
PICTORIAL ESSAY

High-resolution Sonography for Paediatric Scrotal Pathology

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ABSTRACT

High-resolution sonography is widely accepted as the method of choice for screening and diagnosis of scrotal pathology in childhood. High-resolution sonography enables rapid evaluation of the paediatric scrotum, with virtually no risk. There is a wide spectrum of disease entities associated with scrotal pathology in childhood. This pictorial essay provides a comprehensive and illustrative review of the use of high-resolution sonography for scrotal lesions in childhood.

Key Words: Pediatrics; Scrotum; Testis; Ultrasonography

INTRODUCTION

High-resolution sonography is widely accepted as the method of choice for screening and diagnosis of scrotal pathology in childhood. High-resolution sonography provides full details of the scrotal wall, testis, and epididymis. Despite advances in imaging technology, including high-resolution magnetic resonance imaging (MRI) and multi-detector computed tomography (MDCT), sonography enables rapid evaluation of the paediatric scrotum, with virtually no risk to the child. The major advantages of sonography include wide availability, low cost, speed, no radiation, and no sedation requirement. Many publications on ultrasound of the paediatric scrotum have focused on the important issue of testicular torsion, which, despite being important, is not frequently encountered in clinical practice. There is a wide spectrum of disease entities other than testicular torsion that are associated with scrotal pathology in childhood. This Pictorial Essay presents a comprehensive and illustrative review of the use of high-resolution sonography in scrotal diseases in childhood, emphasising pathologies other than testicular torsion.

TECHNIQUE

The technique of scrotal sonography for small children is similar to that for adults. A high-resolution ultrasound probe, 10 to 12 MHz, is used for examination. Sector format of the image can increase the field of view and is good for comparison of the testes, scrotal skin, and tunica at one time. However, since the tunica vaginalis is still open in infants, it is helpful to hold 1 finger above the scrotum in the inguinal canal to fixate the testis. Sometimes a small-footprint linear transducer, such as the hockey stick transducer, is helpful for small children. A warm towel can also be used for prepubertal boys to increase the vascular flow in the testis.

CONGENITAL ANOMALY Cryptorchidism

The testes have descended into the scrotum via the inguinal canal in 93% of all male fetuses by a gestational age of approximately 32 to 36 weeks. Undescended testis is one of the most common genitourinary abnormalities in male infants,¹ 10% to 33% of which occur bilaterally. Malpositioned testes may be located anywhere along the pathway of descent from the retroperitoneum to the scrotum, but the majority of undescended testes (80%) are palpable and will be found at or below the level of the inguinal canal. Ultrasound is useful for the localisation of a testis in the high scrotal or inguinal area (Figure 1).² Diagnosis and management of this condition helps to prevent potential

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Submitted: 7 September 2007; Accepted: 12 October 2007.

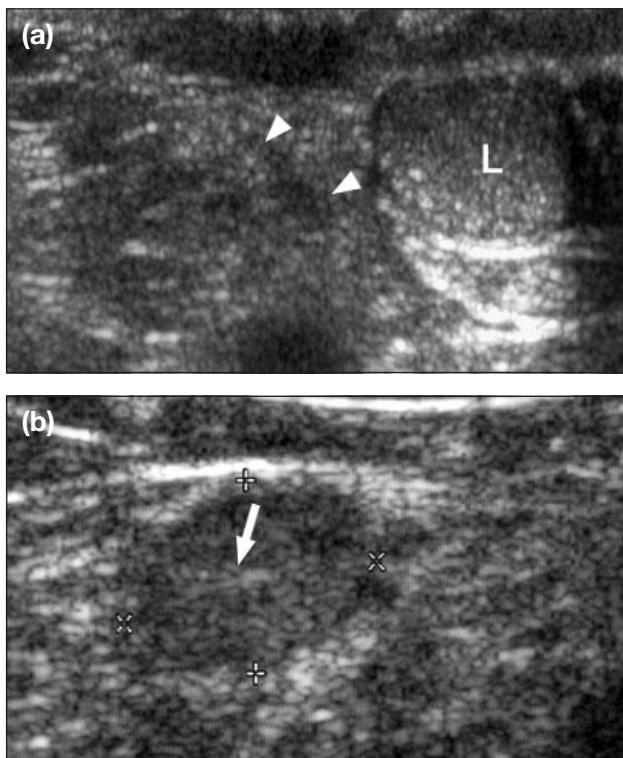


Figure 1. A 6-month-old boy with an undescended right testis. (a) Transverse midline sonogram showing normal left testis (L) as a homogeneous low-to-medium-level echo oval structure — the right scrotal sac (arrowheads) is empty; (b) longitudinal sonographic image over the right inguinal region showing the undescended right testis (surrounded by crosses) with slightly low echogenicity but comparable size to the contralateral normal testis — the mediastinum testis (arrow) can be seen within the testis.

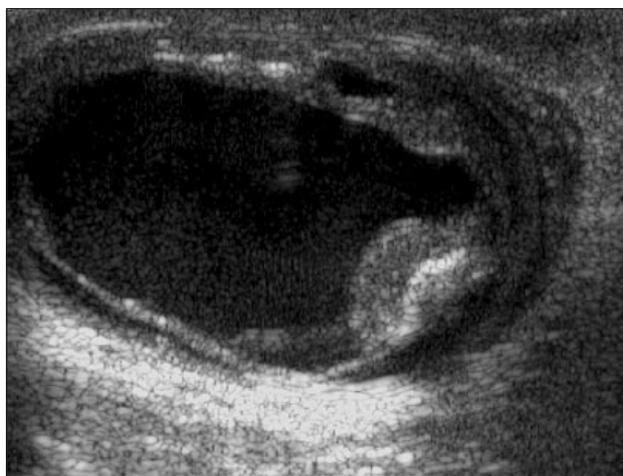


Figure 2. A 2-month-old boy with malignant transformation of undescended testes presenting with bilateral empty scrotal sacs. Transverse sonographic image shows a mixed cystic and solid mass with calcifications in the right side of the abdomen. The baby had open resection of both tumour masses and pathology revealed bilateral seminomas.

complications, including infertility, trauma, torsion, and cancer.^{3,4} The most frequently encountered malignancy in an undescended testis is a seminoma (Figure 2).

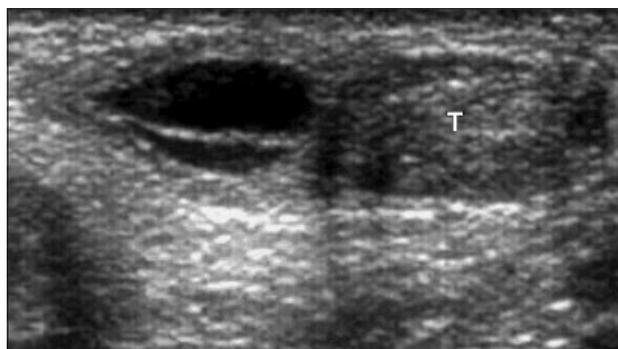


Figure 3. A 3-year-old boy with hydrocele of the cord. Longitudinal sonogram shows a septated cyst in the superior aspect of the right testis (T). No fluid is present in the lower pole of the scrotum. The cyst is separate from the epididymis and testis, and runs parallel to the inguinal canal. No communication with the peritoneal cavity is noted.

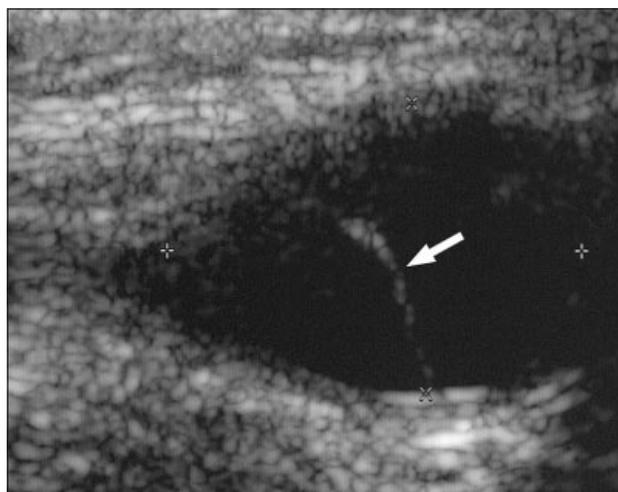


Figure 4. Loculated hydrocele in a 4-year-old boy with painful right scrotal swelling. Transverse sonogram shows a loculated hydrocele (surrounded by crosses) with internal septa (arrow) and debris is present in the right scrotum.

EXTRATESTICULAR PATHOLOGY

Hydrocele and Pyocele

Hydrocele is an abnormal collection of serous fluid accumulating between the visceral and parietal layers of the tunica vaginalis. Hydrocele is the most common cause of a painless scrotal swelling in a child. The processus vaginalis is closed by the end of the first year of life. Congenital hydrocele results from incomplete closure of the processus vaginalis. Acquired hydrocele usually occurs in patients with a normally closed processus vaginalis following scrotal trauma or secondary to epididymitis, torsion, or neoplasm. Various subtypes of hydrocele include intermittent hydrocele, scrotal hydrocele, hydrocele of the cord (Figure 3), inguinoscrotal hydrocele, and abdominoscrotal hydrocele. Ultrasound examination of the inguinal canal is important to evaluate whether the hydrocele is communicating or

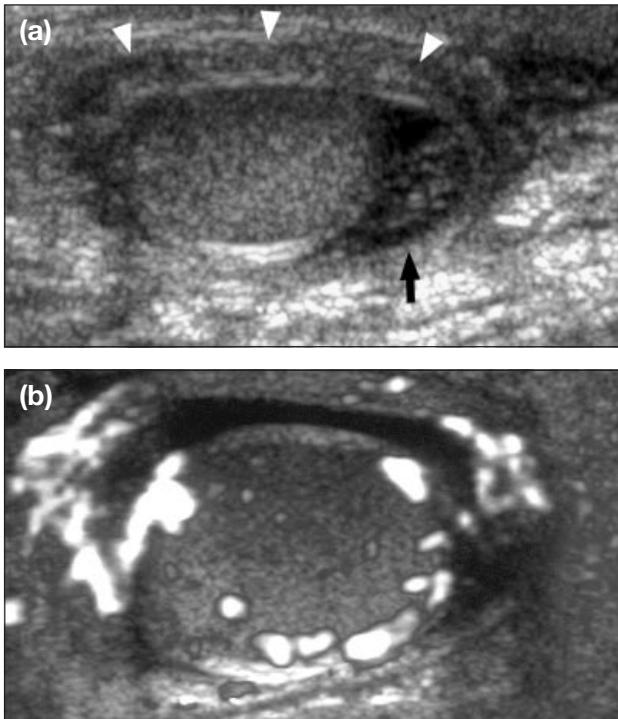


Figure 5. Epididymitis complicated by pyocele in a 5-year-old boy with a history of pain, swelling, and redness for a few days. (a) Longitudinal sonogram shows diffusely thickened tunica vaginalis (arrowheads), and an associated pyocele with multiple internal septations and debris (arrow) — surgery confirmed pus collection within the scrotum; and (b) colour flow Doppler image (grey scale representation) demonstrates pronounced hyperaemia of the epididymis, indicative of acute inflammation.

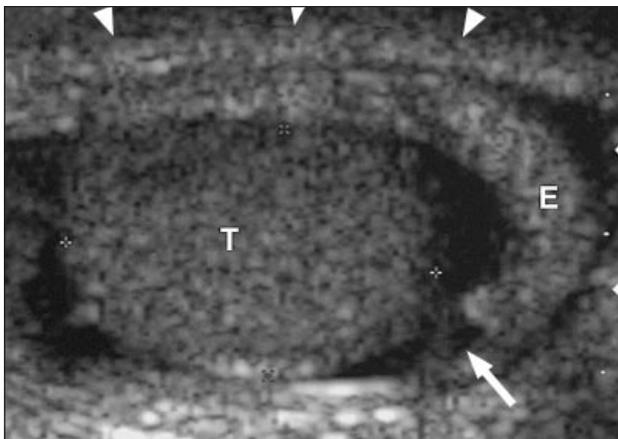


Figure 6. Haematocoele due to scrotal injury 4 days previously in a 9-year-old boy. Longitudinal sonogram shows anechoic collection with internal debris (arrow) surrounding the testis. The scrotal wall (arrowheads) and the tunica vaginalis (E) are thickened, whereas the underlying testis (T, surrounded by crosses) looks normal. One month later, the follow-up sonogram showed complete resolution of the haematocoele.

non-communicating. Treatment is not usually necessary for a non-communicating hydrocele. Sometimes, septations may be found within a hydrocele, which is suggestive of early loculation (Figure 4). In some of these

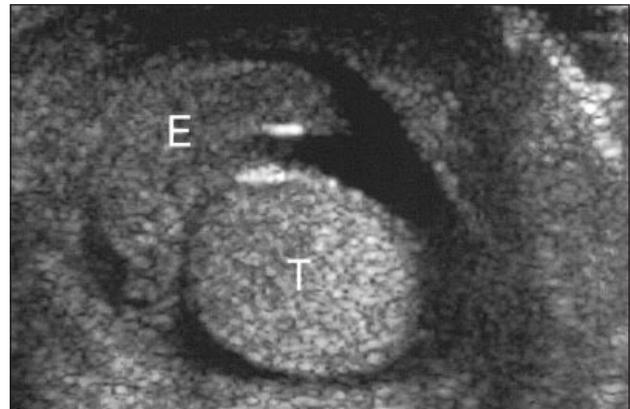


Figure 7. Haematocoele in a 7-year-old boy with a history of haemophilia but no history of trauma or infection. Transverse sonogram shows a moderate amount of blood surrounding the testis (T) and epididymis (E). No internal echo is present because of the underlying coagulopathy. There is also significant scrotal wall oedematous change.

hydroceles, the fluid is infected, and the collection is then termed a pyocele (Figure 5).

Haematocoele

Haematocoele is a complex extratesticular fluid collection between the layers of the tunica vaginalis. Haematocoele can be caused by scrotal injury (Figure 6) or haemorrhage extending from the peritoneal cavity via the patent processus vaginalis. Haematocoele due to haemophilia is rare (Figure 7). In neonates or infants presenting with a sudden-onset haematocoele, adrenal haemorrhage should be considered (Figure 8).⁵

Varicocele

Varicocele is composed of dilated veins of the pampiniform plexus. Bilateral varicoceles are more common than unilateral disease. However, when a varicocele is unilateral, 99% occur on the left side because the left spermatic vein enters the renal vein at a right angle.^{4,6,7} Isolated right-sided varicocele is rare and its occurrence mandates the exclusion of an intra-abdominal neoplasm or mass in the retroperitoneum. Ultrasound typically shows dilated veins with tortuous tubular echo-free structures, with a ‘bag of worms’ appearance (Figure 9a). Colour flow Doppler examination can confirm the vascular nature of these structures with a positive Valsalva manoeuvre test (Figure 9b). There is a strongly significant correlation of varicosity with infertility in adults.

Spermatocele and Epididymal Cyst

Cystic masses can occur at any portion of the epididymis. When a cyst is small, it is termed an epididymal cyst (Figure 10a) and, when the cyst is large, it is known as

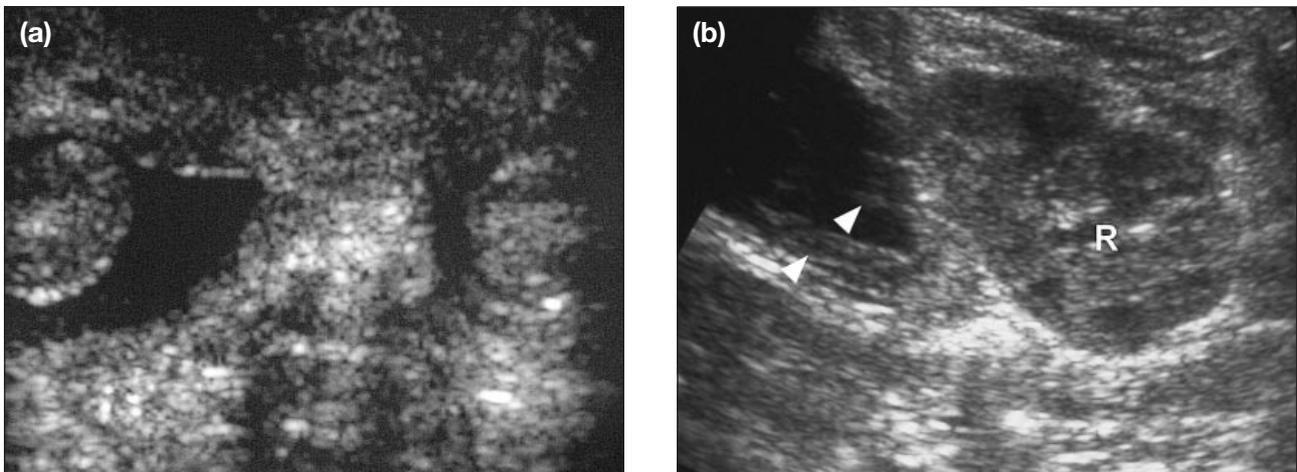


Figure 8. A 2-day-old neonate presented with a right haematocele secondary to adrenal haemorrhage. (a) Midline transverse sonogram of the scrotum shows a hydrocele within the right scrotum; and (b) upper abdominal sonogram shows a heterogeneous cystic mass at the right adrenal bed, associated with multiple internal septations (arrowheads), and displacing the right kidney (R) inferiorly — the findings are compatible with spontaneous adrenal haemorrhage.

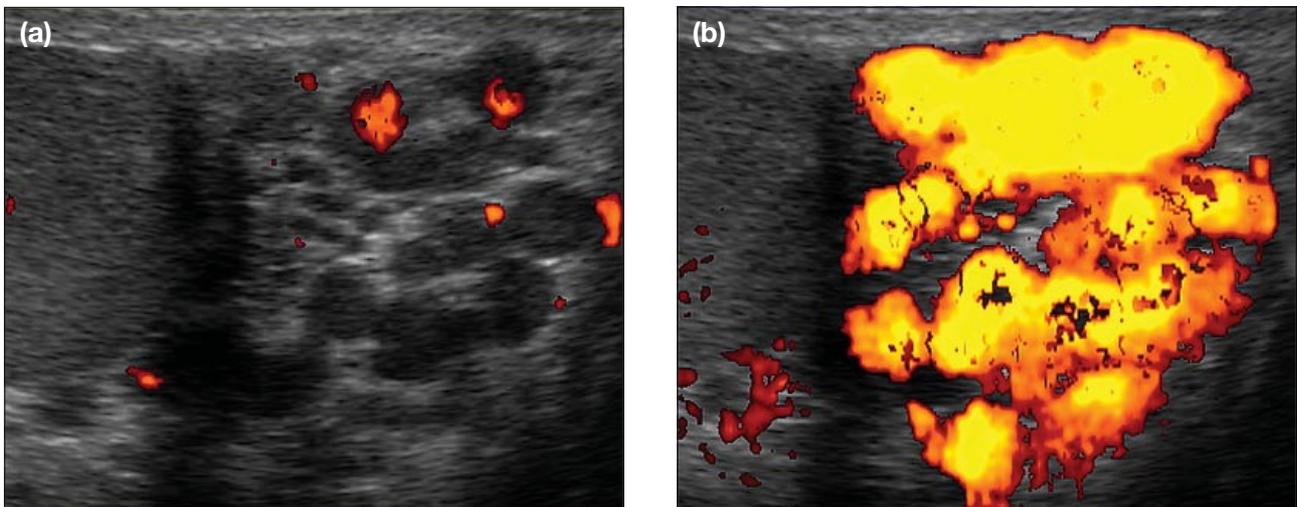


Figure 9. Varicocele in an 8-year-old boy presenting with left scrotal pain. (a) Ultrasonogram shows dilated serpiginous structures ('bag of worms') present in the tail region of the epididymis; and (b) colour flow Doppler image shows positive valsalva manoeuvre with increased vascularity within the dilated venous plexus.

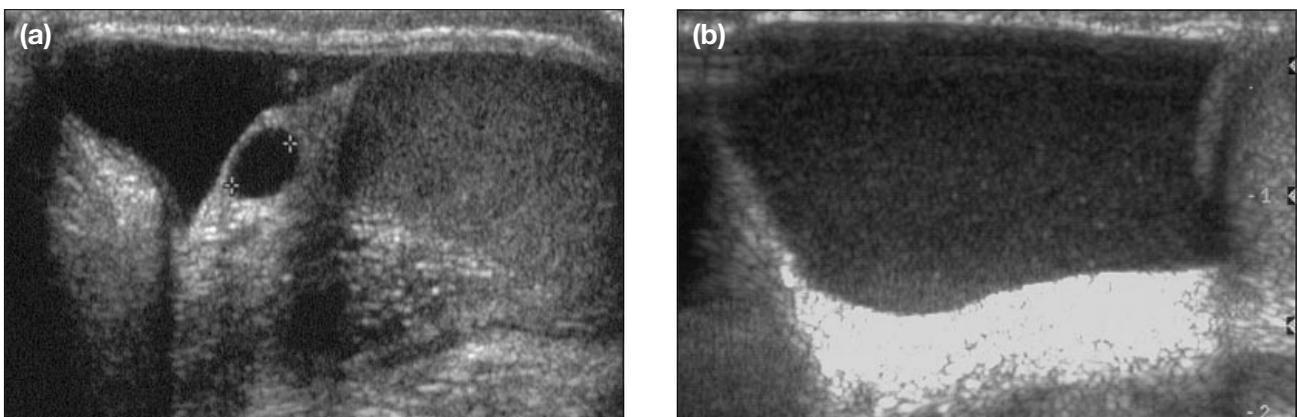


Figure 10. Patients presenting with right scrotal swelling. (a) An 8-year-old boy with an epididymal cyst — a simple well-defined cyst with typical acoustic enhancement is present at the head of the epididymis, and no solid components or internal septations are present; and (b) a 14-year-old boy with a spermatocele — a large well-defined loculated cystic mass with low-level echo is present in the head of epididymis, and no internal septations or solid components are present.

a spermatocele (Figure 10b). The cysts originate from the dilated efferent ductules of the testes and are filled with seminal plasma.^{1,7}

ACUTE SCROTUM

Acute painful scrotal swelling is commonly due to testicular torsion, torsion of a testicular appendage, infection, acute hydrocele, abscess, or neoplasm.

Testicular Torsion

Testicular torsion is caused by an abnormal twist of the spermatic cord and usually occurs in adolescents aged



Figure 11. Missed torsion in a 4-year-old boy presenting with acute scrotal pain for the previous 2 days. Colour flow Doppler image shows an enlarged left testis with an inhomogeneous but predominantly hypoechoic appearance. Echogenic areas (arrows) within the testis correspond to the areas of haemorrhage. There is also a hydrocele (arrowheads) and tunica vaginalis thickening. Blood flow is absent in the testis but reactive hyperaemia is present in the tunica vaginalis. Overall features are compatible with a missed torsion.

between 11 and 18 years. The normal testis is anchored and fixed posterolaterally in the scrotal sac. If these attachments fail to develop properly, the testis may rotate and undergo torsion, which is called ‘bell-clapper’ deformity. Torsion must be diagnosed rapidly since testicular salvage depends on immediate surgical detorsion.⁸ If the torsion is not diagnosed, orchidectomy may have to be performed (Figure 11). Sonographic appearances are variable.⁹⁻¹⁴

Torsion of Testicular and Epididymal Appendages

Torsion of testicular and epididymal appendages typically occur in the 6 to 12 years age group. The clinical picture can mimic that of complete torsion. Ultrasound is helpful to exclude testicular torsion. Ultrasound typically shows a nodule between the head of the epididymis and the testis, with a swollen appearance and of variable echogenicity. Secondary reactive inflammatory changes usually occur. The absence of vascularity in the appendage may help to establish the diagnosis (Figure 12).^{12,15-17} Only conservative treatment is required for this condition.

Epididymitis and Epididymo-orchitis

Epididymitis is the most common cause of acute scrotum in postpubertal men but is rare in prepubertal boys.¹⁸ Epididymitis usually results from infection via the ascending route (urinary tract infection, congenital anomalies) or by hematogenous spread.¹³ Epididymitis is usually caused by bacterial rather than viral infection (e.g., mumps).

Sonography typically shows an enlarged hypervascular hypoechoic epididymis with scrotal skin thickening and a reactive hydrocele (Figure 13).^{1,9,19} The testis is usually normal, but 20% of cases are complicated by

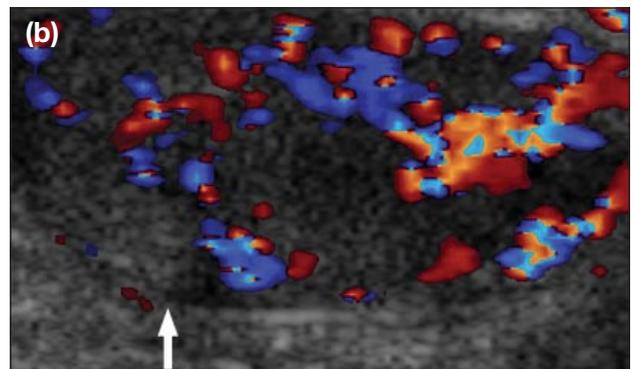
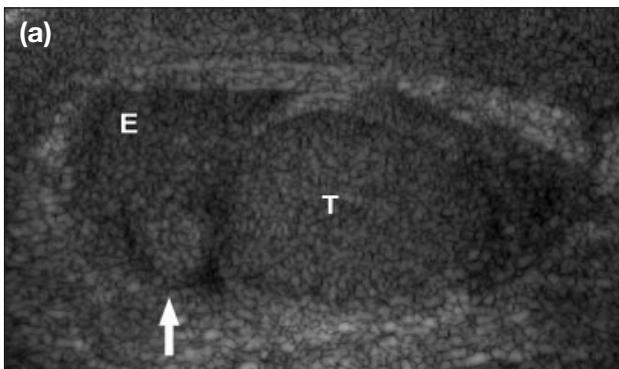


Figure 12. Torsion of the testicular appendage in a 13-year-old boy. (a) Transverse sonogram shows a swollen appendage (arrow) with a small amount of hydrocele (testis [T] and epididymis [E]); and (b) colour flow Doppler image shows marked inflammatory changes in the head of the epididymis and testis — no vascularity is present within the prominent appendage (arrow).

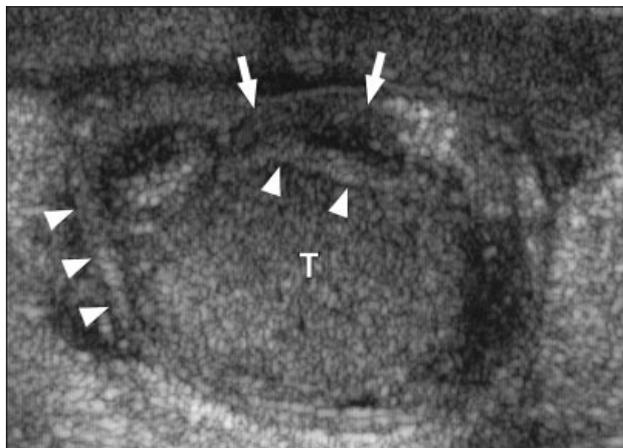


Figure 13. Acute epididymo-orchitis in a 7-year-old boy. Longitudinal sonogram shows markedly thickened epididymis (arrows) and tunica vaginalis (arrowheads). The testis (T) is also swollen, compatible with inflammation.

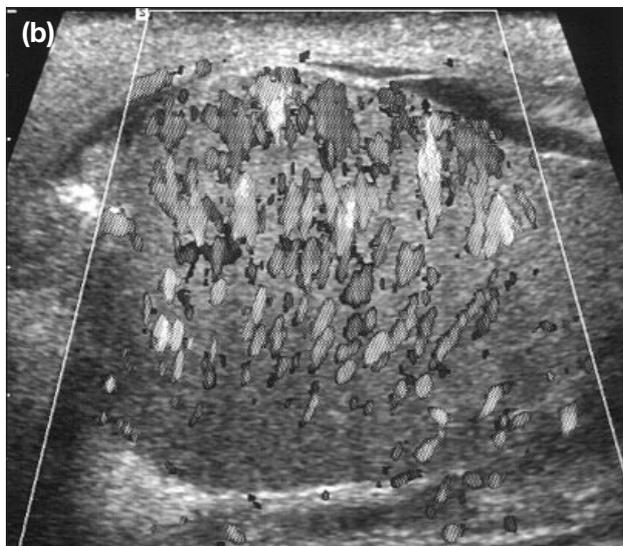


Figure 14. Acute orchitis in a 5-year-old boy presenting with right scrotal pain. (a) Ultrasonogram shows marked enlargement of the right testis (R) with hypoechoic appearance, and thickening of the scrotal wall (white arrow); and (b) colour flow Doppler image (grey scale representation) demonstrates hypervascularity within the enlarged testis.

orchitis.^{13,18} Primary orchitis is usually of viral origin (Figure 14).¹⁸ Complications of epididymitis include abscess, pyocele, and focal infarct.²⁰

Scrotal Injury

The scrotum is prone to direct trauma due to its position external to the body. In the presence of a testicular or epididymal haematoma, ultrasound shows a heterogeneous mass, which can be hyper- or hypoechoic.²¹ A discrete fracture line is seen in only 20% of all patients with testicular rupture (Figure 15).⁸ Complications can include atrophy of the testis.

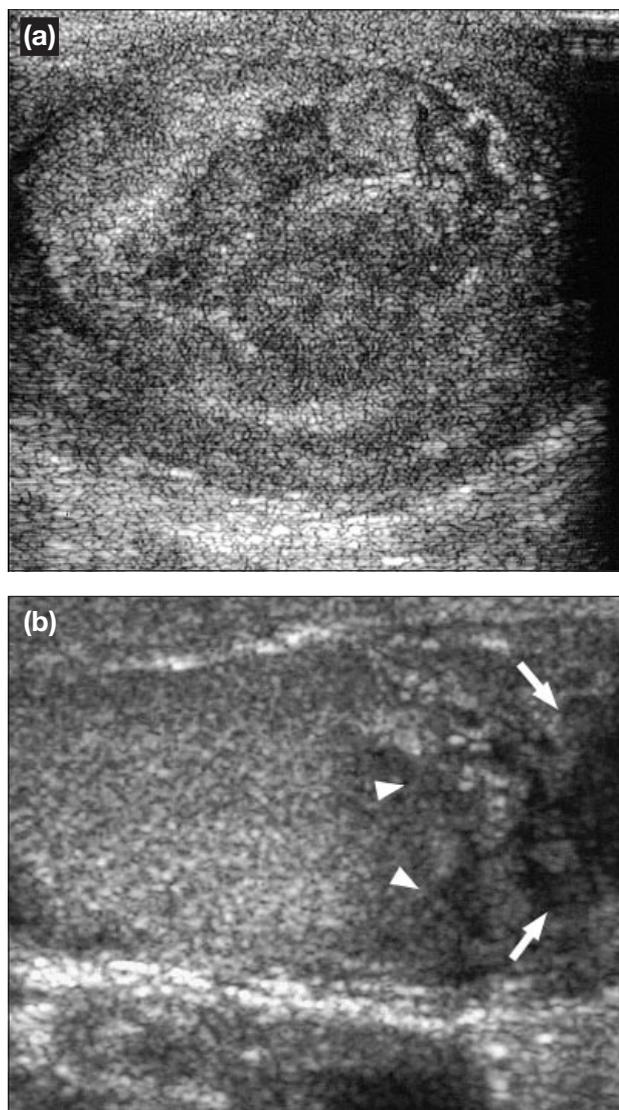


Figure 15. A 16-year-old boy presenting with acute scrotal injury after a direct blow from a kick by a classmate. (a) Transverse sonogram at the inferior aspect of the scrotum shows a large haematoma related to a ruptured epididymal tail — the haematoma is typically heterogeneous with hyper- and hypoechoogenicity; and (b) longitudinal sonogram shows a ruptured epididymal tail (arrows) mixed with haematoma, together with irregular border of the inferior pole of the testis (arrowheads), suggestive of a ruptured testis.



Figure 16. Hernia in a 2-month-old boy presenting with right scrotal swelling. Sonogram shows the tubular structure with the bowel wall and contents. Real time scanning shows peristalsis of the bowel (testis [S]).

Hernia

A patent processus vaginalis may result in hydrocele or even inguinal hernia, in which either mesentery or bowel content is present (Figure 16).^{3,7}

TESTICULAR AND PARATESTICULAR NEOPLASMS

Testicular neoplasms are uncommon and account for only 1% of all childhood malignancies. The peak incidence occurs at the age of 2 years. Primary testicular tumours are usually germ cell tumours (yolk sac carcinoma, teratoma, or seminoma) and are rarely gonadal stromal tumours or tumours of supporting tissues (e.g., fibroma).

Germ Cell Tumours

Yolk sac tumour is the most common germ cell tumour. Mixed tumours (teratocarcinoma) are more common than pure embryonal cell carcinoma. Mixed tumours can be aggressive and invade the tunica albuginea. Haemorrhage frequently occurs. Epidermoid cyst is a benign tumour of germ cell origin but is a rare occurrence.²²

Testicular teratoma occurs in 10% of childhood germ cell tumours.²² Three variants are described pathologically: mature differentiated (solid) teratoma (Figure 17a), benign cystic teratoma (dermoid; Figure 17b), and embryonic (undifferentiated) solid teratoma (Figure 18).^{3,4,6}

Solid teratoma may be benign but is more usually malignant. However, embryonic solid teratomas are usually malignant. Choriocarcinoma and seminoma are extremely rare testicular tumours in children.

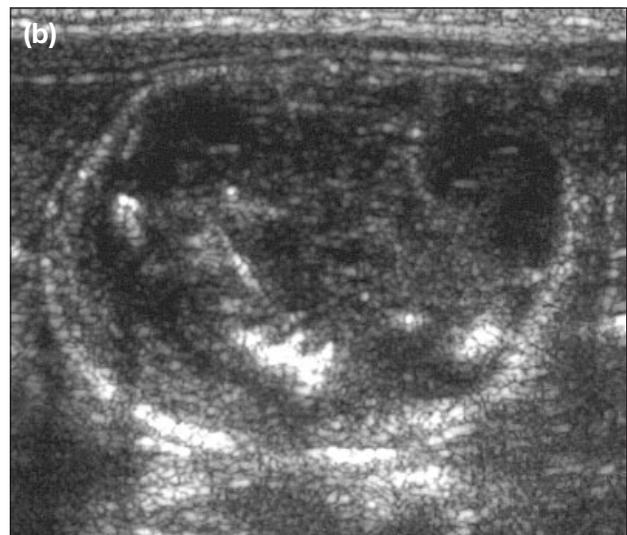
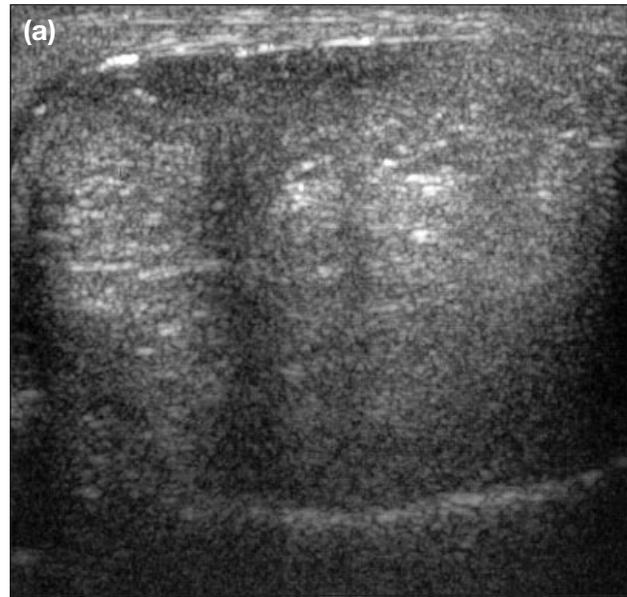


Figure 17. Patients with teratoma. (a) A 2-year-old boy presented with a mature teratoma — longitudinal sonographic image shows that the testis is completely replaced by a tumour with heterogeneous echogenicity, there is significant posterior acoustic shadow indicative of fat attenuation, no calcification or cystic components are noted, the epididymis is compressed and displaced peripherally but not invaded (arrow), and pathology confirmed a well-encapsulated mature teratoma with mature skin and skin appendages together with underlying mature adipose tissue; and (b) a 3-year-old boy presented with a mature teratoma — transverse sonographic image shows a mixed cystic and solid mass with calcifications in the scrotum compatible with mature teratoma.

Non-germ Cell Tumours

Non-germ cell tumours are usually benign lesions and represent 25% of paediatric testicular tumours. Leydig cell tumours and Sertoli granulosa cell tumours are the most common non-germ cell tumours. The sonographic appearance is not specific.^{23,24} Extratesticular tumour and metastasis are extremely rare.

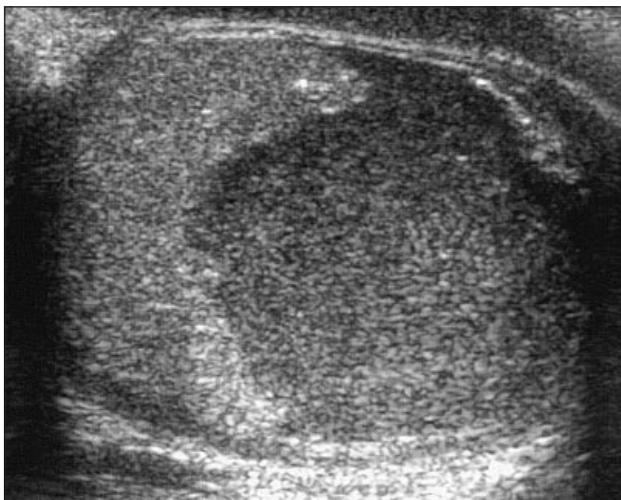


Figure 18. Yolk sac tumour in a 3-year-old boy presenting with right scrotal swelling after orchitis a few weeks previously. Longitudinal sonogram shows a heterogeneous tumour mass in the right scrotum replacing a large portion of the testis. More echogenic component was present in the periphery of the tumour mass. Pathology confirmed a pure yolk sac tumour.

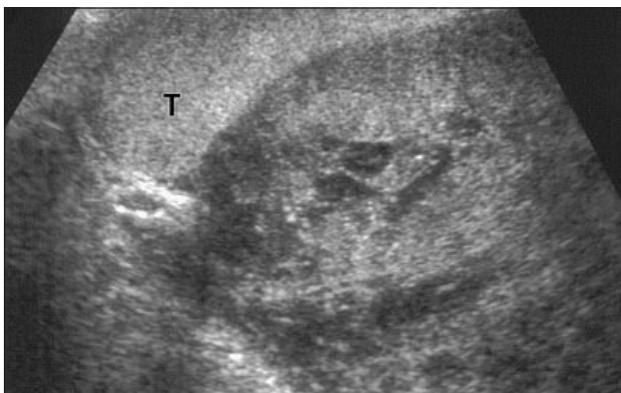


Figure 19. Rhabdomyosarcoma of the right epididymis in a 15-year-old boy presenting with a scrotal mass. Longitudinal sonogram shows a large tumour mass within the right scrotum compressing on and displacing the testis (T) with no obvious invasion. The tumour mass is heterogeneous in echotexture without calcification. Intralesional septations are present.

The most common malignant paratesticular mass is rhabdomyosarcoma (Figure 19).^{4,24} Ultrasound usually shows a predominantly echogenic mass at the head of the epididymis, with or without necrosis.

Leukaemia is the most common secondary testicular neoplasm in children.²² The testis may be diffusely involved (Figure 20) or only a focal deposit of tumour may be present.^{3,6}

MISCELLANEOUS CONDITIONS

Testicular Microlithiasis

Microlithiasis are the calcifications within the lumina of the seminiferous tubules (Figure 21).²⁵ Ultrasound

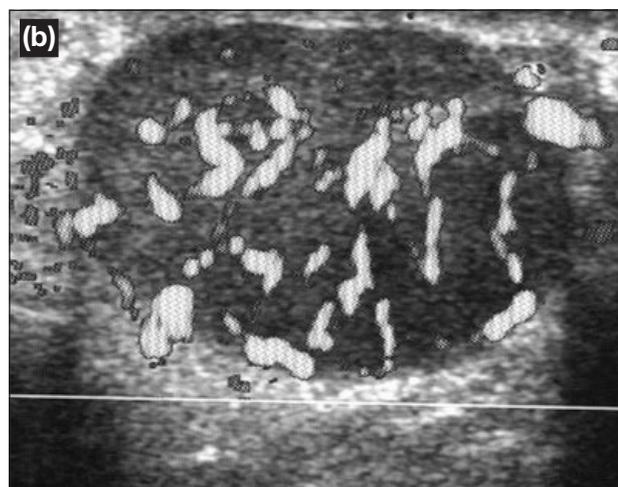
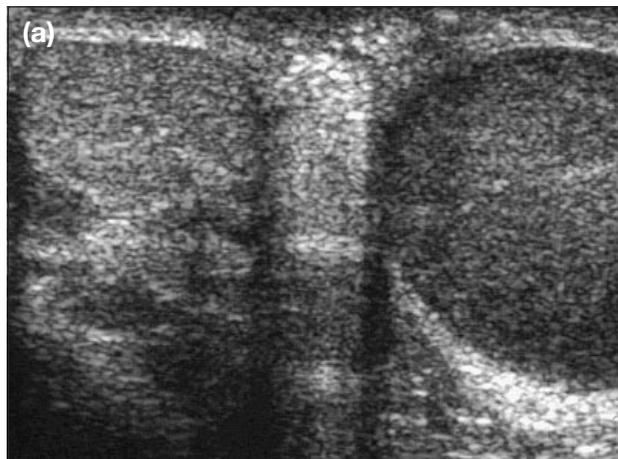


Figure 20. Leukaemic metastasis to the left testis in a 14-year-old boy with a history of acute lymphoblastic leukaemia presenting with left scrotal swelling. (a) Midline transverse sonogram shows an enlarged left testis when compared with the right side; and (b) colour flow Doppler image (grey scale) shows a diffusely enlarged hypoechoic left testis with markedly increased vascularity.

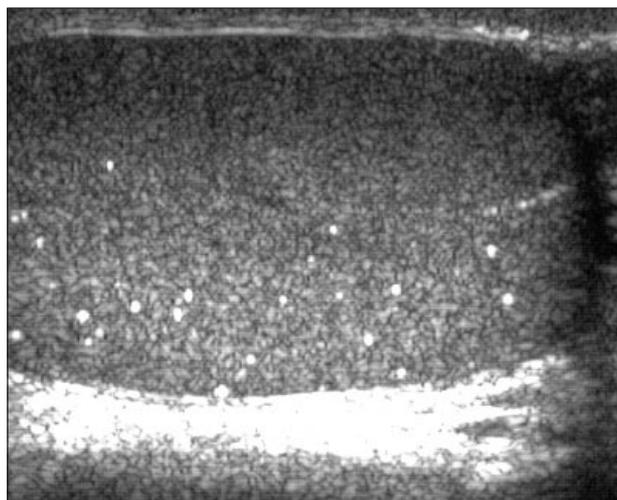


Figure 21. Microlithiasis of the right testis in a 3-year-old boy presenting with a right scrotal swelling diagnosed as a spermatocele. Incidental findings of multiple echogenic foci diffusely present in the testis and compatible with microlithiasis.

shows typical echogenic foci with or without acoustic shadowing. There is association with testicular neoplasm, particularly germ cell tumours.²⁶ The aetiology is uncertain.

CONCLUSION

Scrotal sonography provides an accurate, non-invasive, and rapid technique for paediatric imaging. The interactive real-time capability enables accurate correlation with clinical symptoms and signs, and provision of an extension of the clinical examination. With the use of high-resolution transducers, the majority of scrotal diseases in childhood can be identified.

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