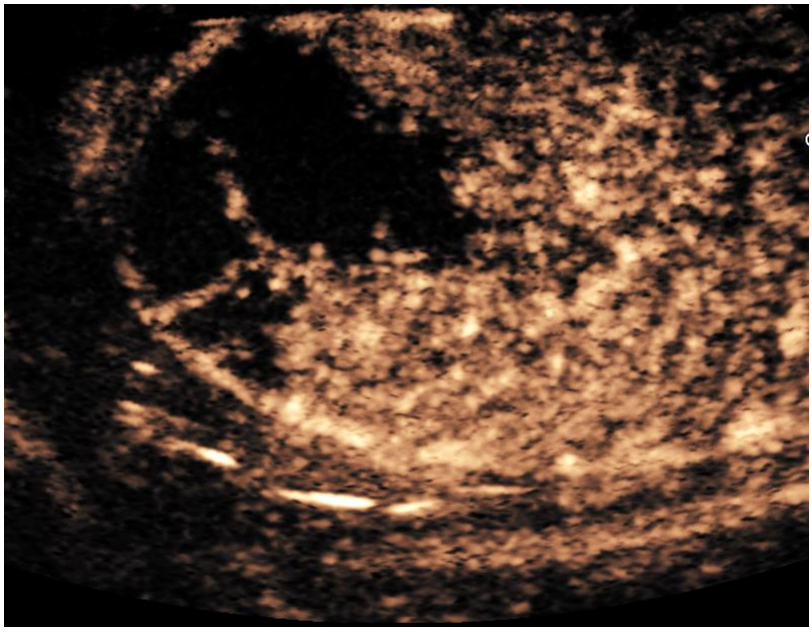


Figure 25c Segmental infarction. The focal wedge-shaped area of low reflectivity demonstrates no enhancement on a contrast enhanced ultrasound examination.



Splenogonadal fusion

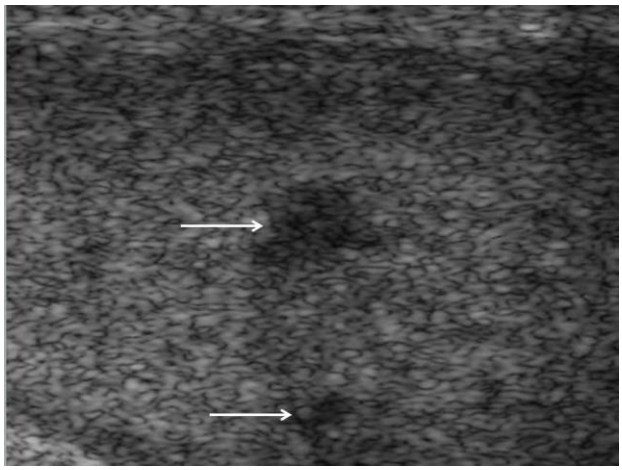
Splenogonadal fusion is a rare condition where an accessory spleen exists within the scrotum or pelvis fused to the gonadal organs; the majority of cases occur on the left side. Splenogonadal fusion is far more common in males, in whom presentation is usually with a scrotal mass (79). There are two types of splenogonadal fusion described: continuous and discontinuous (80). In the more common continuous type, a cord connects the normal and ectopic spleen; this cord may be beaded with small splenunculi. In the discontinuous type there is no cord present. The sonographic appearance of splenogonadal fusion is a mass within the scrotal sac of low reflectivity, which may appear to be fused to the testis (81;82). Colour Doppler ultrasound flow in the abnormal tissue assumes a pattern similar to that seen in the central aspect of the normal testis or that seen in splenic tissue (83). If this diagnosis is considered, a 99mTc-sulphur colloid scan will demonstrate uptake within the ectopic splenic tissue. A contrast enhanced ultrasound examination will demonstrate increased uniform enhancement in the splenic aspect of the tissue in comparison to the remaining normal testis parenchyma (84).

Sarcoidosis

Sarcoidosis commonly involves the epididymis and solitary testicular involvement is uncommon (85-87). Differentiation from a primary testicular malignancy can be demanding,

but may be inferred if there is clinical evidence of sarcoidosis elsewhere, if the intratesticular lesions are multifocal or if there is associated epididymal involvement. The reported incidence of genital involvement at post-mortem is between 4% and 4.5%, but only 0.5% of these patients have clinical symptoms (88). On sonography, sarcoidosis appears as a low reflective focal lesion (89) [Figure 26].

Figure 26 Testicular sarcoidosis. Two focal lesions within the testis in a patient with sarcoidosis (arrows).



Focal orchitis and testicular abscess

Pure orchitis is uncommon and is usually the result of mumps; the testis is frequently involved when epididymitis occurs, which results in epididymo-orchitis (90). On sonography, the testis is enlarged with either diffuse low reflectivity with pure orchitis or, more commonly, focal areas of low reflectivity when associated with epididymitis. Occasionally, a focal abnormality may be produced that mimics a tumour, which should regress with time [Figure 12]. Abscess formation may occur, particularly with severe epididymo-orchitis, where the abscess demonstrates low reflectivity and peripheral, but no internal, colour Doppler signals (91) [Figure 27]. If an abscess ruptures through the tunica albuginea, a pyocoele may develop. Idiopathic granulomatous orchitis can also present as a focal mass or diffuse enlargement of a testis and is indistinguishable from a tumour on ultrasound.

Figure 27a Intratesticular abscess. A focal area of mixed reflectivity (arrow) in a patient with epididymo-orchitis representing a focal abscess.

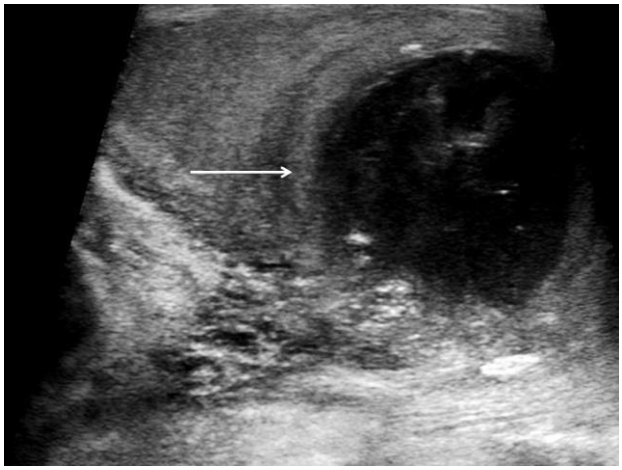


Figure 27b Intratesticular abscess. The focal area of low reflectivity is seen with inceased colour Doppler surrounding the abscess cavity.

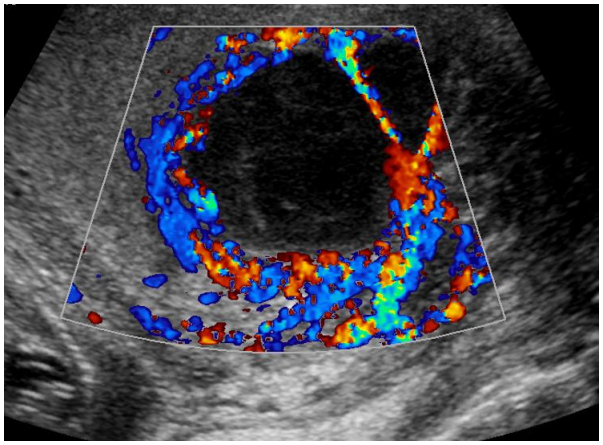
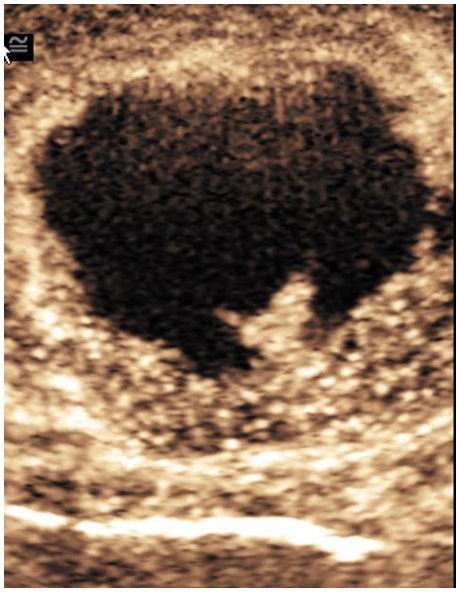


Figure 27c. Intratesticular abscess. A focal area of mixed reflectivity (arrow) in a patient with epididymo-orchitis representing a focal abscess.



Intratesticular haematoma

Testicular rupture, extra-testicular haematoma and a haematocoele are the most common sequelae of testicular trauma (92). An uncommon finding is an isolated intratesticular haematoma, which has a variable appearance on sonography with a sequential change in characteristics (43;93). A history of trauma to the scrotum should be sought. Acutely the haematoma appears as increased reflectivity that becomes low reflective and decreases in size as the haematoma retracts. It eventually resolves completely and demonstrates no colour Doppler flow [Figure 28]. The differential diagnosis is a malignant tumour, but a lack of lesion vascularity and a clinical history should lead to the correct diagnosis. The addition of contrast enhanced ultrasound aids the determination of the absence of internal vascularity within the haematoma to differentiate with an incidental primary testicular tumour, and the serial changes on strain elastography will mirror the resolution of the haematoma (93;94).

Figure 28a Intratesticular haematoma. An area of predominantly low reflectivity (arrow), but with areas of high reflectivity in a patient following a motorcycle accident.

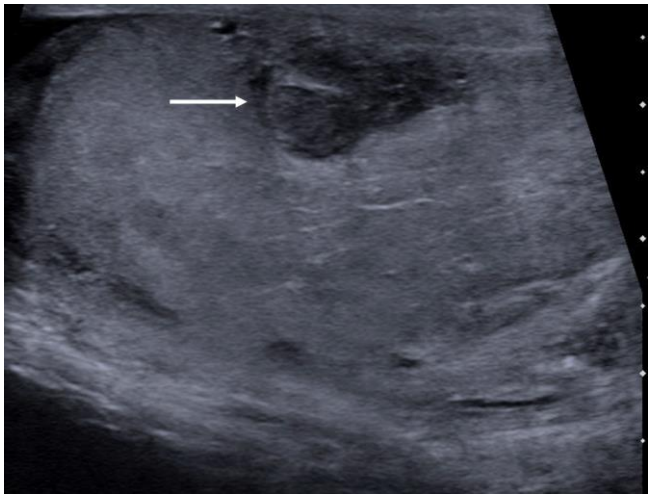


Figure 28b Intratesticular haematoma. The area of predominantly low reflectivity (arrow), is avascular on the contrast enhanced ultrasound examination (arrow).

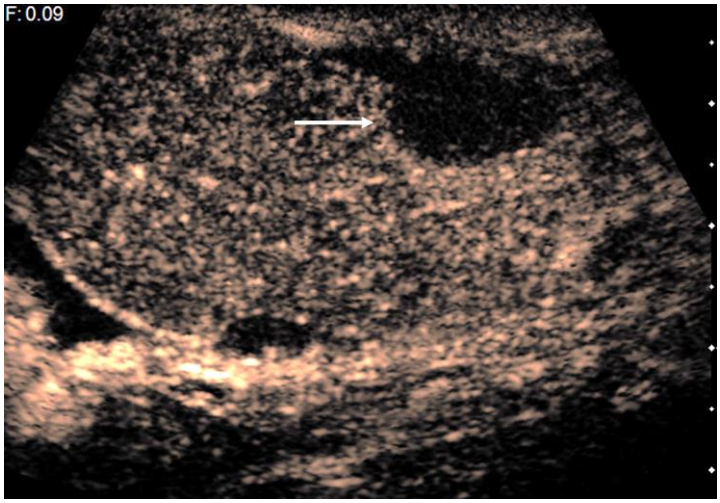
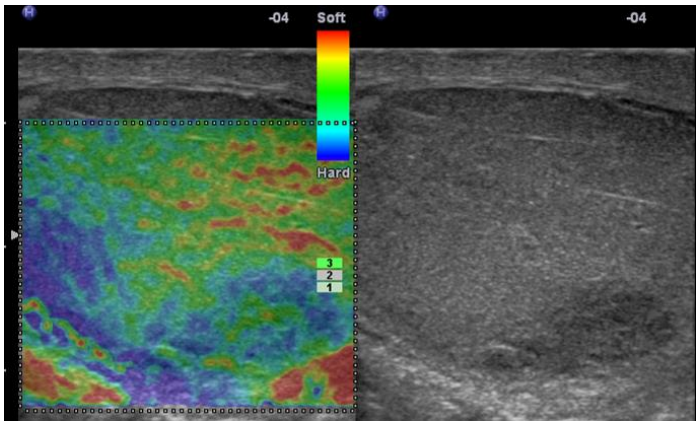


Figure 28c Intratesticular haematoma. The area of predominantly low reflectivity is of mixed stiffness on the strain elastography image.



Post-operative and post-biopsy testis

Following surgery to the pelvis, prostate and scrotum, oedema of the scrotal wall is a frequent finding, which causes visible thickening on ultrasound [Figure 29]. Often there is oedema of the testicular parenchyma causing a characteristic “crazy-paving” appearance as the oedema follows anatomical boundaries. Following biopsy, a surgical scar may be seen as a localized alteration in parenchymal reflectivity extending to the surface of the testis [Figure 30].

Figure 29 Scrotal wall oedema. There is marked thickening of the scrotal wall (arrow) following an inguinal hernia repair.

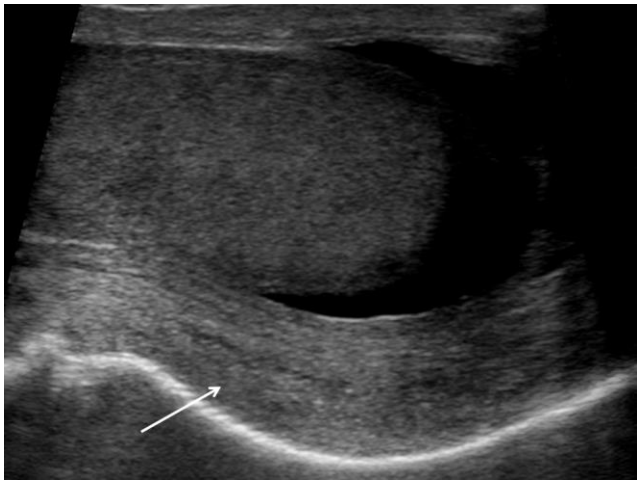
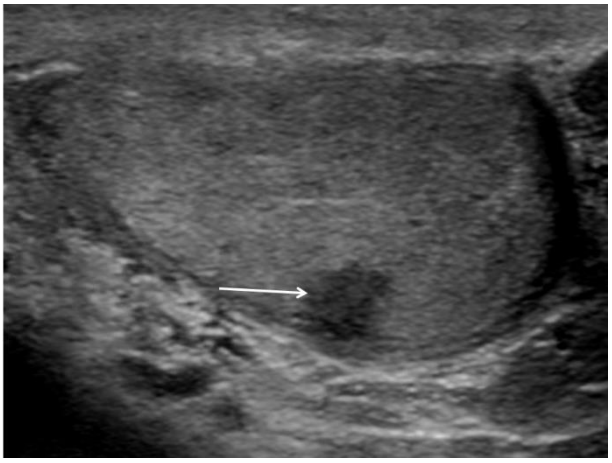


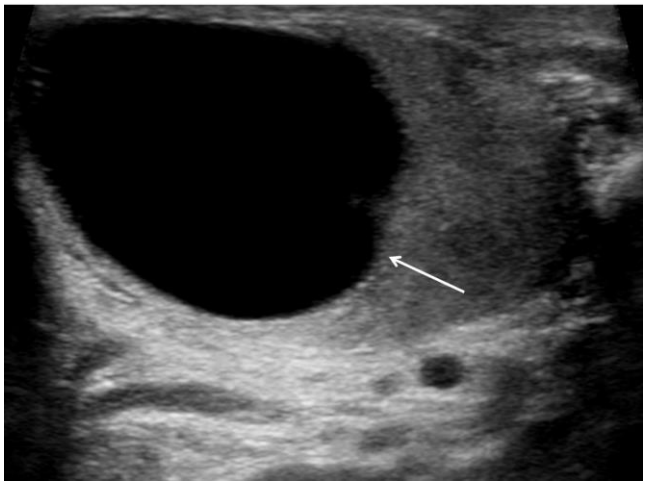
Figure 30 Post-biopsy “scar”. A focal low reflective “scar” (arrow) following a biopsy in the investigation of infertility.



Intratesticular cysts

Intratesticular cysts were thought to be rare. but are now seen as incidental findings in 8–10% of sonographic examinations (95). These cysts are rarely palpated and, even if large, are not firm. Simple cysts are well-delineated anechoic round structures, with a thin smooth wall and posterior acoustic enhancement [Figure 31]. The intratesticular cysts may be congenital, or arise post-trauma or post-inflammation. These cysts are often near the mediastinum testis and may arise from an anomalous efferent duct. Careful sonographic examination to exclude any wall irregularity, which may suggest a cystic tumour, is needed.

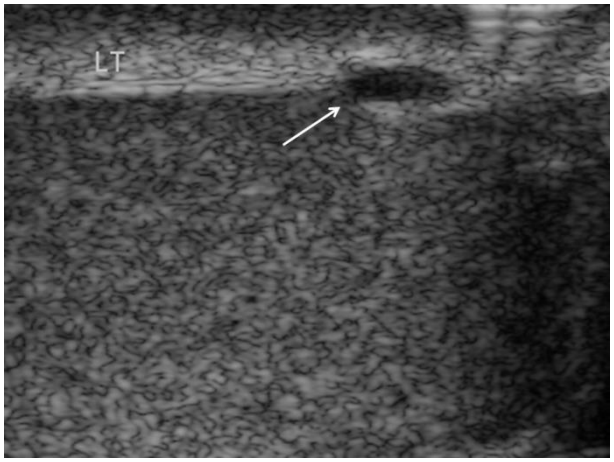
Figure 31 Intratesticular cyst. A large low reflective lesion (arrow) within the testis demonstrating posterior acoustic enhancement



Tunica albuginea cyst

Tunica albuginea cysts are located within the dense tissue of the closely adherent tunica albuginea [Figure 32]. These cysts are usually solitary, unilocular and readily palpated by the patient as a firm nodule on the surface of the testis.

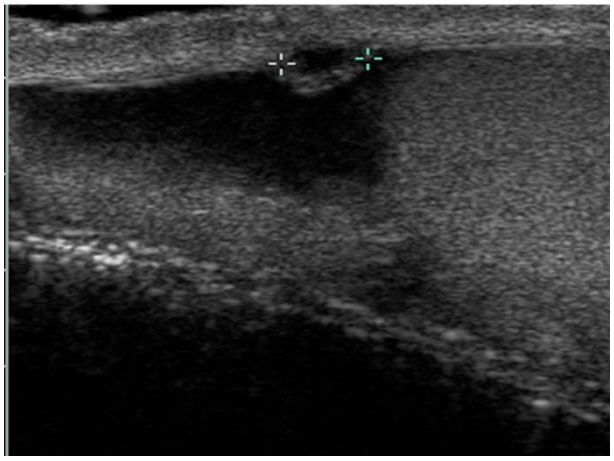
Figure 32 Tunica albuginea cyst. A small cyst (arrow) is situated in the line of the echogenic tunica albuginea. These tunica albuginea cysts are frequently palpated by the patient and can cause concern.



Tunica vaginalis cyst

A tunica vaginalis cyst arises from either the visceral or parietal layer of the tunica vaginalis [Figure 33].

Figure 20 Tunica vaginalis cyst. In the presence of a hydrocoele, this tunica vaginalis cyst (between markers (+)) is readily visible.

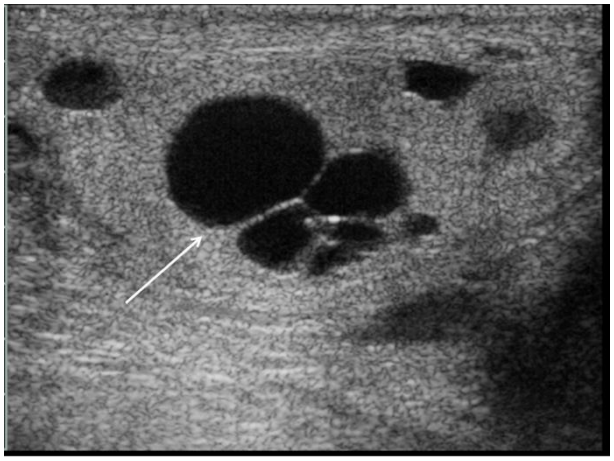


Dilatation of the rete testis

Cystic ectasia of the rete testis results from the partial or complete obstruction of the efferent ducts, often by inflammation or trauma, and causes dilation of the rete testis in an asymmetrical unilateral distribution, although often symmetrically as a normal consequence of aging [Figure 34]. The differential diagnosis is a malignant cystic testicular tumour, although the bilateral nature of ectasia usually suggests the diagnosis, and a cystic tumour is extremely

rare. On sonography, appearance of a dilated rete testis is multiple low reflective oval or rounded structures, which do not demonstrate vascular flow within the mediastinum testes (10). The cysts usually measure a few millimeters in diameter, but can vary considerably (96). While this is a benign entity it may be of significance in a patient suffering from infertility and azoospermia because there may be obstruction of the ipsilateral spermatic ducts. Distension of the rete testes has been described in association with a seminoma, in which the obstruction of the tubules by a tumour is thought to be responsible (95).

Figure 34 Dilated cystic rete testis. The central aspect of the testis, along the line of the mediastinum testis, has multiple areas of cystic dilatation (arrow) of varying size, which is in keeping with dilatation of the rete testis. Further cysts are present elsewhere in the testis.



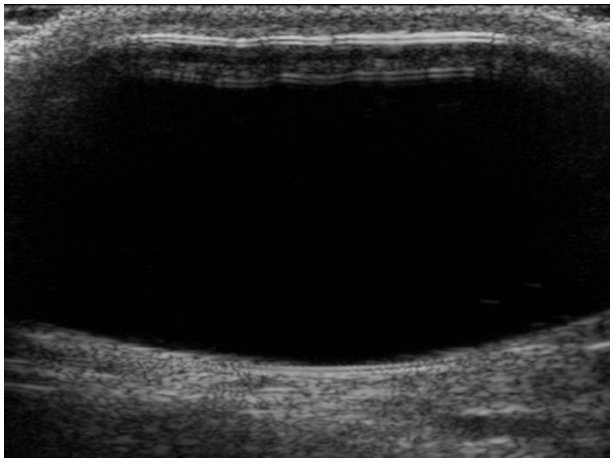
Cystic dysplasia of the testis

Although cystic dysplasia is similar in appearance to a dilated rete testis, it is thought to represent a rare congenital anomaly and is usually diagnosed in childhood (10).

Testicular prosthesis

Following orchidectomy, patients may elect to have a testicular prosthesis inserted, which is normally made of silicon. A testicular prosthesis has a characteristic appearance on ultrasound [Figure 35].

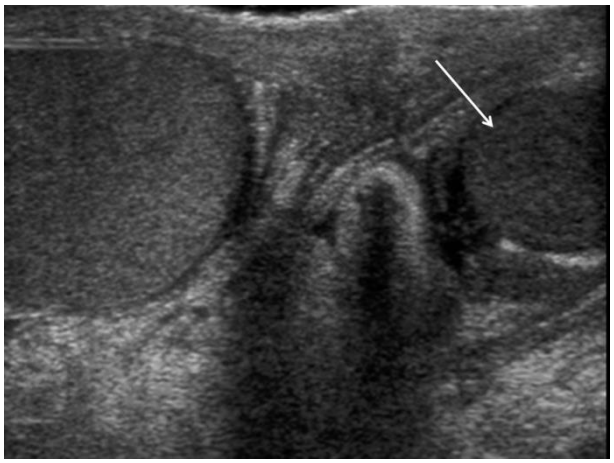
Figure 35 Testicular prosthesis. A silicone testicular prosthesis of uniform low reflectivity.



Atrophy

Testicular atrophy may occur following cryptorchidism, inflammation, torsion, trauma, hypothyroidism, oestrogen treatment, liver cirrhosis, hypopituitary disease and ageing. The testis is globally reduced in size, usually unilateral with changes in testicular reflectivity related to the underlying cause, but usually of lower reflectivity [Figure 36]. While volume and vascularity of the testis are reduced, the epididymis remains normal. Atrophy is a natural phenomenon of ageing when changes in the normal testis reflectivity, usually of a heterogeneous nature, may occur (97).

Figure 36 Testicular atrophy. Testicular atrophy (arrow) in this spectacle view demonstrating a small low reflective testis.



Malignant focal lesions

Malignant focal lesions are summerised in Table 1.

Table 1 Classification of testicular tumours

Germ cell tumours
Precursor lesions
Intratubular germ cell neoplasia
Tumours of one histological type
Seminoma
Classic
Spermatocytic
Embryonal carcinoma
Yolk sac tumour
Choriocarcinoma
Teratoma
Mature
Immature
With malignant transformation
Tumours of more than one histological type
Non-germ cell tumours (sex cord and stromal tumours)
Leydig cell tumour
Sertoli cell tumour
Granulosa cell tumour
Fibroma-thecoma
Tumours with both sex cord and stromal cells and germ cells
Gonadoblastoma
Lymphoid and haematopoietic tumours
Lymphoma
Leukaemia
Metastasis

Testicular carcinoma represents 1% of all neoplasms in men and is the most common malignancy in the 15–35-year age range (98). A second peak prevalence occurs in the 70–90-year age range, with metastasis and lymphoma the most common. A third, smaller peak, occurs in children where yolk sac tumours and teratoma occur. Testicular carcinoma is predominantly a cancer of white males. The most common presenting symptom is a painless scrotal mass and it is rare that patients present with pain. A small number of patients present with metastases or rarely with endocrine abnormalities, such as gynaecomastia. Survival rates for testicular carcinoma are almost 95% (98).

Risk factors for the development of testicular carcinoma include previous testicular tumour, family history, cryptorchidism, infertility and intersex syndromes. Even with the removal of an undescended testis, there remains an increased risk in the contralateral testis. Testicular tumours may be divided into germ cell and non-germ cell tumours; 95% of testicular tumours are germ cell tumours, which arise from spermatogenic cells. Non-germ cell tumours derive from sex cords (Sertoli cells) and stroma (Leydig cells); these tumours are malignant in 10% of cases. Lymphoma, leukaemia and metastases may present as a testicular tumour.

Most testicular tumours are of homogenous low reflectivity in comparison with the surrounding testicular parenchyma, although a wide range of appearances occur including high reflective heterogeneous lesions with areas of calcification and cystic change (99). Larger tumours demonstrate increased vascularity (100), although with newer high-frequency transducers, malignant vascularity may be identified in small volume tumours (101).

Recently the ultrasound imaging of these testicular tumours has altered, with increased application of contrast enhanced ultrasound and elastography in the overall assessment of the potential malignant nature of a focal intra-testicular lesion (2;3;94;102-104).

Germ cell tumours

The precursor of germ cell tumours is thought to be intratubular germ cell neoplasia; if development is along a “unipotential” gonadal line a seminoma will form, but if development occurs along a “totipotential” gonadal line, a non-seminomatous tumour will develop. The totipotential cells may remain undifferentiated (embryonal carcinoma), or develop towards

embryonic differentiation (teratoma) or extraembryonic differentiation (yolk sac tumours, choriocarcinoma). Multiple histological types occur together (mixed germ cell tumour) as the totipotential cells develop along multiple pathways. Tumour markers play an important role in diagnosis, staging, prognosis and follow-up of germ cell tumours; α-fetoprotein is raised in yolk sac tumours and teratomas, human chorionoic gonadotrophin is raised in choriocarcinoma.

Seminomatous germ cell tumours

Seminoma represents the most common solid tumour in young men with the highest rates reported in Europe, Scandinavia and North America, with a white: black ratio of 5:1. Seminomas are usually associated with cryptorchidism. Sonographic appearances mirror the uniform cellular nature of the tumour i.e. uniform low reflectivity, although larger tumours may be heterogeneous; and lobulated or present as multinodular areas in continuity [Figure 37]. These tumours are particularly radiosensitive.

Figure 37a Seminoma. A low reflective mass (arrow) lying within testicular parenchyma with a well delineated border demonstrating features of a seminoma.

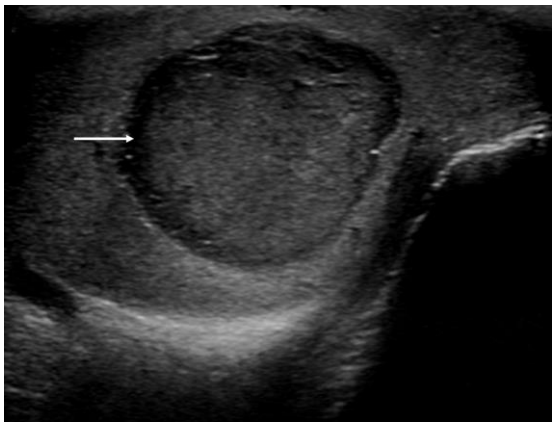


Figure 37b Seminoma. Here is increased colour Doppler flow to the tumour in a disordered manner (arrow).

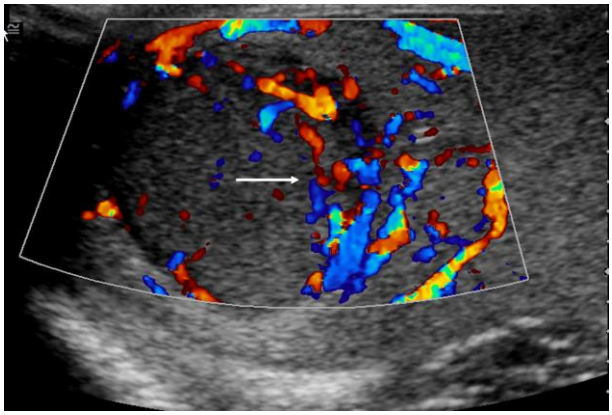


Figure 37c Seminoma. There is enhancement of the tumour in a less intense manner (arrow) than the normal testis.

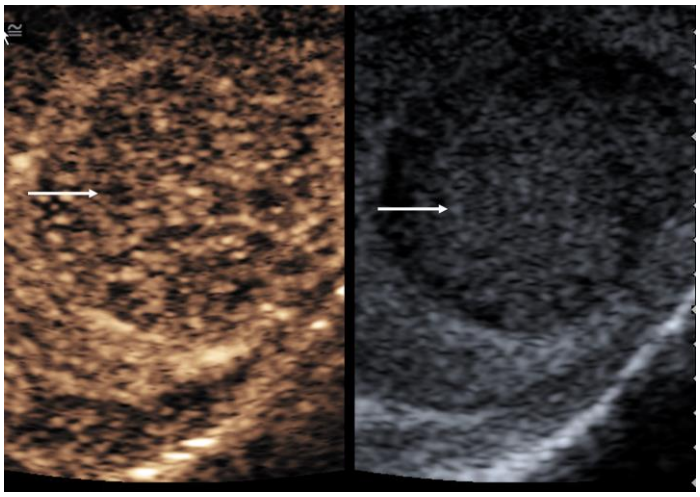
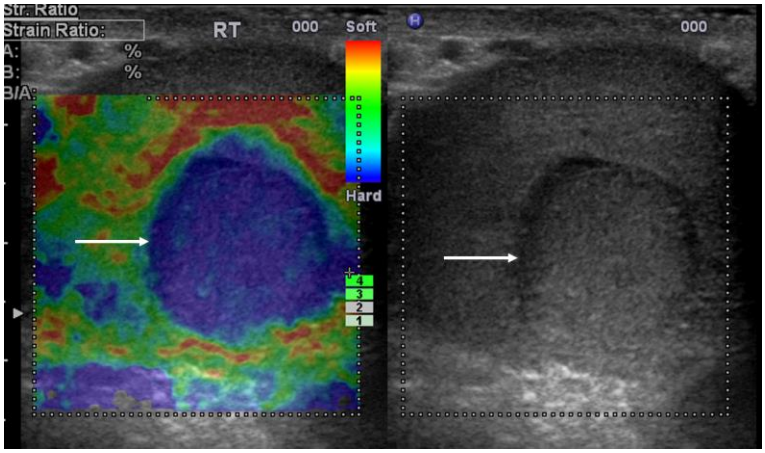


Figure 37d Seminoma. The lesion is of increased stiffness on the strain elastography images (arrows).



Non-seminomatous germ cell tumours

The non-seminomatous germ cell tumours are a collective group of various cell types. They affect younger patients than seminomatous germ cell tumours and are more aggressive. They are:

Mixed germ cell tumours contain more than one germ cell component and any combination of cell type can occur. The most common combination is a teratoma and embryonal cell carcinoma often termed teratocarcinoma. These tumours are more common than the pure histological forms of testicular tumours. With ultrasonography the appearance reflects the diverse nature of the histology with areas of calcification, cystic change, haemorrhage and necrosis [Figure 38].

Embryonal cell carcinoma is present in nearly all mixed germ cell tumours, but in the pure form account for 2% of all testicular tumours. Embryonal carcinoma affects younger men, tends to be more aggressive and a significant number will present with metastases. These tumours are often heterogeneous, ill-defined and blend imperceptibly into adjacent testicular parenchyma [Figure 39].

Choriocarcinoma is a rare tumour in the pure form, which occurs more often in a mixed germ cell tumour where it is highly malignant. Choriocarcinoma carries the poorest prognosis of any germ cell tumour; a high level of human chorionic gonadotropin results in a poor prognosis. Sonography will demonstrate a heterogeneous solid mass with areas of haemorrhage, necrosis and calcification.

Yolk sac tumours are the infantile form of embryonal cell carcinoma and account for most tumours in infants (under 2 years old). This tumour is rare in adults except as a component of mixed germ cell tumours and there is often an elevation of α-fetoprotein levels present. The sonographic features are non-specific and similar to a mixed germ cell tumour with cystic change and areas of calcification.

Teratoma may be divided into mature, immature and teratoma with malignant transformation according to the presence of derivatives of the different germinal layers (endoderm, mesoderm and ectoderm). Teratoma is the second most common testicular tumour in children under 4 years old and teratoma cells occur in more than 50% of adult cases of mixed germ cell tumours. A teratoma tends to be a complex tumour, and the sonographic features are a well-defined complex mass with calcification and cystic change [Figure 40].

Malignant transformation into a teratocarcinoma has been documented. In the pre-pubertal testes, a pure teratoma is considered benign and testis sparing surgery may be undertaken, but this is not the case for the post-pubertal teratoma, which will metastasize irrespective of the histological features.

“Regressed” or “burnt-out” germ cell tumours have widespread germ cell metastases but no primary tumour except for an area of calcification or fibrosis within an often-atrophic testis, which may be encountered (105). The pathogenesis of this phenomenon may be the result of the high metabolic rate of the tumour that can outgrow its blood supply and involutes (106;107). The appearances of a ‘burnt-out’ tumour can be varied, demonstrating lesions that were hypo-echoic, hypovascular (108) and stiff on elastography. ‘Burnt-out’ tumours can also manifest as areas of macrocalcification within the testis (109), and the presence of macrocalcification may increase the risk of malignancy (110).

Figure 38 Mixed germ cell tumour. A focal mass (arrow) (a mixed germ cell tumour) is present at the upper aspect of the testis. It is heterogeneous but mainly highly reflective and is not as clearly defined as a seminoma.

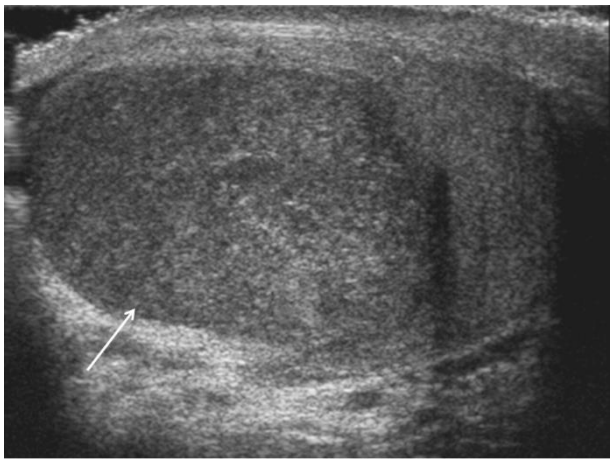


Figure 39 Embryonal cell tumour. Often a component of mixed germ cell tumours, this is an example of a pure embryonal cell tumour, which is ill-defined and lobulated (arrow).

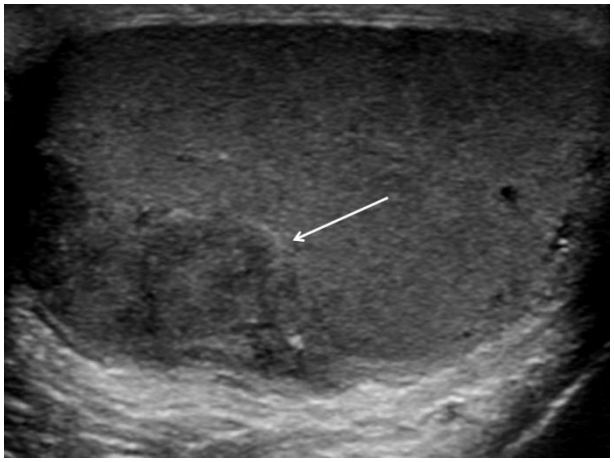
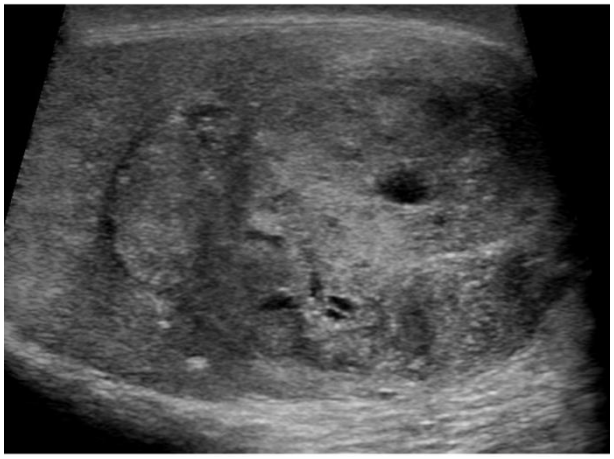


Figure 40 Teratoma. A large teratoma occupying the entire testis and demonstrating pockets of cystic change.



Non-germ cell tumours

Non-germ cell tumours (gonadal stromal tumours) account for 3–6% of all testicular tumours with a higher prevalence in the paediatric age group. Nearly all non-germ cell tumours are benign (90%), with no clear sonographic appearance that allows differentiation from malignant testicular tumours, although work in progress suggests that the pattern of enhancement with contrast enhanced ultrasound may allow for better prediction of the histology (102;104;111). These non-germ cell tumours contain Leydig, Sertoli, thecal, granulosa or lutein cells and fibroblasts. When they are combined with germ cell tumours they are called gonadoblastomas.

Leydig cell tumours make up the majority of non-germ cell tumours. They occur across all age groups, but are the most common tumour found incidentally in infertile men (112). Patients demonstrate symptoms related to androgen or oestrogen secretion by the tumour, which include precocious virilization, gynaecomastia or decreased libido. On sonography Leydig cell tumours are small and low reflective with cystic change (113). Colour Doppler ultrasound may demonstrate poor internal vascularisation with increased peripheral vascularity when small. Internal vascularity increases with tumour size, contrats enhanced ultrasound shows increased and prolonged enhancement, and elastography demonstrates intermediate stiffness (2;94) [Figure 41].

Sertoli cell tumours are less likely than Leydig cell tumours to secrete hormones. On sonography Sertoli cell tumours are well-circumscribed, round and lobulated [Figure 40].

Lymphoma patients do not usually develop in the testis. Only 0.3% of patients with lymphoma have testicular involvement (114), but testicular lymphoma may be the primary site of involvement, the initial manifestation of widespread disease or the site of recurrence. **Testicular lymphoma** is the most common testicular tumour in patients over 60 years old, the most common secondary tumour of the testis and is the most common bilateral tumour. The most frequent type of lymphoma to affect the testis is non-Hodgkin's lymphoma, which has a sonographic appearance similar to germ cell tumours particularly a seminoma (115). Complete testicular involvement may be seen, which emphasizes the need to compare the reflectivity of both testes [Figure 42]. Colour Doppler, contrast enhanced ultrasound and elastography have been used to aid the diagnosis; with the pattern of vessels in lymphoma more likely unaltered in structure and configuration as the lymphoma cells do not destroy the blood vessels (44;116).

Primary leukaemia of the testis is rare, but is a common site of recurrence in children (117). The blood-testis barrier prevents chemotherapy agents from dealing with intratesticular leukaemia cells. The sonographic appearance is variable, it can be unilateral or bilateral, diffuse or focal, low or high reflective with increased colour Doppler flow [Figure 43]. Differentiation from inflammatory disease is difficult without a full clinical history.

Metastasis to the testis is unusual; the most frequent primary sites are the prostate, lung, melanoma, colon and kidney (118). Metastases occur most commonly in patients over 50

years old and usually in advanced disease. Metastases are indistinguishable from primary tumours of the testis on ultrasonography.

Figure 41a Leydig cell tumour. A large mixed reflective heterogeneous tumour at the upper aspect of the testis, which on histological examination was found to be a Leydig cell tumour.

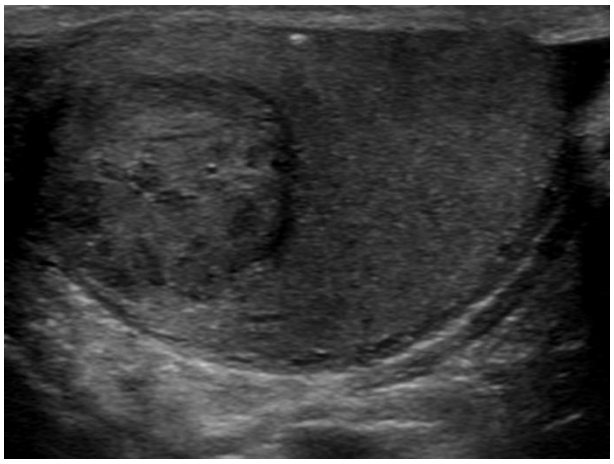


Figure 41b Leydig cell tumour. Increased colour Doppler flow indicating a vascular tumour.

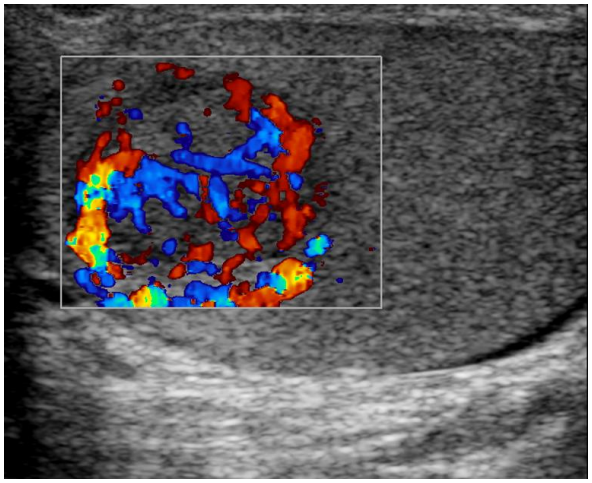


Figure 41c Leydig cell tumour. Marked and prolonged contrast enhancement following the administration of an ultrasound contrast agent.

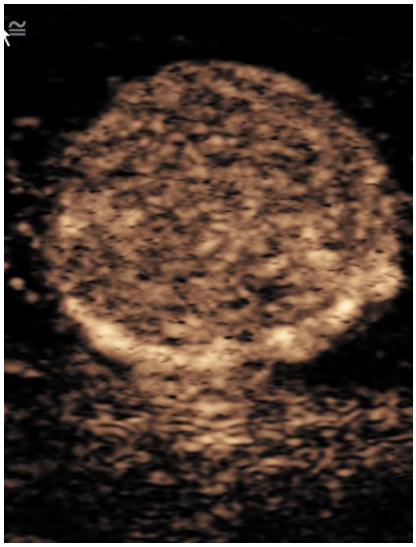


Figure 41d Leydig cell tumour. Strain elastography demonstrates an intermediate stiffness.

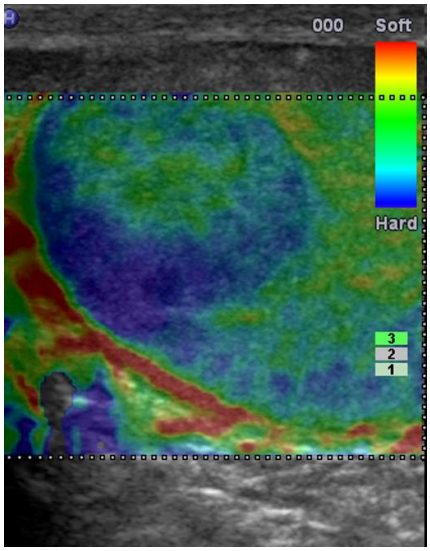


Figure 42 Sertoli cell tumour. This well circumscribed Sertoli cell tumour has linear wall calcification.

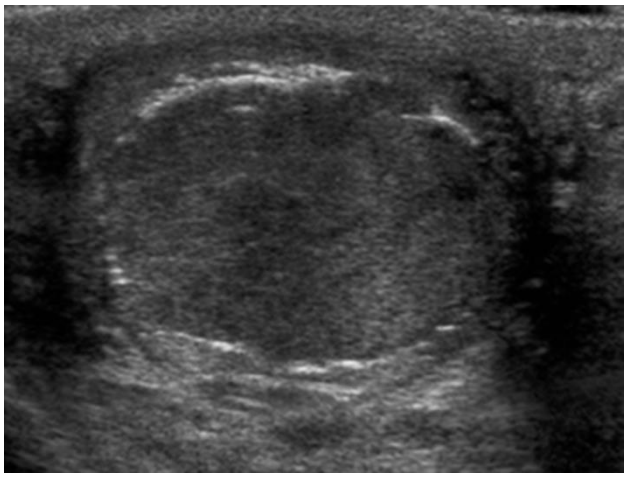


Figure 21a Lymphoma. There is enlargement of the testis, with a mass of mixed predominantly low reflective appearance.

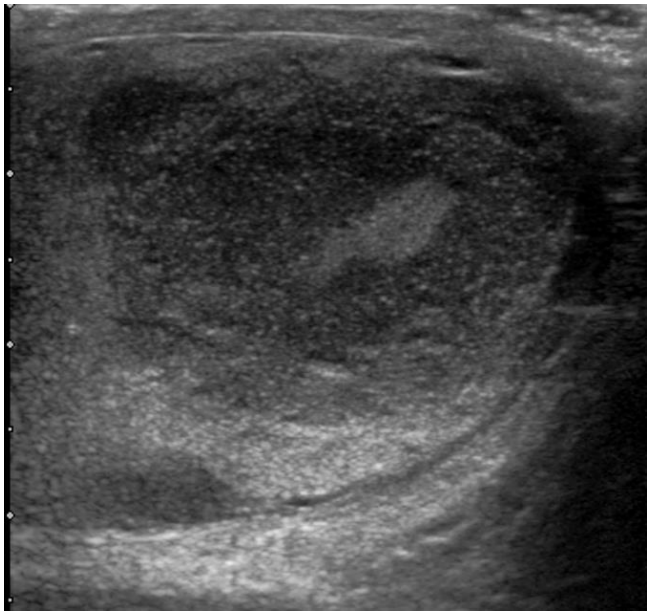


Figure 43b Lymphoma. There is increased colour Doppler flow, without marked vascualr distortion.

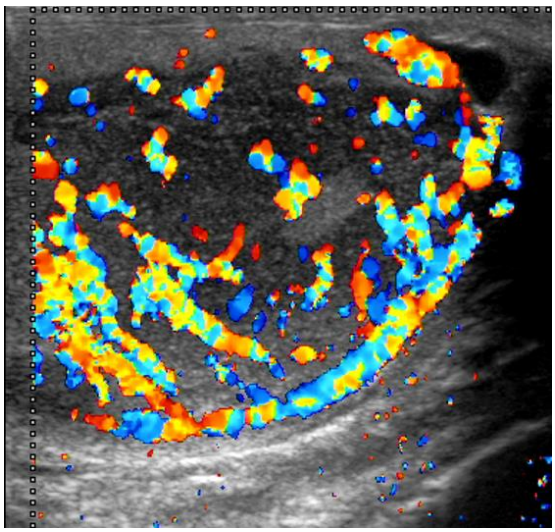


Figure 43c Lymphoma. There is an overall increase in stiffness of the focal area of lymphoma.

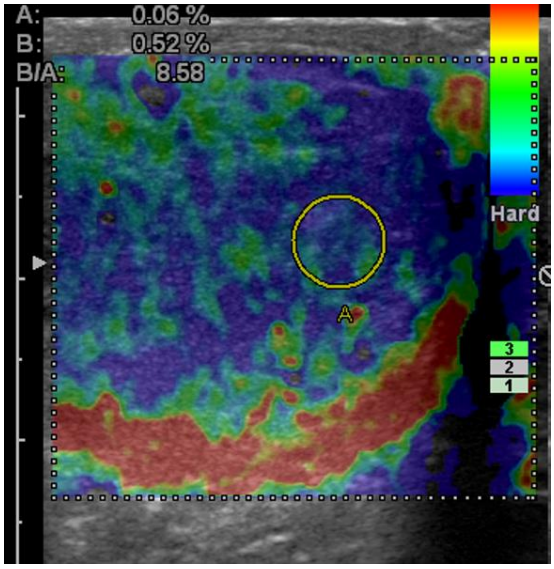
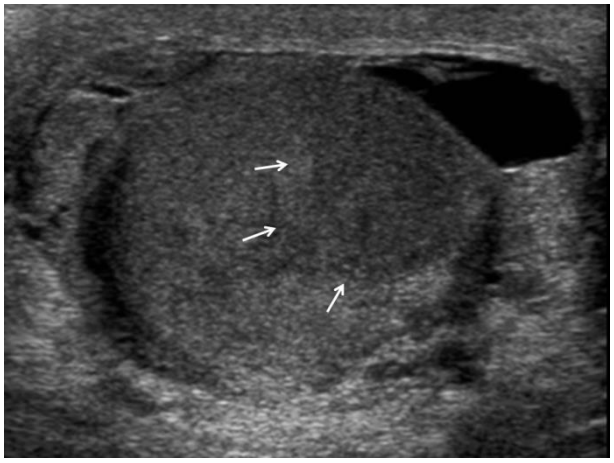


Figure 44 Leukaemia. An area of lower reflectivity (arrows) in a patient with acute myeloid leukaemia with a small hydrocoele.



Extra-testicular masses

Epididymal focal lesions

Extra-testicular solid tumours are uncommon and the majority of extra-testicular lesions are cystic abnormalities of the epididymis. Primary solid tumours of the extra-testicular tissues are normally benign except in children where a rhabdomyosarcoma is a possibility. Rarely, metastases can occur in the extratesticular space.

Extra-testicular cysts are found in the spermatic cord, epididymis [Figure 45], tunica albuginea or tunica vaginalis. Epididymal cysts are usually found in the epididymal head, contain clear

serous fluid and on sonography demonstrate features typical of a cyst, i.e. anechoic structure with posterior acoustic enhancement. A spermatocoele consists of cystic dilatation of tubules and efferent ductules. It occurs in the epididymal head [Figure 46] and often contains low reflective debris representing spermatozoa, lymphocytes, cellular debris fat and proteinaceous fluid (119). The differentiation between a spermatocoele and a simple cyst is unimportant and often indistinguishable on sonography. A spermatocoele is more common than an epididymal cyst and more frequent in the epididymal head. An epididymal cyst may be large and simulate a hydrocoele; differentiation is usually attained by demonstrating fluid anterior to the testis in a hydrocoele.

Tubular ectasia and vasectomy

Following vasectomy, the epididymis has a characteristic appearance of dilatation, with an inhomogeneous appearance of the epididymis, which is unrelated to symptoms and seen in more than 45% of patients (120) [Figure 48]. If there has been obstruction to the epididymis, particularly with inflammatory change, obstruction of the vas deferens will manifest with areas of increased echogenicity, which in a high powered ultrasound field will be seen as movement – termed ‘dancing mega-sperm’ (121;122), distinct from the classical ‘filarial dance’ previously described (123).

Sperm granuloma

A sperm granuloma is a granulomatous reaction to extravasated sperm cells and may occur secondary to inflammation, trauma or vasectomy. On sonography a sperm granuloma is well-demarcated, of low- or high-reflectivity, without colour Doppler flow, normally found in the epididymis [Figure 49] and is often painful in the early stages (124).

Lipoma

This is the most common benign tumour of the extra-testicular space and is commonly found in the spermatic cord (125). Patients of all ages are affected and the tumour manifests as a non-tender scrotal lump. On sonography a lipoma has a homogenous high- to iso-reflective appearance and varies in size [Figure 50].

Adenomatoid tumour

This is the most common tumour of the epididymis probably of a mesothelial origin. Adenomatoid tumours usually occur in patients over 20 years old and is present as a painless slow-growing mass, which arises in the tail of the epididymis and is predominantly left-sided (126). The sonographic appearance is non-specific, but the majority are iso-reflective to the epididymis, well-defined, oval in shape and may be cystic (127) [Figure 51]. Resection is normally curable, but will interfere with sperm ejaculation on the side of the resection.

Leiomyoma

This is the second commonest tumour of the epididymis, which usually involves the epididymal head and is often associated with a hydrocele. The patient presents with a slow-growing non-tender mass. On sonography there are no specific features, it may be cystic or solid and contain areas of calcification (128).

Other rare benign tumours of the extra-testicular space

Haemangiomas [Figure 52] (129), which may be indistinguishable from a varicocoele; a papillary cystadenoma associated with von Hippel-Lindau disease and appears as a solid lesion with small cystic spaces in the head of the epididymis (130); or a fibrous pseudotumour [Figure 50] may result from a history of trauma, haematocoele or from epididymo-orchitis (131).

Malignant neoplasms

Malignant lesions of the extra-testicular space are rare and usually present as a mildly painful enlarging mass. The vast majority are sarcomas (126). A rhabdomyosarcoma is the most common sarcoma of the spermatic cord and presents as an enlarging painless mass in children. This is an aggressive tumour, which may present with metastases. Sonographic features are non-specific and include variable reflectivity with areas of necrosis and haemorrhage and increased colour Doppler flow (132). A liposarcoma is very rare and usually arises from the spermatic cord. It is of low-grade malignancy and advances by local spread with patients presenting with a slow-growing fluctuant mass. Sonography demonstrates a high reflective mass of varying size. Other rare malignant lesions of the extra-testicular space

include leiomyosarcoma, which is seen as a predominantly low reflective mass (133); malignant schwannoma; and malignant fibrous histiocytoma. A mesothelioma may develop from the tunica vaginalis in patients exposed to asbestos (134). Lastly, metastases to the extra-testicular space occur from a testicular primary, renal, prostate or gastrointestinal tumour.

The application of contrast enhanced ultrasound and strain elastography to tumours of the extra-testicular space has not been informative, with overlap in appearances of a lipoma and adenomatoid abnormality, but contrast enhanced ultrasound is more successful in delineating an epididymal abscess (37).

Figure 45 Epididymal head cyst. A large epididymal head cyst (star) displaces the testis inferiorly. An additional feature is a thickened epididymal body (arrow).

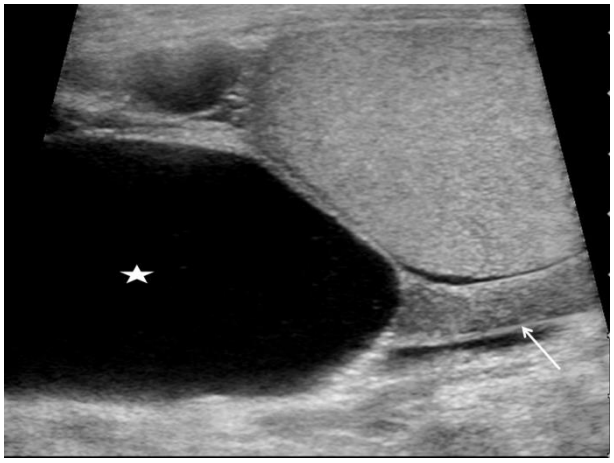


Figure 46 Spermatocoele. Two cysts in the epididymal head demonstrate debris (arrows) known as "layering"

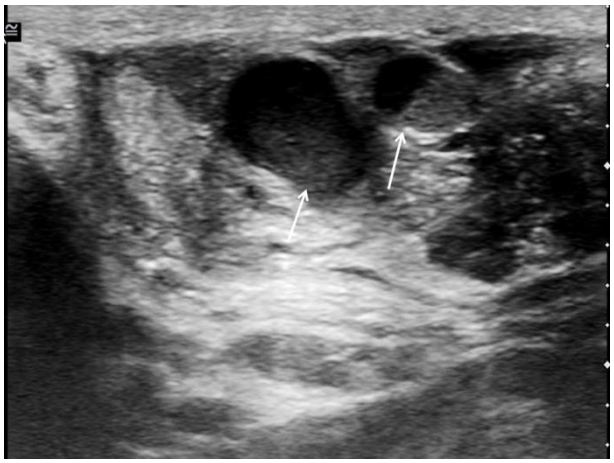


Figure 47 Post-vasectomy. The epididymis is dilated (between arrows) in a patient who has undergone a vasectomy. A characteristic reflective pattern demonstrated.

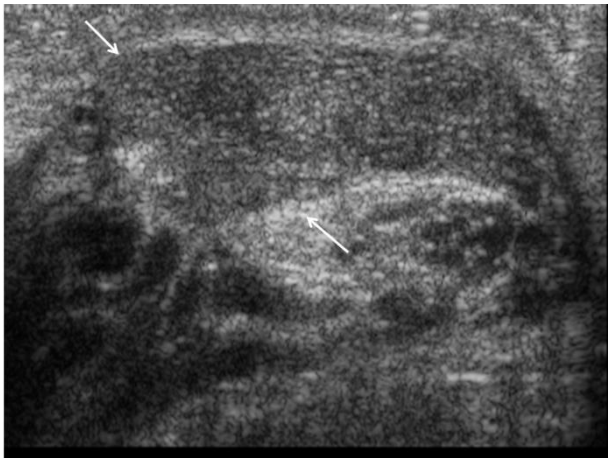


Figure 48 Sperm granuloma. A focal low reflective lesion in the epididymis (arrow), which is painful. Confirmed as a sperm granuloma on histology.

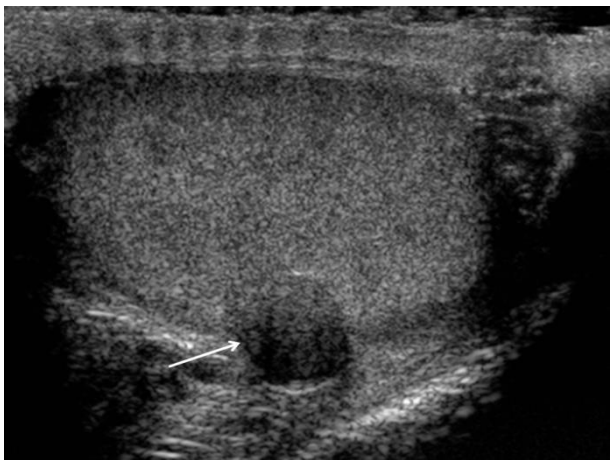


Figure 49 Lipoma. A focal mixed reflective extra-testicular lesion (arrow) in keeping with a lipoma lying at the lower aspect inferior to the testis (star).

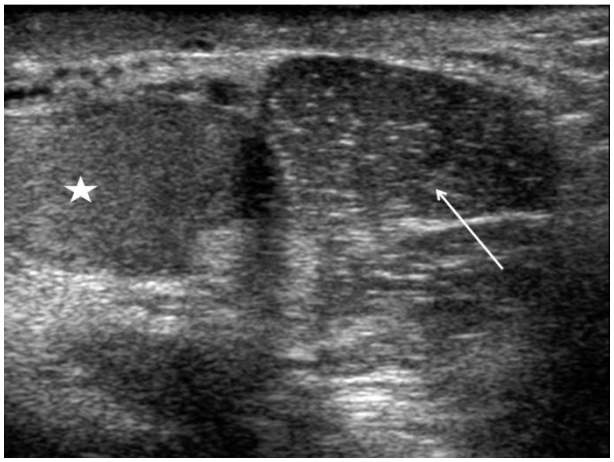


Figure 50 Adenomatoid tumour. A large mixed reflective mass (arrow) present in the tail of the epididymis. Confirmed as an adenomatoid lesion on histology.

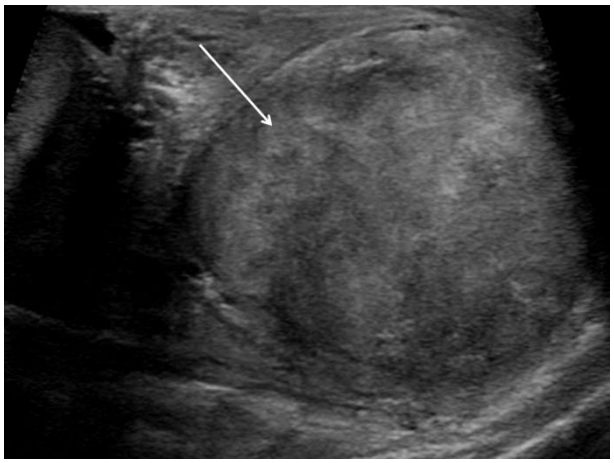


Figure 51 Cavernous haemangioma of the spermatic cord. A well-circumscribed lesion of the spermatic cord containing pockets of increased colour Doppler flow (arrow).

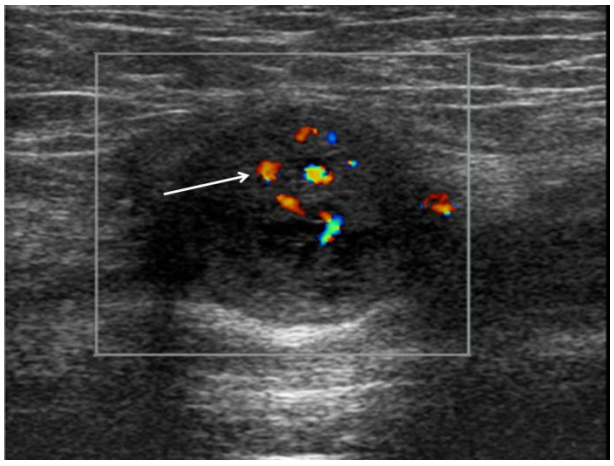
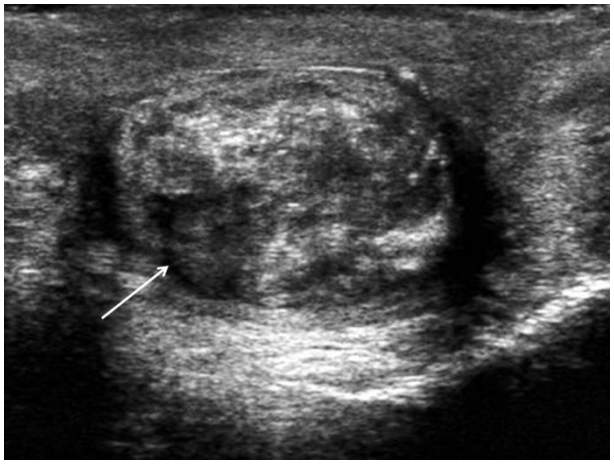


Figure 52 Fibrous pseudotumour. A fibrous pseudotumour of the epididymal tail (arrow) demonstrating a spectrum of different reflectivity.



Scrotal calcification

Testicular microlithiasis and macrocalcification

Testicular microlithiasis describes the appearance of multiple tiny bright foci, measuring 1–2mm in diameter, which may be unilateral or bilateral [Figure 53]. Acoustic shadowing is not seen, probably owing to the small size of the calcifications. Testicular microlithiasis has been arbitrarily classified into “limited”, which is defined as less than five microliths per ultrasound field and “classical”, which is defined as greater than five microliths per field (135-139). “Florid” is a further suggested definition, where there are innumerable microliths per ultrasound field (140). The prevalence of all forms of testicular microlithiasis is reported at 0.6–9.0% (141;142). Testicular microlithiasis is characterized by the formation of microliths from degenerating cells in the seminiferous tubules. Testicular microlithiasis has been associated with various medical conditions, including infertility, cryptorchidism, Klinefelter’s syndrome, Down's syndrome and pulmonary alveolar microlithiasis (99;143). Testicular microlithiasis has also been found in association with malignant tumours in the testis with seminoma, the commonest tumour to occur in association with testicular microlithiasis (139) [Figure 54]. As a consequence, the significance of finding isolated testicular microlithiasis is as yet uncertain; surveillance with ultrasonography on an annual basis had been advocated, but

manual self-examination would probably suffice. A number of case reports have detailed the development of a primary testicular tumour while on an ultrasound surveillance program (144;145).

The association of testicular macrocalcification within benign testicular lesions is well-documented and can be found in association with intratesticular cysts and epidermoid tumours (146). Large smooth curvilinear calcification at the periphery of a tissue mass has been shown in Sertoli cell tumours. Granulomatous disease within the testes can also present with a low-reflective mass and areas of calcification within (147). The presence of macrocalcification in association with malignant tumours has also been noted, particular with the entity of “burnt-out” tumours. Recently macrocalcification has been associated with a higher prevalence of primary testicular tumours (109;110;139) [Figure 55].

Figure 53 Testicular microlithiasis. Right-sided classical testicular microlithiasis; small high reflective areas measuring 1–2mm without evidence of posterior acoustic shadowing.

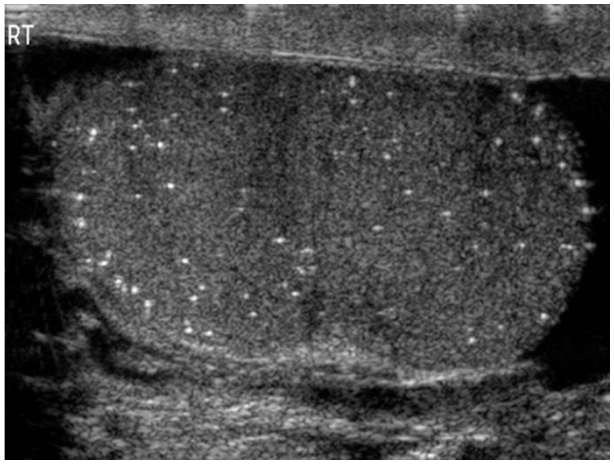


Figure 54 Seminoma with testicular microlithiasis. Testicular microlithiasis (short arrows) in association with a bi-lobulated seminoma (long arrows). There is an increased prevalence of primary testicular tumours in the presence of testicular microlithiasis.

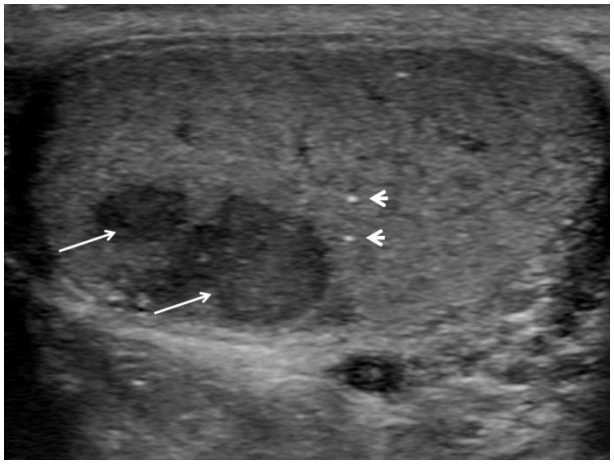
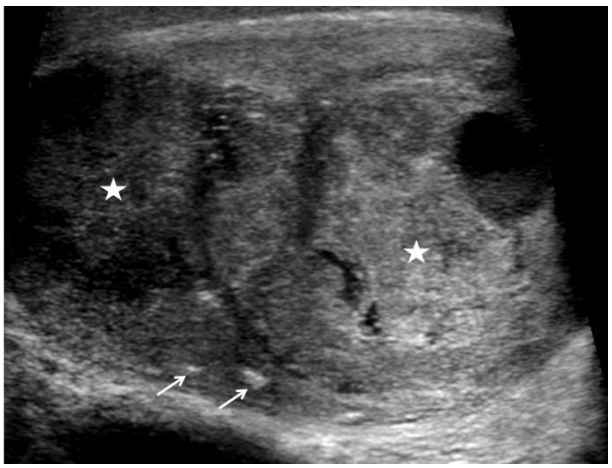


Figure 55 Tumours with testicular macrocalcification. Two germ cell tumours are present (stars) the testis. Focal areas of macrocalcification lay outside the tumour margins (arrows).



Extra-testicular calcification

Calcification within the epididymis is common and represents benign disease (147). The tunica vaginalis may sometimes calcify producing a plaque with acoustic shadowing as well as calcification in the tunica albuginea [Figure 56]. Calcification in the epididymis is usually due to chronic epididymitis. Haematoma and sperm granulomas (sperm extravasation with granuloma formation) may occur and produce a solitary high reflective area within the epididymis. The appendix epididymis and appendix testis may calcify and are recognized by their characteristic position and shape (146). Calcifications presenting in between the two layers of the tunica vaginalis are termed “scrotal pearls”, which are best appreciated in the

presence of a hydrocoele [Figure 57]. A scrotal pearl, often palpated by the patient, is usually freely mobile within a hydrocoele.

Figure 56 Tunica albuginea calcification. A focus of high reflectivity in the tunica albuginea (arrow) causing extensive posterior acoustic shadowing.

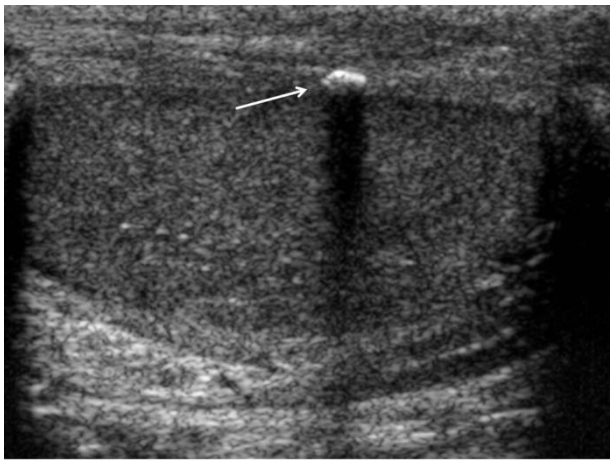
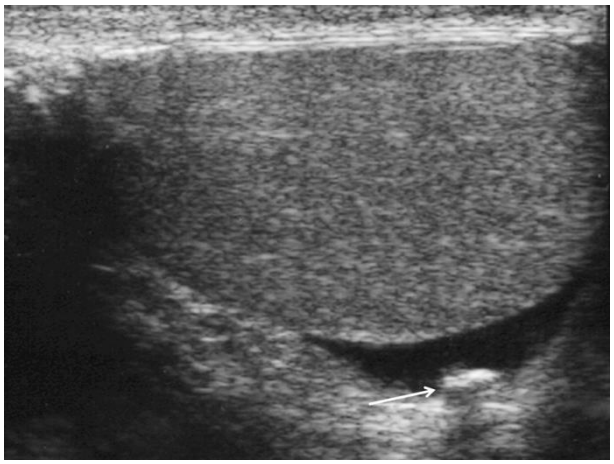


Figure 57 Scrotal pearl. The high reflective area (arrow) lying free in a small hydrocoele within the scrotal sac represents a "scrotal pearl" and causes posterior acoustic shadowing.



Extra-testicular non-focal lesions

Inguinal hernia

Inguinal hernias are a common cause of a scrotal swelling with physical examination sufficient to arrive at the correct diagnosis, but sonography may be useful in difficult cases. On

sonography the hernia contains bowel or omentum giving rise to peristalsis of fluid-filled loops of bowel, air within bowel or high reflective omental fat [Figure 58].

Hydrocoele, pyocoele and haematocoele

Between the two layers of the tunica vaginalis there is normally a small amount of serous fluid present, which can be visualized in up to 85% of asymptomatic men (14). When the collection of fluid enlarges, a hydrocoele develops and this is the commonest cause of a painless scrotal swelling. Fluid accumulation is confined to the anterior and lateral aspects of the scrotum and therefore sparing the bare area of the testis. A hydrocoele is normally of low reflectivity, with posterior acoustic enhancement, but may contain multiple echoes in the presence of cholesterol crystals (148) [Figure 59]. Hydrocoeles may be idiopathic or develop secondary to trauma (haematocoele), infection (pyocoele), torsion, tumour or congenital (secondary to a patent processes vaginalis). The testis is normally displaced to the posterior aspect of the scrotal sac in the presence of a hydrocoele, in contrast to the inferior position when a large epididymal cyst causes displacement of the testis.

Varicocoele

A varicocoele is present in up to 15% of adult male patients (149) and is caused by incompetent valves in the internal spermatic vein. Impaired drainage is more evident when standing upright or during a Valsalva manoeuvre, which renders the varicocoele more prominent. Varicocoeles are left-sided in 78%, right-sided in 6% and bilateral in 15%. This abnormal dilatation of veins arises more often on the left as a consequence of the angle at which the left testicular vein enters the left renal vein. The normal veins of the pampiniform plexus measure 0.5–1.5mm and a vein diameter of greater than 2mm should be considered abnormal (150). On sonography, a varicocoele consists of multiple low reflective serpiginous tubular structures of varying size, which is best seen superior and lateral to the testis. If large, the varicocoele may extend to the inferior aspect of the testis [Figure 60]. Tumbling low-level echoes may be identified on real-time imaging, secondary to low flow. Sonography in the supine and erect positions as well as following the Valsalva manoeuvre will help identify the varicocoele and document retrograde filling. Where a varicocoele is present, examination of the left kidney in all patients is advocated by many clinicians, to exclude a renal tumour;

however, there is little supporting evidence as to the prevalence of this association (151). This is probably only indicated in the presence of a varicocoele that has recently arisen in patients over the age of 40 years old (152).

Occasionally an intratesticular varicocoele may occur (153;154) [Figure 61]. There is a characteristic appearance on colour and spectral Doppler examination, as an intratesticular varicocoele demonstrates vascular flow. An intra-testicular varicocoele will behave in a similar fashion to an extra-testicular varicocoele, by increasing in size and demonstrating retrograde flow on Valsalva manoeuvre. A common clinical presentation is testicular pain attributed to stretching of the tunica albuginea secondary to venous congestion (155).

The classification of varicocoeles based on clinical features is as follows: Grade 1, varicocoele is palpable only during the Valsalva manoeuvre; Grade 2, readily palpable without the need for the Valsalva manoeuvre; and Grade 3, visible on inspection (156). The recent document of the European Society of Urogenital Radiology outlines the radiological and ultrasound assessment of a varicocele (152). Identification of a varicocoele in patients being investigated for infertility may be of relevance, although testicular volume, sonographic appearances and Doppler studies may also be importance (157).

Figure 58 Inguinal hernia. The left scrotal sac contains high reflective omentum (arrow) from an inguinal hernia on this spectacle view of the scrotal contents.

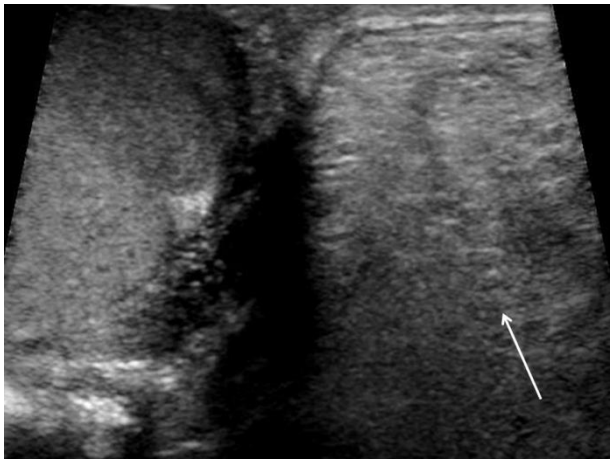


Figure 59 Extra-testicular fluid collection. Extensive high reflective material within a chronic hydrocele representing cholesterol crystals. The testis is at the lower aspect (star).

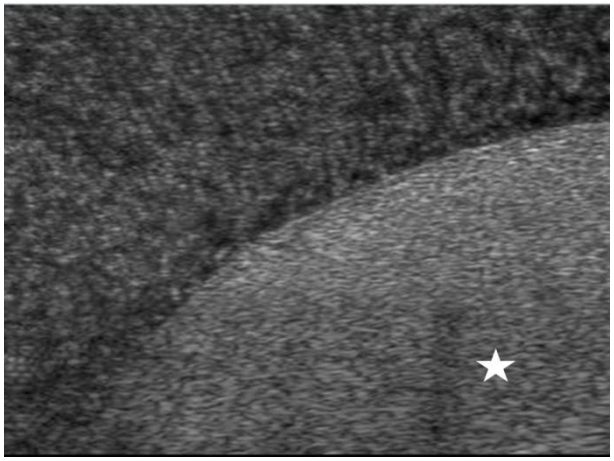


Figure 60 Extra-testicular varicocoele. Serpiginous dilated (>2mm) veins at the lower aspect of the testis; a testicular varicocoele (arrow).

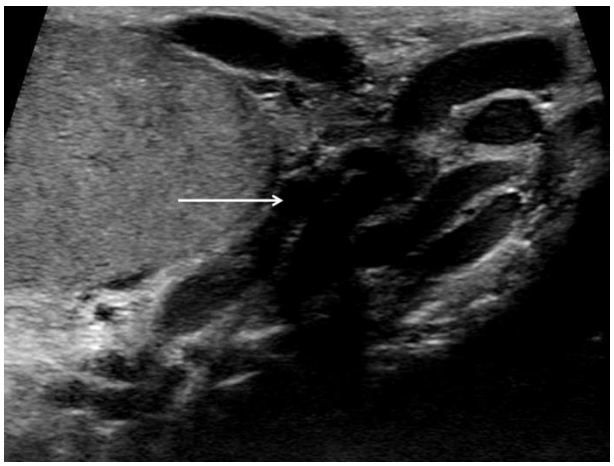
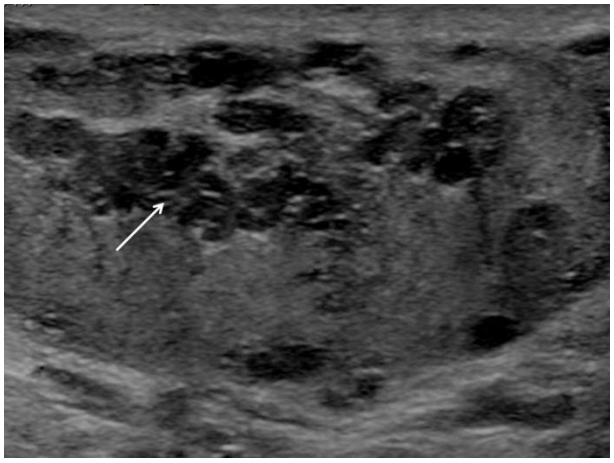


Figure 61 Intratesticular varicocoele. A dilated intratesticular tubular structure (arrow) traversing the testis.



Scrotal wall abnormalities

Scrotal wall oedema may occur in many conditions, e.g. heart failure, liver failure, lymphatic obstruction and venous obstruction. Lymph oedema of the scrotal wall is classically described in filarial worm infestations (158) [Figure 62]. Testicular oedema results in fluid tracking into the interstitial tissues of the testis as a consequence of marked subcutaneous oedema of the scrotal sac. This gives rise to low reflective linear branching throughout the testes giving a “crazy paving” appearance (89). The linear branching low reflective areas demonstrate no colour Doppler signal [Figure 63].

Figure 62 Scrotal wall oedema: There is marked thickening of the scrotal wall (arrow), with an underlying right sided hydrocoele and a normal testis.

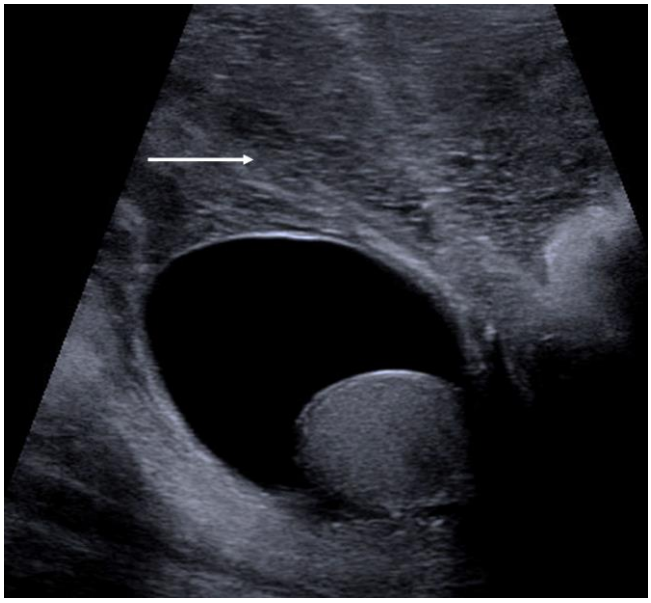
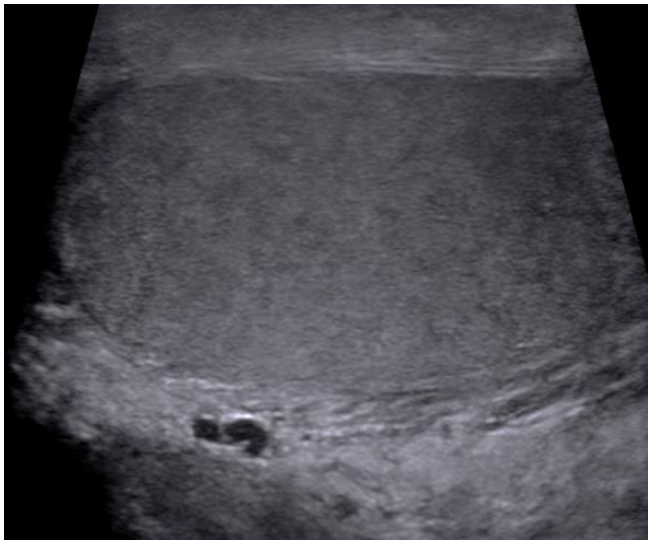


Figure 63 Straited testis: Multiple serpiginous changes in the testis encountered in a patient with scrotal wall oedema.



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