Scrotal Sonography Revisited

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Received 27 May 2009; accepted 14 August 2009

ABSTRACT: Sonography is the imaging modality of choice for the scrotum because it is simple, relatively inexpensive, and quick. Recent technological advances and transducer improvements have led to exquisite high-resolution detail in gray-scale as well as Doppler imaging. The purposes of this pictorial essay are to review the anatomy and embryology of the scrotal contents and to review the various scrotal and extrascrotal pathologic conditions, including acute scrotum, pediatric and adult testicular and extratesticular scrotal neoplasms, traumatic lesions, and miscellaneous other scrotal lesions.

VASCULAR ANATOMY

Scrotal blood flow is supplied primarily by the internal spermatic (testicular), cremasteric, and deferential arteries. Testicular arteries, which provide the major blood supply to the testis, arise from the anterior aspect of the aorta just below the level of the renal arteries. They enter the spermatic cord at the internal inguinal ring. In the spermatic cord, the testicular artery is joined by the deferential artery (arising from the vesicular artery) and the cremasteric artery (arising from inferior epigastric artery). The testicular artery penetrates the tunica albuginea and gives off capsular arteries. The deferential and cremasteric arteries supply mainly the epididymis and peritesticular tissues.
Venous drainage from the scrotum is through the pampiniform plexus. The pampiniform plexus of draining veins forms around the upper half of the epididymis and flows into the testicular vein via the cremasteric and internal spermatic veins. Testicular veins drain into the inferior vena cava on the right and the left renal vein on the left.

VARICOCELE
A varicocele, an abnormal venous dilatation of the pampiniform plexus that occurs more frequently on the left side, manifests most commonly as a soft mass or swelling that becomes more prominent with upright posture or straining. Gray-scale findings include venous dilatation greater than 2 mm. In general, varicoceles demonstrate augmented flow with Valsalva, which may make them look artificially larger on Doppler imaging (Figure 7). Patients who experience a sudden-onset varicocele, a right-sided varicocele, or a varicocele that is not reduced in size when they are lying supine should be suspected of having a retroperitoneal neoplasm; such a neoplasm blocks the testicular vein where it enters the renal vein on the left or the inferior vena cava on the right.
Maldescent or Cryptorchidism

The incidence of testicular maldescent, or cryptorchidism, varies from approximately 1–10%; this wide range is in part due to the varying ages of patients at the time of diagnosis. In most cases of cryptorchidism diagnosed at birth, the testes descend spontaneously during the first years of life. A prospective study in the United States found an incidence of 3.68% at birth,
1.00% at 3 months, and 1.06% at 1 year.\(^5\) The undescended testis rests in the inguinal canal in 80% of cases (Figures 8 and 9) and in the abdomen in the other 20%, where it is not always detectable (Figure 10).

Infertility and cancer of the testis are the major risks for these patients. A man with a history of cryptorchidism has a 3–5% risk of developing a testicular malignancy.\(^6\) Surgical orchiopexy is typically recommended when the patient is younger than 2 years old. Although the risk of infertility is reduced if surgical orchiopexy is performed earlier rather than later, the risk of cancer is not eliminated with surgery.\(^7\) Sonography is valuable in the preoperative localization of the cryptorchid testis, especially when the testis is not palpable.\(^8\)–\(^10\) The cryptorchid testis is frequently atrophic, which may cause difficulty in visualizing it on sonographic evaluation (Figure 11).

**Polyorchidism**

Polyorchidism is a rare developmental anomaly that results in supernumerary testes; fewer than 100 cases have been reported.\(^11\)–\(^13\) Patients may have a painless palpable scrotal mass on their initial evaluation. Sonography demonstrates a homo-
geneous, well-defined mass that is separate from but identical in appearance to the normal testis. MRI is helpful in confirming the diagnosis (Figure 12). The supernumerary testis can have important reproductive implications, and there is an approximate 5% incidence of malignancy in the extra testis. In addition, the presence of the supernumerary testis may be complicated by torsion.

HYDROCELE
A hydrocele is an accumulation of serous fluid that lies between the 2 layers of the tunica vaginalis; it should not have a mass effect on the testis. The most common collection is a simple hydrocele (Figure 13), which is secondary to a persistent communication between the abdominal and scrotal cavities known as a patent processus vaginalis, which usually resolves in infancy. However, a hydrocele that occurs secondary to inflammation, trauma, or tumor can be complex in appearance.

CYSTS
A number of types of cysts may be visualized on sonography of the scrotum. An encysted hydrocele of the spermatic cord is a focal patency of the processus vaginalis in which fluid is trapped. It appears sonographically as a focal anechoic fluid collection superior to the testis and epididymis (Figure 14). This manifests clinically as a firm, painless inguinal or upper scrotal mass.

Epididymal cysts and spermatoceles can be identical in sonographic appearance. Both can be simple echolucent cystic lesions or contain internal septations (Figures 15 and 16). However, epididymal cysts can be located anywhere in the epididymis and, on histopathologic examination, are lined with mesothelium. In contrast, spermatoceles are dilated efferent ductules, have a fibromuscular wall, and contain spermatozoa. Moreover, they are found only at the head of the epididymis.

Intraparenchymal testicular cysts occur in 8–10% of patients and are usually detected incidentally in men 40 years or older. Unless they are located peripherally within the testis, they are usually not palpable. Their size is variable, ranging from 2 mm to 2 cm, and although they are usually solitary, they can be multiple (Figure 17). Both simple testicular intraparenchymal cysts and tunica albuginea cysts appear as simple cysts on sonography. Although tunica albuginea cysts are small, ranging from 2–5 mm, they are usually palpable.

ACUTE SCROTUM
In a patient who first appears in the clinic with acute scrotal pain, it is critical to distinguish between testicular torsion and acute epididymoorchitis. Whereas torsion requires emergent surgical treatment, epididymo-orchitis is treated medically.
Torsion

Testicular torsion is possible at any age but is most common in youths 12–18 years old. Two types of torsion have been described: intravaginal, occurring in the peripubertal group, and extravaginal, occurring in the perinatal group. The intravaginal type is more common, and it occurs secondary to an abnormally narrow mes-}

enteric attachment from the spermatic cord onto the testis and epididymis that allows the testis to rotate like a clapper in a bell. Because this bell-clapper deformity is usually bilateral, orchiopexy involves surgically anchoring both testes so that they cannot twist in the future. If surgical detorsion of a twisted testis occurs within 6 hours, the probability of testicular salvage is high, but the salvage rate drops dramatically after 12–24 hours. With doppler sonography, the diagnosis can be made by demonstrating decreased or absent vascular flow within the symptomatic testis. Comparison should be made with the vascular flow in the contralateral, asymptomatic testis (Figure 18). With time, the testis becomes hypoechoic and swollen on gray-scale images, and peritesticular hyperemia develops. One potential limitation with color Doppler sonography is in the detection of an episode of torsion after spontaneous detorsion has occurred. In such cases, blood flow may be normal, or there may even be postischemic hyperemia.
Patients with infection are usually slightly older than those with torsion: 20–30 years old. Common causes include the retrograde ascent of urethral pathogens and sexually transmitted diseases. These patients usually experience scrotal pain and swelling of sudden onset. The typical sonographic appearance of epididymitis includes enlargement and hypoechoicinity of the epididymis (Figure 19). The testis may or may not be involved; associated orchitis has been reported in as many as 20% of cases.\textsuperscript{21,22} If orchitis is present as well, the testis may be of normal size or enlarged and is usually hypoechoic. Vascular flow to the involved structures is usually increased. Asymmetric hyperemia of an epididymis with or without ipsilateral testicular hyperemia suggests infection. Associated findings may include skin thickening and reactive hydroceles (Figure 20).

Tuberculosis may also infect the epididymis. An enlarged, homogeneously hypoechoic testis and epididymis are typical of nontuberculous epididymo-orchitis, but tuberculous involve-
ment of these structures usually has a more heterogeneous sonographic appearance. The epididymis can be involved solely, demonstrating heterogeneously hypoechoic echotexture, enlargement, and mildly increased peripheral blood flow.\textsuperscript{23} Concomitant testicular involvement is usually the result of direct extension from the epididymis. Bilateral involvement has

FIGURE 20. Epididymo-orchitis. (A) Transverse midline sonogram in a 33-year-old man shows global enlargement and decreased echogenicity of the right testis (arrows). Longitudinal sonograms show (B) a surrounding right septated hydrocele (arrows) and (C) global thickening of the entire right epididymis (arrows), which demonstrates heterogeneous echotexture. (D) Power Doppler image in the same patient demonstrates increased blood flow within the right testis. Overall, these features are consistent with a diagnosis of epididymo-orchitis.

FIGURE 21. (A) Epididymitis. Longitudinal sonogram in a 48-year-old man shows a markedly swollen right epididymis (arrows) with thin peripheral calcifications (arrowheads) as well as a thickened dartos muscle (asterisk). (B) Epididymal abscess. Transverse sonogram in the same patient shows thickened tunica (arrows). Surgery revealed an epididymal abscess.
been reported in up to 22% of cases. The possibility of tuberculous epididymitis is suggested by a history of nonpainful chronic swelling of the epididymis, lack of response to the usual antibiotics, and the presence of a draining sinus tract.

Complications of epididymo-orchitis include testicular infarction, scrotal abscess (Figure 21), a chronic draining scrotal sinus, chronic epididymitis (Figures 22 and 23), and infertility. To diagnose the hyperemic epididymis and testicle, one must rule out spontaneous detorsion resulting in reactive hyperemia, torsion of the testicular and/or epididymal appendages, and leukemic or lymphomatous infiltration.

FOURNIER GANGRENE
Fournier gangrene is an eponym used to describe necrotizing fasciitis of the perineal, genital, or perianal regions. Men are affected 10 times more than women. Predisposing factors include diabetes mellitus, alcoholism, and human immunodeficiency virus infection. Synergistic effects of the bacteria lead to thrombosis of small subcutaneous vessels and rapid gangrenous involvement of the surrounding skin and deep fascia ensues. The testes are rarely involved in necrotizing fasciitis because they have a separate gonadal blood supply. Diagnosis of Fournier gangrene is largely based on clinical examination. Ultrasound will demonstrate highly echogenic subcutaneous gas within an edematous scrotal wall with or without reactive extratesticular fluid.

TESTICULAR MASSES
Most testicular tumors are hypoechoic compared with the surrounding parenchyma. Others can be heterogeneous with associated calcifications and cyst formations. Larger tumors tend to be more vascular than smaller tumors; however, the use of color Doppler imaging to investigate suspected tumors is not particularly helpful in adults. Color Doppler imaging, however, has proven to be helpful in prepubertal boys when gray-scale findings are subtle and may help to identify an isoechoic mass.

Malignant
Pediatric. A testicular mass in a prepubescent boy is more likely to be benign than one seen in an adult. Most testicular neoplasms derive from cells native to the testis, typically from germ cells. Yolk sac tumors, a type of germ-cell neoplasm also known as endodermal sinus tumors, are the most commonly reported malignant testicular neoplasms in prepubescent boys (Figures 24 and 25); however, these may also be benign. They are usually seen in boys younger than 3 years old, with the mean age at diagnosis being 18 months. The alpha-fetoprotein levels are usually higher than normal, which can help in differ-
entiating yolk sac tumors from other lesions and can be monitored as a marker for tumor response or recurrence. Seminoma, the most common testicular germ-cell tumor in adults, is not seen in the pediatric population, and other malignant germ-cell tumors, including embryonal cell carcinoma (Figure 26) and teratocarcinoma, typically occur only after puberty.

In the pediatric population, although malignant yolk sac tumors are those most commonly reported in the literature, some argue that benign testicular tumors, such as teratomas, actually occur more commonly in prepubescent boys (Figure 27).

Neoplasms from either Leydig or Sertoli cells of the testicular interstitium account for 10–30% of malignant tumors in pediatric patients. Leukemia or lymphoma account for less than 10% of testicular masses; such masses can be bilaterally distributed. Primary leukemia of the testis is rare. The testes form a sanctuary for these malignancies during chemotherapy, and they are a common site of recurrence of leukemia in children (Figure 28). The patient’s clinical history is useful in making the diagnosis.

**Adult.** Testicular cancer is the most common in younger men, 20–34 years old. Patients typically exhibit a painless unilateral testicular mass or diffuse testicular enlargement. Metastatic disease is already present at the time of the initial evaluation in 10–15% of patients. Identification of the site of primary tumor is clinically important because patients respond more favorably to chemotherapy after removal of the primary tumor.

Most (90–95%) primary testicular tumors in adults are of germ-cell origin, the most common being seminomas and mixed germ-cell tumors, which consist of variable mixtures of embryonal, teratomatous, and choriocarcinomatous components. Seminomas are typically homogeneous, hypoechoic nodules that may range from small, sharply demarcated masses to large masses causing diffuse testicular enlargement (Figures 29 and 30). Mixed germ-cell tumors are usually much more heterogeneous in sonographic appearance than seminomas are. Their margins tend to be more ill defined, and tunica invasion is more common. Cystic regions, echogenic areas (including calcifications), and mixed echogenic regions (necrosis and hemorrhage) are much more common in mixed germ-cell tumors than they are in pure seminomas. Occasionally, the primary tumor undergoes spontaneous regression and appears as an irregular “scar” containing macroscopic calcifications within the tes-
The term “burned-out testicular tumor” refers to a regressed testicular tumor which presents with its metastases. This particular form accounts for 10% of apparent primary retroperitoneal germ-cell tumors. Pathologically, an intratesticular scar, testicular atrophy, or both may be evident without evidence of a neoplasm. Alternatively, an in situ tumor may be evident. Patients with nonseminomatous tumors probably have the highest proportion of regressed primary neoplasms.

Other tumors that can involve the testes include lymphoma, leukemia, and metastases.

**Benign**

Testicular epidermoid cysts are germ-cell lesions that can have varying sonographic appearances as determined by cyst content. The characteristic sonographic appearance is an “onion skin” or laminated appearance surrounded by a hypoechogenic or echogenic rim. These cysts characteristically have no color flow signal on Doppler imaging (Figure 33).

**EXTRATESTICULAR MASSES**

**Benign**

Most extratesticular masses are benign. The most common benign paratesticular tumors are lipomas, which arise from the spermatic cord. The most common tumors of the epididymis are adenomatoid tumors, which are benign tumors of...
connective tissue origin and account for 30% of all extratesticular masses. Adenomatoid tumors are usually located in the tail of the epididymis. Their sonographic appearance is variable; they may appear solid and homogeneously hyperechoic. Epidermoid cysts can also be extratesticular in location; they most commonly appear as hypoechoic, well-circumscribed masses with or without internal echogenic foci (Figure 34).

Malignant
Malignant extratesticular tumors arising in the spermatic cord and paratesticular regions are rare. Primary mesenchymal tumors are the most common malignancy to arise in the spermatic cord (Figure 35). Paratesticular rhabdomyosarcomas, which tend to grow rapidly, are the most common extratesticular malignancies in children. Mesothelioma and lymphoma can also involve the paratesticular structures.

INGUINAL HERNIA
Most hernias are clinically obvious; sonography is generally reserved for patients who have confusing findings on physical examination or who have scrotal enlargement of unknown cause. Gray-scale sonographic findings are a fluid-filled or air-filled loop of bowel that may demonstrate peristalsis on real-time scanning. These patients have normal testes and epididymides. When the omentum accompanies the bowel into the inguinal canal, the sonographic appearance is one of a complex echogenic mass (Figure 36).

TRAUMA
Sonography plays an important role in the evaluation of patients with testicular injury of penetrating or blunt origin. Focal hypoechoic lesions detected after trauma may be intratesticular hematoma or testicular tumors presenting after trauma. In the early phase of a hematocele, the blood is usually hyperechoic, whereas in an older hematocele, septa are seen traversing

FIGURE 29. Seminoma. Longitudinal sonogram of the left testis in a 37-year-old man shows multiple focal solid hypoechoic masses (arrows) within the testis representing multifocal seminoma.

FIGURE 30. Seminoma. (A) Longitudinal sonogram of the left testis in a 51-year-old man shows whorled, lobulated, heterogeneous echotexture (arrows) consistent with a seminoma. (B) Color Doppler image shows florid vascularity.
anechoic fluid areas (Figure 37). Hematoceles are avascular on color Doppler imaging. Hematoceles may be iatrogenic secondary to herniorraphy in the elderly.

FIGURE 31. Seminoma. Longitudinal sonogram of the left side of the scrotum in a 44-year-old man who exhibited extensive bilateral cervical and retroperitoneal lymphadenopathy shows heterogeneous hypoechogenicity (arrows) and background microlithiasis (arrowhead). Pathologic evaluation showed a “burned-out” seminoma.

FIGURE 32. Lymphoma. (A) Longitudinal sonogram of the right testis in a 45-year-old man shows heterogeneous echoes (arrows) representing lymphomatous involvement. (B) Longitudinal sonogram in the same patient after he underwent chemotherapy shows a “burned-out” appearance that is markedly hypoechoic with posterior acoustic shadowing (arrows).

FIGURE 33. Testicular epidermoid cyst. (A) Longitudinal sonogram in a 35-year-old man shows a well-defined solid hypoechoic nodule (arrows) within the left testis consistent with an intratesticular epidermoid cyst. Also note incidental background microlithiasis (arrowheads). (B) Color Doppler image shows no hypervascularity within the nodule.

FIGURE 34. Paratesticular epidermoid cyst. Longitudinal sonogram shows an ovoid heterogeneously hypoechoic paratesticular mass (arrows) with internal echogenic foci (arrowheads) most consistent with cholesterol crystals. Pathologic evaluation indicated a paratesticular epidermoid cyst.
Testicular rupture appears sonographically as irregularity of the testicular margin and inhomogeneous testicular echotexture; these are possibly accompanied by hematoceles. Surgical exploration is the treatment of choice for any patient suspected of having testicular rupture because early surgery reduces morbidity, leads to a 90% testicular salvage rate, and may decrease the incidence of secondary autoimmune male infertility.

TESTICULAR MICROLITHIASIS

Microlithiasis refers to the presence of multiple small (1–3 mm), typically bilateral, nonshadowing, hyperechoic foci within the testicular parenchyma. These foci represent calcified concretions within the lumina of the seminiferous tubules (Figure 38). The incidence of microlithiasis in boys is 1 in 618 (0.16%), whereas that in men reportedly ranges from 0.6–9%. Testicular microlithiasis has been reported in patients with undescended testes, Down syndrome, Klinefelter syndrome, or pulmonary alveolar microlithiasis, and it may occur in association with other pathologic conditions as well. Reported estimates for the relative risk for cancer in association with testicular microlithiasis are between 2 and 20. However, there is growing concensus that an intensive screening program with ultrasound for men with testicular microlithiasis is not cost-effective and would do little to improve outcomes associated with testicular cancer.

SCROTAL EDEMA

Scrotal edema may result from many causes, including idiopathic lymphedema, heart failure, hepatic failure, lymphatic or venous obstruction, and low albumin concentration. The role of sonography in these cases is often to exclude an
underlying cause relating to the testis or epididymis. Sonographic findings of scrotal edema have been described as a thickened scrotal wall with alternating bands of echogenicity, resembling the layered appearance of an onion.\(^{56}\) (Figure 39). The testis and epididymis appear normal.

**SCROTAL PEARL.**

A calculus within a hydrocele is described as a scrotal pearl or a fibrinoid loose body that is mobile and appears echogenic on sonography (Figure 40). It is composed mostly of calcium magnesium phosphate, with the remainder consisting of apatite, cholesterol, or urate.

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**CONCLUSIONS**

High-resolution real-time sonography has a high degree of accuracy and sensitivity in the detection, characterization, and localization of scrotal lesions, making it the undisputed modality of choice for imaging the scrotum. It is essential to be familiar with the clinical features of scrotal and extrascrotal pathologic states and to correlate the sonographic findings with the patient’s history and symptoms to make an accurate differential diagnosis. Doppler technology enables the assessment of vascular physiologic characteristics, flow, and perfusion, aiding in the evaluation for testicular torsion. In the pediatric population, sonography is helpful in the diagnosis of developmental abnormalities, epididymitis, testicular torsion, and testicular neoplasms. In adults, scro-
tal sonography is helpful in differentiating cysts from solid neoplasms.

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