
PICTORIAL ESSAY

Sonographic Features and Diagnostic Algorithm of Common Scrotal Masses in Children: with Pathological Correlations

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ABSTRACT

This pictorial review aimed to present the sonographic appearances of common scrotal masses in children, supplemented with pathological findings in operative cases. This review also provides a diagnostic algorithm to summarise the imaging features of common testicular and paratesticular mass lesions classified into painful and non-painful scrotal masses according to the clinical presentation.

Key Words: Child; Scrotum; Testicular neoplasms; Ultrasonography, Doppler, Color

中文摘要

兒童常見陰囊腫塊的聲像圖特徵和診斷算法：與病理學的相關性

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本圖文回顧旨在討論兒童常見陰囊腫塊的超聲表現，並複習手術病例的病理結果。此外，根據患者的臨床表現把常見的睪丸和睪丸旁腫塊分為有痛和無痛的陰囊腫塊，提出一套診斷處理規則來總結其超聲特徵。

INTRODUCTION

Ultrasound is the first-line imaging modality for assessment of paediatric patients presenting with scrotal masses. It is widely available to provide rapid and timely assessment without imposing a risk of radiation. This pictorial essay is based on our institutional experience with imaging of children referred to a tertiary paediatric surgical centre. In all ultrasound studies, high-frequency (12 MHz) linear array transducers with sector format are used to increase the field of view, which allows good comparison of the testes, scrotal skin, and tunica.¹ This

article provides a comprehensive and illustrative review of the sonographic appearances of common scrotal masses in children, with pathological correlation in certain cases. We propose a simple diagnostic algorithm based on clinical presentation and sonographic features to arrive at the most likely diagnosis in children presenting with scrotal masses.

PAINFUL SCROTAL MASSES

Under this category, patients present with acute scrotal pain. The common causes of acute painful scrotal

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masses include trauma, ischaemia, or infection. In general, painful testicular lesions are either cystic or mixed solid and cystic on ultrasound appearance, while painful paratesticular masses are predominantly solid.

Painful Testicular Masses

Testicular Laceration

The scrotum is prone to injury due to its position external to the body,¹ which is usually associated with a history of recent direct trauma. Sonographic features include focal areas of altered echogenicity, corresponding to areas of haemorrhage or infarction, and haematocoele formation in 33% of patients.² A discrete fracture is seen in only 20% of all patients, but should be suspected when the margins of the testis are poorly defined or disruption of capsular blood flow is observed.³ The tunica albuginea needs to be evaluated sonographically for integrity as patients with intrascrotal haematoma alone usually do not need surgical exploration. For patients with large intrascrotal haematomas or haematocoeles surrounded by complex fluid, surgical exploration may be inevitable as it would be difficult to exclude rupture sonographically (Figure 1).²

Testicular Torsion

Testicular torsion occurs when there is spontaneous or traumatic twisting of testis and spermatic cord within the scrotum, resulting in vascular occlusion or infarction. The torsion knot can be within or outside the tunica vaginalis.⁴ Sonographic appearance is variable,

depending on the duration of torsion and time of presentation. The degree of compromised vascular flow or diminished Doppler signal depends on the severity of torsion. For partial or incomplete testicular torsion, the intra-testicular blood flow may still be present, but diminished when compared with that of its contralateral counterpart. Gangrene may be present in cases with extreme cystic change and delayed presentation.⁵ The testis is usually beyond salvage intraoperatively if it appears cystic (Figure 2). Testicular torsion should, therefore, be actively looked for by frontline clinicians, especially when examining very small children who cannot verbally express clinical symptoms.

Orchitis

Orchitis follows in 20% to 40% of cases with epididymitis due to direct spread of infection. Sonographically, this condition is characterised by an enlarged testis with heterogeneous echogenicity and hypoechoic septae, confined within a rigid tunica albuginea. In focal orchitis, hypoechoic areas can be seen adjacent to the enlarged and inflamed epididymis, while in diffuse orchitis, the entire testis becomes enlarged with thickening of tunica albuginea. Severe cases may result in testicular infarction, with sonographic features indistinguishable from those of testicular torsion.⁶

Painful Paratesticular Masses

Spermatic Cord Haematoma

This condition is most often related to blunt trauma,

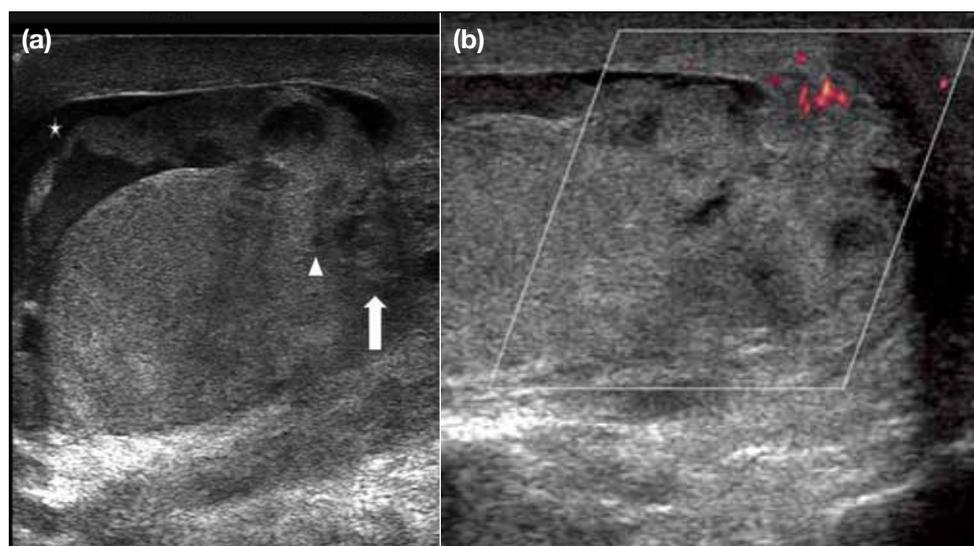


Figure 1. Testicular laceration in a 16-year-old boy after assault. (a) A longitudinal sonographic image shows an irregularly heterogeneous mass lesion in the left lower scrotum (arrow), involving the left epididymal tail and obscuring the lower border of the left testis. A 5-mm hypoechoic line (arrowhead) is noted in the lower pole of the testis, representing a small laceration. Moderate amount of left haematocoele is seen (*). (b) Power Doppler ultrasound image shows this mass is avascular.



Figure 2. Gangrenous testicular torsion with cystic change in a 4-month-old boy who presented with a painful scrotal mass for 2 days. (a) A transverse sonographic image shows a 3-cm anechoic and avascular cystic collection in the left scrotum, replacing the normal left testis. (b) Laparoscopic inguinal orchidectomy confirms intravaginal torsion of the left testis with complete gangrenous change, with a cystic structure replacing the normal testis. (c) The histology of benign testicular cyst. The cyst is lined by a single layer of attenuated bland-looking epithelial cells and contains loose oedematous stroma (H&E; original magnification, x 100).

where the history gives the best clue for diagnosis. Spontaneous idiopathic haematomas have been reported, mostly in young adults after physically stressful exercise. Possible causes include spontaneous spermatic vein rupture or tear of the cremasteric muscle.⁷ Sonographically, it presents as a paratesticular mass with heterogeneous echogenicity (Figure 3), indistinguishable from a paratesticular tumour. Doppler study may show perilesional vascularity with an avascular centre that represents haemorrhage. Coexisting testicular injury should be actively looked for; in particular, the integrity of the tunica albuginea should be assessed to look for testicular rupture. The injury may be managed conservatively if the tunica albuginea appears intact on ultrasound images. Immediate exploration is warranted if the tunica appears indistinct, or when the ultrasound images are equivocal but there is a high suspicion of testicular rupture. As a rule of thumb, for sonographically equivocal cases, the method of management will be determined on the basis of clinical findings, history, and level of suspicion.⁸

Torsion of Testicular Appendage

As the commonest cause of acute scrotum in prepubertal boys, this condition most frequently presents with spontaneous twisting of the left appendix testis. When a nodule with bluish discoloration in the upper scrotum is palpated, ultrasound examination is not necessary (the

pathognomonic ‘blue dot sign’). Ultrasound is reserved for clinically inconclusive cases to exclude testicular torsion.¹ Sonographically, the twisted appendage appears as a round extra-testicular mass of variable echogenicity seen between the head of the epididymis and the testis (Figure 4). Secondary inflammatory changes usually occur, including an enlarged epididymal head, reactive hydrocoele, and scrotal skin swelling. The epididymis and scrotal tunics may be hypervascular, while no blood flow can be detected in the twisted appendage. Within days, the twisted appendix calcifies and becomes detached, leaving a scrotal calcification known as scrotolith.^{1,3}

Epididymitis

As the most common cause of acute scrotal pain in sexually active young adults, epididymitis is 9 times more common than testicular torsion in patients older than 20 years of age.⁶ It is usually caused by haematogenous seeding of bacteria associated with genitourinary tract infection, for example, *Escherichia coli* and other Gram-negative bacilli. *Staphylococcus aureus*, tuberculosis, and mumps are other possible causes.⁶ Sonographically, the epididymis is enlarged, hypoechoic, and hypervascular with scrotal skin swelling and a reactive hydrocoele. The epididymal head is most commonly affected, but occasionally the entire gland can be involved. Approximately 20% of

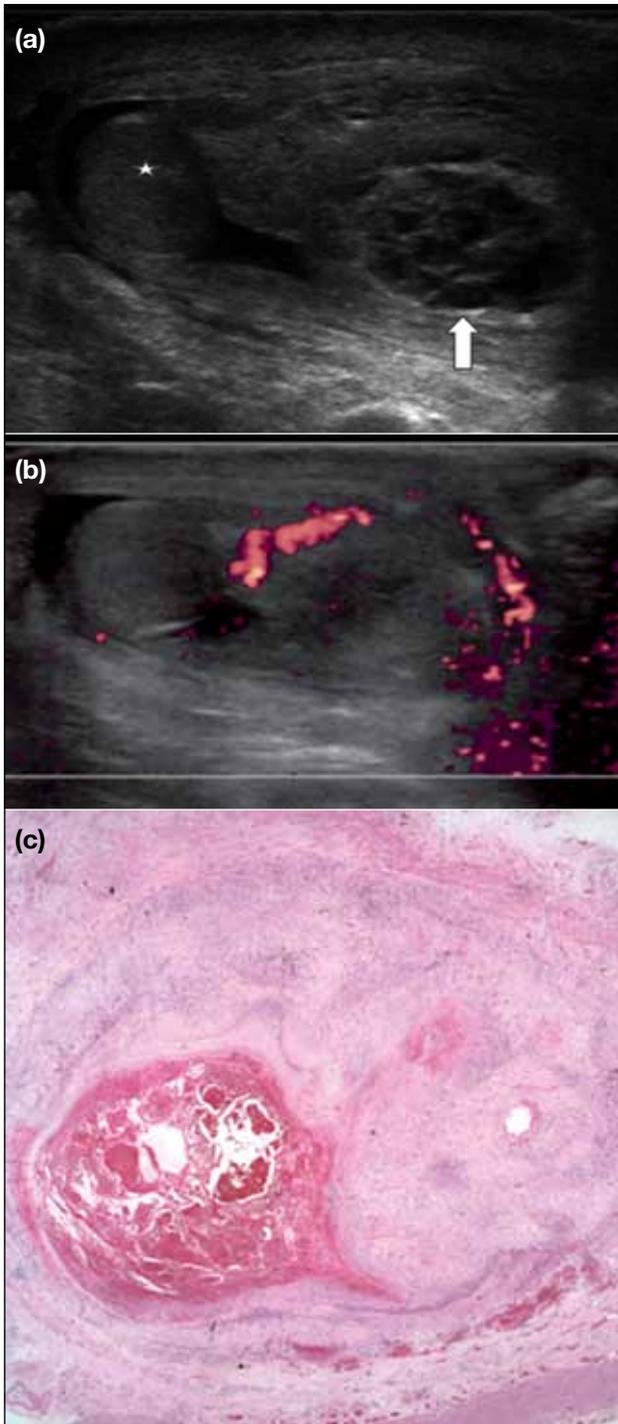


Figure 3. An organised haematoma of the spermatic cord in a 2-year-old boy. (a) A longitudinal, grey-scale image shows a tender, heterogeneously hypoechoic, left paratesticular mass (arrow) displacing the normal left testis (*). (b) Power Doppler scan shows significant perilesional vascularity, and the hypovascular centre may represent haemorrhage. Left inguinal orchidectomy is performed, with the gross specimen mimicking a paratesticular tumour. (c) The left spermatic cord contains a large organised haematoma (H&E; original magnification, x 40).

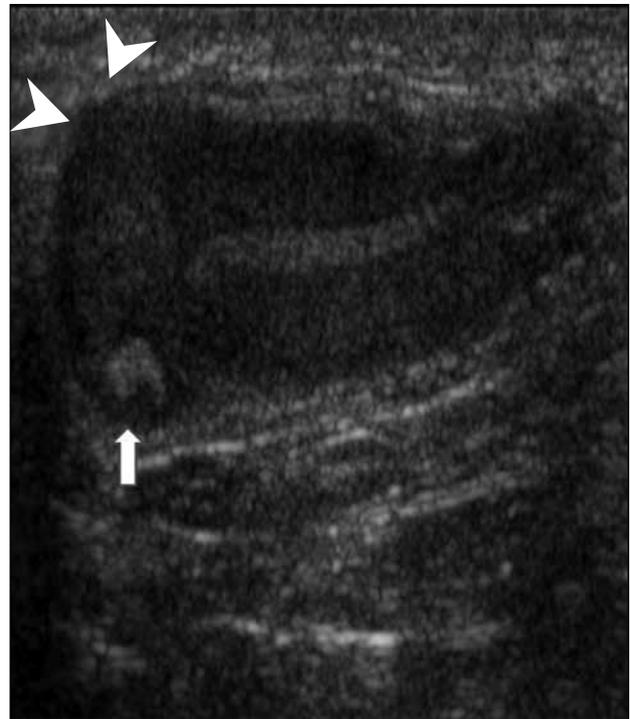


Figure 4. A 12-year-old boy with torsion of testicular appendage. Longitudinal sonographic image shows a swollen left epididymal head (arrowheads) when compared with its right counterpart. A small calcific focus in the left epididymal head (arrow), may represent a scrotolith. The patient was treated conservatively.

cases are complicated by orchitis. Increased Doppler signal is seen within the epididymis or the testis (Figure 5). Complications include abscess, pyocele, and focal testicular infarct.^{1,3}

PAINLESS SCROTAL MASSES

In general, a painless scrotal swelling is the most common manifestation of scrotal tumours, with an estimated prevalence of 0.5 to 2.0 cases per 100,000 boys.⁹ Ultrasound is nearly 100% sensitive for identifying scrotal masses, and allows differentiation between cystic and solid tumours and localisation as intra- or extra-testicular masses.³ Tumour markers (alpha fetoprotein and beta human chorionic gonadotropin) are routinely checked in all patients with suspected scrotal tumours. According to our institutional experience, only one out of five histologically proven tumours has elevated markers. These marker-positive tumours include immature teratoma and yolk sac tumour. All mature teratomas of the testis and paratesticular tumours

are not associated with elevated markers. It should be noted that serum alpha fetoprotein level can be physiologically elevated in the newborn.

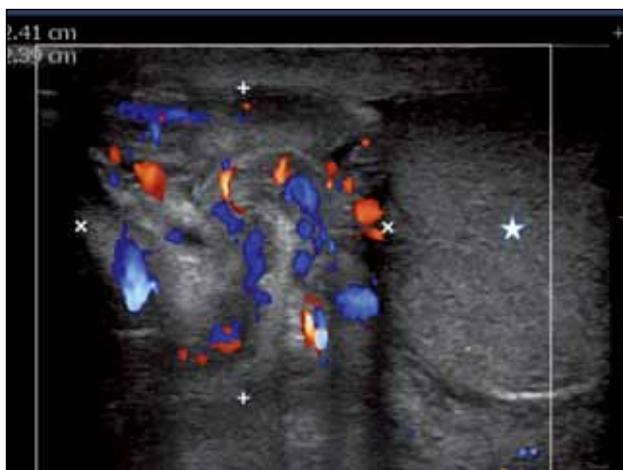


Figure 5. An adolescent male with epididymitis. Transverse sonographic scan of the right scrotum shows a swollen right epididymis with increased vascularity (crosses). The adjacent right testis is normal (*). No hydrocoele is seen. Patient's urethral swab was positive for *Chlamydia*. He was then treated with a course of antibiotics.

Painless Testicular Masses

Testicular neoplasms account for 1% of all paediatric solid tumours.¹⁰ There are two peaks of incidence: before 3 years of age and in the postpubertal period.³ They are either of germ-cell or non-germ-cell origin; germ cell tumours can be further divided into seminomatous and non-seminomatous types.

Seminoma

This is the commonest pure germ-cell tumour, where the histological feature is uniform cellular morphology resembling primitive germ cells. Seminomas are usually confined within the tunica albuginea at presentation, and only 25% have metastases at the time of diagnosis. Rarely occurring before puberty, seminomas are less aggressive than other testicular tumours, and have the most favourable prognosis among all malignant testicular tumours. Sonographically, seminomas are homogeneous solid tumours of variable sizes from a small nodule in a normal-sized testis to a large mass causing diffuse testicular enlargement. They often appear hypoechoic compared with the normal testicular parenchyma. Uniform, low-level internal echoes are common, and there is no calcification. With high-resolution probes, some seminomas may have a more

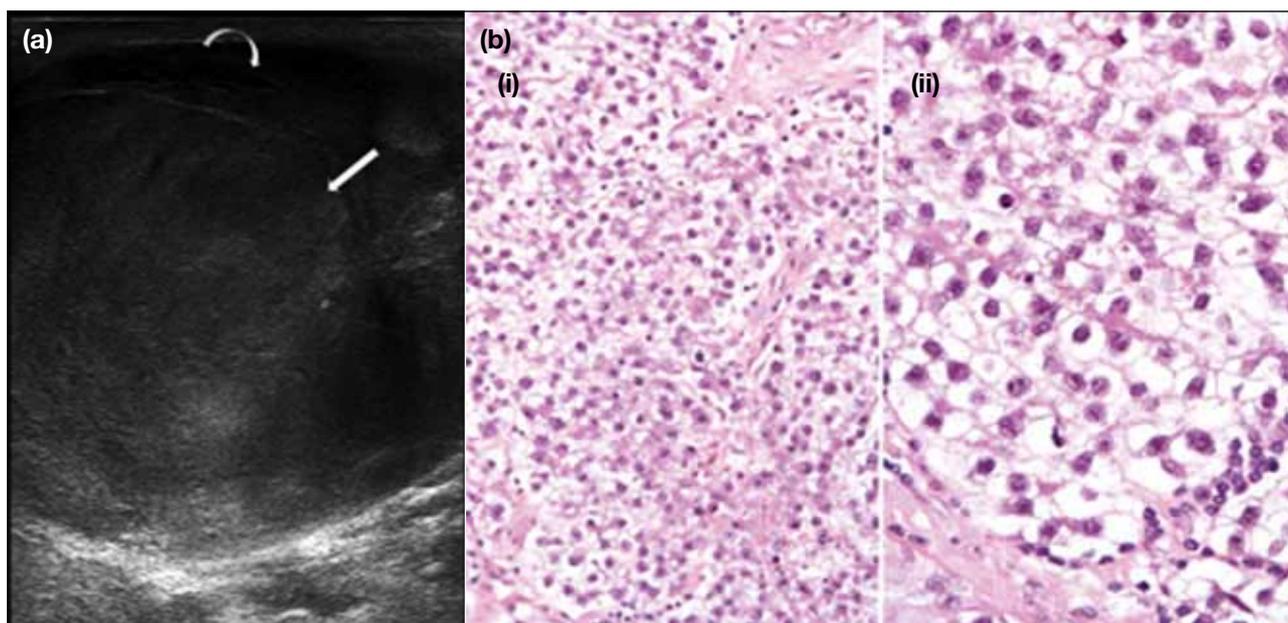


Figure 6. Testicular seminoma in a 17-year-old boy. (a) Longitudinal sonography of the left testis shows a large lobulated heterogeneous mass (arrow) replacing most of the left testis, leaving only a thin rim of normal parenchyma. The epididymis is spared (curved arrow). The scrotal skin is mildly thickened. Doppler ultrasonography (not shown) shows moderate intralesional vascularity. (b) Histology of the testicular seminoma. The tumour is composed of clusters of tumour cells separated by delicate fibrous septae and infiltrated by scattered small lymphocytes. The tumour cells exhibit enlarged nuclei, prominent nucleoli, well-demarcated cell border, and large amount of clear cytoplasm (H&E; original magnification, [i] x 100, [ii] x 400).

heterogeneous echotexture (Figure 6). Necrosis and cystic changes are rare.² Note that sonography is often used for screening of occult seminoma in both testes after orchidopexy as the risk of developing a seminoma is substantially increased in an undescended testis even after orchidopexy. The risk is also increased in the contralateral, normally located testis.²

Non-seminomatous Germ-cell Tumours

These include yolk sac tumours (most common; Figures 7 and 8), teratomas (second most common; Figures 9 to 11), embryonal carcinoma, choriocarcinoma, and mixed germ-cell tumours.³ Non-seminomatous germ-cell tumours (NSGCTs) occur more often in younger patients within the first decade and behave

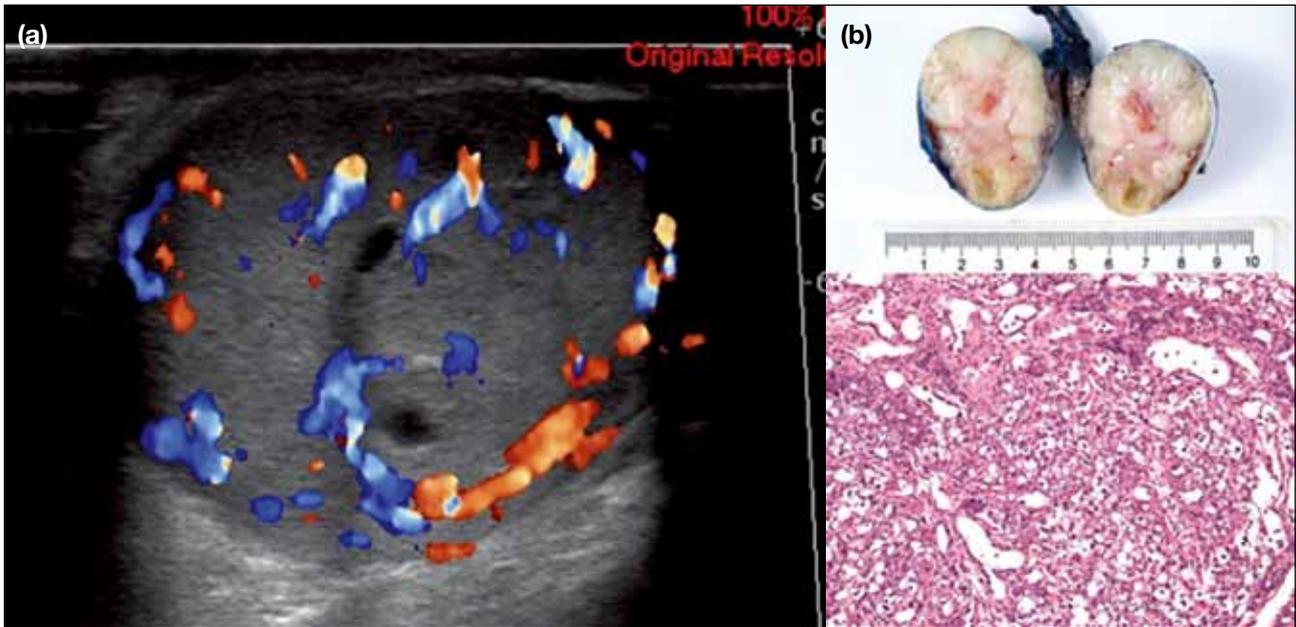


Figure 7. Yolk sac tumour in a 6-month-old boy. (a) Longitudinal sonography shows a diffusely enlarged left testis with multiple small internal cystic spaces (compatible with tumour necrosis) and increased intrinsic vascular channels. Serum alpha fetoprotein level was >38,000 IU/L. (b) Gross specimen and histology of the yolk sac tumour. The tumour cells are arranged in a reticular pattern and exhibit enlarged nuclei, prominent nucleoli, and pale-to-clear cytoplasm (H&E; original magnification, x 100).

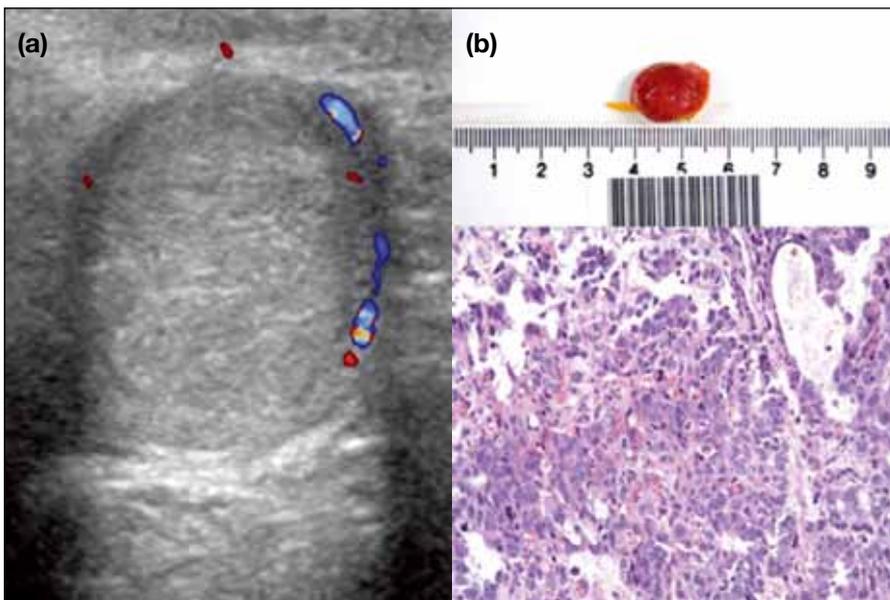


Figure 8. Atypical appearance of a yolk sac tumour in a 16-month-old boy. (a) Transverse sonography shows a heterogeneously echogenic solid right testicular mass with no intrinsic vascularity. The serum alpha fetoprotein level was slightly elevated for age (6 IU/L) but the serum human chorionic gonadotropin level was normal. (b) Gross specimen and histology of the yolk sac tumour. The tumour is composed of tumour cells arranged in solid and glandular patterns and exhibit enlarged nuclei, prominent nucleoli, and pale-to-clear cytoplasm. Many eosinophilic hyaline globules are present (H&E; original magnification, x 200).

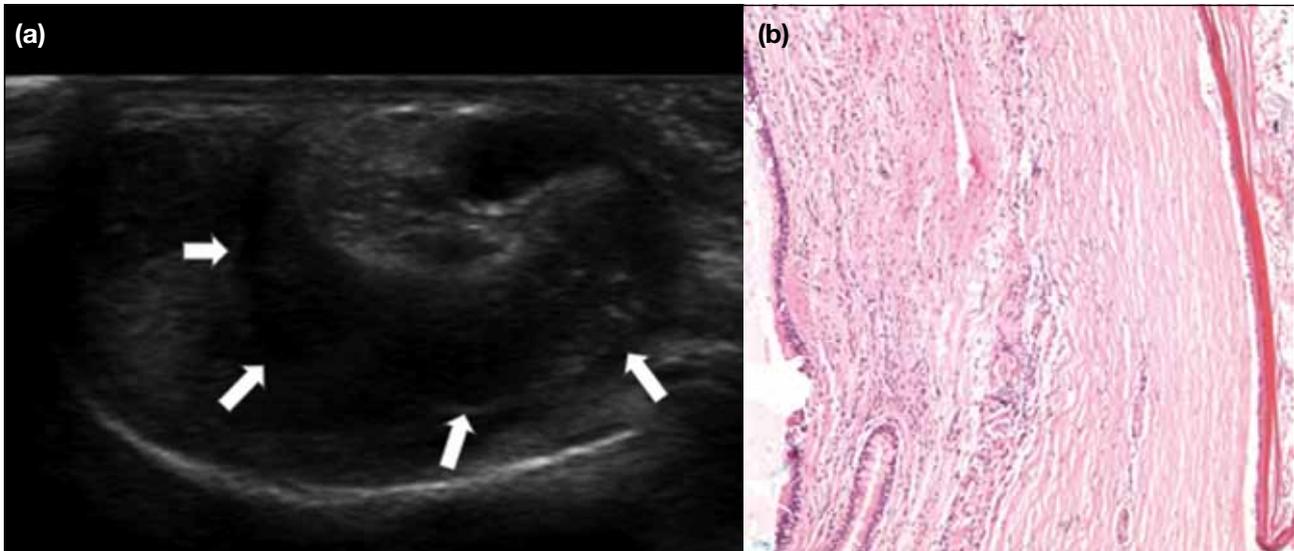


Figure 9. Mature teratoma in a 6-year-old boy. (a) Longitudinal sonography shows a large heterogeneous lobulated mass in the inferior pole of left testis (arrows) with mixed solid and cystic components. No increased vascularity is evident. Both serum alpha fetoprotein and human chorionic gonadotropin levels are normal. (b) Histology of the mature cystic teratoma. A fibrous septum in the cyst is lined by mature keratinising squamous epithelial lining and respiratory-type ciliated epithelial lining on the right and left sides, respectively (H&E; original magnification, x 100).

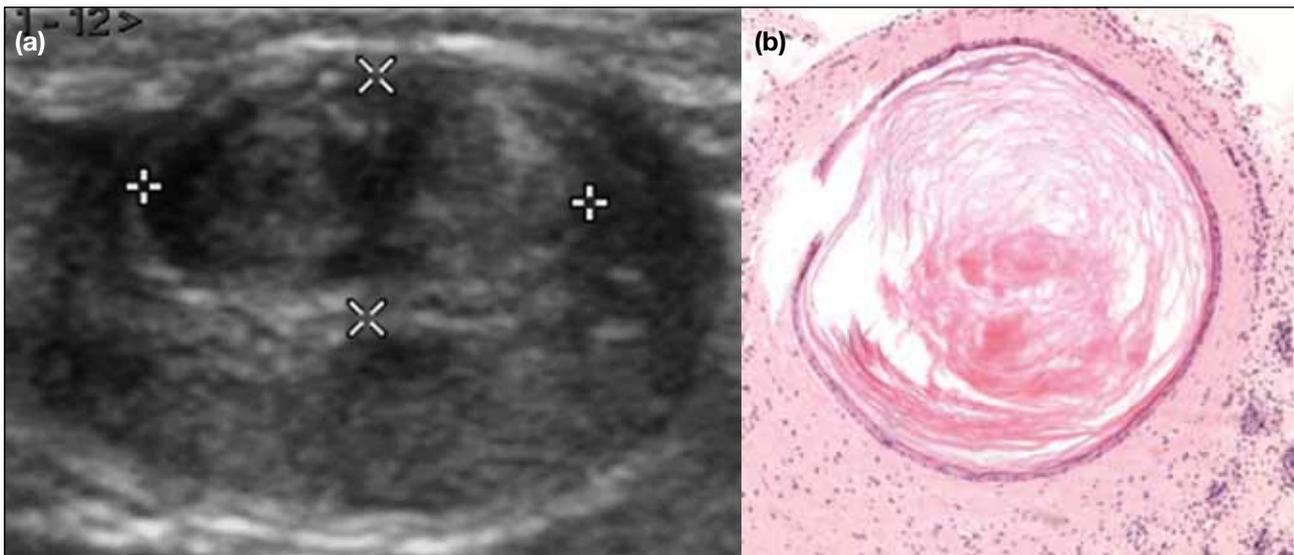


Figure 10. Atypical appearance of mature teratoma in a 7-year-old boy. (a) Longitudinal sonography shows a well-circumscribed, heterogeneously echogenic bilobed mass in the right upper testis (crosses). Echogenic foci with comet-tail artefacts are noted. There is no increased vascularity. Serum alpha fetoprotein and human chorionic gonadotropin levels are normal. The provisional diagnosis is epidermoid cyst but testicular biopsy confirms the diagnosis of mature teratoma. (b) An epidermal cyst-like structure is present as a component of the mature cystic teratoma (H&E; original magnification, x 100).

more aggressively than seminomas. For instance, most patients with yolk sac tumour (accounting for the majority of NSGCTs in the paediatric group) present before the age of 2 years. Sonographically, NSGCTs are usually more heterogeneous than seminomas; coarse

calcifications are also common. In general, it is not possible to distinguish between the various subtypes of NSGCTs on sonography,² but most present with both solid and cystic components. Of note, yolk sac tumours and teratomas typically present with cystic components

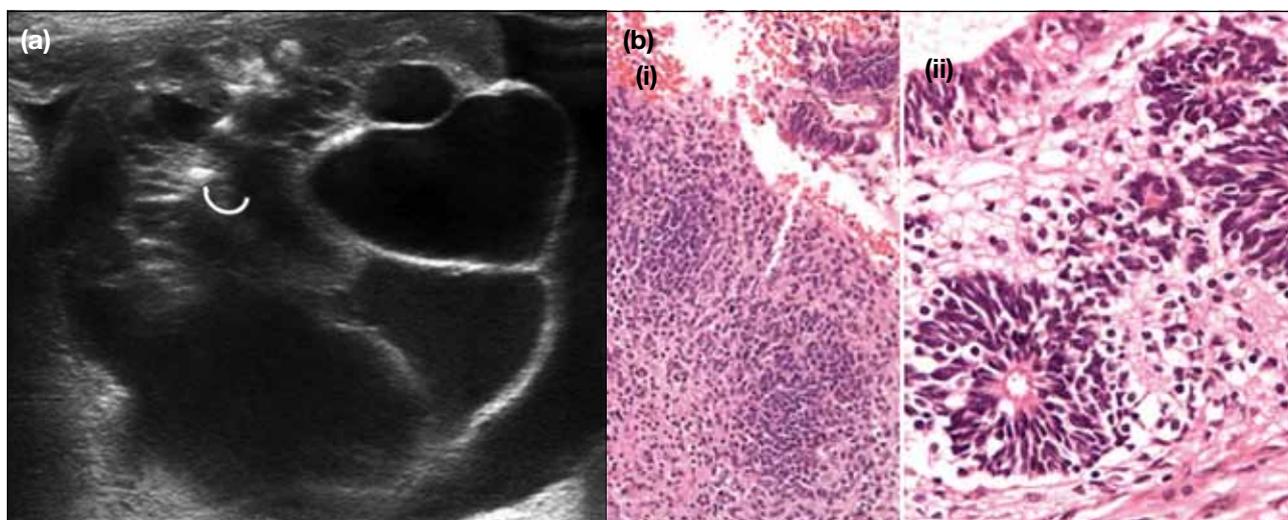


Figure 11. Immature teratoma in a 4-day-old neonate. (a) Longitudinal sonography shows a large, complex multicystic mass replacing the right testis with small intralesional calcification (curved arrow). Serum alpha fetoprotein level was >120,000 IU/L. (b) Histology of the immature teratoma. Immature primitive neural tissue is composed of clusters of small blue round cells and primitive neural tubes (H&E; original magnification, [i] x 100, [ii] x 400).

and increased vascularity, and only in atypical types do they present with solid masses without cysts or even avascular masses mimicking epidermoid cysts. Since primary intratesticular cysts are very rare in children, such lesions, regardless of the appearance, should be carefully investigated to exclude a cystic neoplasm.

Correlation with tumour markers (e.g. alpha fetoprotein, beta human chorionic gonadotropin, and lactate dehydrogenase) is important when assessing NSGCTs. In our institution, however, only approximately 50% of patients have a raised marker level at the time of scanning. A normal tumour marker level, therefore, cannot exclude the possibility of this diagnosis.¹¹

Epidermoid Cyst

Also known as 'monodermal dermoid' or 'keratin cyst of testis', this is considered a type of benign teratoma with only ectodermal components / squamous metaplasia of surface mesothelium. It can present at any age, most commonly between 20 and 40 years of age. Patients are usually asymptomatic, and findings of such lesions on sonographic examination are likely incidental.¹² Sonographic appearances are variable and may present as echogenic lesions surrounded by hypoechoic or echogenic rim, a target appearance, and an 'onion ring' configuration with alternating echogenic and anechoic areas within the lesion (Figure 12). Some may resemble solid tumours on grey-scale images, and

the solid contents correspond to the cheesy materials they contain.¹³⁻¹⁵ The presence of well-delineated borders and absence of blood flow on colour Doppler imaging favour its diagnosis. Magnetic resonance imaging (MRI) is reserved for inconclusive cases where they are seen as sharply demarcated, low-signal intensity lesions without contrast enhancement.¹⁶

Painless Paratesticular Masses

Extratesticular scrotal neoplasms are rare and usually involve the epididymis. Most neoplasms in adults are benign while those in children are frequently malignant. Larger masses (>1.5 cm) with prominent colour flow that present without clinical symptoms of inflammation are more likely to be malignant.²

Paratesticular Rhabdomyosarcoma

Pathologically originating from the mesenchyme of the urogenital ridge, this type of firm, fleshy, lobulated tumour accounts for up to 8% of all malignant solid tumours in children. This is the most frequent extratesticular tumour encountered in boys, presenting at a mean age of 7 years. Sonographically, the tumour presents as a rapidly growing, complex, hypervascular paratesticular mass with variable echogenicity (Figure 13). Mimickers include inflammatory processes such as pseudotumour, chronic epididymitis, or meconium periorchitis. As sonographic findings are non-specific and cannot distinguish benign from malignant,

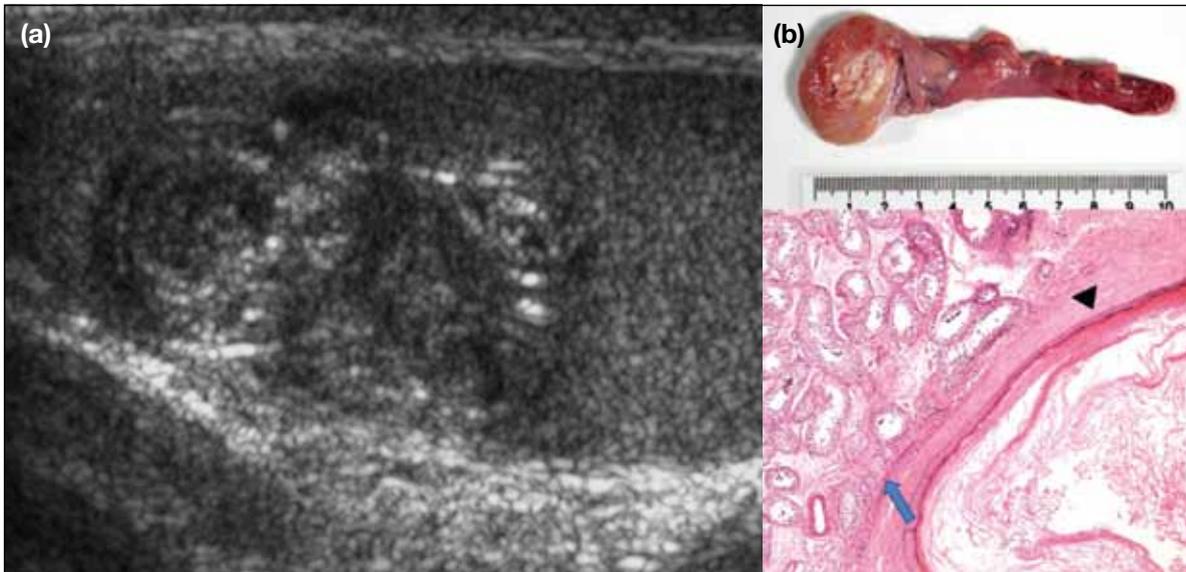


Figure 12. Epidermoid cyst in an 11-year-old boy. (a) Transverse sonography shows a heterogeneous mass with multiple echogenic foci in a lamellar / onion-skin pattern in the left testis. No intrinsic vascularity is demonstrated. (b) Gross specimen and histology of the epidermoid cyst. The epidermal cyst (black arrowhead) is entirely composed of keratinising squamous epithelial lining and is present adjacent to seminiferous tubules (blue arrow) [H&E; original magnification, x 40].

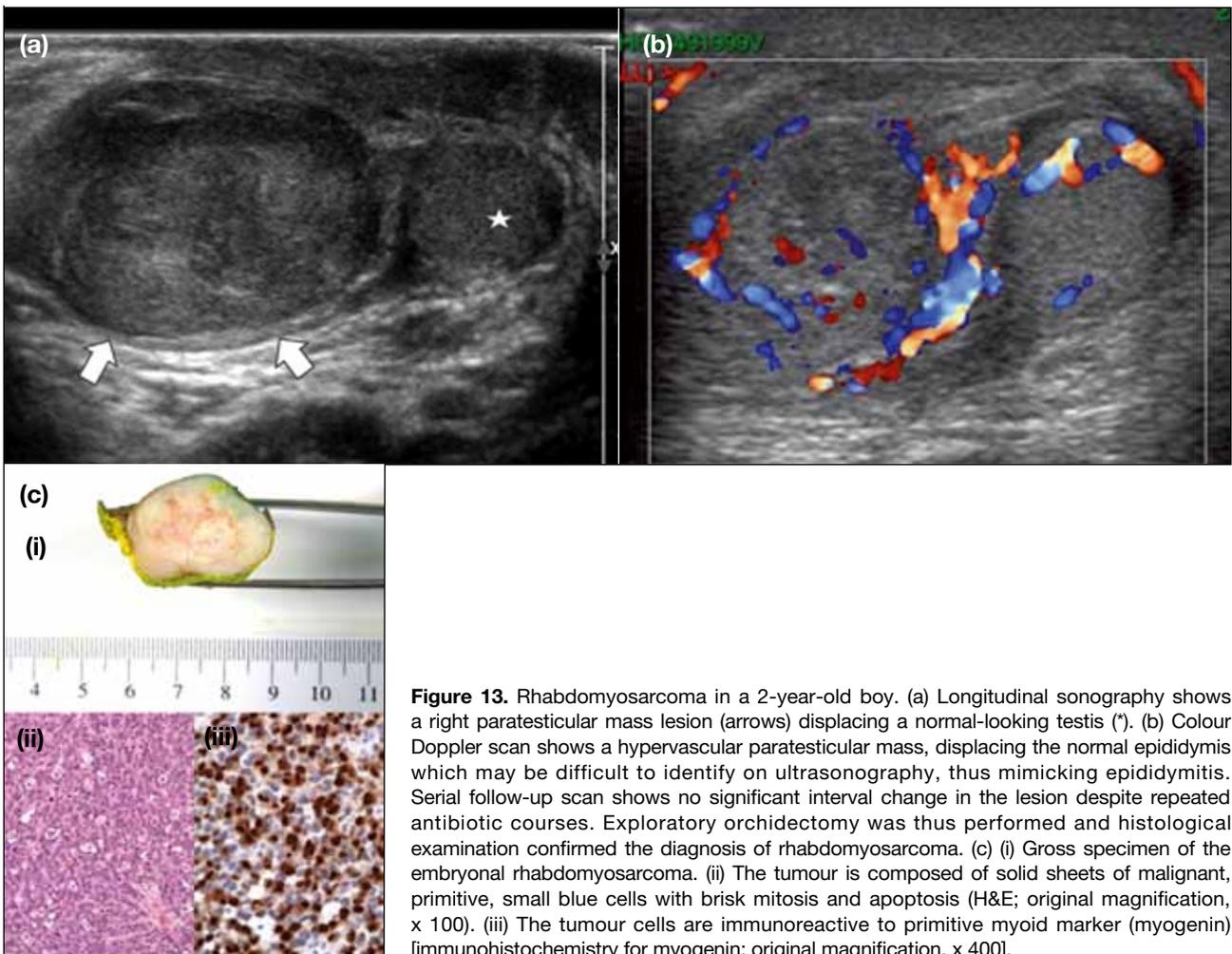


Figure 13. Rhabdomyosarcoma in a 2-year-old boy. (a) Longitudinal sonography shows a right paratesticular mass lesion (arrows) displacing a normal-looking testis (*). (b) Colour Doppler scan shows a hypervascular paratesticular mass, displacing the normal epididymis which may be difficult to identify on ultrasonography, thus mimicking epididymitis. Serial follow-up scan shows no significant interval change in the lesion despite repeated antibiotic courses. Exploratory orchidectomy was thus performed and histological examination confirmed the diagnosis of rhabdomyosarcoma. (c) (i) Gross specimen of the embryonal rhabdomyosarcoma. (ii) The tumour is composed of solid sheets of malignant, primitive, small blue cells with brisk mitosis and apoptosis (H&E; original magnification, x 100). (iii) The tumour cells are immunoreactive to primitive myoid marker (myogenin) [immunohistochemistry for myogenin; original magnification, x 400].

interval follow-up scans for lesions that do not resolve with antibiotics are suggested, and worrisome paratesticular masses should be removed. As metastasis of paratesticular tumours in retroperitoneal nodes is common, and up to 30% of patients present with lung metastases at the time of diagnosis, computed

tomography of the thorax, abdomen, and pelvis is recommended for tumour staging.^{17,18} MRI of the paratesticular solid mass can be performed to delineate the borders of the mass relative to the epididymis and testis.³ Rhabdomyosarcoma is an important mimic of epididymitis which often results in delayed clinical detection. Local recurrence is very common, and 5-year survival remains poor (<35%) despite radical surgery. Early detection is, therefore, of utmost importance and sonographic assessment takes up a very important role in this respect. A patient with a heterogeneous paratesticular mass with or without testicular involvement and showing increased vascularity should therefore be closely followed up. In the absence of radiological resolution, surgical exploration is advocated.

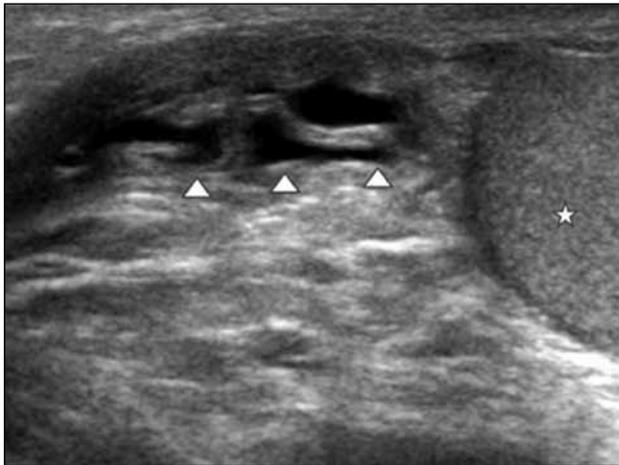


Figure 14. Encysted hydrocoele of spermatic cord in an adolescent. Longitudinal sonography of the right scrotum shows small locules of fluid collection (arrowheads) around the right spermatic cord, superior to the right testis (*). No hernia is evident.

Hydrocoele of Spermatic Cord / Spermatic Cord Cyst

In contrast to the more common hydrocoele which is a result of a patent processus vaginalis, spermatic cord cyst, also known as hydrocoele of spermatic cord or funiculocoe, is a rare congenital anomaly.⁴ Sonographically, it appears as a fluid collection in the spermatic cord.³ In ‘encysted hydrocoele’, the fluid collection does not communicate with the peritoneum or the tunica vaginalis (Figure 14); while in

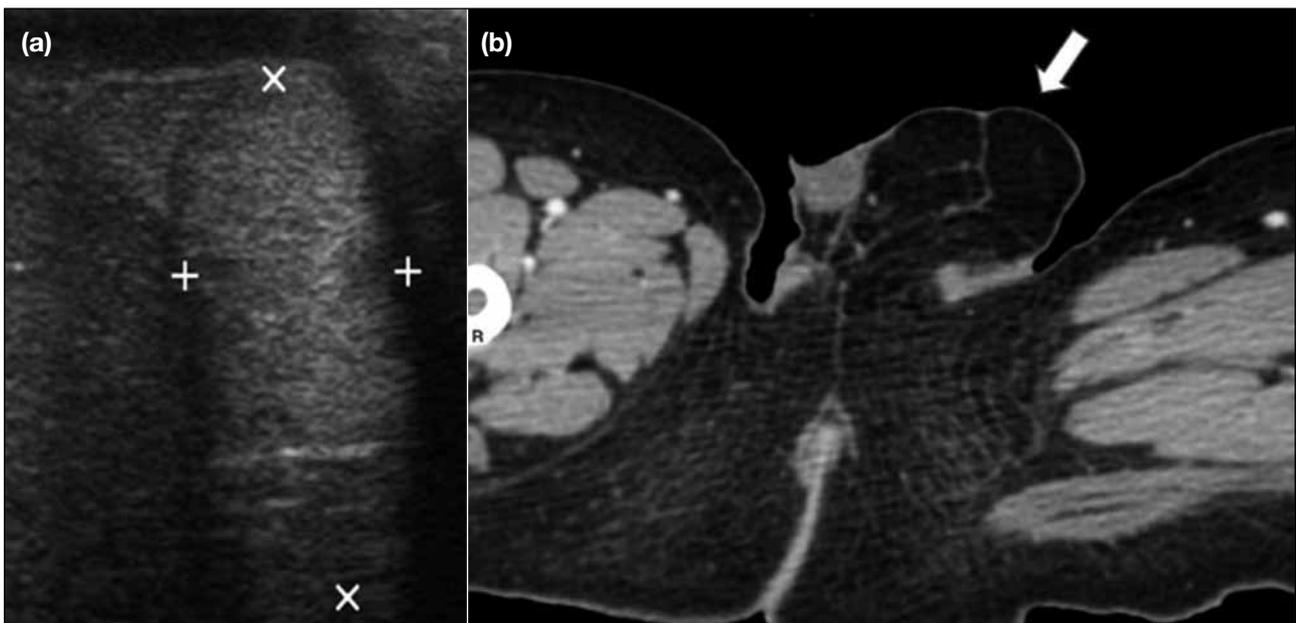


Figure 15. Paratesticular lipoblastoma in an 18-month-old boy. (a) Transverse sonographic image shows an echogenic fatty mass in the left scrotal sac (crosses). The left testis and epididymis are not identified. The right testis appears normal (not shown). (b) Axial computed tomographic image shows a septated fatty lesion occupying the entire left scrotal sac (arrow). Surgical exploration of the left scrotum shows presence of a fatty mass and histological examination confirms lipoblastoma.

‘funicular hydrocoele’, fluid collection along the cord communicates with the peritoneum at the internal ring.¹⁹

Lipoblastoma

Lipoblastomas are rare, benign, soft tissue tumours that occur primarily in young children (<2 years old). Most occur in the extremities, trunk, head, and neck. An intrascrotal location is unusual, with only a few cases reported (Figure 15).²⁰

DIAGNOSTIC ALGORITHM

To date, there is no standardised international guideline regarding sonographic assessment of paediatric scrotal lesions. Based on our institutional experience, it would be helpful to first enquire whether there is any history of recent trauma, and whether the patient presents with pain. Both painful and painless masses can be further categorised according to location (testicular vs. paratesticular) and subsequently by their appearance (solid, cystic, or mixed). Painful lesions are generally

benign conditions associated with trauma, torsion (testicular / appendage) and infection; while painless lesions have a broader differential list ranging from hydrocoele, epidermoid cysts, to more aggressive lesions such as germ-cell tumours and rhabdomyosarcoma. A summary of the diagnostic algorithm is suggested for quick reference in the clinical setting (Figure 16). For sonographically inconclusive cases, prompt discussion with the referring team for decision on early exploration and close radiological follow-up should be made.

CONCLUSION

There is a wide spectrum of disease entities encountered in paediatric patients presenting with scrotal swelling. The use of ultrasound in a systematic approach may help differentiate various pathologies and triage patients who may need surgery. Radiologists and sonographers should be aware of the important mimics, and follow-up scans serve a very important role in assessing patients with doubtful diagnoses or atypical clinical progress.

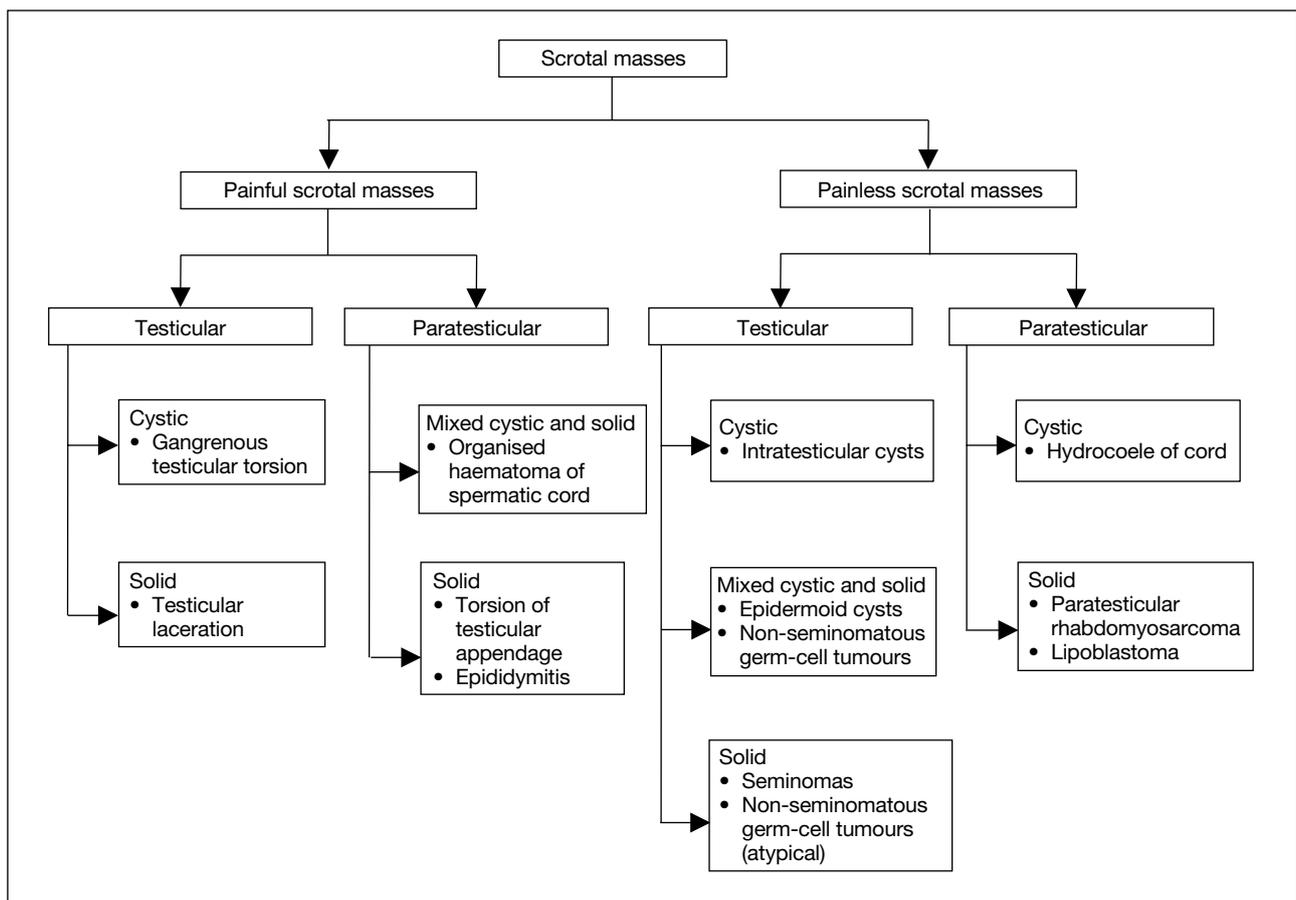


Figure 16. Diagnostic algorithm for paediatric scrotal masses based on our institution’s experience.

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