

Sonography of scrotal abnormalities in adults: an update

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ABSTRACT

The purpose of this pictorial review is both to demonstrate newly described conditions such as whirlpool sign, fibrosis, benign testicular lobulation, and effect of hydrocele on the testis and to scrutinize usual and unusual scrotal abnormalities to bring the reader up to date. The use of ultrasonography will give the correct diagnosis in most conditions providing that it is used appropriately. Familiarity with the ultrasonography features of both common and newly described entities is important for the management of scrotal abnormalities.

Key words: • scrotum • testis • ultrasonography, Doppler

Ultrasonography (US) is the imaging modality of choice for evaluating scrotal abnormalities. Familiarity with US pitfalls, tips, and tricks are essential for establishing the correct diagnosis. The first objective of this pictorial review is to demonstrate newly described conditions such as whirlpool sign, fibrosis, benign testicular lobulation, and effect of hydrocele on the testis; and the second objective is to provide current information on common and unusual scrotal abnormalities. In addition, normal anatomy and examination technique of the scrotum with tips are briefly summarized.

Normal anatomy and technique

In adults, the normal testes are paired organs with a symmetrical fine echotexture; each testis has a volume of 12–20 cm³ (Fig. 1a). The epididymis is mostly isoechoic to the testis. The ductus deferens, with a luminal diameter of 0.1 mm, is a continuum of the tail of the epididymis. The key feature to identify the ductus deferens is its typical thick smooth muscle wall. Of the appendages, the appendix testis and the appendix epididymis (Fig. 1b) are well seen at US. In contrast to the appendix testis, which is located in the groove between the testis and the epididymis, appendix epididymis is found mostly on top of the epididymal head (1).

Motion and maladjusted imaging parameters are pitfalls to color Doppler imaging of blood flow. To optimize color flow, imaging should be performed with a low wall filter, a low pulse repetition frequency, and a relatively high color gain output setting (Figs. 1c, d). Color priority with some equipments and a small color sampling box may also contribute to the optimization of the color flow image. Power and/or pulsed Doppler imaging as well as comparison with the contralateral testis are especially useful in cases of epididymoorchitis and incomplete testicular torsion. Pulsed Doppler provides a great deal of information about blood flow that is simply not available with color Doppler, particularly in a still image. During pulsed Doppler evaluation, changing transducer position is advised whenever beam steering is a problem. In addition, wider sample volume improves the spectral waveform.

Normally in the cord, the testicular artery has low resistance and a mean resistive index (RI) of 0.62, whereas deferens and cremasteric arteries have higher resistance (mean RI >0.75). Intratesticular arterial vascular trees also have low resistance, as in the cord.

Acute scrotal pain

Causes of acute scrotal pain include epididymoorchitis or focal orchitis (Fig. 2a), torsed appendix or torsion of testis (Fig. 2b), infarction (Fig. 2c), trauma (Fig. 2d), incarcerated inguinal hernia (Fig. 2e), neoplasm (in 10% of cases) (Fig. 2f), and scrotal wall inflammation (Fig. 2g). The

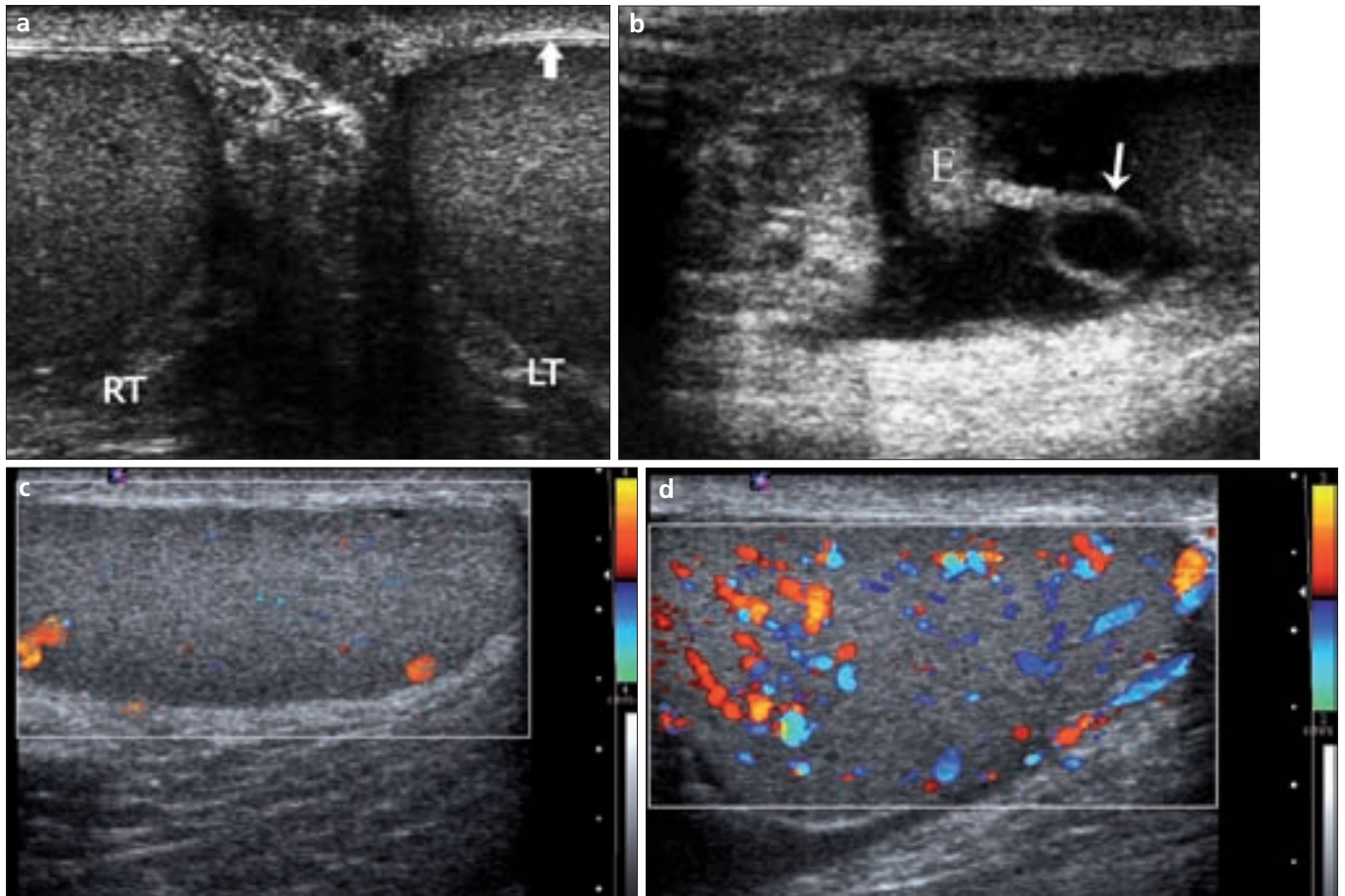


Figure 1. a–d. Normal anatomy and techniques. A 35-year-old man with transverse gray-scale US image of both testes (a) through the median raphe of the scrotum in order to compare the echogenicity of the testes on a single image. Symmetrical homogenous fine granular echo pattern with detail of the surface of the testes showing hyperechoic lines, tunics (arrow). Transverse axis median raphe view is usually angled inferiorly on the left due to lower position of the left testis (RT, right testis; LT, left testis). Longitudinal gray-scale US image of the scrotum (b) in a 23-year-old man. Cystic, long stalked appendix epididymis (arrow) is seen in the minimal fluid between the layers of tunica vaginalis, which makes easier to detect it (E, epididymis). Cystic appearance of the appendix epididymis is occasionally seen as a normal variant and should not be mistaken for a torsed testicular appendage. Color Doppler US images of the same testis (c, d) of a 32-year-old man with different US machine settings and positions. High wall filter, high pulse repetition frequency, and decreased color gain output settings produce scanty color coding on the testis (c). Instead, using low wall filter, low pulse repetition frequency, and increased color gain output settings in addition to changing the transducer position to a different location on the surface of the scrotum clearly improves color detection (d). No change of beam steering on either image.

asymptomatic testis should be thoroughly evaluated first. After US settings are adjusted according to asymptomatic side, interpretation of findings of symptomatic side will be easier. Starting the spermatic cord examination on the symptomatic side is also important for detection of a twisted cord or whirlpool sign. The whirlpool sign is recently described: various appearances of a whirlpool sign are described as a snail, a snail shell (Fig. 2b), a doughnut shape, a target with concentric rings, and a storm on a weather map (2). The whirlpool sign is elicited in the following manner: When tortuosity of the spermatic cord is seen, a short axis scan of the cord above the level of tortuosity is obtained. The transducer is then

moved down along the cord, and a rotation of the cord structures is looked for. If an acute rotation is seen, it is taken as a positive whirlpool sign.

On pulsed Doppler, peak systolic velocity in intratesticular arteries increase 1.7–2.0 fold on symptomatic side in epididymoorchitis (3). The RIs in the testicular artery (<0.5) and epididymal artery (<0.7) decrease. High resistance in the testicular arteries is a clue for developing infarction in epididymoorchitis or incomplete torsion.

Trauma may increase the risk of torsion, lead to epididymoorchitis, or may result in fracture of the testis with or without large hematocele. Paratesticular coagulum may mimic testicular fracture in trauma patients. An impor-

tant question in trauma is the status of tunica albuginea. If it is ruptured, surgery is required to maintain testicular viability and to prevent development of antibodies (4). Testicular rupture is a surgical emergency; more than 80% of ruptured testes can be saved if surgery is performed within 72 hours after injury. But, in some cases, orchiectomy is the treatment of choice. Other indications for US are assessment of the integrity of the epididymis, vascular status, and follow-up of patients undergoing conservative therapy.

Complications of acute epididymoorchitis include chronic pain, infarction, abscess (Fig. 2h), pyocele (Fig. 2i), gangrene, infertility, and atrophy.

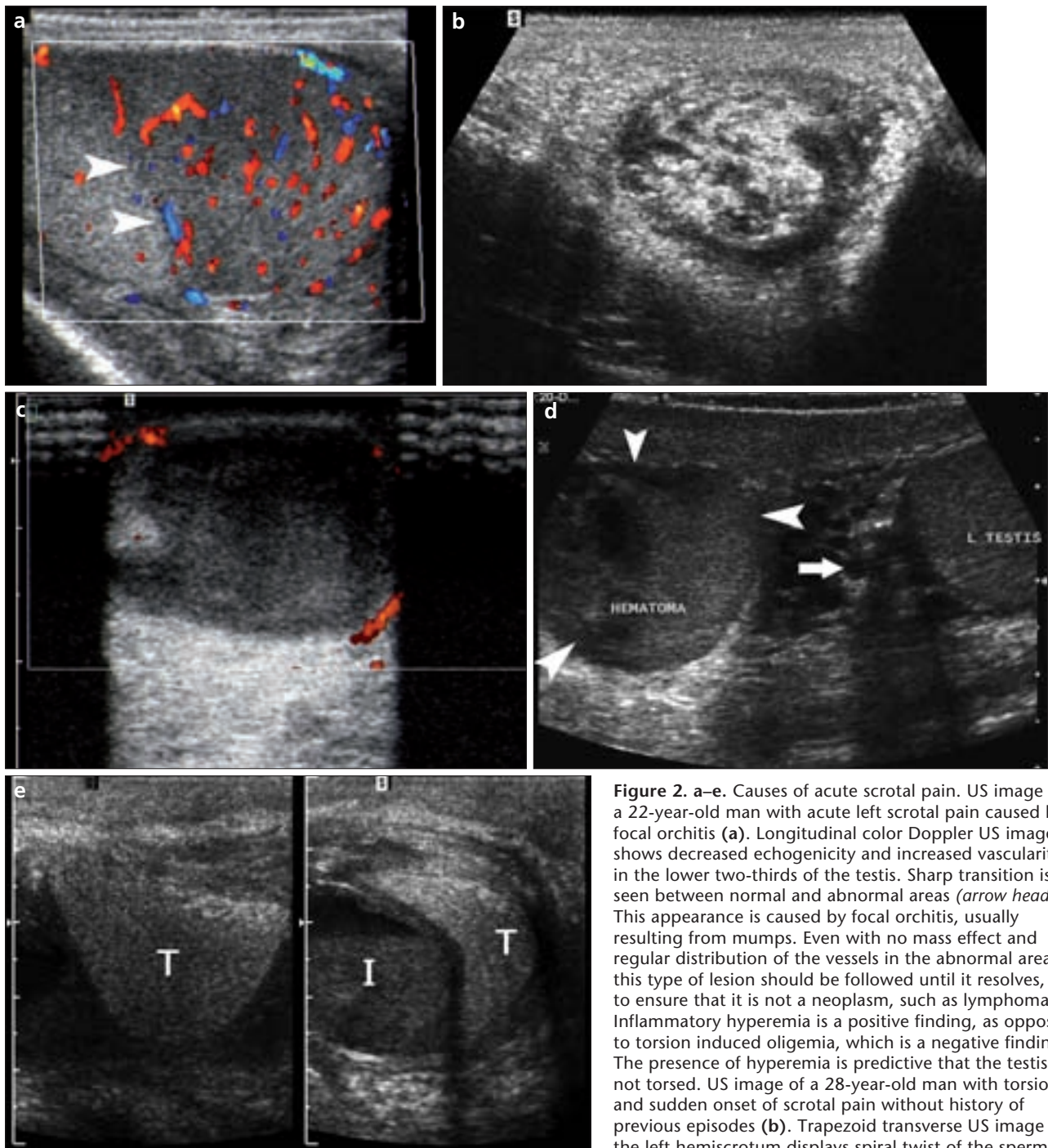


Figure 2. a–e. Causes of acute scrotal pain. US image of a 22-year-old man with acute left scrotal pain caused by focal orchitis (a). Longitudinal color Doppler US image shows decreased echogenicity and increased vascularity in the lower two-thirds of the testis. Sharp transition is seen between normal and abnormal areas (*arrow heads*). This appearance is caused by focal orchitis, usually resulting from mumps. Even with no mass effect and regular distribution of the vessels in the abnormal area, this type of lesion should be followed until it resolves, to ensure that it is not a neoplasm, such as lymphoma. Inflammatory hyperemia is a positive finding, as opposed to torsion induced oligemia, which is a negative finding. The presence of hyperemia is predictive that the testis is not torsed. US image of a 28-year-old man with torsion and sudden onset of scrotal pain without history of previous episodes (b). Trapezoid transverse US image of the left hemiscrotum displays spiral twist of the spermatic

cord at the external inguinal ring, which is diagnostic for torsion, regardless of color Doppler findings in the testis. On this image, the spermatic cord resembles a snail shell, with enlargement and increased echogenicity. On a 28-year-old man with infarcted left testis due to torsion, longitudinal power Doppler US image (c) shows markedly hypoechoic, enlarged testis without detectable blood flow, but peripheral blood flow is seen. Increased blood flow in the wall of the scrotum, tunica vasculosa, is a sign of late period torsion. Most adults with acute scrotal pain have infection, which can also complicate with infarction, rather than torsion that can be intravaginal or extravaginal. Intravaginal torsion, the most common type, is generally associated with a preexisting anomaly of fixation of the testis, termed bell and clapper testis. A 34-year-old man with testicular fracture and acute pain after a ball hit on the scrotum (d). Gray-scale transverse US image of the right testis shows hypoechoic heterogenous areas with anterior surface irregularities (*arrowheads*). All findings are consistent with testicular fracture with intratesticular hematoma needing surgical emergency. Also notice dilatation (>2 mm) of the paratesticular plexus pampiniformis veins on the left side (*arrow*). This shows retrograde flow during deep inspiration (not shown), consistent with varicocele. A 42-year-old man with inguinal hernia and acute scrotal pain (e). Split transverse (*left*) and longitudinal (*right*) gray-scale US images of the left hemiscrotum show bowel with fluid-fluid level next to the medial side of the testis, which is distorted by compression but otherwise normal. No peristalsis was seen during real-time examination, which supported the diagnosis of incarcerated hernia (T, testis; I, intestine). Inguinal hernia can be divided into indirect hernia, which is lateral to the inferior epigastric vessels and seen in the scrotum through the inguinal canal, and direct hernia, which is medial to the inferior epigastric vessels. (Continued on next page.)

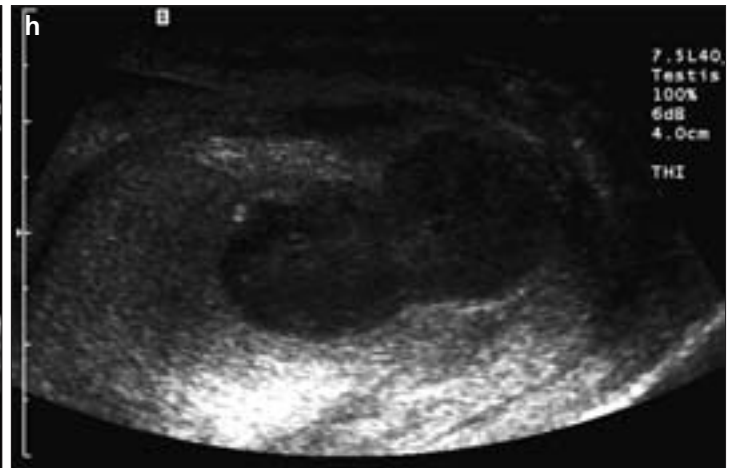
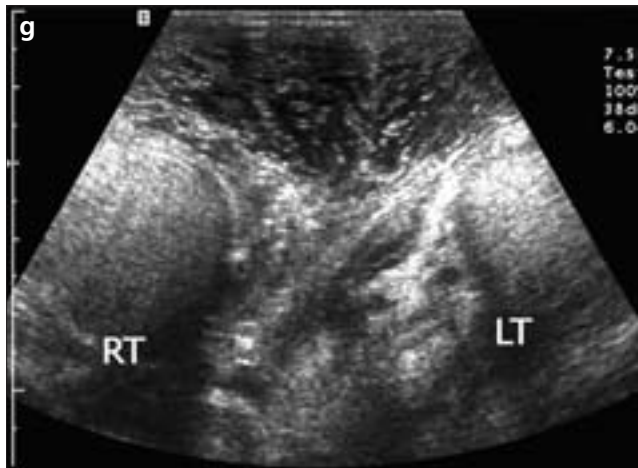
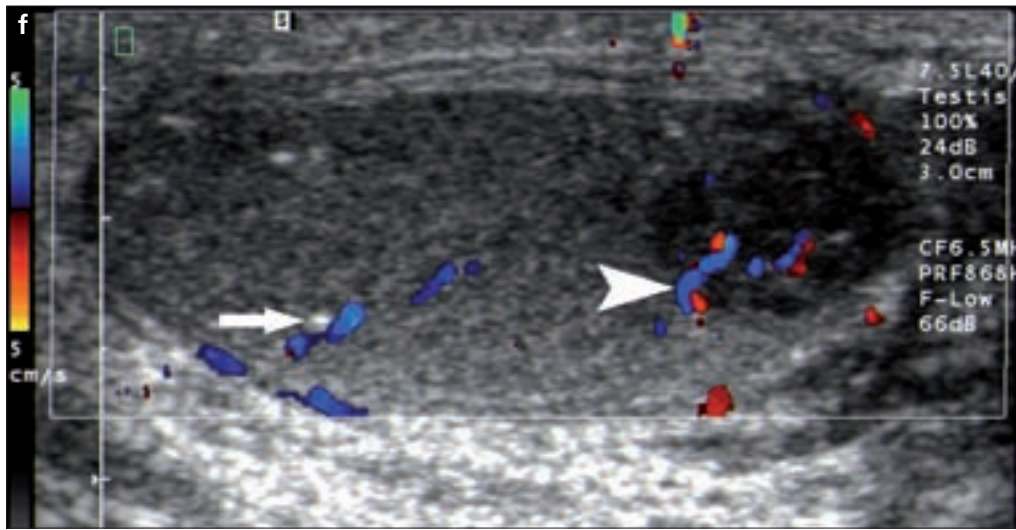


Figure 2 (continued). f–i. A 32-year-old man with a testicular neoplasm who presented with scrotal pain without fever (f). Color Doppler longitudinal US image of the left testis shows a relatively small hypoechoic area with a large feeding vessel (arrowhead) in the lower third of the testis. Also notice limited microlithiasis (arrow). The lesion was identified by histopathology as a seminoma, the most frequent testicular germ cell tumor. Ten percent of testicular neoplasms present with acute symptoms caused by hemorrhage into the lesion. A 30-year-old man with scrotal wall cellulitis (g). Transverse gray-scale US image of the scrotum. On this trapezoid image, which shows larger areas than can be seen on a linear image, the anterior portion of the scrotal septum shows markedly hypoechoic areas with wall thickness and increased blood flow (increased blood flow not shown). Scrotal wall cellulitis may lead to scrotal abscess. Otherwise both testes and paratesticular areas are normal (RT, right testis; LT, left testis). A 36-year-old man with a palpable mass and persistent pain in the right hemiscrotum (h). Trapezoid gray-scale longitudinal image

reveals an ectophytic bilobed markedly hypoechoic lesion in the tail of the epididymis (epididymitis). The patient had a history of acute scrotal pain. But persistent pain with palpable lesion suggests epididymal abscess formation as a complication of epididymitis. Patients with predominant involvement of the tail are diagnosed clinically, therefore, less frequently require imaging studies for definitive diagnosis. Otherwise, infection is routinely spread in the order of deferentitis, epididymitis (tail through body via head) and orchitis if untreated. A 34-year-old man with pyocele as a complication of epididymo-orchitis (i). Trapezoid gray-scale longitudinal US image of the left hemiscrotum displays multiseptated fluid collections between parietal and visceral layers of the tunica vaginalis. Fluid is relatively hypoechoic because of pus accumulation. Chronic hydrocele can mimic pyocele.

Scrotal masses

The primary function of US in the diagnosis of a testicular mass is to distinguish intratesticular from extrates-

ticular location because the majority of extratesticular masses are benign, but intratesticular ones are malignant (5). US does not offer the histologic

diagnosis. Gray-scale US is extremely sensitive for detection of testicular masses.

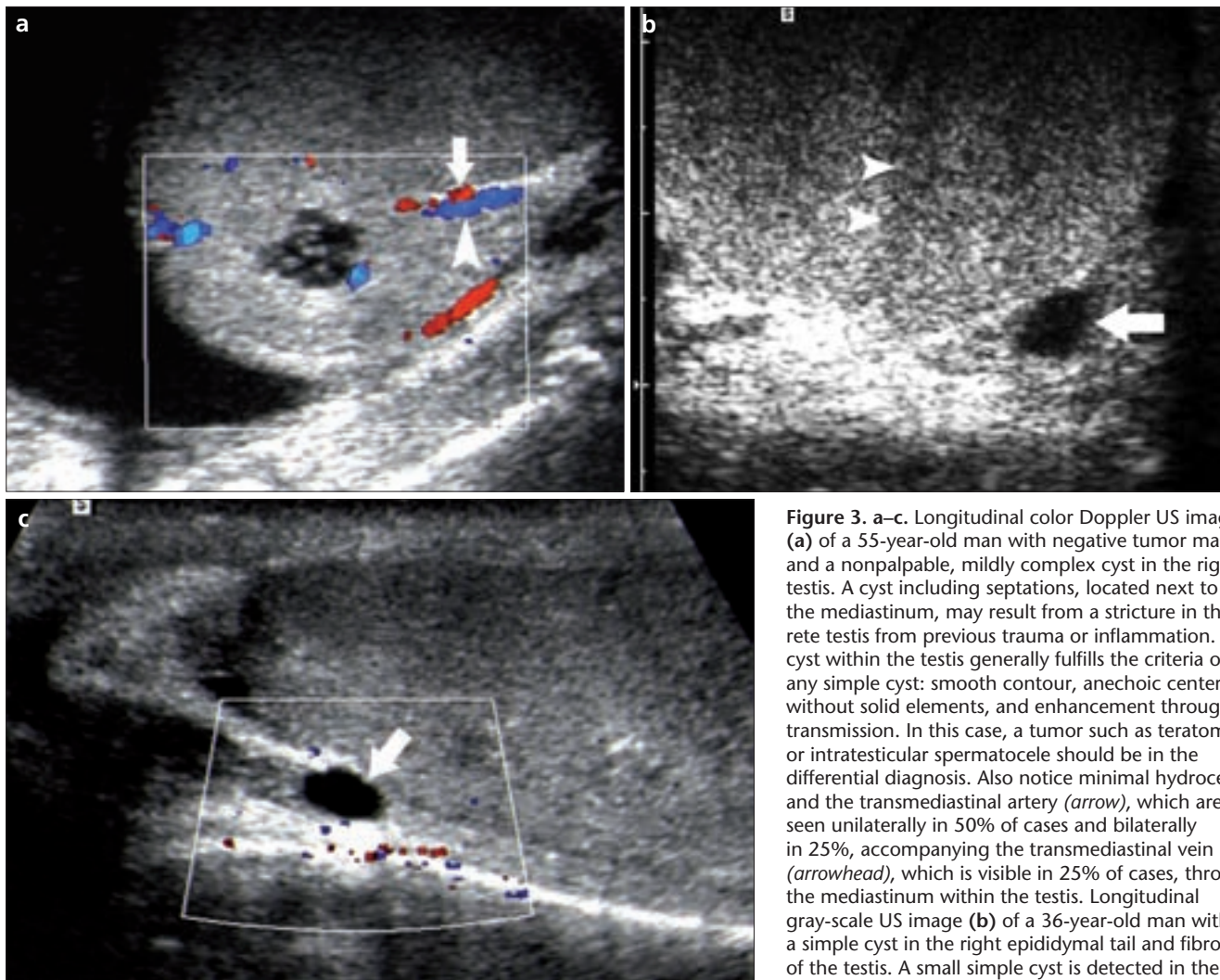


Figure 3. a–c. Longitudinal color Doppler US image (a) of a 55-year-old man with negative tumor markers and a nonpalpable, mildly complex cyst in the right testis. A cyst including septations, located next to the mediastinum, may result from a stricture in the rete testis from previous trauma or inflammation. A cyst within the testis generally fulfills the criteria of any simple cyst: smooth contour, anechoic center without solid elements, and enhancement through transmission. In this case, a tumor such as teratoma or intratesticular spermatocele should be in the differential diagnosis. Also notice minimal hydrocele and the transmediastinal artery (arrow), which are seen unilaterally in 50% of cases and bilaterally in 25%, accompanying the transmediastinal vein (arrowhead), which is visible in 25% of cases, through the mediastinum within the testis. Longitudinal gray-scale US image (b) of a 36-year-old man with a simple cyst in the right epididymal tail and fibrosis of the testis. A small simple cyst is detected in the tail of the epididymis (arrow), consistent with an

epididymal simple cyst instead of spermatocele (a cyst containing echoic particles [dead sperm] and located in the head of the epididymis is generally referred to as spermatocele.) Epididymal simple cysts can be single or multiple, very tiny, and situated in every part of the epididymis. Also notice the hypoechoic striations in the testicular parenchyma (arrowheads) radiating toward the mediastinum (not in the image plane), consistent with fibrosis. This condition can be misdiagnosed as tumors if these areas become more confluent. Scanning another plane will overcome this pitfall. A 35-year-old man with a firm small palpable nodule which moves with the testis during the physical examination in the right hemiscrotum (c). Trapezoid, longitudinal color Doppler US image reveals a small, solitary unilocular simple cyst in the tunica of the testis (arrow). Despite its firmness, it can be ignored. The etiology is unclear (congenital or acquired, trauma or infection).

Cysts and cyst-like lesions

Tubular ectasia of the rete testis is a benign condition and seen as fluid-filled tubular structures at the level of the mediastinum. Intratesticular retention cysts are also situated near the mediastinum (Fig. 3a). Although intratesticular retention cysts and intratesticular spermatoceles cannot be differentiated on US, intratesticular spermatocele communicates with the seminiferous tubules; this is unlike other cysts or ectasia of the rete testis, which do not communicate directly with the seminiferous tubule on histopathology (6). Spermatocele and simple cysts in the epididymis are encountered in

most adults (Fig. 3b). Spermatocele is similar to cysts elsewhere, but it contains low-level echoes or can be septated. Clinically, differentiation of these two entities is not important. In typical cases, epidermoid cysts show a characteristic pattern of concentric layers of rings. The center is totally avascular, and any vascularity within the lesion excludes the diagnosis. But this is not always observed. Furthermore, most epidermoid cysts are intratesticular lesions in young men. The true reason for recognizing the lesion preoperatively is that in such cases, testis-sparing surgery (employing intraoperative ultrasound assistance) should be con-

sidered as a treatment option. Cysts of the tunica albuginea may bulge into the testis or out into the paratesticular space (Fig. 3c).

Intratesticular neoplasms

Most palpable intratesticular lesions are neoplasms, and most nonpalpable lesions (>1 cm) are not neoplasms. Lesions smaller than 1 cm may be nonpalpable neoplasms or benign lesions (Fig. 4). The presence of abnormally increased flow within testicular neoplasms depends on their size rather than their cell type. Masses larger than 1.5 cm are more likely to have demonstrable flow (7). In general, color or

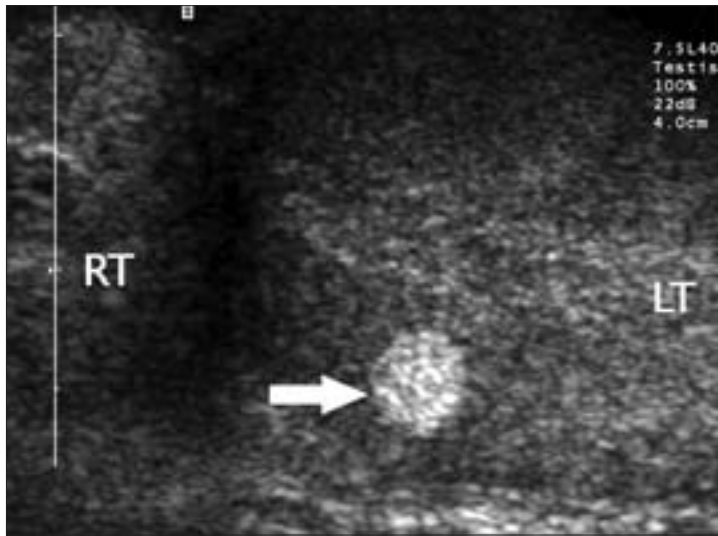


Figure 4. A 54-year-old man with a lipoma in the left testis. Transverse gray-scale US image reveals an incidentally found, 4-mm, markedly hyperechoic, well-demarcated solid lesion in the parenchyma (*arrow*). It was not palpable, and tumor markers were negative. Color Doppler examination (not shown) revealed little vascular coding at the periphery of the lesion (RT, right testis; LT, left testis).

pulsed Doppler is not necessary for detection of intratesticular tumors. Distortion of the normal vessel course is more likely found in neoplasms than in inflammation. Intratesticular neoplasms can be divided into primary germ cell tumors, other primary tumors, and secondary tumors. Malignant germ cell tumors constitute 90% to 95% of intratesticular primary neoplasms.

Germ cell tumors are divided into seminomas (Fig. 2f) and nonseminomatous tumors, including burned-out germ cell tumors (Fig. 5a). Burned-out germ cell tumors occur secondary to rapid tumor growth, resulting in occlusion of blood supply and subsequent tumor regression. When present, nodal metastases help confirm the presence and stage of a tumor. Whenever retro-

peritoneal adenopathy is detected in an adult male, occult testicular tumors should be considered; a scan of the testes should be performed to look for an occult tumor. Other intratesticular neoplasms are lymphoma, leukemia, sex cord-stromal tumors, mesenchymal tumors, adenocarcinoma of the rete testis, carcinoid, plasmacytoma, metastases (mostly from the prostate), and benign fibrous proliferation. Ten percent of testicular neoplasms present with acute symptoms (e.g., pain) usually caused by hemorrhage into the lesion; 10% of neoplasms present after scrotal trauma; and 10% of neoplasms present with metastases (8).

Extratesticular neoplasms

If the lesion is limited to the epididymis, the differentiation can easily be made. But, if the lesion originates from the tunica of the testis, differentiation can be difficult (Fig. 5b). Most extratesticular neoplasms are benign adenomatoid tumors (9). Other rare extratesticular masses are lipoma/liposarcoma, fibrous pseudotumor, papillary benign mesothelioma, and sperm granuloma.

Hydrocele

A hydrocele is an abnormally large collection of fluid between layers of tunica vaginalis and is the most common cause of painless scrotal swelling.

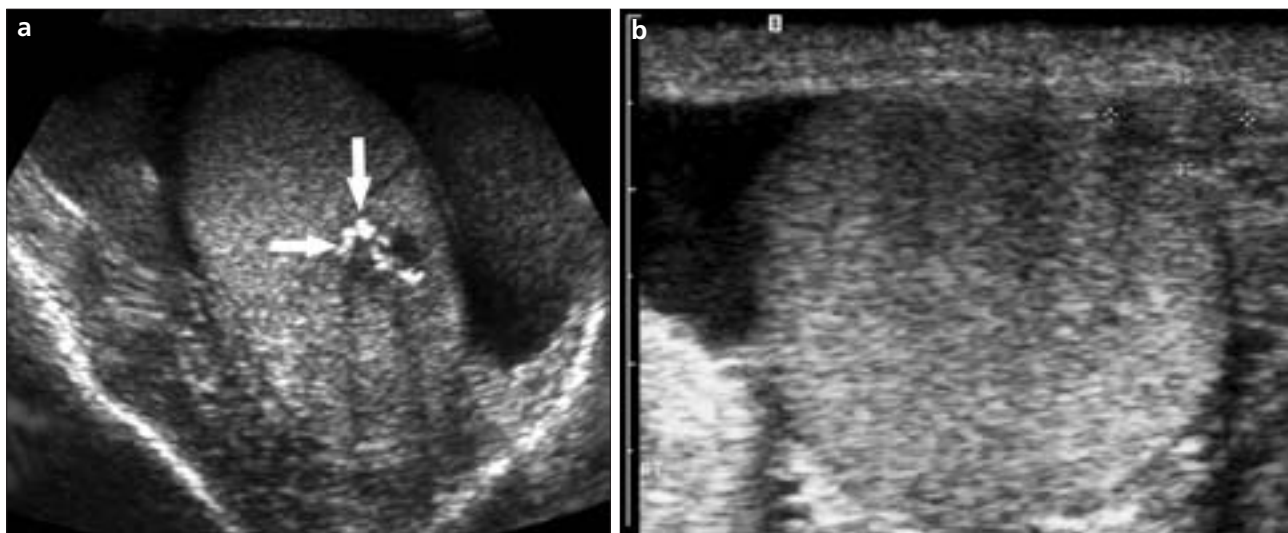


Figure 5. a, b. Testicular tumors. US image of a 28-year-old man with biopsy-proven retroperitoneal extragonadal germ cell nodal metastases and burned-out tumor in the left testis; scrotum felt normal on physical examination (**a**). Trapezoid, gray-scale US image reveals small calcific clusters with hypoechogenic rim in the testis (*arrows*). Notice also minimal hydrocele. Burned-out germ cell tumor occurs secondary to rapid tumor growth and results in the occlusion of blood supply itself and subsequent tumor regression. US image of a 45-year-old man with a one-month history of a right scrotal mass (**b**). Transverse gray-scale US image reveals a homogeneous, hypoechoic, 7.9 × 5.3 mm solid lesion on the anterior surface of the testis (*between calipers*) (RT, right testis). The lesion was surgically proven to be an adenomatoid tumor of the tunica vaginalis. Association of the mass with the testis can be determined by pushing the testis during real-time examination. In this situation, the mass will remain at its original location while the testis is displaced.

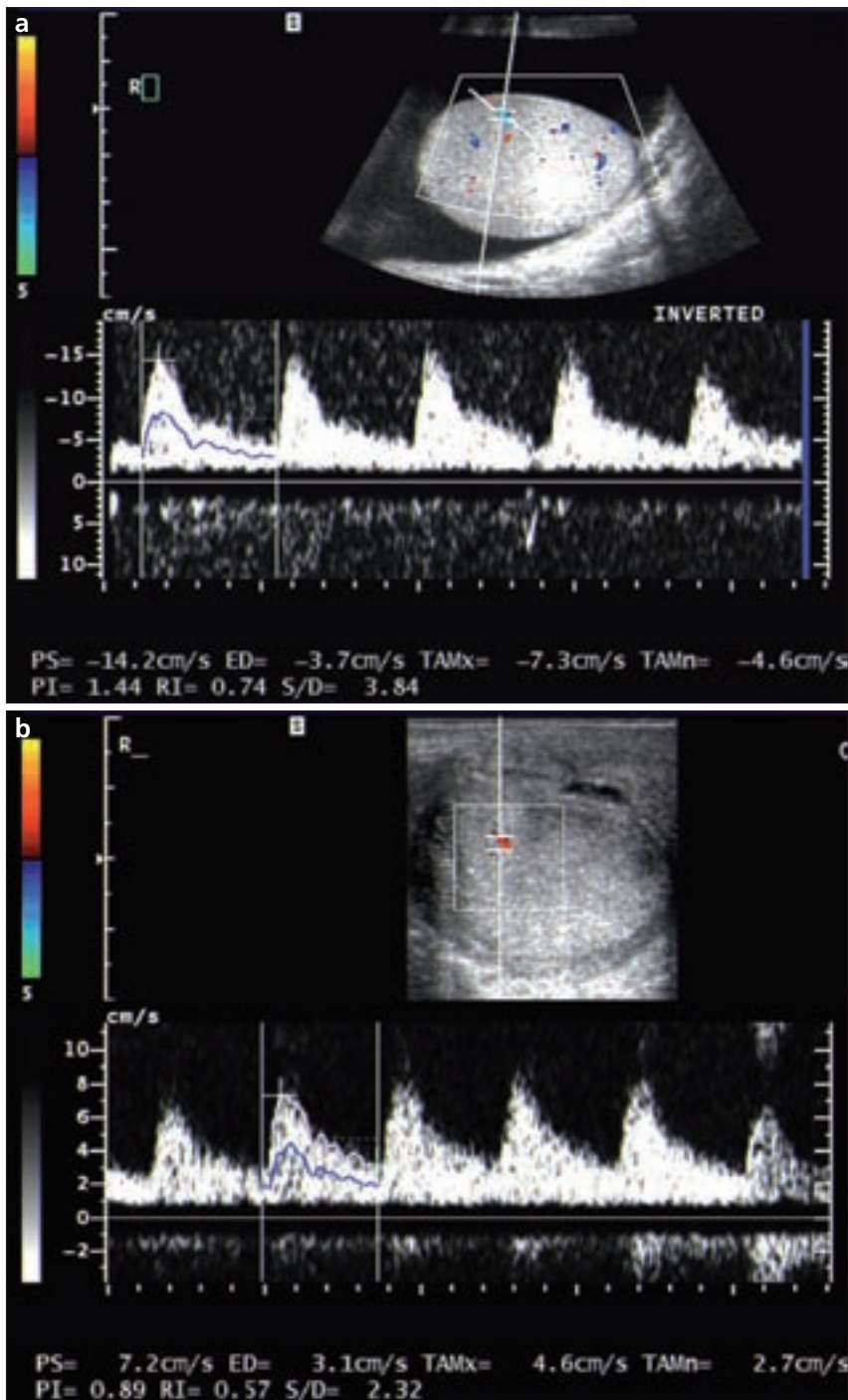


Figure 6. a, b. Hydrocele. Doppler US images (a, b) from a 45-year-old man with right hydrocele. Pulsed Doppler US image of the testis before hydrocelectomy (a) shows a resistive index (RI) value of 0.74. Pulsed Doppler US of the same testis 4 months after hydrocelectomy (b) displays decreased RI (0.57). In addition, testis volume decreased after hydrocelectomy (preoperatively, 20.7 cm³; postoperatively, 15.7 cm³) (not shown).

Until recently, the effect of hydrocele on the testis was poorly understood; it was thought that hydrocele needed no treatment except for cosmetic reasons or patient request. But idiopathic hydrocele may cause testicular enlargement and increased vascular resistance

in the intratesticular arteries (Fig. 6). Hence, it may be associated with infertility by interfering with spermatogenesis. Increase in testicular volume and increased vascular resistance are explained by an increase in impedance to venous and lymphatic flow (10).

Infertility

Ultrasonography is used to evaluate testicular location (Fig. 7a), size and appearance of testicular parenchyma, contour abnormalities (Fig. 7b) and epididymis (Figs. 7c, d), presence of initial varicocele (intra- or extratesticular) (Figs. 7e, f), and any postoperative complications (Fig. 7g). Agenesis or partial agenesis of the epididymis and ductus deferens can be evaluated by ultrasound. In such cases, additional imaging of the seminal vesicles, prostate, bladder, ureterovesical junctions, and kidneys is essential for full evaluation of developmental abnormalities.

Approximately 80% of undescended testes are located within the inguinal canal. Sonography is especially useful for identifying testes in the inguinal canal. Evaluation of mediastinum is sometimes important to differentiate testes from lymph nodes. Intraabdominal testes occur in the retroperitoneum from the level of the kidneys to the internal inguinal ring (11). Magnetic resonance imaging can be helpful in detection of intraabdominal testes. If orchiopexy is not performed in childhood (possibly before 5 years of age, and certainly before puberty), the undescended testis is usually sterile or hypospermic and atrophic (12). The incidence of malignancy, mostly seminoma, is 2.5 to 8 times as great in the undescended testis as in the general population (greater increase with increased distance from the scrotum) (12). Because of the increased risk of malignancy in the undescended testis, even after orchiopexy and in the contralateral testis, it would be reasonable to use US as a screening test, although detection of tumors can sometimes be difficult in hypoplastic testis due to isoechogenicity (hypoechoic lesion in hypoechoic testis).

Benign testicular lobulation may be an idiopathic embryologic variant (13) or may develop after orchiopexy as a consequence of fibrosis (14). A contour abnormality on physical examination is not always indicative of malignancy. In this situation, sonography is helpful for excluding testicular lesions.

Varicocele may be extratesticular or intratesticular; intratesticular varicocele is rare and is usually found with extratesticular varicocele (15, 16). The size of the veins in varicocele is measured at rest and during Valsalva maneuver. US criteria for diagnosis of varicocele are

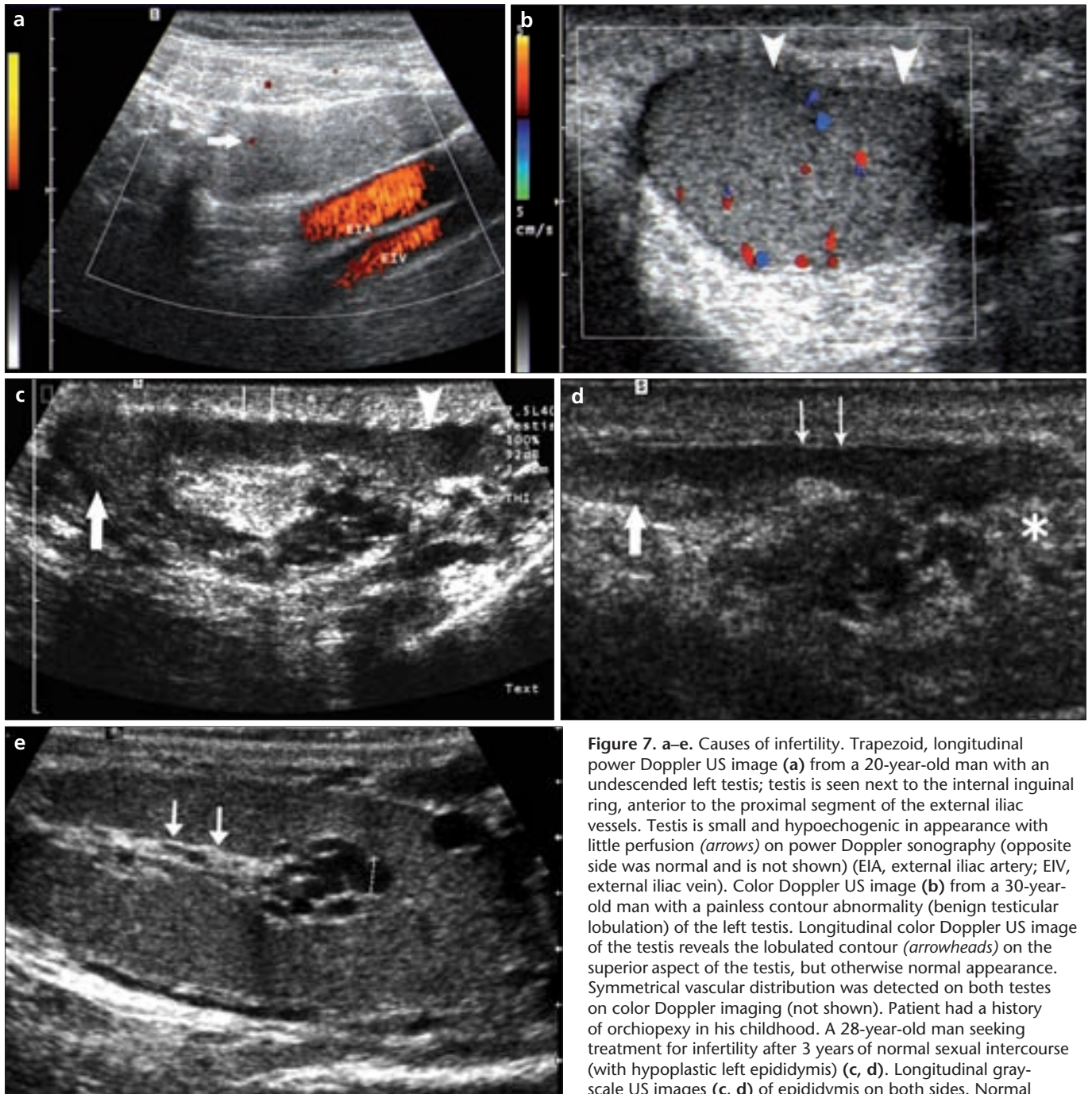


Figure 7. a–e. Causes of infertility. Trapezoid, longitudinal power Doppler US image (a) from a 20-year-old man with an undescended left testis; testis is seen next to the internal inguinal ring, anterior to the proximal segment of the external iliac vessels. Testis is small and hypoechoic in appearance with little perfusion (arrows) on power Doppler sonography (opposite side was normal and is not shown) (EIA, external iliac artery; EIV, external iliac vein). Color Doppler US image (b) from a 30-year-old man with a painless contour abnormality (benign testicular lobulation) of the left testis. Longitudinal color Doppler US image of the testis reveals the lobulated contour (arrowheads) on the superior aspect of the testis, but otherwise normal appearance. Symmetrical vascular distribution was detected on both testes on color Doppler imaging (not shown). Patient had a history of orchiopexy in his childhood. A 28-year-old man seeking treatment for infertility after 3 years of normal sexual intercourse (with hypoplastic left epididymis) (c, d). Longitudinal gray-scale US images (c, d) of epididymis on both sides. Normal

right epididymis (c) and partially hypoplastic left epididymis (tail) (d). Right epididymis has a head (thick arrow), body (thin arrows), and tail (arrowhead) isoechoic to the testis, situated on the superior and posterolateral aspect of the testis. But left epididymis consists of head (thick arrow), and body (thin arrows). Both parts are isoechoic and located on the superior and posterolateral aspect of the testis. The tail (globus minor) of the left epididymis is not present (asterisk). US images of a 31-year-old man with intratesticular varicocele, seeking treatment for infertility after 2 years of normal sexual intercourse (e, f). Trapezoid, longitudinal gray-scale US image (e) shows dilated intratesticular tubular structures near mediastinum (arrows) and in the peripheral portion of the testis. (Continued on next page.)

the largest pampiniformis vein measured more than 2 mm in diameter in supine position or more than 3 mm in diameter in standing/semierect position and/or more than 1 mm increase in size of the largest vein during Valsalva on gray-scale examination and/or more than 2-s retrograde flow during

Valsalva maneuver on color Doppler US (7). A combination of the first and the second or the first and the third criteria are used. However, the presence of venous reflux should be determined by color Doppler US (reflux in seconds). Varicocele can also be graded as follows: grade 1, slight reflux (<2 s)

during Valsalva; grade 2, reflux (>2 s) during Valsalva, but no continuous reflux during the maneuver; and grade 3, reflux in rest during normal respiration or continuously during the entire Valsalva maneuver (7). Recurrence of varicocele is diagnosed with presence of reflux on color Doppler US. In the

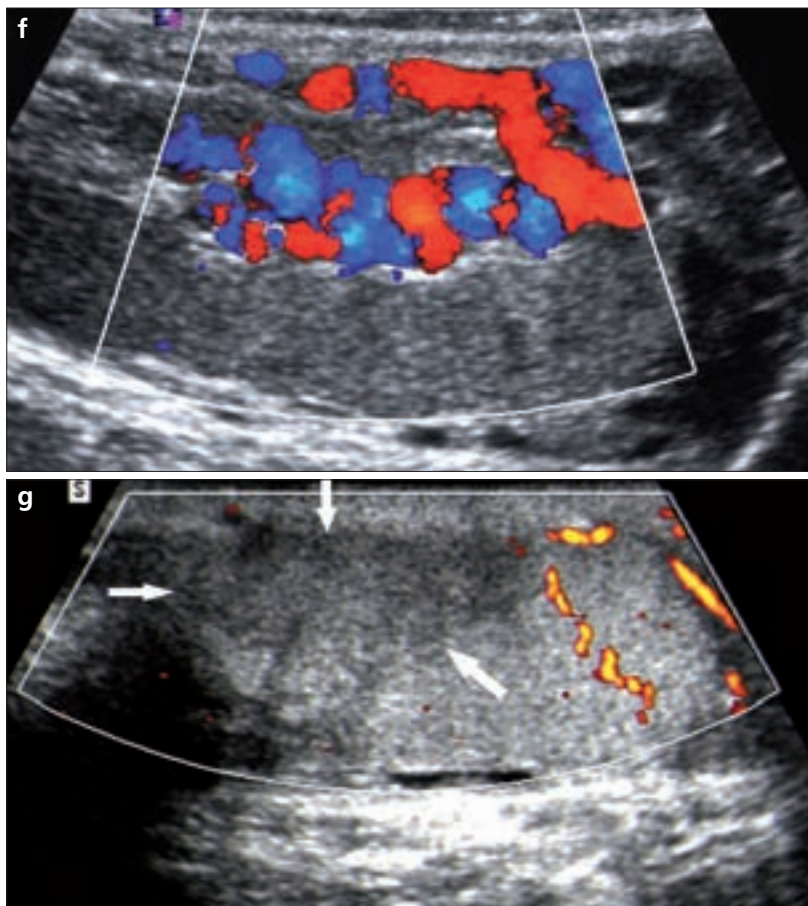
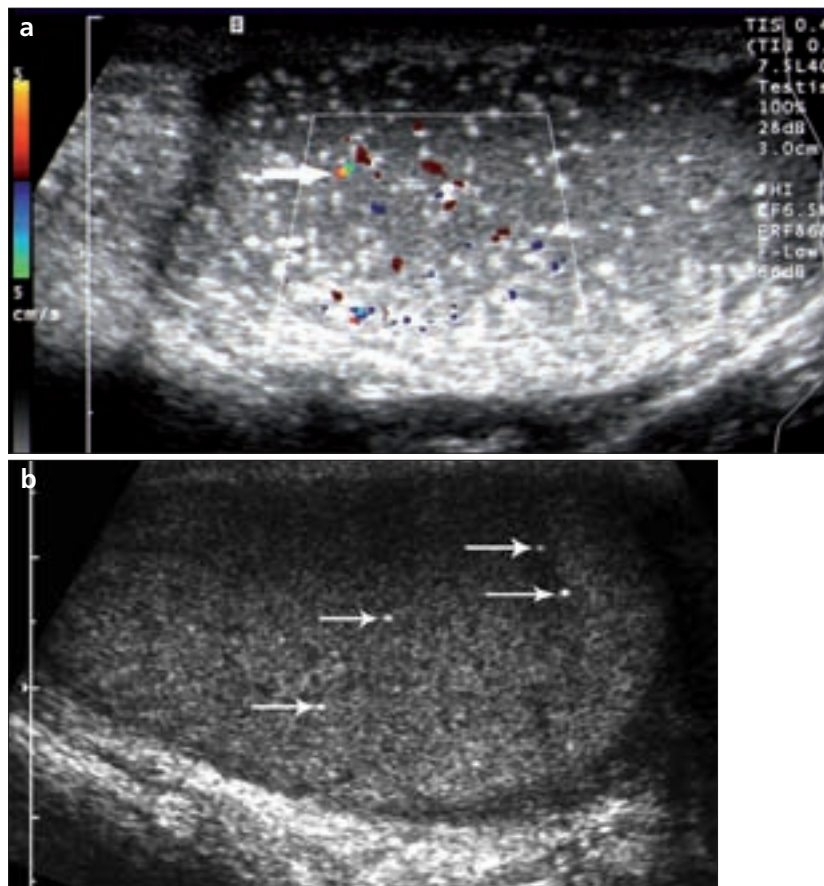


Figure 7 (continued). f-g. Trapezoid color Doppler US image (f) displays these are intratesticular vessels, confirming varicocele rather than tubular ectasia of the rete testis. Pulsed Doppler confirmed the diagnosis (not shown). A 34-year-old man with left scrotal pain and focal infarct in the testis after varicocelectomy (g). Longitudinal trapezoid power Doppler US shows an infarcted area in the anterosuperior portion of the testis that is hypoechoic with no perfusion (arrows). Focal infarct is not a frequent cause of acute scrotal pain, but it is not uncommon after inguinal surgery, especially hernia operation. It can also occur after a varicocele operation, as in this case.

Figure 8. a, b. Microlithiasis. A 26-year-old man with microlithiasis, seeking treatment for infertility after 1.5 years of normal sexual intercourse (a). Trapezoid longitudinal color Doppler US shows classic microlithiasis with numerous fine (<2 mm), bright, nonshadowing hyperechoic foci that are uniform in size and are distributed in a diffuse pattern on this single slice. Notice also twinkle artifact (arrow) behind a microlith. A 27-year-old man with limited testicular microlithiasis (b). Trapezoid, longitudinal gray-scale US image shows fewer than 5 microliths in the testis (arrows), classified as limited microlithiasis. Microliths can also be clustered at the periphery of the testis. Limited microlithiasis is regarded as a benign condition.



elderly, it is essential to look for secondary varicoceles (secondary to retroperitoneal disease processes), particularly in men with newly developing varicoceles.

Testicular microlithiasis

Testicular microlithiasis (TM) may be described as classic (Fig. 8a) or limited (Fig. 8b) based on the presence of five or more microliths on one or more images of the testes (17). Its association with tumor development is controversial.

The etiology of TM is unknown, though an association with Sertoli cell dysfunction and an anomaly in the LKB1 gene, which maps the 19p13.3 chromosome, have been hypothesized to be responsible for TM (18). TM can be associated with several conditions, such as undescended testis, alveolar microlithiasis, congenital urethroperineal fistula, and Klinefelter syndrome. They are more common in patients with oligospermia. Men with TM, especially classical form, are at increased risk of developing germ cell tumors, particularly seminoma (7); the risk is small but not clearly quantified. Yearly

US screening or regular self-examination is recommended.

In conclusion, the use of gray-scale, color, power, and pulsed Doppler US will provide the correct diagnosis in most conditions when used appropriately. Knowledge of the US features of both common and newly described entities is important for the management of scrotal abnormalities.

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References

1. Kantarci F, Ozer H, Adaletli I, Mihmanli I. Cystic appendix epididymis: a sonomorphologic study. *Surg Radiol Anat* 2005; 27:557–561.
2. Vijayaraghavan SB. Sonographic differential diagnosis of acute scrotum: real-time whirlpool sign, a key sign of torsion. *J Ultrasound Med* 2006; 25:563–574.
3. Brown JM, Hammers LW, Barton JW, et al. Quantitative Doppler assessment of acute scrotal inflammation. *Radiology* 1995; 197:427–431.
4. Pavlica P, Barozzi L. Imaging of acute scrotum. *Eur Radiol* 2001; 11:220–228.
5. Ragheb D, Higgins JL. Ultrasonography of the scrotum: technique, anatomy, and pathologic entities. *J Ultrasound Med* 2002; 21:171–185.
6. Davis RS. Intratesticular spermatocele. *Urology* 1998; 51:167–169.
7. Oyen RH. Scrotal ultrasound. *Eur Radiol* 2002; 12:19–34.
8. Dogra VS, Gottlieb RH, Oka M, Rubens DJ. Sonography of the scrotum. *Radiology* 2003; 227:18–36.
9. Kolgesiz AI, Kantarci F, Kadioglu A, Mihmanli I. Adenomatoid tumor of the tunica vaginalis testis: a special maneuver in diagnosis by ultrasonography. *J Ultrasound Med* 2003; 22:303–305.
10. Mihmanli I, Kantarci F, Kulaksizoglu H, et al. Testicular size and vascular resistance before and after hydrocelectomy. *AJR Am J Roentgenol* 2004; 183:1379–1385.
11. Aso C, Enriquez G, Fite M, et al. Gray-scale and color Doppler sonography of scrotal disorders in children: an update. *RadioGraphics* 2005; 25:1197–1214.
12. Cochlin DL. The scrotum. In: Cochlin DL, Dubbins PA, Goldberg BB, Halpern EJ, eds. *Urogenital ultrasound*. London: Taylor and Francis, 2006;183–255.
13. Kao EY, Gerscovich EO. Benign testicular lobulation: sonographic findings. *J Ultrasound Med* 2003; 22: 299–301.
14. Kantarci F, Mihmanli I, Yilmaz MH, Cetinkaya S, Selcuk D, Ogut G. Orchiopexy: a cause of benign testicular lobulation. *J Ultrasound Med* 2003; 22:1417–1419.
15. Ozcan H, Aytac S, Yagci C, Turkolmez K, Kosar A, Erden I. Color Doppler ultrasonographic findings in intratesticular varicocele. *J Clin Ultrasound* 1997; 25:325–329.
16. Mihmanli I, Kantarci F, Ozbayrak M. Intratesticular varicocele: a rare cause of testicular pain. *Ultraschall Med* 2007; 28:446–448. Article in German.
17. Middleton WD, Teefey SA, Santillan CS. Testicular microlithiasis: prospective analysis of prevalence and associated tumor. *Radiology* 2002; 224:425–428.
18. Backus ML, Mack LA, Middleton WD, King BF, Winter TC 3rd, True LD. Testicular microlithiasis: imaging appearances and pathologic correlation. *Radiology* 1994; 192:781–785.