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UROGENITAL

Imaging features of benign solid testicular and paratesticular lesions

Sung Bin Park · Won Chan Lee · Jeong Kon Kim · Seong Hoon Choi · Byeong Seong Kang · Kyung Hyun Moon · Young Min Kim · Yoong Ki Jeong

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Abstract
Objective The presence of an intratesticular solid lesion is usually highly suspicious for malignancy. Conversely, most extratesticular solid lesions including paratesticular lesions are benign. The characteristic imaging features of malignant solid testicular lesions are well known, but various unusual causes and imaging features of benign solid testicular lesions can be particularly misleading. Therefore, a careful assessment of solid testicular and paratesticular lesions is warranted. The purpose of this article is to present the clinical and imaging features of the spectrum of benign solid testicular and paratesticular lesions.
Methods We demonstrate a variety of benign solid testicular and paratesticular lesions and correlate them with pathologic results.
Results Specific the clinical and imaging features of the spectrum of benign solid testicular and paratesticular lesions have been described.
Conclusions Familiarity with the clinical setting and imaging features of benign solid testicular and paratesticular lesions should facilitate prompt, accurate diagnosis and treatment.

Keywords Testis · Neoplasms · Cysts · Scrotum · Diseases · Ultrasound (US) · Magnetic resonance imaging (MRI)

S. B. Park (✉)
Department of Radiology, Cheil General Hospital and Women's Healthcare Center, Kwandong University College of Medicine,
1–19, Mookjeong-dong,
Jung-gu, Seoul 100–380, Korea
e-mail: pksungbin@paran.com

S. B. Park · W. C. Lee · S. H. Choi · B. S. Kang · Y. K. Jeong
Departments of Radiology, Ulsan University Hospital,
University of Ulsan,
290–3, Jeonha-dong,
Dong-gu, Ulsan 682–714, Korea

J. K. Kim
Departments of Radiology and Research Institute of Radiology,
Asan Medical Center, University of Ulsan,
388–1 Poongnap-dong,
Songpa-gu, Seoul 138–736, Korea

K. H. Moon
Departments of Urology, Ulsan University Hospital,
University of Ulsan,
290–3, Jeonha-dong,
Dong-gu, Ulsan 682–714, Korea

Y. M. Kim
Departments of Pathology, Ulsan University Hospital,
University of Ulsan,
290–3, Jeonha-dong,
Dong-gu, Ulsan 682–714, Korea

Most solid testicular lesions are malignant [1–4]. Primary intratesticular malignancy can be divided into germ cell tumours and non-germ cell tumours. Germ cell tumours are further categorized as either seminomas or nonseminomatous tumours. The non-germ cell tumours include Leydig cell and Sertoli cell tumours [2]. Benign solid testicular lesions are rare, but their recognition is important to avoid unnecessary radical surgery [1].

The paratesticular region consists of the spermatic cord, epididymis, vestigial remnants, and tunica vaginalis [4, 5]. The vast majority of paratesticular lesions are benign cystic lesions of the epididymis (cysts, spermatoceles), scrotal fluid collections (hydroceles, pyoceles), inflammatory lesions (acute and chronic epididymitis), or hernia. Although paratesticular solid lesions are benign and rare,

these lesions are clinically significant and affect patients of all ages [5]. Therefore, a careful assessment of solid testicular and paratesticular lesions is warranted.

In this article, we describe clinical and imaging features for the spectrum of benign solid testicular and paratesticular lesions.

Evaluation of scrotal lesions

Scrotal enlargement or palpable scrotal lesions on physical examination require further evaluation for a solid testicular lesion. Ultrasound (US) performed with a high-frequency transducer and color Doppler analysis is the primary imaging investigation for investigating scrotal lesions [2]. When a palpable mass is evaluated with US, the primary goal is localization of the mass (intratesticular or extratesticular) and further characterization of the lesion (solid or cystic). The presence of an intratesticular solid mass is highly suspicious for malignancy, and more than 95% of intratesticular lesions are malignant. Conversely, extratesticular lesions, which are more common than intratesticular lesions, are benign in the vast majority of cases [1–4].

Scrotal US is performed with the patient in the supine position and the scrotum supported by a towel placed between the thighs. A high-resolution, near-focused, linear-array transducer with a frequency of 7.5 MHz or greater is used. Transverse and longitudinal grey-scale imaging of the scrotum and inguinal regions bilaterally is performed. Scrotal skin thickness is evaluated. Colour Doppler examination is subsequently performed, optimized to be sensitive to low-velocity flow. This is accomplished by having low pulse repetition frequency and a low wall filter with appropriate color gain setting (generally over 80%). When examining the acute scrotum, the asymptomatic side should be scanned first to ensure that the flow parameters are set appropriately. Transverse image of all or a portion of both testicles in the field of view is also obtained to allow side-to-side comparison of their size, echogenicity, and vascularity. On US, the normal testicle is slightly echogenic with homogeneous echotexture. The testicle is surrounded by a fibrous band, the tunica albuginea, which is often not visualized in the absence of intrascrotal fluid. However, the tunica is often seen as an echogenic line around testicle. The epididymis is located posterolateral to the testis. On US, it is iso- to hyperechoic to the normal testis and has equal or diminished vascularity [2].

Magnetic resonance imaging (MRI) can be used as a problem-solving tool when US findings are equivocal or suboptimal [2–4]. MRI allows improved characterization of scrotal lesions as intratesticular or extratesticular and can reveal various types of lesions and tissue, including cyst, fluid or haemorrhage, solid masses, fat, and fibrosis. When used properly, MRI can decrease the overall number of unnecessary surgical procedures and reduce cost [2].

The MRI examination should be performed with a phased-array surface coil with patient positioning similar to that used during US, a folded towel is placed between the patient's legs to elevate the scrotum and penis [2. 4]. The typical imaging protocol consists of large field-of-view axial pelvic imaging to assess the inguinal canal, bowel for hernias and ascites. Both T1-weighted and T2-weighted sequences (axial, sagittal and coronal) should be performed [2]. A fat-suppressed sequence or gradient-echo sequence should be used in cases in which fatty or haemorrhagic lesion is a consideration [2, 4]. Although generally not needed, intravenous gadolinium contrast material can be administrated to evaluate vascularity. On MRI, the normal testis has a homogeneous appearance, with intermediate signal intensity on T1-weighted images and high signal intensity on T2-weighted images relative to skeletal muscles. The relatively high signal intensity of the testis on T2-weighted images allows excellent contrast from solid lesions, which invariably have lower signal intensity on T2-weighted images. The tunica albuginea appears as low signal intensity on T1- and T2-weighted images. The epididymis has signal intensity characteristics similar to testicular parenchyma on T1-weighted images but lower signal intensity on T2-weighted images [2].

Benign intratesticular solid lesions

Epidermoid cyst

Epidermoid cysts are the most common benign intratesticular neoplasms and constitute approximately 1% of testicular tumours. They are of germ cell origin but contain only ectodermal tissue [1–3]. This type of cyst typically manifests in younger men and adolescents as a painless, palpable mass and is usually 1–3 cm at discovery [2].

Although they are true cysts by pathology, they are filled with laminated keratinized material that appears solid and is reflected on imaging [3]. On US, they are well-circumscribed, round to slightly oval masses with hyperechoic walls that are sometimes calcified. The mass may be hypoechoic, but the laminations often give rise to an "onion-ring" or target appearance (Fig. 1). On MRI, they may have a similar alternating appearance, with a low signal intensity capsule. The layers of keratinized material within the lesion are rich in water and lipid and appear as areas of high signal intensity on both T1-and T2-weighted images (Fig. 2) [1–3, 6, 7]. These cysts do not show blood flow or enhancement on Doppler US or enhanced MRI (Figs. 1 and 2). The combination of an onion ring configuration, negative tumour marker status, and avascu-

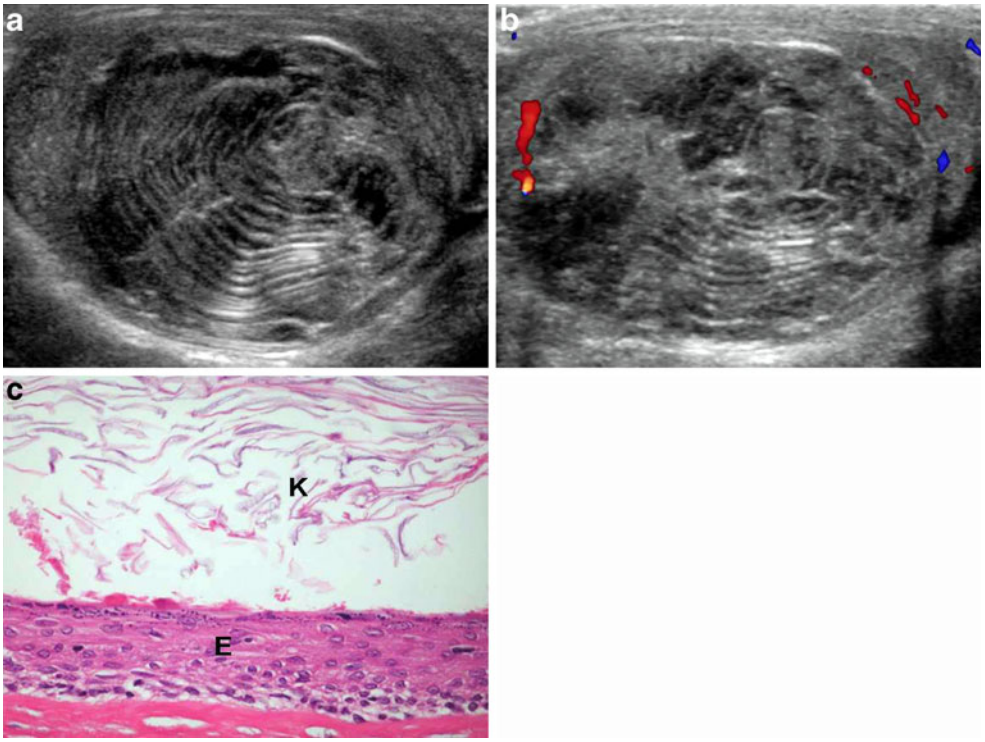

Fig. 1 A 28-year-old man with epidermoid cyst of the right testis suffered from a palpable right scrotal mass. All tumor markers are within the normal range. **a** Longitudinal US of the right testis shows a well-defined mass with prominent concentric rings or multilayered appearance. **b** Colour Doppler US shows absent vascularity. Radiologic primary diagnosis was epidermoid cyst. Enucleation was performed. **c** Microphotograph shows the cyst wall contains keratinized squamous epithelium (E) and the cystic lumen contains keratinized debris (K), confirming diagnosis of epidermoid cyst (H & E stain, original magnification, X10)

larity helps differentiate testicular epidermoid cysts from other germ cell tumours [1].

Management of epidermoid cysts has been controversial. The prevailing wisdom was that orchiectomy was necessary for histologic diagnosis. However, if the lesion has been thoroughly evaluated and if there is a strong likelihood that it is an epidermoid cyst (negative tumour marker and lesion smaller than 3 cm), some investigators have suggested performing a conservative, testicular-sparing enucleation [7].

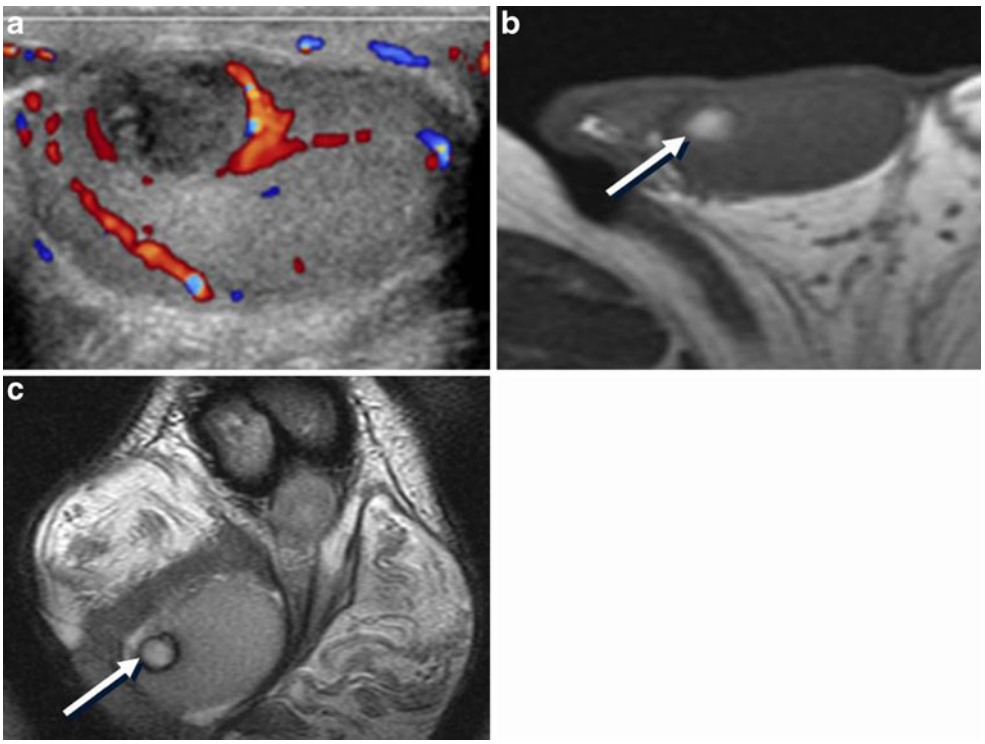

Fig. 2 A 45-year-old man with epidermoid cyst of the right testis suffered from a palpable right scrotal mass. All tumor markers are within the normal range. **a** Colour Doppler US of the right testis shows a well-defined hypoechoic mass with absent vascularity. **b** & **c** T1-(B) weighted axial and T2-(C) weighted coronal MRI show a hyper-intensity lesion and low signal intensity rim (arrows) on both sequences. Enhanced MRI indicated the absence of enhancement (not shown). Radiologic primary diagnosis was epidermoid cyst. Enucleation was performed. The pathologic results indicated epidermoid cyst

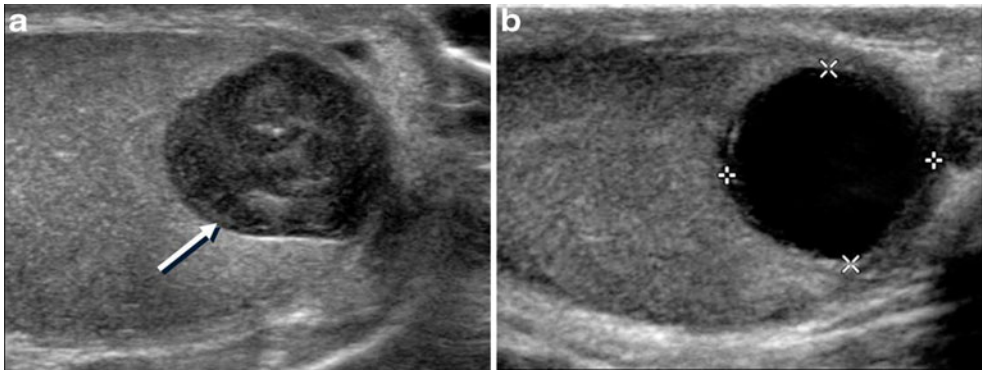

Fig. 3 A 41-year-old man with traumatic testicular haemorrhage of the right testis suffered from right scrotal pain after trauma. **a** Initial longitudinal US of the right testis shows heterogeneous hypoechoic mass (arrow). A small amount of haematocele is also noted (not shown). Radiologic primary diagnosis was testicular haemorrhage. Conservative treatment was performed. **b** Follow-up US after 2 weeks showed a change to anechoic cyst (calibers) due to liquefaction and confirmed diagnosis as intratesticular haemorrhage

Testicular haemorrhage

Intratesticular haemorrhage or haematomas are a common occurrence in the traumatized scrotum (Fig. 3) and may manifest various features [8]. Although spontaneous haemorrhage has been reported (Fig. 4) [9, 10], it is important to know and take into consideration the clinical setting such as trauma history. Single or multiple haematomas may be present and they may range in size from small to large. In addition, haemorrhage or haematomas may range in age from hyperacute to chronic, and may or may not be associated with other testicular and extratesticular injuries [8].

The ultrasonographic appearance can vary depending on the age of the haematoma, and at times it may be difficult to differentiate it from neoplastic lesions. Acute intratesticular haematomas appear hyperechoic on US and may simulate a focal mass (Figs. 3 and 4). After 1–2 weeks, the haematoma undergoes liquefaction and may appear cystic (Fig. 3) [2, 8]. On MRI, both intracellular and extracellular methaemoglobin within subacute blood appears hyperintense on T1-weighted images (Fig. 4). Chronic haematomas can have a lower signal intensity rim on T2-weighted images compared to haemosiderin deposition within macrophages. No enhancement is seen after administration of gadolinium contrast material [2].

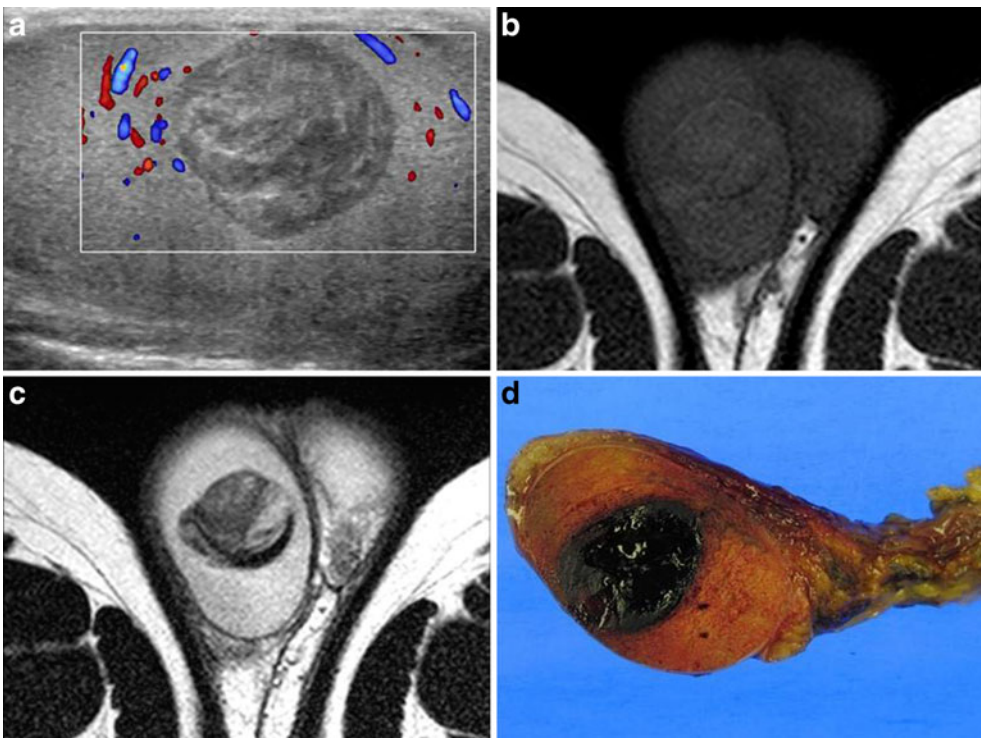

Fig. 4 A 29-year-old man with spontaneous testicular haemorrhage of the right testis suffered from sudden onset right scrotal pain but denied any history of trauma. **a** Colour Doppler US of the right testis shows well defined heterogeneous hypoechoic mass without vascularity. Alternative layers or "onion ring" appearance are suspicious for an epidermoid cyst. **b** & **c** T1-(B) and T2-(C) weighted MRI show heterogeneous intensity mass with low signal intensity rim in both sequences. Enhanced MRI shows absent enhancement (not shown). Radiologic primary diagnosis was epidermoid cyst. **d** The orchiectomy was performed. Photograph of the gross specimen shows dark coloured testicular haemorrhage correlating with the findings of concern on US and MRI. No epidermoid cyst was present

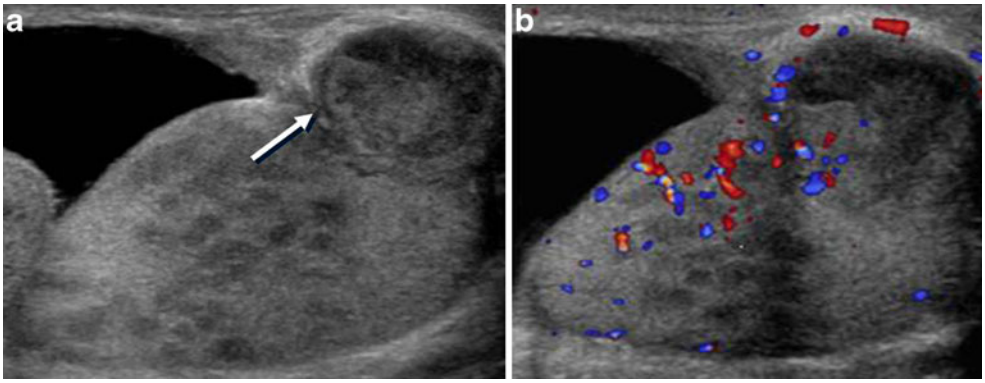

Fig. 5 A 35-year-old man with tuberculous epididymo-orchitis of the left testis suffered from a left scrotal palpable mass. **a** Longitudinal US of the left testis shows mass-like enlargement (arrow) of the epididymis tail and multiple hypoechoic nodular lesions within the whole testis. **b** Colour Doppler US of the left testis shows increased peripheral vascularity

Tuberculosis with testicular involvement

The genitourinary tract is the most common site of extrapulmonary involvement of tuberculosis. The epididymis appears to be affected first and to a much greater extent than the testis (Fig. 5). Tuberculous epididymal infections are through to result from renal disease seeding the lower genitourinary tracts, although haematogenous dissemination has also been suggested. Approximately 25% of patients have bilateral involvement [4]. Initially tuberculous epididymitis manifested as discrete or conglomerate yellowish, necrotic areas in the tail portion of the epididymis. At the later stage the inflammatory process usually involves both the head and tail of the epididymis, although diffuse involvement of the whole epididymis can be observed. Infection can spread to the testis, causing an epididymo-orchitis, but this is less common than isolated epididymal disease. An isolated testicular involvement is extremely unusual (Figs. 6 and 7) [3].

On US, the epididymis appears enlarged with variable echogenicity. Heterogeneous echogenicity can be caused by the presence of caseation necrosis, granulomas, fibrosis, and calcifications. Orchitis has a similar appearance, but the presence of multiple small hypoechoic nodules has also been described (Fig. 5). On Doppler US, a lower degree of blood flow in the peripheral portion has been reported (Figs. 5, 6 and 7) [1, 11]. On MRI, heterogeneous abnormal signal intensity can be seen on T2-weighted images (Fig. 7) [2].

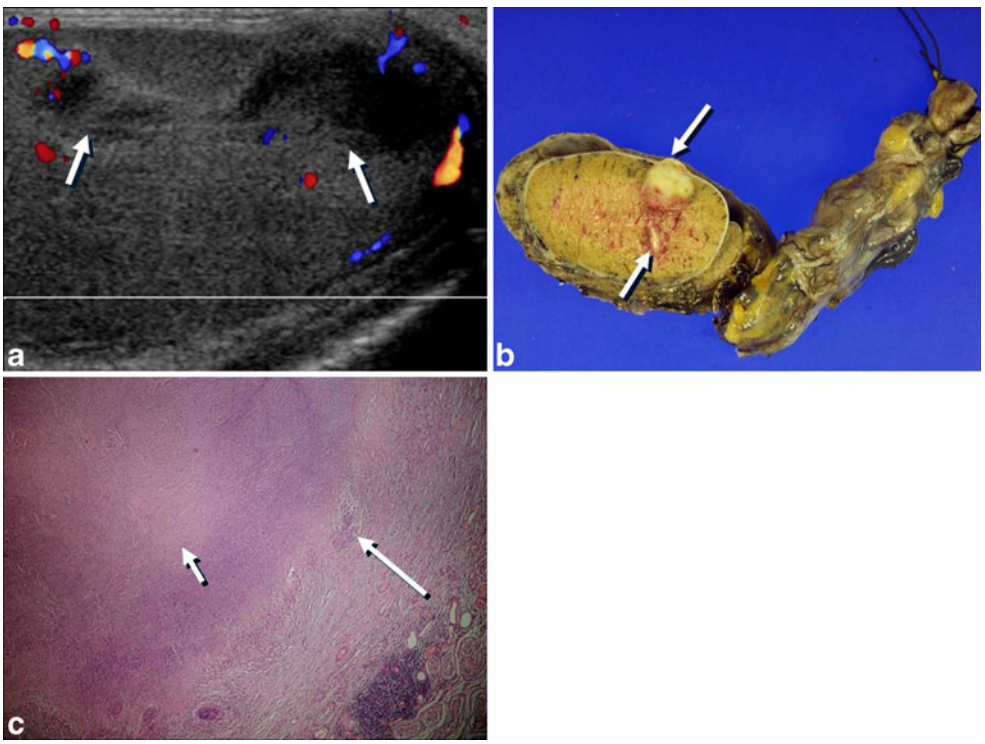

Fig. 6 A 30-year-old man with isolated testicular tuberculosis of the right testis suffered from a right scrotal palpable mass. **a** Colour Doppler US of the right testis shows two heterogeneous hypoechoic lesions with peripheral vascularity (arrows). No associated abnormal findings of the epididymis are evident (not shown). Radiological primary diagnosis was testicular cancer. The radical orchiectomy was performed. **b** Photograph of the gross specimen shows two nodular firm lesions (arrows) within the right testis. **c** Microphotograph shows granulomas (small arrow) with caseation necrosis (arrow), confirming of testicular tuberculosis (H & E stain, original magnification, X4)

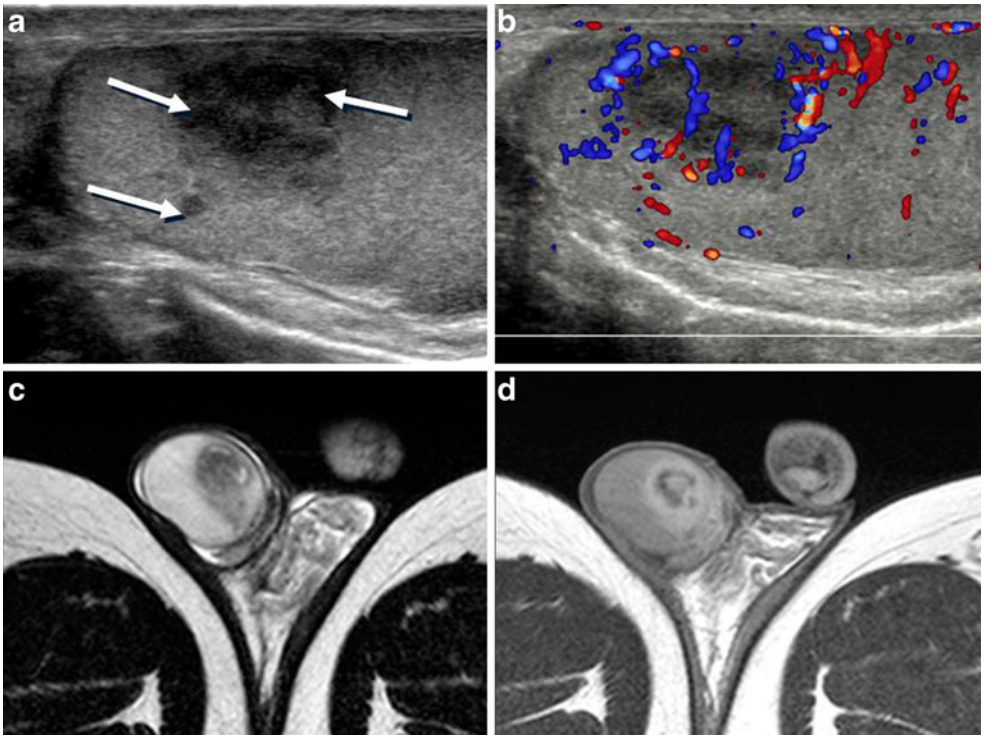

Fig. 7 A 44-year-old man with isolated testicular tuberculosis and abscess formation of the right testis. **a** Longitudinal US of the right testis shows heterogeneous ill-defined hypoechoic lesions (arrows). **b** Colour Doppler US shows increased peripheral vascularity. **c** T2-weighted MRI shows heterogeneous low signal intensity lesion within the right testis. **d** Enhanced T1-weighted MRI shows peripheral strong enhancement. Radiologic primary diagnosis was testicular cancer. The radical orchiectomy was performed. The pathologic results indicated testicular tuberculous abscess without epididymal involvement

Other benign intratesticular solid lesions

Other benign intratesticular solid lesions include ischaemia or infarction, adrenal rest, leydig cell hyperplasia, and sarcoidosis [1–3].

Benign abutting solid testicular lesions (paratesticular lesions)

Adenomatoid tumour

Adenomatoid tumour is the most common epididymal tumour and accounts for approximately 30% of all paratesticular neoplasms [4, 5]. Adenomatoid tumour occurs in men with a wide range of ages, with the majority being diagnosed in patients aged 20–50 years. Patients usually present with a painless scrotal mass. The tumours are smooth, round, and well-defined and can vary in size from 0.4 up to 5 cm [4].

Although more frequent in the tail, adenomatoid tumour may occur anywhere in the epididymis and have also been reported in the spermatic cord, paratesticular tissue (Fig. 8) and tunica albuginea, where they can grow intratesticularly [4, 5]. Thus these lesions can extend into the testis from a paratesticular location, and it may be necessary to obtain an MRI after an initial US to prove their extratesticular origin.

On US, they appear nonspecific and variable, although the majority appears isoechoic and homogeneous (Fig. 8) [5]. MRI demonstrates low signal intensity relative to the testicular parenchyma on T2-weighted images. MRI can aid in determining the paratesticular origin of the lesion. After administration of contrast material, slow or decreased enhancement relative to the normal testis may be demonstrated and also suggest a benign condition (Fig. 8) [2].

Testicular appendage with torsion

The appendix testis is a vestigial remnant of the embryonic mesonephric and paramesonephric duct system [12, 13]. It is located at the upper pole of the testis in the groove between the testis and the head of the epididymis. It is a sessile structure, which predisposes it to torsion [12].

Torsion of the appendix testis occurs mainly in prepubertal boys (aged 7–14 years), is more frequent on the left side, and is a common cause of acute scrotum in this age group. Affected patients typically present with gradually developing or sudden intense pain, usually localized in the upper pole of the testis. In approximately one-third of patients, a nodule of the upper scrotum with bluish skin discoloration (the “blue dot” sign) is palpated. This is a pathognomonic feature [12].

Gray scale and Doppler US may be helpful in the diagnosis of torsion of the appendix testis. A size of 5 mm or larger, spherical shape, and increased periappendiceal blood flow are indicative of a torsed appendix testis (Fig. 9) [12, 13].

Management consists of bed rest and nonsteroidal anti-inflammatory agents. The natural history of testicular appendage torsion is normally that the symptoms settle and the twisted appendix atrophies.

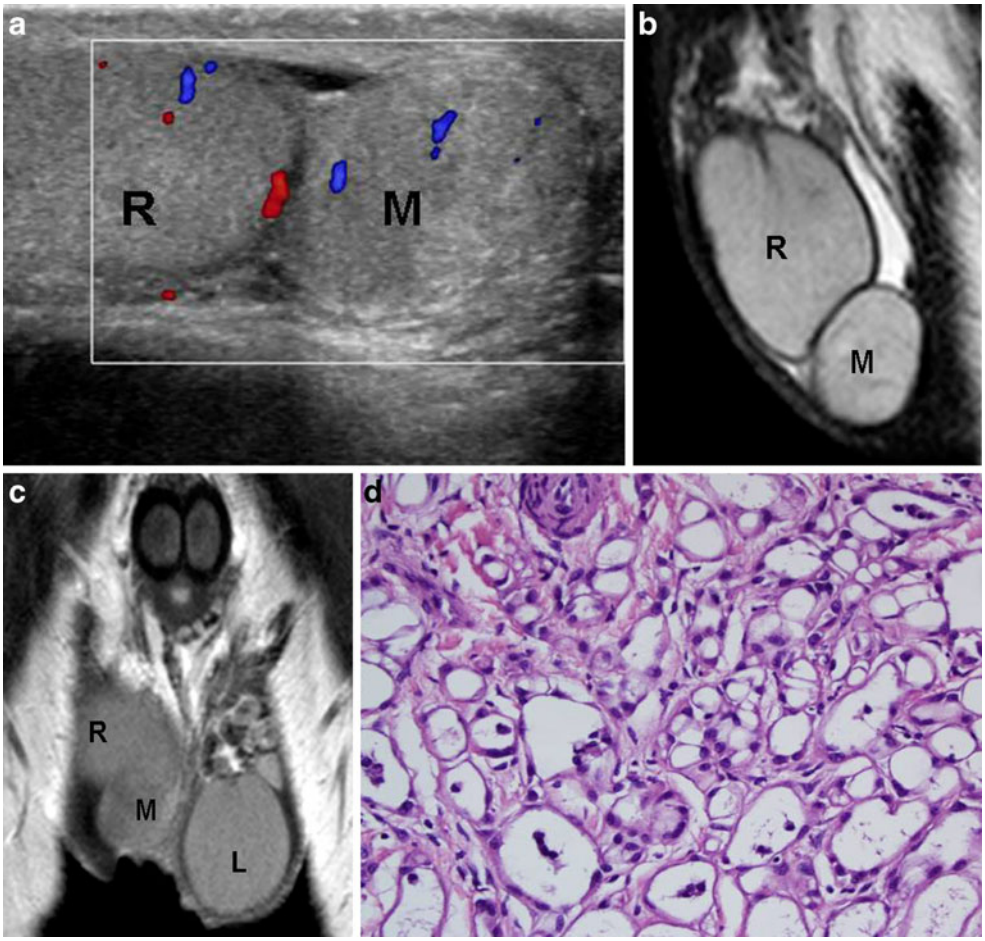

Fig. 8 A 50-year-old man with paratesticular adenomatoid tumor suffered from a right scrotal palpable lesion. **a** Colour Doppler US of the right testis shows a well-defined homogeneous solid mass (M) abutting the lower pole of the right testis (R) without connecting to the epididymis. The mass had almost the same echotexture as the apparently normal right testis. **b** T2-weighted sagittal MRI shows slightly hypointense lesion (M) relative to the adjacent normal right testis (R). **c** Enhanced T1-weighted MRI shows decreased enhancement relative to adjacent normal right (R) and left (L) testis. Mass excision was performed. The results indicated adenomatoid tumor from paratesticular tissue. **d** Microphotograph shows conglomeration of dilated cystic space, confirming diagnosis of adenomatoid tumor (H & E stain, original magnification, X40)

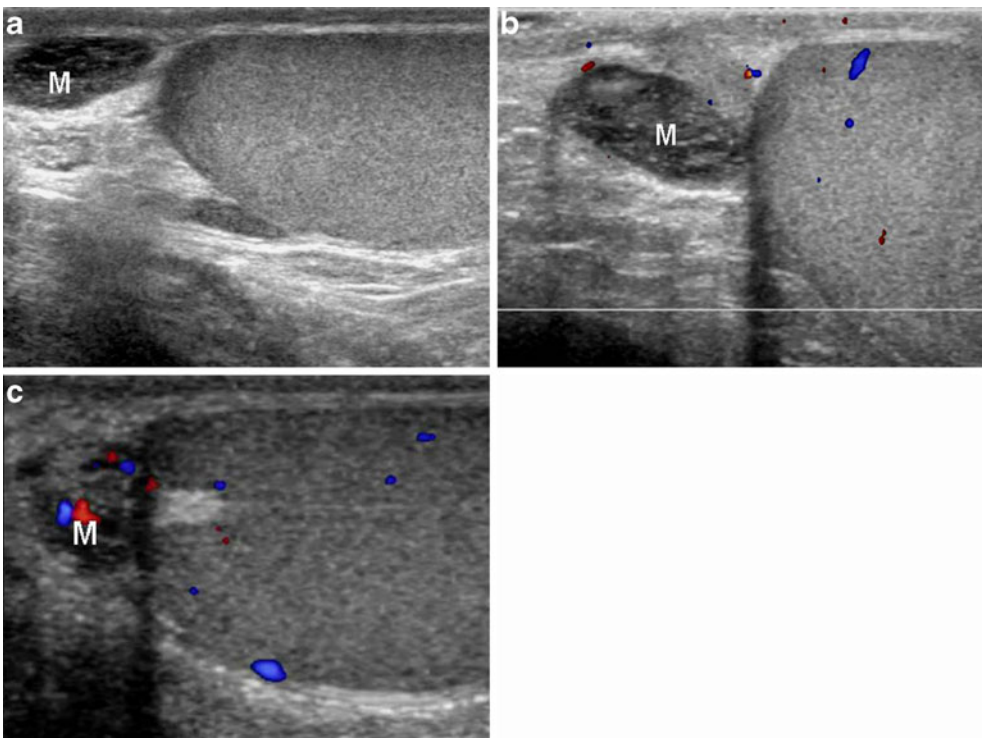

Fig. 9 A 13-year-old man with left testicular appendage with torsion suffered from sudden-onset left scrotal pain. **a** Longitudinal US of the left testis shows hypoechoic mass-like lesion (M) at the left testis upper polar area. **b** Colour Doppler US shows absent vascularity. Radiologic primary diagnosis was testicular appendage with torsion. Conservative treatment was performed. **c** Follow-up US after 1 week shows decreased size of the presumed torsed testicular appendage (M). His pain had also been subsided

Leiomyoma

Leiomyomas are benign tumours that may arise from any structure or organ containing smooth muscle. The majority of male genitourinary tract leiomyomas are found in the renal capsule, but this tumour has also been reported in the epididymis, spermatic cord, and tunica albuginea (Fig. 10).

Leiomyomas are usually well circumscribed and surrounded by a gray-white fibrous capsule. The cut surface bulges and exhibits a whorled pattern. At microscopic analysis, the tumour is seen to consist of smooth muscle spindle cells arranged in interlacing bundles with varying admixtures of fibrous, often hyalinized connective tissue (Fig. 10) [5].

On US, leiomyomas have been reported as a whirling pattern with multiple narrow areas of shadowing without obvious calcifications in the solid mass (Fig. 10) [5, 14].

Lipoma

Lipoma is the most common benign neoplasm of the paratesticular tissues and spermatic cords, comprising 45% of paratesticular masses. This tumour most often manifests as an incidentally discovered nontender scrotal mass and affects patients over a wide age range [5].

On US, it is well-defined, homogeneous, hyperechoic paratesticular lesion of varying size. On MRI, Lipoma appears uniform and follows fat signal intensity with all sequences, including fat-suppressed sequences, thus confirming the diagnosis [2, 4, 5].

Fibrous pseudotumour

Fibrous pseudotumour is not a neoplasm but a benign reactive fibrous proliferation of paratesticular tissue that can mimic a neoplasm. It most commonly arises from the tunica vaginalis. Most patients present with a painless scrotal mass, but they often have a history of prior infection or trauma [4, 5].

The US appearance is nonspecific, and calcification is common. On MRI, owing to the presence of fibrosis, the lesion has low signal intensity on both T1- and T2-weighted images with variable enhancement [2, 4]. Recognizing the benign nature of this entity should allow for a more conservative scrotal exploration with frozen section confirmation rather than an orchiectomy [4].

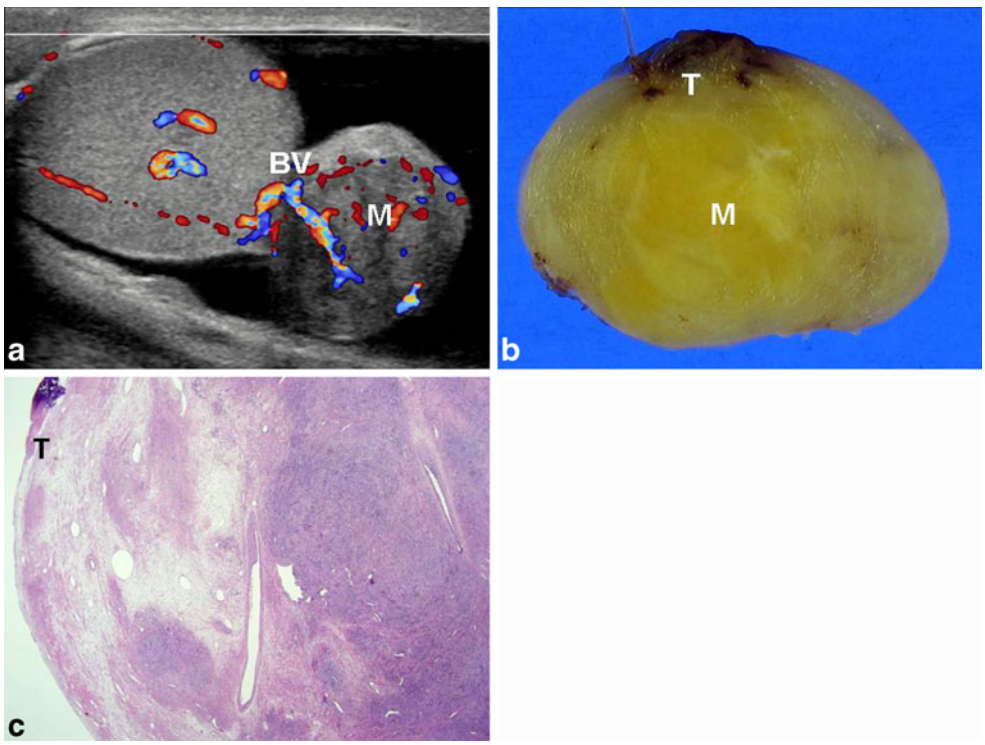

Fig. 10 A 31-year-old man with paratesticular leiomyoma suffered from a left scrotal palpable lesion. **a** Colour Doppler US of the left testis shows heterogeneous hypoechoic bulging nature mass (M), which presented with vascularity and a penetrating or bridging vessel (BV) between the left testis and abutting mass (M). The whirling pattern and multiple narrow areas of shadowing within the mass are suspicious for leiomyoma. Radiologic primary diagnosis was a tumor arising from tunica albuginea. Mass excision was performed. **b** Photograph of the gross specimen shows firm solid yellowish mass (M) arising from tunica albuginea (T, cut surface). **c** Microphotographs show solid mass arising from tunica albuginea (T) and whirling pattern, confirming of leiomyoma arising from tunica albuginea (H & E stain, original magnification, X4)

Other benign abutting solid testicular lesions

Other benign abutting solid testicular lesions (paratesticular lesions) include inguino-scrotal hernia, cystadenoma, haemangioma, tunica albuginea origin fibroma or neurofibroma, splenogonadal fusion, and polyorchidism [4, 5, 15].

Summary and conclusions

The imaging characteristics and causes of benign solid testicular and paratesticular lesions vary widely, and for the most part mimic malignant lesions. The role of the radiologist is to ensure that benign solid testicular and paratesticular lesions are diagnosed preoperatively if possible and are differentiated from the malignant lesions using either particular imaging findings or clinical settings. We suggest that familiarity with the clinical setting and imaging features of benign solid testicular and paratesticular lesions should facilitate prompt, accurate diagnosis and treatment.

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