Role of Ultrasound in Management of Scrotal Abnormalities in Children

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INTRODUCTION

Ultrasonography (US) is the imaging modality of choice for evaluating scrotal abnormalities. Scrotal swellings are frequently seen in children and adolescents and narrowing differential diagnosis is important in assisting the referring clinicians and enhancing their efficiency in coming to a diagnosis. The spectrum ranges from incidental to pathological findings and can be divided into chronic (or at least subacute) and acute; painless and painful.

Familiarity with US is essential for establishing the correct diagnosis. The objective of this pictorial review is to provide current information on common and unusual scrotal abnormalities.

Most common causes of painless scrotal swelling in children and adolescents include hydrocele and non-incarcerated inguinal hernia. Less common causes are varicocele, spermatocele, localized edema, and testicular tumors. Painful scrotal swelling in children are usually require urgent diagnosis and intervention and include but not limited to abscess, testicular torsion, torsed appendix of epididymis/testis, and epidydmitis/orchitis.

KEY WORDS:
ultrasound, pediatric, testes, swelling

PAINFUL SCROTAL MASSES

Abscess

Scrotal abscess can be a complication of epididymo-orchitis, trauma, or surgery. The clinical history and physical examination of a painful hyperemic scrotum is essential in making the diagnosis. On US, this lesion can have a variety of appearances such as a heterogenous hypoechoic mass, thickened wall, and internal debris (Fig. 1). Areas of infection are generally hyperemic and heterogeneous in echotexture. If organized, an abscess may have a well-defined hyperemic wall. If there is gas within the collection, hyperechoic foci with "dirty" shadowing are seen.

Testicular torsion

Testicular torsion leads to ischemia and possibly death of the testis. There are two peak incidences for testicular torsion – one is during puberty and the other is during the neonatal period. There are two types of testicular torsion: extra and intra vaginal. Extra vaginal testicular torsion occurs in neonates, due to the loose attachment of testes and the spermatic cord to the scrotum thus the entire cord above the level of the scrotum can undergo torsion. Intra vaginal testicular torsion occurs more frequently in boys undergoing puberty. This is due to the abnormal development of the tunica vaginalis, where the tunica vaginalis completely covers the epididymis and testis, thus the testis is not fixed to the scrotal walls and is allowed to rotate freely. This deformity is usually seen on both sides, and would require surgical fixation [1].

Usually, these children present with acute onset of severe testicular pain. The ischemia can lead to testicular necrosis if not corrected within 5-6 hours of the onset of pain [2]. Torsion can be intermittent and can undergo spontaneous de-torsion. US is the modality of choice and shows an enlarged hypoechoic testes, showing minimal or no internal vascularity (Figs. 2 and 3).

Torsion of testicular appendix

The appendix epididymis and appendix testis are embryologic remnants of the mesonephric (wolffian) duct and paramesonephric (müllerian) duct, respectively. Torsion of these appendages causes acute scrotal pain and a focal bluish discoloration beneath the skin (so-called "blue-dot" sign) in about one third of the cases; as well as a tender nodule is commonly palpated on physical examination [3]. US typically shows a nonvascular hyperechoic small oval mass adjacent to the testis or epididymis, which may be associated with epididymal inflammation and hydrocele (Fig. 4).

In a child with an acute scrotum, torsion of testicular appendices represents the more common cause of scrotal pain rather than testicular torsion. Typically, torsion of testicular appendices has a more gradual onset than testicular torsion and patients may endure pain for several days before seeking medical attention.

Epididymitis and orchitis

Epididymitis is the most common inflammatory process involving the scrotum and more common in adults but can occur in children. Children usually present with fever, dysuria and a painful scrotum. With the acute and sometimes excruciating scrotal pain presentation associated with a severe orchitis, the clinicians do often encounter difficulties in differentiating an orchitis with a testicular torsion or torsion of the testicular appendix. On conventional ultrasound both orchitis and torsion may result in an enlarged diffusely or heterogeneously hypoechoic testes. US doppler is useful in such a setting, as orchitis usually demonstrates an increased vascular flow in the testicular parenchyma; while the torsed testes will show decreased or absent vascularity with increased flow at the testicular capsule.

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Orchitis is characterized by focal, peripheral, hypoechoic lesions that is poorly defined (Fig. 5). Orchitis may also exhibits testicular hyperemia on color Doppler US images, and is usually follows an underlying epididymitis [4] (Fig. 6). A reactive hydrocele may also be associated with epididymo-orchitis. Focal testicular infarction can also occur as a complication of epididymitis when swelling of the epididymis is severe enough to constrict the testicular blood supply. This appears as a hypoechoic intratesticular mass devoid of blood flow.

PAINLESS SCROTAL MASSES

Hydrocele, encysted hydrocele of the spermatic cord

A hydrocele is a collection of fluid in the scrotal sac between the layers of the tunica vaginalis; and is usually painless. A reactive hydrocele occurs when there is an underlying pathology of the testes or its epididymis for example reactive hydrocele can occur in trauma, infection, torsion and tumors. Encysted hydrocele of the spermatic cord is a fluid along the spermatic cord, separated from and located above the testicle and the epididymis. This is due to abnormal closure of the processus vaginalis. There are two types of hydrocele of spermatic cord - encysted hydrocele of the cord, and funicular hydrocele. Encysted hydrocele of the spermatic cord is when the fluid does not communicate with the peritoneum or the tunica vaginalis and the latter is where fluid is seen communicating with the peritoneum at the internal ring. US shows well demarcated anechoic lesion in the inguinal region, with no color flow on the Doppler (Fig. 7). Most importantly, the underlying testes and epididymis are normal [5, 6].

US features of a simple hydrocele include anechoiec well demarcated fluid collection outlining the testis, with posterior acoustic enhancement. Presence of internal echoes/septae may suggest a complex hydrocele, which could be secondary to trauma or infection (Figs. 8 and 9).

Microlithiasis

Testicular microlithiasis appear as tiny nonshadowing hyperechoic foci ranging in diameter from 1-2 mm. They are usually intraparenchyma but can be seen distributed peripherally or segmentally; and maybe unilateral or bilateral (Fig. 10). Common consensus for the number of microliths required to define testicular microlithiasis is five [7].

Several associations have been reported with testicular microlithiasis including Klinefelter's syndrome, cryptorchidism, Down's syndrome, male pseudohermaphroditism, pulmonary alveolar microlithiasis, previous radiotherapy, and subfertility states [8]. The most important association is with testicular neoplasms. These are, however, only associations, and no cause-and-effect relationship has been established. Associations aside, the increased risk appears to be real, as there are now several case reports documenting the interval development of germ cell tumors of the testis in patients with previously identified isolated microlithiasis [8, 9, 10]. As these patients with microlithiasis are usually found on incidental US investigation for other scrotal abnormality and are mostly asymptomatic, the current recommendation in management of microlithiasis is for annual US follow-up and patient education about self-examination [11].

Testicular tumor

Pediatric testicular tumors are uncommon occurrences. Teratomas and yolk sac tumors are most commonly testicular tumors before puberty and after puberty, embryonal carcinoma occurs more frequently.

A painless testicular mass is the most common finding in a child with a testicular tumor. There are no sonographic features that can reliably distinguish benign and malignant tumors. Size of the lesion is not a factor in determining if the lesion maybe benign or malignant. US features of testicular malignancy may include enlarged testis, with ill-defined heterogenous hypoechoic areas (Figs. 11, 12, and 13). Color Doppler US has also been reported to be more effective than gray-scale sonography in detecting intratesticular neoplasms in the pediatric population [12].

If surgery is warranted, US can also assess whether there is enough normal testis parenchyma remaining for testis sparing surgery [13, 14, 15]. US can also be used to aid in image guided biopsies.

Testicular tumor markers are important tools in the evaluation of testicular tumors in children. Alpha fetal protein (AFP) is more reliable because it is secreted by 90% of yolk sac tumors in children. Pointer in using AFP in these patients is to remember that serum AFP level is normally very high in infancy. It measures in the tens of thousands in newborns and does not decrease to normal adult levels until nearly 1 year of age [16]. Therefore, although elevated AFP in a child older than 1 year with a testicular tumor almost always reflects the presence of a yolk sac tumor, an "elevated" level in infants can also occur in the case of benign tumors.

Scrotal wall edema

Edema of the scrotum can be due to a multitude of reasons, such as ascites, nephrotic syndrome, or even insect bites. It is sometimes clinically difficult to assess the underlying testes due to the overt overlying swelling, and thus US can provided valuable tool in assessing the testes in such conditions. On US, features include marked thickening of the scrotal wall with normal appearing testis and epidydmis (Fig. 14). Normal to slightly increased flow to the scrotal wall on doppler is sometimes seen.

Inguinal hernia

Hernias in children are more common in premature infants. If the hernia is filled with bowel, it is usually easier to detect, but sometimes the hernia maybe filled with soft tissue such as omental fat. On US, the testis and epididymis are normal. Fluid or air containing loops in the scrotum or echogenic areas representing herniated omentum are seen (Fig. 15). Clinical examination of the inguinal canal to distinguish from primary scrotal pathology is essential.

Hematoma

US plays a vital role in patients with penetrating or blunt trauma. Blunt trauma to the scrotum can lead to damage of the testicle and adjacent structures. Injuries to scrotum include laceration, hemorrhage, or contusion of the testicle. The goal of scrotal US in patients with acute trauma to the scrotum is to evaluate injury to the testicle. Acute intra-testicular hematomas appear hyperechoic at US and may

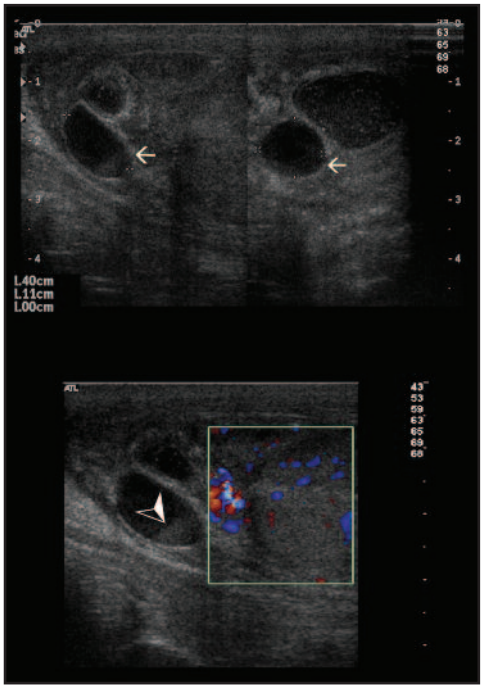

Fig. 1: 8yr old boy presented with right testicular swelling. Gray scale US in transverse (top) and sagittal (bottom) shows a heterogenous hypoechoic mass, thickened wall (white arrows), and internal debris (arrow head), consistent with an abscess.

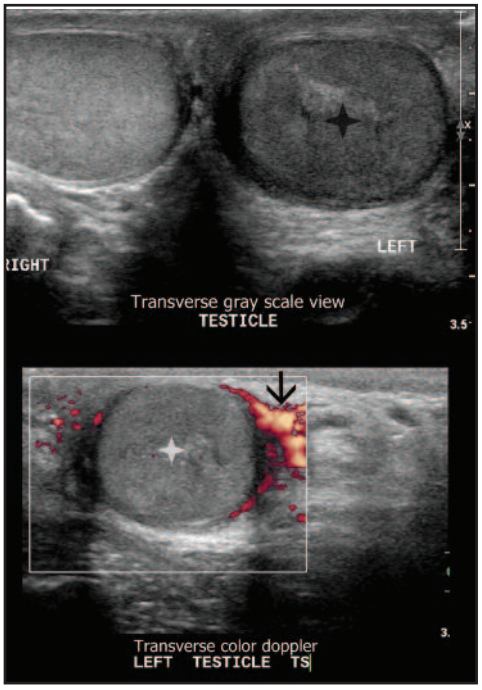

Fig. 2: 13 Year old boy presented with testicular swelling and pain for 3 days. Doppler US (bottom) shows peripheral capsular blood flow but no intratesticular blood flow (white star). The peripheral blood flow is supplied by inguinal and scrotal vessels (black arrow) which attempt but are unable to restore intratesticular blood flow. Grayscale US (top) shows slightly enlarged left testes, with heterogenous hypoechogenity (black star). The child was immediately taken for surgery.

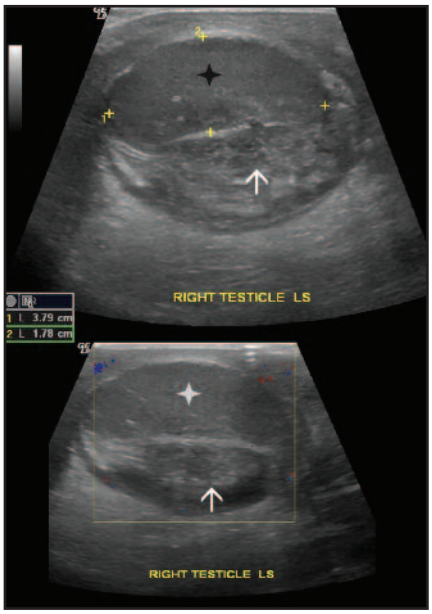

Fig. 3: A child with one day onset of right testicular swelling. Doppler US (bottom) shows an enlarged right testes which shows no vascularity (white star). The epididymis is enlarged and edematous (white arrow). The child was taken for surgery and was proven to have recurrent testicular torsion and detorsion.

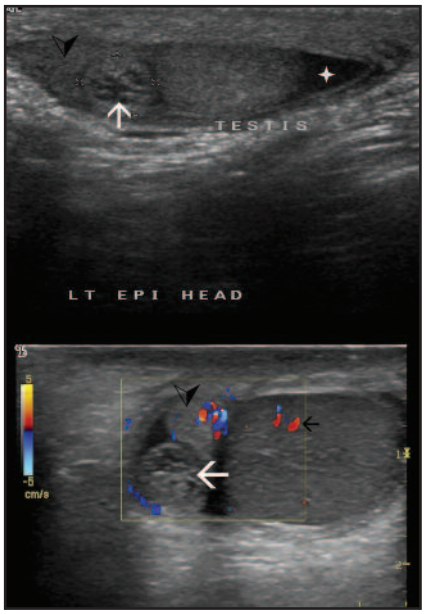

Fig. 4: Child with left testicular swelling for 1 day and having increasing pain over upper part of testis for about 10 hrs. No history of any recent trauma. Grayscale US (top) shows a rounded heterogenous lesion (white arrow) next to the epididymis (arrow head) in the superior aspect of the scrotum (patient was exquisitely tender at this site). The surrounding epididymis (arrow head) appears enlarged, edematous and heterogenous. Doppler US (bottom) shows absence of perfusion in the same area consistent with a twisted epididymal appendage (note that there is normal blood flow in the adjacent testes [black arrow]). Small reactive hydrocele (white star).

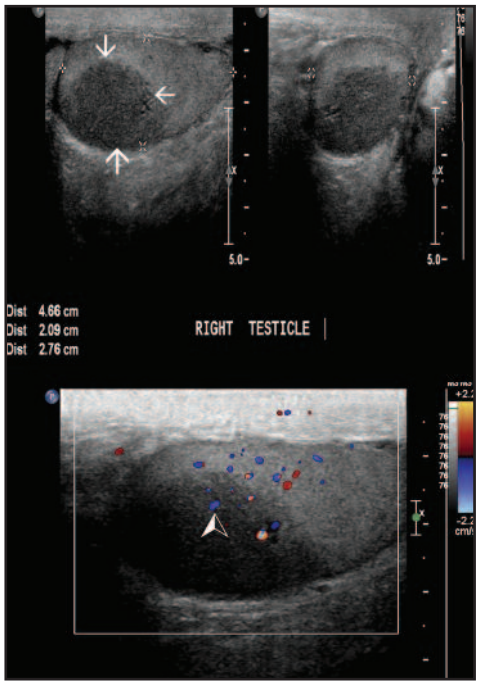

Fig. 5: 14 year old swelling over right testicular region for the last 1 week. Grayscale US (top) shows an edematous testes, with a relatively well defined heterogenous hypoechioc area within the testes (white arrows) within, suggestive of focal orchitis. Color doppler (bottom) show mildly increased intratesticular blood flow (arrow head). Patient's symptoms regressed after a course of antibiotics.

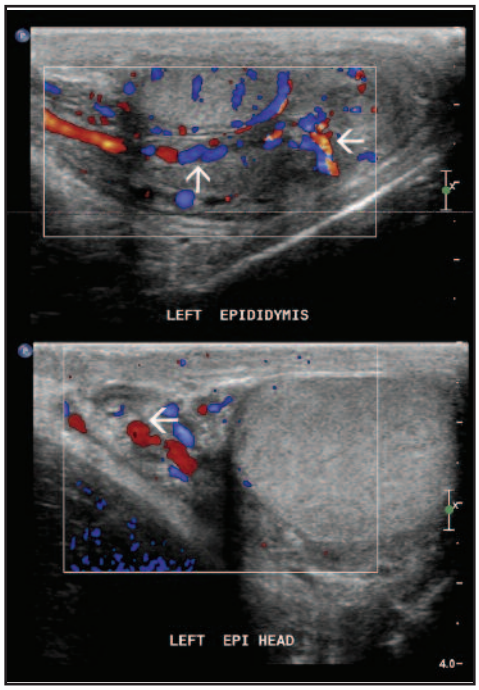

Fig. 6: A 10 year old boy with sudden onset of left testicular pain and swelling. Color Doppler US shows enlarged heterogenous left epididymis, which shows increased vascularity (white arrows). Features were suggestive of epididymitis and a course of antibiotics was given to the patient.

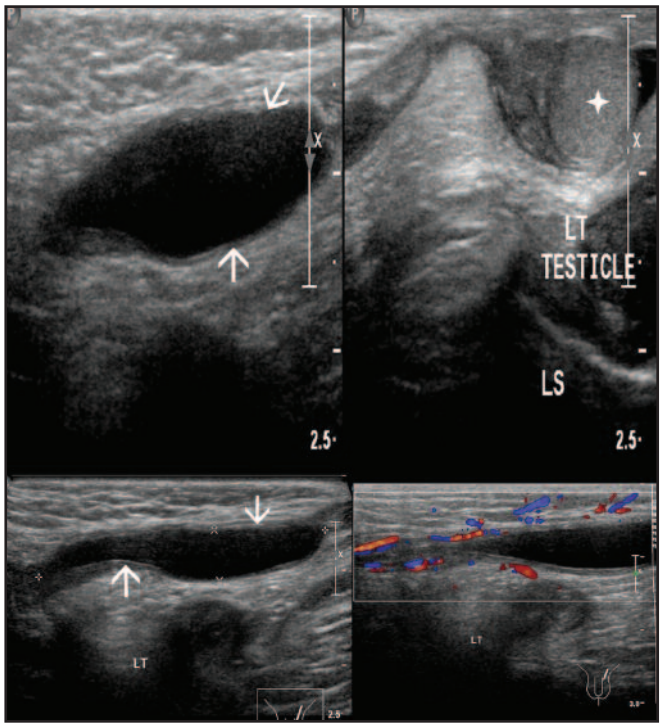

Fig. 7: 2 year old boy presented with painless swelling in the left inguinal region. Grayscale US (top) shows an ovoid cystic structure along the spermatic cord (white arrows). No associated vascularity; and the testes appears normal (white star). Color Doppler (bottom right) shows this cystic structure to be devoid of blood flow. Findings consistent with an encysted hydrocele of the spermatic cord.

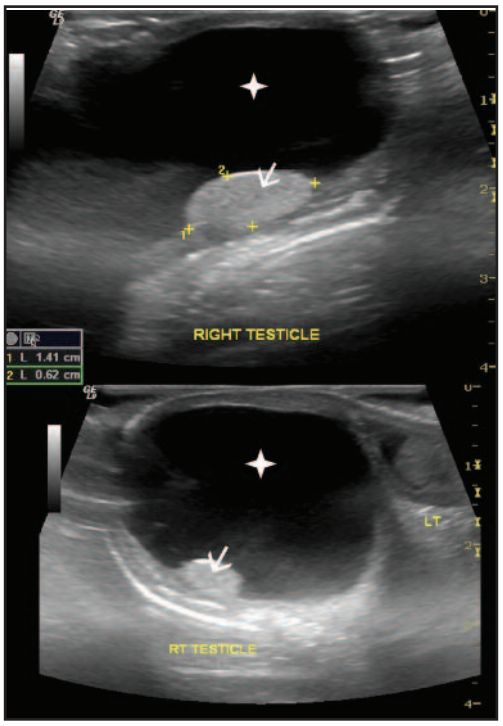

Fig. 8: 12year old boy presented with scrotal swelling for 2 months. He has no history of pain or trauma. Grayscale US shows a large anechoic collection (white star) in the scrotal sac indicative of a simple hydrocele. The testes (white arrow) is pushed to the periphery as it is attached to the tunica vaginalis and appears normal.

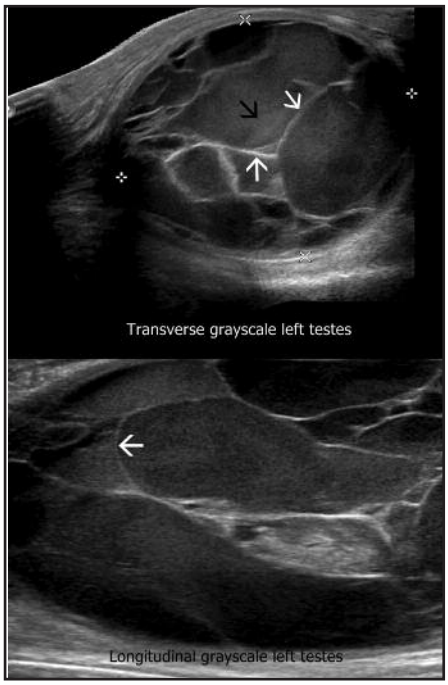

Fig. 9: A 13 yr old boy with painless scrotal swelling of 1 month duration. Grayscale US shows a large complex hydrocele with multiple septations (white arrows) and internal debris (black arrow). It was likely secondary to resolving infection.

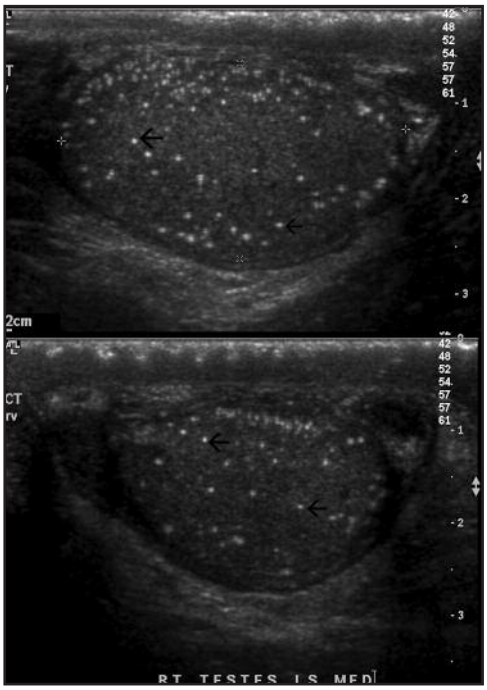

Fig. 10: 7 year old boy, with history of cryptorchidism presented with possible swelling of his right testes. Grayscale US showed numerous tiny nonshadowing hyperechoic foci (black arrows) scattered in the testes consistent with testicular microlithiasis.

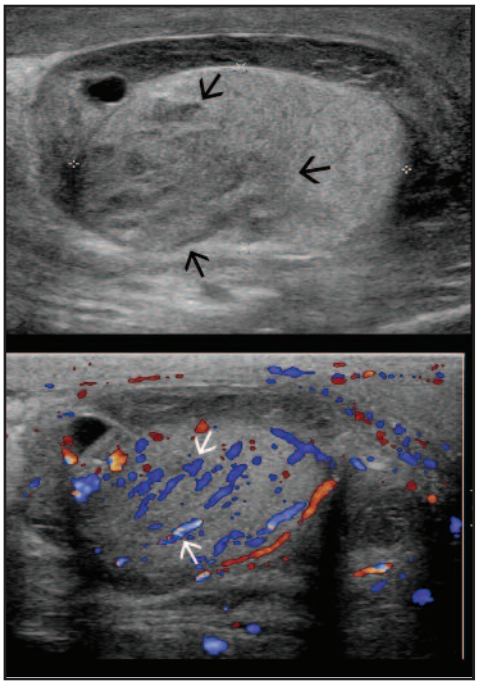

Fig. 11: 14 year old with known B cell lymphoma presented with progressive increasing painless scrotal swelling for 2 months. No history of pain nor trauma. Grayscale US (top) shows heterogeneously ill defined hypoechoic intratesticular mass (black arrows). Color doppler (bottom) shows the mass to be extremely vascular (white arrows). Histologically proven to be lymphomatous involvement.

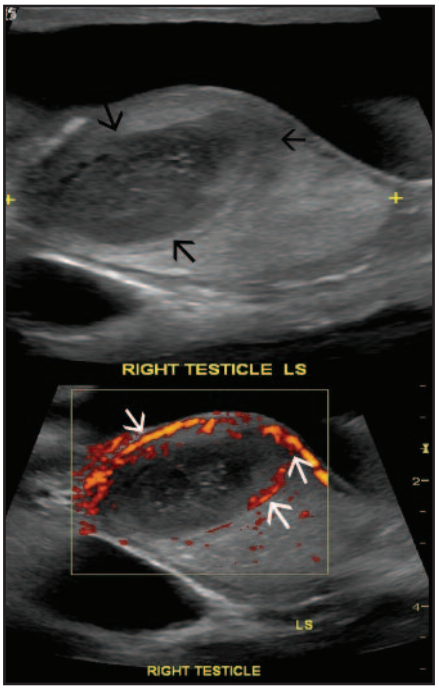

Fig. 12: A 15 year old boy presented with painless right testicular swelling for 4 months. Grayscale US (top) shows a nearly well-defined hypoechoic solid lesion in the right testes (black arrow). Color Doppler (bottom) shows with increased peripheral vascularity (white arrows). The lesion was biopsy proven to be a seminoma and an orchidectomy was performed.

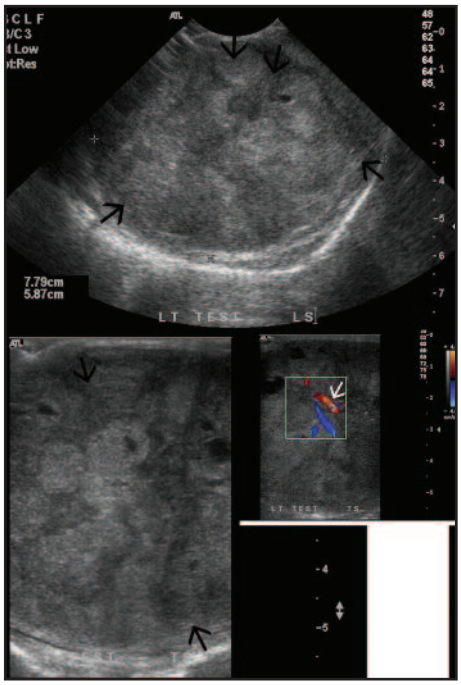

Fig. 13: 10 year old boy presented with painless left testicular swelling for 4 months. Grayscale and Doppler US show replacement of the normal testicular parenchyma, with a heterogenous mass (black arrows), with increased peripheral vascularity (white arrows). The lesion was biopsy proven to be a testicular germ cell tumor.

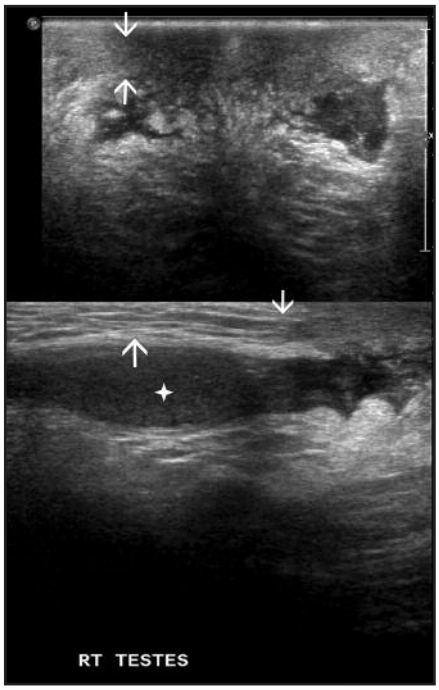

Fig. 14: A 6 year old boy with nephrotic syndrome, presented with diffuse scrotal swelling and redness. Grayscale US shows normal testes and epididymis (white star) and extensive scrotal wall edema (white arrows).

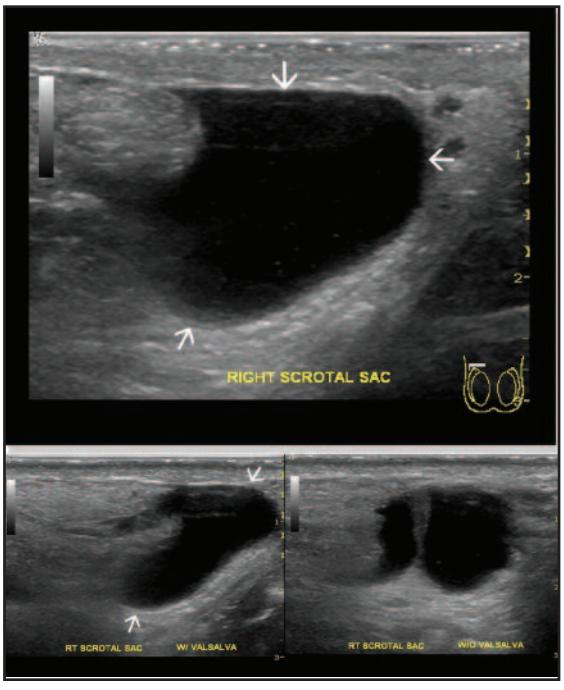

Fig. 15: An 8 year old boy presented with right scrotal swelling and pain. Grayscale US shows echogenic mass (white arrows) projecting into the scrotal sac, and is seen to extend superiorly into the inguinal region and showed accentuation on Valsalva, consistent with hernia.

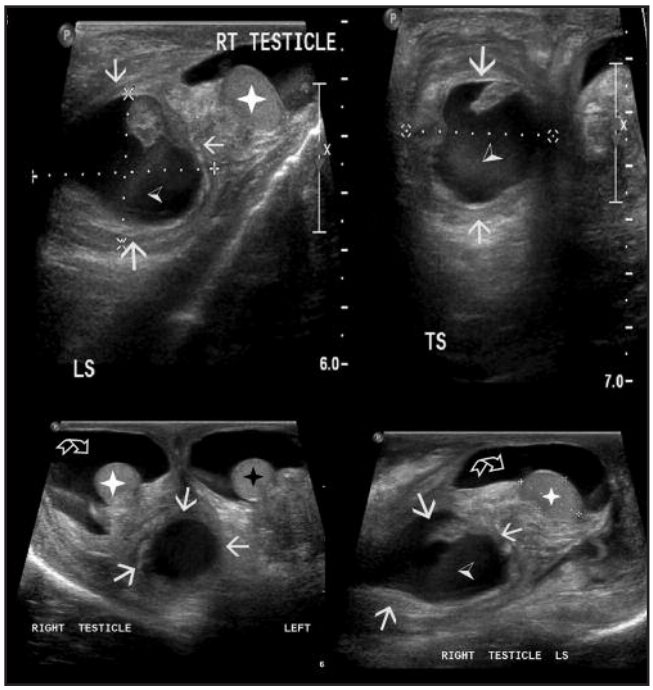

Fig. 16: 10 year boy presented with scrotal swelling and pain, and has a history of recent trauma with ball while playing. Grayscale US shows a heterogenous predominantly cystic mass (white arrows) with internal echoes (arrow heads), consistent with a resolving scrotal hematoma. Both the testis (right denoted by white star and the left denoted by black stars) with bilateral hydrocele (curved arrows), likely reactive.

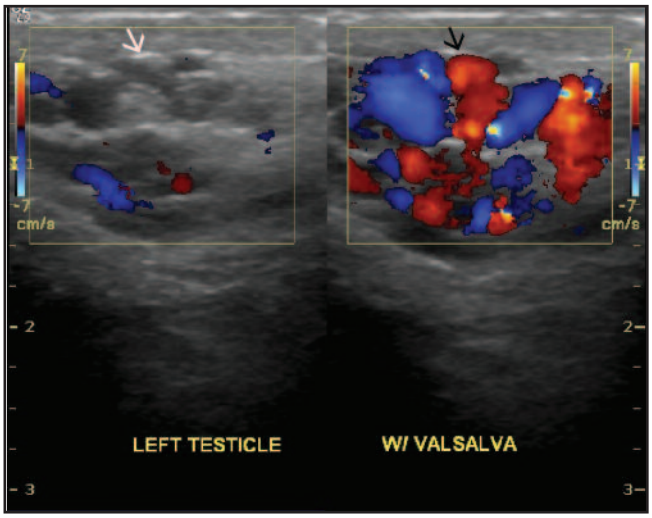

Fig. 17: A 14 year old boy with pain and heaviness in the left scrotum. Color Doppler US shows normal testes, with dilated pampiniform plexus (white arrows). The plexus shows accentuation on Valsalva (black arrows), appearing consistent with a varicocele.

simulate a focal mass. After 1–2 weeks, the hematoma undergoes liquefaction and may appear cystic. The sonographic appearance can vary depending on the age of the hematoma, and at times it may be difficult to differentiate between this entity and neoplastic lesions [17].

US usually shows an avascular mass, variable echogenicity (with age of hematoma) (Fig. 16). Associated findings of scrotal hemaotma, hematocele and wall thickening sometimes may give a clue.

Varicocele

Varicocele is abnormal dilatation of the pampiniform plexus. Varicocele is mass of painless enlarged testicular veins like a bag of worms and usually occurs on the left due to the left spermatic vein entering the left renal vein at a perpendicular angle (where else on the right, it enters the inferior vena cava obliquely which may have protective element). Retrograde flow into the spermatic vein causes dilatation and tortuous pampinifrom plexus. There are other more sinister causes of varicocele, such as mass effect or thrombosis of the renal veins, or the internal vena cava. As such, if an asymmetric right sided varicocele is found it is necessary to exclude other causes of abdominal compression secondary effects [18].

On US, serpentine, anechoic structures greater than 2mm are seen with flow on the Doppler imaging; and shows venous waveform on the pulsed Doppler imaging (Fig. 17). Augmentation of Doppler flow on valsalva and upright position are usually seen.

CONCLUSION

US plays a major role in the diagnosis, follow up and management of scrotal abnormality in pediatric age group. It is readily available, and usually the first and usually only investigation required for assessment of the scrotum and provides an accurate insight into the underlying process. It is able to easily distinguish causes of acute scrotal swelling such as testicular torsion and epidiymo-orchitis from not so acute ones such as hematomas, hydrocele and testicular tumors.

The authors declared no conflicts of interest.

APPENDIX: SONOGRAPHIC TERMS

1. Echogenicity: refers to 'brightness' directly related to the type and density of the tissue
- echogenic/hyperechoic = bright
- hypoechoic = dark
- anechoic = black

2. Characteristics: refers to tissue composition
- cystic = no internal echos, smooth borders good through transmission, posterior enhancement
- complex = cystic with solid components, septae
- solid = no cystic areas

3. Pattern: refers to tissue uniformity
- homogenous = uniform echos throughout
- heterogenous = echo levels variable

4. Planes: sagittal and transverse
- sagittal = divides into vertical plane (right half, left half)
- transverse = divides into horizontal plane (top half, bottom half)

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