Approach to ultrasound of paediatric scrotal masses

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Learning objectives

This educational exhibit provides a comprehensive and illustrative review of the sonographic appearances of common scrotal masses in children referred to our department.

Our learning objectives are:

- To generate an approach to narrow the differential diagnostic considerations of testicular and paratesticular abnormalities in both acute and non-acute settings by categorizing their sonographic features.

- To discuss the sonographic imaging features of common testicular and paratesticular tumours, other benign scrotal lesions, trauma related conditions and sequelae of testicular torsion.

- To identify some important mimics and their differential diagnoses.

Background

Ultrasound is the first line imaging modality for assessment of pediatric patients presenting with scrotal masses. It is widely available to provide rapid and timely assessment without imposing radiation risk to children. It also helps triage patients by differentiating lesions that require urgent surgery from those that can be managed conservatively. With the use of high resolution sonography, detailed images of the scrotal wall, testis and epididymis can be achieved. However assessment and interpretation of sonographic findings can be challenging to radiology residents.

In this educational exhibit, sonographic images of scrotal masses among pediatric patients were reviewed from our archives. All ultrasound scans were performed with high frequency (12MHz) linear array transducers. Sector format of the image was obtained to increase the field of view, which was also good for comparison of the testes, scrotal skin, and tunica. The location and sonographic features of the mass as well as patient history on page were correlated with histopathologic diagnosis or outcome of clinical-radiological follow up, and data were used to create a diagnostic algorithm.
Fig. 1: High resolution ultrasound scan is the most useful first-line imaging tool for assessing scrotal masses among paediatric patients.
Imaging findings of 23 patients were reviewed, that were categorized into painful and painless conditions. They were then further classified into testicular and paratesticular lesions according to sonographic findings.

**PAINFUL SCROTAL MASSES**

These patients presented with acute scrotal pain. They were either related to trauma, ischemia or infection. Among the cases we encountered, the testicular lesions were all cystic or mixed solid and cystic, while the paratesticular ones were predominantly solid in appearance.

**Painful testicular masses**

**Testicular laceration**

The scrotum is prone to direct trauma due to its position external to the body. Sonographic features include focal areas of altered echogenicity, corresponding to areas of hemorrhage or infarction, and hematocoele formation in 33% of patients. 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. Patients with large intrascrotal hematomas or hematocoeles will often undergo surgical exploration because it is difficult to exclude rupture sonographically in the presence of surrounding complex fluid. Complication include atrophy of testis. Fig. 2 on page 11

**Gangrenous testicular torsion**

Depending on the duration of torsion, variable extent of gangrene (to the extreme of entire cystic change) can be detected. Our case was a 4 month-old who presented with irritability for a few days, and an acute scrotum was not suspected until the baby was presented to our tertiary pediatric surgical unit. By the time US was performed, the involved testis has become entirely cystic. Intraoperative findings reviewed a gangrenous testis beyond salvage. Testicular torsion should therefore be actively looked for by frontline clinicians, especially when examining very small children who cannot verbally express clinical symptoms. Fig. 3 on page 13

**Painful paratesticular masses**

**Organized hematoma of spermatic cord**
These are most often related to blunt trauma. Spontaneous idiopathic hematomas have been reported, mostly in untraumatized young adults after physically stressful exercises. Possible causes include spontaneous spermatic vein rupture or tear of the cremasteric muscle. As clinically it is impossible to differentiate from other causes of acute scrotum, surgical exploration is often warranted. Fig. 4 on page 15 Fig. 5 on page 15

**Torsion of testicular appendage**

It is a common cause of acute scrotum in prepubertal boys (6-12 years old). The appendix testis is most commonly affected and more frequently on the left side. If a nodule of the upper scrotum with bluish discoloration is palpated, then US examination is not necessary (the pathognomonic "Blue dot sign"). In clinically inconclusive cases US can be used to exclude testicular torsion. Sonographically, the twisted appendage appears as a round extra-testicular mass. A nodule may be seen between the head of the epididymis and the testis. Echogenicity is variable. Secondary inflammatory changes usually occur, including an enlarged epididymal head, reactive hydrocoele and scrotal skin swelling. The epididymis and scrotal tunics may be hypervascularized, while no blood flow can be seen in the twisted appendage. Within days the twisted appendix calcify and becomes detached, leaving a scrotal calcification known as scrotolith. Fig. 6 on page 16

**Epididymitis**

This is the most common cause of acute scrotum in children. The infection usually originates from the bladder or prostate gland, spreads through the vas deferens and the lymphatics of the spermatic cord to the epididymis and eventually reaches the testis. Predisposing factor includes imperforate anus, ureteral ectopia to the seminal vesicle, bladder extrophy, neurogenic bladder, posterior urethral valves and dysfunctional voiding. Sonographically, there is enlarged hypervascular hypoechoic epididymis with scrotal skin swelling and a reactive hydrocoele. The epididymal head is the most affected, but occasionally the entirely gland can be involved. Around 20% cases are complicated by orchitis. Increased blood flow is seen within the epididymis, the testis or both. Complications include abscess, pyocele, and focal infarct. Fig. 7 on page 18

**PAINLESS SCROTAL MASSES**

In general, a painless scrotal swelling is the most common manifestation of scrotal tumours, with an estimated prevalence of 0.5 - 2.0 cases per 100000 boys. US is nearly 100% sensitive for identifying scrotal masses, by differentiation between cystic and solid tumours and classification as intra or extratesticular. Tumour markers (AFP and BhCG) were routinely checked in all patients with suspected scrotal tumours, but only 2 out of 10 of histologically proven tumours in our series had elevated markers (including
an immature teratoma and a yolk sac tumour). All mature teratomas of the testis and paratesticular tumours were not associated with elevated markers. Special note should be made when interpreting blood tests in newborns, that AFP level can be physiologically elevated.

**Painless testicular masses**

Testicular neoplasms account for 1% of all pediatric solid tumours. They have two peaks of prevalence, before 3 years of age and in the postpubertal period. In 10% of cases they may mimic torsion or epididymitis. 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**

Rarely occur before puberty, seminomas are less aggressive than other testicular tumours, and have the most favourable prognosis among all malignant testicular tumours. They are usually confined within the tunica albuginea at presentation, and only 25% have metastases at the time of diagnosis. Sonographically they are homogeneously solid, firm tumours of variable sizes from a small nodule in a normal size testis to a large mass causing diffuse testicular enlargement. They often appear hypoechoic compared with normally echogenic testicular parenchyma, without calcification. Uniform, low level internal echoes are common. With high resolution probes, some seminomas may have a more heterogeneous echotexture. Necrosis and cystic changes are rare. Note that sonography is often used for screening of occult seminoma in both testes after orchiopexy 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. **Fig. 8 on page 18**

**Non-seminomatous germ cell tumour (NSGCTs)**

NSGCTs include yolk sac tumours (the most common non-germ cell tumour among pediatric patients), teratomas (second most common), embryonal carcinoma, choriocarcinoma and mixed germ cell tumours. They occur more often in younger patients and behave more aggressively than do seminomas. Invasion of the tunica albuginea, distortion of the testicular contour, lymphatic spread and distant visceral metastases are also more common. Sonographically, NSGCTs typically are more heterogeneous than seminoma and have both solid and cystic components. Coarse calcifications are common. It is not possible to distinguish the various subtypes of NSGCTs on sonography. Correlation with tumour markers is important when assessing NSGCTs. Elevated AFP and HCG are suggestive of immature or malignant types of teratomas, which are more prevalent among pubertal and post-pubertal males. LDH and AFP are elevated in over 90% of yolk sac tumours.
Epidermoid cyst

They are the most common benign testicular tumours with no malignant potential. They contain chesy material and may resemble a solid tumour on US. Sonographic appearances are variable: an echogenic lesion surrounded by hypoechoic or echogenic rim, a target appearance, and an "onion ring" configuration with alternating echogenic and anechoic areas within the lesion. The presence of well-delineated borders and avascularity at color Doppler imaging favours its diagnosis. MR imaging is reserved for inconclusive cases where they are seen as sharply demarcated low signal intensity lesions without contrast enhancement.

Painless paratesticular masses

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

Paratesticular rhabdomyosarcoma

This is the most frequent extratesticular tumour encountered in children, which originates in the spermatic cord or scrotal tunics. Majority occurs in first two decades of life and belong to the embryonal histopathologic subtype. Sonographically they present as rapidly growing hypervascular complex paratesticular masses, with variable echogenicity. Mimickers include inflammatory processes such as pseudotumour, chronic epididymitis, or meconium periorchitis. As sonographic findings are non-specific and cannot distinguish benign from malignant, interval follow-up scans for lesions that do not resolve with antibiotics are suggested, and worrisome paratesticular masses should be biopsied or removed. CT is recommended in the initial work-up to determine tumour spread, and MR imaging can be performed to delimit the borders of the mass relative to the epididymis and testis. Long term survival is expected in patients under 10 years of age with disease confined to scrotum.

Diagnosis may be less straightforward particularly in cases of infection, with rhabdomyosarcoma as an important mimic of epididymitis. A patient with a heterogeneous paratesticular mass with or without testicular involvement and showing increased vascularity should be closely followed up. In the absence of radiologic resolution, surgical exploration is advocated.
Lipoblastoma

They are rare benign soft tissue tumours that occur primarily in young children. Most lipoblastomas occur in the extremities, trunk, head, and neck. An intrascrotal location is unusual with only a few cases reported. Sonographically they appear as paratesticular fatty tissues. Fig. 19 on page 28 Fig. 20 on page 27

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 funiculocoele, is a rare congenital anomaly. It is due to abnormal closure of the processus vaginalis above the testis but below the internal inguinal ring. Sonographically they appear as fluid collections in the spermatic cord. Two types are identified, one as encysted hydrocoele where the fluid collection does not communicate with the peritoneum or the tunica vaginalis, and funicular hydrocoele, where there is a fluid collection along the cord that communicates with the peritoneum at the internal ring. They rarely resolve spontaneously and surgical treatment is often applied. Fig. 21 on page 30
Fig. 22: Summary of institutional review of US findings of painful scrotal tumours.
Painless Scrotal Masses

Testicular
- Cystic
  - Intratesticular cysts
- Mixed Cystic & Solid
  - Epidermoid cysts
  - Non-seminomatous Germ Cell Tumours
- Solid
  - Seminomas
  - Non-seminomatous Germ Cell Tumours (Atypical)

Paratesticular
- Cystic
  - Hydrocoele of Cord
- Solid
  - Paratesticular Rhabdomyosarcoma
  - Lipoblastoma
Fig. 23: Summary of institutional review of US findings of painless scrotal tumours.  
References: Diagnostic Imaging & Interventional Radiology, The Chinese University of Hong Kong, Prince of Wales Hospital - Hong Kong/CN

Images for this section:
**Fig. 2:** Testicular laceration in a 16-year-old boy after assault. Longitudinal sonographic image shows an irregularly heterogeneous and avascular mass lesion at the left lower scrotum (arrows), involving the left epididymal tail and obscuring the lower border of left testis. A 5mm hypoechoic line (arrow head) is noted in the lower pole of the testis, representing a small laceration. Moderate amount of left hematocoele (*) noted.
Fig. 3: Gangrenous testicular torsion with cystic change in a 4 month old boy who presented with a painful scrotal mass for 2 days. Transverse sonographic image shows a 3cm anechoic and avascular cystic collection in the left scrotum, replacing the normal left testis.

Fig. 4: Organized hematoma of the spermatic cord in a 2-year-old boy. Ultrasound scan shows a tender heterogeneously variegated left paratesticular mass (arrows), displacing the normal left testis (*). Power Doppler scan (not shown) shows significant perilesional vascularity, and the low vascular centre may represent hemorrhage. Left inguinal orchidectomy was performed, with gross specimen mimicking paratesticular tumour.
**Fig. 5:** Histological exam demonstrates a large organized hematoma of the left spermatic cord only.
Fig. 6: A 12 year-old boy with torsion of testicular appendage. Longitudinal sonographic images shows a swollen left epididymal head (arrow heads) with increased vascularity when compared with its right counterpart. Small calcific focus in left epididymal head (arrow), may represent a scrotolith. The patient was treated conservatively.

Fig. 7: An adolescent male with epididymitis. Transverse sonographic scan of the right scrotum shows a swollen right epididymis with increased vascularity. The adjacent right testis is normal (*). No hydrocoele. Patient's urethral swab was Chlamydia positive and then treated with a course of antibiotics.
**Fig. 8:** Testicular seminoma in a 17-year-old boy. Longitudinal sonography of the left testis shows a large lobulated heterogeneous mass (arrow) with moderate vascularity replacing most of the left testis, with only a thin rim of normal parenchyma remains. Epididymis is spared (curved arrow). Scrotal skin mildly thickened.

**Fig. 9:** Yolk sac tumour in a 6-month-old boy. Longitudinal sonography shows a diffusely enlarged left testis with multiple small internal cystic spaces (compatible with tumour necrosis) and increased intrinsic vascular channels. AFP measures >38000IU/L.
**Fig. 10:** Atypical appearance of a yolk sac tumour in a 16-month-old boy. Transverse sonography shows a heterogeneously echogenic solid right testicular mass with no intrinsic vascularity. AFP measures 6 IU/L and hCG is normal.

**Fig. 12:** Atypical appearance of mature teratoma in a 7-year-old boy. Longitudinal sonography shows a well circumscribed, heterogeneously echogenic bilobed mass in right upper testis (crosses). Echogenic foci with comet tail artefacts are noted. No increased vascularity. AFP and hCG are normal. The provisional diagnosis was epidermoid cyst but testicular biopsy confirmed the diagnosis of mature teratoma.
Fig. 11: Mature teratoma in a 6-year-old boy. Longitudinal sonography shows a large heterogeneous lobulated mass in inferior pole of left testis (arrows) with mixed solid and cystic components. No increased vascularity evident. Both AFP and HCG are normal.
Fig. 13: Immature teratoma in a 4-day-old neonate. Longitudinal sonography shows a large complex multicystic mass replacing the right testis with small intralesional calcification (curved arrow). AFP measures >120000 IU/L.
Fig. 14: Immature primitive neural tissue is composed of clusters of small blue round cells (LEFT) and primitive neural tubes (RIGHT) which are characteristic for immature teratoma.
**Fig. 16:** Inguinal orchidectomy was performed. Histologically, an epidermal cyst (RIGHT, black arrow head) is entirely composed of keratinizing squamous epithelial lining and present adjacent to seminiferous tubules (LEFT, blue arrow).

**Fig. 15:** Epidermoid cyst in an 11-year-old boy. 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.
Fig. 20: Axial CT images shows a septated fatty lesion occupying the entire left scrotal sac (arrow). Surgical exploration of the left scrotum showed presence of a fatty mass and histological examination confirmed lipoblastoma.
**Fig. 19:** Paratesticular lipoblastoma in a 18-month-old boy. Transverse sonography shows an echogenic fatty mass in the left scrotal sac (crosses). The left testis and epididymis are not identified. The right testis appears normal (*).

![Image of a sonogram showing a lipoblastoma in the left scrotal sac with echogenic fatty mass, and the right testis appearing normal.]

**Fig. 21:** Encysted hydrocoele of spermatic cord in an adolescent. Longitudinal sonography of the right scrotum shows small locules of fluid collections (arrow heads) around the right spermatic cord, superior to the right testis (*). No hernia is evident.

![Image of a sonogram showing a hydrocoele of the spermatic cord with small fluid collections around the cord and above the testis. No hernia is visible.]
**Fig. 17:** Rhabomyosarcoma in a 2-year-old boy. Longitudinal sonography shows a right paratesticular mass lesion (arrows) displacing a normal looking testis (*).
**Fig. 18:** Color Doppler scan shows a hypervascular paratesticular mass, displacing the normal epididymis which may be difficult to identify in US, and thus mimicking epididymitis. Serial follow-up scan shows no significant interval change of the lesion despite repeated course of antibiotics. Exploratory orchidectomy was hence performed and the histological exam confirmed the diagnosis of rhabdomyosarcoma.
Conclusion

There is a wide spectrum of disease entities encountered in pediatric patients presenting with scrotal swelling. Use of ultrasound in a systematic approach may help differentiate different 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.

References


Personal Information