The extratesticular scrotal contents consist of the epididymis, spermatic cord, and fascia derived from the embryologic descent of the testis through the abdominal wall. As opposed to intratesticular masses, most extratesticular masses are benign. Cystic masses (including hydroceles, epididymal cysts, and varicoceles) are easily diagnosed with ultrasonography (US) and are benign. Epididymitis is a common extratesticular lesion as well as the most frequent cause of an acute scrotum. It may be either acute or chronic and can be potentially complicated by epididymo-orchitis or scrotal abscess. Findings include epididymal enlargement, skin thickening, hydroceles, and hyperemia. The epididymis can also be affected by sarcoidosis, a noninfectious granulomatous disorder. The most common extratesticular neoplasms are lipomas (most often arising from the spermatic cord) and adenomatoid tumors (most often found in the epididymis). Despite their relative rarity, malignant neoplasms do occur and include rhabdomyosarcoma, liposarcoma, leiomyosarcoma, malignant fibrous histiocytoma, mesothelioma, and lymphoma. These tumors are often large at the time of presentation. The US findings of solid masses are often nonspecific. Magnetic resonance imaging can be very helpful in the evaluation of some of these disorders, allowing for a more specific diagnosis in cases of lipoma, fibrous pseudotumor, and polyorchidism.
Introduction

The scrotum is a fibromuscular sac divided into two compartments by a median raphe. Each sac contains a testis, epididymis, spermatic cord, and associated fascial coverings. Each of these structures can be affected by a wide variety of pathologic processes including congenital, inflammatory, and neoplastic. Because physical examination often lacks specificity for these various conditions, the radiologist is often in the position of making the diagnosis and directing further work-up.

When a scrotal mass is evaluated, the two most important questions to answer are (a) is the mass intratesticular or extratesticular and (b) is it cystic or solid. With rare exception, intratesticular solid masses should be considered malignant. If the mass is extratesticular and cystic, the lesion is almost certainly benign and a specific diagnosis is often possible. Extratesticular solid masses are also most likely benign, with the prevalence of malignancy being approximately 3% (1). Unfortunately, there is considerable overlap in the sonographic appearances of many solid extratesticular masses, precluding a specific diagnosis in most cases. Localizing the abnormality to the epididymis, spermatic cord or paratesticular location can shorten the differential diagnosis. Further refinement can sometimes be made on the basis of patient history and specific imaging characteristics, with magnetic resonance (MR) imaging being helpful in selected cases. In this article, we review the pathologic processes involving the extratesticular structures with an emphasis on differentiating features and clinical significance.

Embryologic and Anatomic Characteristics

The scrotum is derived from the labioscrotal folds, which under the influence of testosterone, swell and fuse to form twin scrotal sacs. The point of fusion is the median raphe, which extends from the anus along the perineum to the ventral surface of the penis. At approximately the 8th week of
gestation, the processus vaginalis, a socklike evagination of peritoneum, elongates caudally through the abdominal wall into these sacs. This process results in the component layers of the adult scrotum. The processus vaginalis forms just anterior to the developing testes and, along with the gubernaculum (a ligamentous cord extending from the testis to the labioscrotal fold), aids in their descent. The testes remain retroperitoneal throughout their descent, but they are intimately associated with the posterior wall of the processus vaginalis (Figs 1, 2) (2,3).

As the processus vaginalis begins to evaginate, it becomes ensheathed by fascial extensions of the abdominal wall, which ultimately form the layers of the scrotum and spermatic cord. The first of these is the transversalis fascia, which lies deep to the transversus abdominus muscle. This layer becomes the internal spermatic fascia. The transversus abdominus itself is discontinuous inferiorly and does not contribute to the formation of the scrotum. The next layer is from the internal oblique muscle, which forms the cremasteric muscle and fascia. Finally, the processus vaginalis protrudes through the external oblique muscle giving rise to the external spermatic fascia. These fascial layers are invested within the fibromuscular scrotal sac, which contains a smooth muscle layer (the dartsos muscle) embedded in the loose areolar tissue. The superior portion of the processus vaginalis closes and forms an isolated mesothelial-lined sac, the tunica vaginalis (Figs 1, 2) (2,3).

Figure 3. Appendix epididymis. Longitudinal US image shows an appendix epididymis (arrow) projecting from the normal triangular epididymal head (arrowhead). Visualization is aided by the presence of a hydrocele. T = testis.

Figure 4. Appendix testis. Longitudinal US image shows a small soft-tissue remnant projecting from the superior aspect of the testis (arrow). There is also a moderate-sized hydrocele.

Between the 8th and 12th weeks of gestation, the Leydig cells in the developing testes begin to secrete testosterone. Under this hormonal influence, the mesonephric (wolfian) duct differentiates into the epididymis, vas deferens, seminal vesicle, and ejaculatory duct. An embryologic remnant of this system may remain as the appendix epididymis located at the superior end of the epididymis (Fig 3). In addition, the Sertoli cells secrete müllerian-inhibiting factor, causing the paramesonephric (müllerian) ducts to regress. A vestigial remnant of this system may persist as the appendix testis, which is located near the head of the epididymis on the superior surface of the testis (Fig 4) (2,3).

The epididymis is a crescent-shaped structure, running along the posterior border of the testis and connecting the testis with the vas deferens. Approximately 15–20 efferent ductules pierce through the tunica albuginea of the testis and form the head of the epididymis (globus major). These ductules merge to form a single, long (approximately 600 cm), highly convoluted tubule in the body of the epididymis. The tubule continues inferiorly to the tail (globus minor), which is attached to the lower pole of the testis by loose areolar tissue. The diameter of this tubule increases distally as it emerges at an acute angle from the tail as the vas deferens. The vas deferens (also referred to as ductus deferens) continues
cephalad in the spermatic cord to merge eventually with the duct of the seminal vesicle to form the ejaculatory duct (Fig 5) (4,5).

In addition to the vas deferens, other components of the spermatic cord include blood vessels, nerves, lymphatics, and connective tissue. The primary arterial supply within the spermatic cord is the testicular artery, a branch of the aorta. Also present is the artery to the vas deferens (deferential artery), which arises from the superior vesicle artery and the cremasteric artery, a branch of the inferior epigastric artery. Venous drainage is through an interconnected network of small veins, the pampiniform plexus (Fig 5). These elements of the cord are covered by the spermatic fascia (ie, internal spermatic fascia, cremasteric fascia and muscle, and external spermatic fascia) derived from the descent through the abdominal wall. The spermatic cord begins at the internal inguinal ring, defined by the opening through the transversalis fascia, and passes through the inguinal canal, which is approximately 4–5 cm in length. The cord exits the inguinal canal through the external inguinal ring (opening through the external oblique muscle) to enter the scrotum (4,5).

Imaging Evaluation

Ultrasonography

Ultrasonography (US) is the primary modality for imaging scrotal lesions. It provides excellent spatial resolution and has been shown to be nearly 100% sensitive in the identification of scrotal masses. Intratesticular versus extratesticular pathologic conditions can be differentiated with 98%–100% sensitivity (6–8). Occasionally, a mass that originates on the capsule or that is extratesticular and very firm (indenting the capsule and protruding into the testis) can be difficult to localize with US. Pathologic processes involving the epididymis and other extratesticular structures have been well described in the US literature (9–15).

Sonography of the scrotum should be performed with the highest frequency transducer that gives adequate penetration (ie, 5–10 MHz). Scanning is generally performed with the patient in the supine position, with the scrotum supported on towels and the penis placed on the abdomen and covered with a towel. Scanning can also be done while the patient is standing, which can be helpful for evaluating varicoceles. The room and coupling gel should be warm to avoid cremasteric muscle contraction. Color or power Doppler US is routinely used to assess vascularity. We strongly believe that obtaining a patient history and performing a physical examination at the time of the US procedure is an essential part of a complete examination. A physical examination is particularly necessary to detect small palpable masses, which may be mobile and easily missed if a directed examination is not performed.

The normal testis has a homogeneous, medium-level, granular echotexture. The epididymis is isoechogenic to slightly hyperechoic compared with the testis. The head of the epididymis is approximately 10–12 mm in diameter and is best seen in the longitudinal plane, appearing as a slightly
rounded or triangular structure on the superior pole of the testis. The body of the epididymis thins to approximately 4 mm, and its tail is often not large enough to be seen. Visualization of the epididymis is often easier when a hydrocele is present (Fig 3). Masses arising in the epididymal head can often be identified as originating from the epididymis, but the small size of the normal epididymal body and tail make definite localization difficult. Therefore, the differential diagnosis for masses in the area of the epididymal body and tail should also include masses originating from the other paratesticular tissues as well as the epididymis.

**MR Imaging**

Because US is easily performed, inexpensive, and highly accurate, MR imaging is seldom needed for diagnostic purposes. MR imaging can, however, be a useful problem-solving tool and is particularly helpful in better characterizing extratesticular solid masses (16,17). The examination should be performed with a phased-array surface coil with patient positioning similar to that used during US, with a towel placed under the scrotum and the penis positioned on the abdominal wall out of the area of interest. A second towel is then draped over the scrotum and the coil is placed on the towel. Both T1-weighted and T2-weighted sequences should be performed. A fat-suppressed sequence should also be used in cases in which a lipoma or liposarcoma is a consideration. Although generally not needed, gadolinium contrast material can be administered to evaluate vascularity.

On T1-weighted images, the testis and epididymis both have intermediate signal intensity, similar to that of muscle. Use of T2-weighted sequences allows better discrimination of scrotal anatomy, and they are generally the most helpful pulse sequence. The testis has high signal intensity on T2-weighted images, with a thin low-signal-intensity capsule, the tunica albuginea. The epididymal head is well seen and is hypointense compared with the testis. As expected, a simple hydrocele has low signal intensity on T1-weighted images and high signal intensity on T2-weighted images (Fig 6).

**Tunica Vaginalis**

**Fluid Collections**

The tunica vaginalis invests all but the posterior aspect of the testis and is composed of a visceral portion around the testis and a parietal layer against the scrotal wall. The visceral layer of the tunica vaginalis blends imperceptibly with the tunica albuginea. Several pathologic processes can involve this space, predominantly in the form of fluid collections. Hydroceles occur when serous fluid accumulates between the parietal and visceral layers of the tunica vaginalis. A small amount of fluid is normal and has been noted at sonography in up to 86% of asymptomatic men (18). Hydroceles may be congenital or acquired. Congenital hydroceles occur when there is incomplete closure of the processus vaginalis (Fig 7). Congenital hydroceles are present in 6% of male infants at delivery but in less than 1% of adults, since most hydroceles resolve by 18 months of age (5). Patients with a patent processus vaginalis are at increased risk for developing an inguinal hernia.
Acquired hydroceles may form as a reaction to tumors, infection, or trauma. They may also be idiopathic. Although the mechanism is unclear, idiopathic hydroceles may result from either excessive production of fluid or from failure of the mesothelial lining to reabsorb fluid or perhaps absence of efferent lymphatics (5). Hydroceles are easily diagnosed with sonography and are generally anechoic, but occasionally they can have low-level echoes or fibrin strands (Figs 3, 4) (7,19).

Hematoceles (accumulation of blood within the tunica vaginalis) may be either acute or chronic, and they have a more complex heterogeneous appearance with echogenic debris and septations. They often exert mass effect, distorting the contour of the testis (Fig 8) (20). Possible causes most often include trauma, torsion, tumor, and surgery. The trauma may be quite minor and go unnoticed, as may occur with bike riding or weight lifting. Frequently in such cases, a varicocele is an associated finding. Presumably, the minor trauma results in rupture of one of the dilated vessels. Patients usually present with a hard mass and scrotal discomfort, although the latter is usually not as severe as the pain accompanying torsion or epididymitis (19). Most hematoceles spontaneously resolve with conservative therapy, although some may become fibrotic and calcified (5).

A scrotal abscess, or pyocele, is most often a complication of epididymo-orchitis, which has crossed the mesothelial lining of the tunica vaginalis. On US scans, an abscess appears as a complex, heterogeneous fluid collection. Gas may be present, causing bright specular reflectors and shadowing. Patients present with an acutely painful, swollen scrotum and often have an elevated white blood cell count and fever. A scrotal abscess may be further complicated by a potentially life-threatening, necrotizing infection of the perineum, Fournier gangrene (Fig 9). Patients frequently have a history of diabetes, human immunodeficiency virus infection, and other immunosuppressive conditions. Etiologic agents include Clostridium bacteria, as well as other gas-forming bacteria and anaerobes. Fournier gangrene is a urologic emergency, and aggressive treatment with surgical débridement and antibiotics is necessary. Some patients may require a suprapubic cystostomy if there is significant penile involvement or a diverting colostomy for rectal involvement (21).

**Tumors**

The tunica vaginalis is lined by mesothelial cells, which in rare cases may become involved by mesothelioma, although scrotal mesotheliomas are less common than those found in the pleural or peritoneal compartments. Although the mean age of patients at presentation is 53 years, the age range is wide, with some patients presenting in adolescence (4,22,23). Asbestos exposure has been linked to this disease, but less than half of patients have such a history (4). Although benign mesotheliomas have been reported, they are less common than their malignant counterpart. Concomitant malignant pleural or peritoneal me-
sothelioma may be present (24). Hydroceles are a typical associated finding and may be the presenting complaint. On US scans, scrotal mesothelioma most frequently appears as multiple soft-tissue masses either studding or infiltrating the surface of the tunica vaginalis (Fig 10) (25–28).

Figure 8. Hematocele. (a) Longitudinal US scan shows a complex, heterogeneous fluid collection distorting the left testis (T). (b) Photograph of the gross specimen shows the large hematocele (arrow) compressing the normal testicular parenchyma. T = testis.

Figure 9. Scrotal abscess with Fournier gangrene. (a) Transverse US image shows a large, complex, heterogeneous fluid collection. It is exerting marked mass effect with displacement and distortion of the testis (arrow). (b) Preoperative photograph shows a tense, swollen scrotum with sloughing and weeping of the dermal tissues.

Mesothelioma is a very aggressive tumor and may infiltrate local soft tissues or metastasize to retroperitoneal lymph nodes (22). A minority of mesotheliomas appear cystic (23).
Other rare causes of cystic masses involving the tunica vaginalis include benign intraepithelial cysts and serous borderline tumors (identical histologically to their ovarian counterpart) (29,30).

Paratesticular Masses
Paratesticular masses is a somewhat arbitrary classification referring to a miscellaneous group of lesions that are extratesticular but are not easily classified as originating from one of the other paratesticular tissues. Such lesions include hernias, scrotal calculi, fibrous pseudotumors, and polyorchidism. They are discussed here because they often appear as a mass within the tunica vaginalis.

Hernias
An inguinal hernia is a common paratesticular mass. Most hernias are clinically apparent, and imaging is not needed to make the diagnosis. In some cases, however, a hernia may manifest as a hard, irreducible mass, clinically indistinguishable from a primary scrotal mass. Hernias are classified as either indirect or direct. An indirect hernia exits the abdominal cavity through the internal inguinal ring, traversing the inguinal canal into the scrotum. Indirect hernias occur more frequently in children and are associated with a patent processus vaginalis. A direct hernia is more common in adults and is a protrusion through the Hesselbach triangle, an area of weakness in the abdominal wall. The borders of this triangle are formed by the lateral border of the rectus sheath medially, the inferior epigastric artery laterally, and the inguinal ligament inferiorly (31).

The US appearance of an inguinal hernia depends on its contents. Hernias containing bowel are often easier to diagnose than those with only omentum. Bowel (either large or small) will often be fluid filled and have multiple bright echoes. Gas within a hernia may cause shadowing, a finding also seen in cases of abscess and thus potentially confusing. Often bowel wall (either valvulae conniventes or haustra) can be identified, and if peristalsis is seen the diagnosis is clinched (Fig 11). Hernias with just omentum can be more

Figure 10. Scrotal mesothelioma. (a) Transverse US image shows a hydrocele with several soft-tissue nodules studding the tunica vaginalis (arrows). (b) Photograph of the resected scrotum demonstrates multiple soft-tissue nodules (arrows).

Figure 11. Inguinal hernia in a 2-year-old boy. Longitudinal US image of the right inguinal canal shows a fluid-filled loop of bowel (arrow). Peristalsis at the time of examination allowed a definitive diagnosis. EPID = epididymis, RT TEST = right testis.
difficult to diagnose because their appearance overlaps that of other echogenic masses, particularly lipomas. Lipomas tend to be more well-defined masses, whereas herniated omentum appears more elongated and should be traceable back to the inguinal area. Scanning along the inguinal canal as well as the scrotum is necessary to make the diagnosis (10,19,31,32). Hernias can also be diagnosed with computed tomography (CT) (Fig 12), MR imaging, and even plain radiography if the bowel loops contain gas.

**Calculi**

Scrotal calculi, also known as scrotoliths or scrotal pearls, are free-floating calcifications within the tunica vaginalis. They may result from torsion of the appendix testis, torsion of the appendix epididymis, or inflammatory deposits on the tunica vaginalis that have separated from the lining. They are histologically described as fibrinoid deposits around a central nidus of hydroxyapatite (33). On US scans, they appear as mobile, echogenic calculi with posterior acoustic shadowing (Fig 13). They can be multiple and range in size from a few millimeters to over 1 cm. Scrotal calculi are often associated with hydroceles, and repeated microtrauma may be a risk factor for their development. In a study of 85 mountain bikers by Frauscher et al (34), 81% had scrotal calculi. This same group also had an increased prevalence of both testicular and epididymal calcifications (34).

**Fibrous Pseudotumors**

A fibrous pseudotumor is an interesting lesion known by a host of names, including chronic peri-orchitis, fibrous proliferation of the tunica, fibroma, nonspecific paratesticular fibrosis, granulomatous peri-orchitis, nodular fibropseudotumor, inflammatory pseudotumor, reactive peri-orchitis, and even clinically as a “scrotal mouse” for mobile masses within the tunica vaginalis (5). As the multiple names imply, the exact cause of this mass is not completely understood. It is not a neoplasm but rather a benign fibroinflammatory reaction resulting in one or more nodules and most commonly involving the tunica vaginalis or tunica albuginea. Because differentiating between these two layers is often not possible, they are referred to together as the tunica. These masses can be quite large and mimic neoplasms. The lesion may also appear as a diffuse thickening or plaque-like process of the testicular capsule and has even been reported to occur in the epididymis. Fibrous pseudotumors have been observed in patients of an extremely wide age range (7–95 years). Most patients present with a painless scrotal mass, but they often have a history of prior infection or trauma. At histologic analysis, the masses are

**Figure 12.** Inguinal hernia. Axial CT image shows contrast material–filled loops of bowel and mesenteric vessels (arrow) in the upper portion of the right hemiscrotum.

**Figure 13.** Scrotal calculi. Longitudinal US image shows a densely calcified free body with posterior acoustic shadowing (arrow). $T =$ testis.
typically composed of hyalinized collagen and granulation tissue, and they may be extensively calcified (4,5).

Sonographic evaluation generally shows one or more solid masses typically attached to or closely associated with the capsule of the testis. A hydrocele is often present. The echogenicity of these masses is variable, but if they contain a substantial amount of calcification, they may be associated with acoustic shadowing (35,36). Because of the nonspecific nature of the physical examination and US findings, it is not unusual for patients to undergo surgery, often an orchietomy, for what proves to be benign disease.

Although experience is currently limited, MR imaging may prove to be more definitive for making a preoperative diagnosis. In the existing case reports, fibrous pseudotumors have intermediate to low signal intensity on T1-weighted images (similar to that of the testis) and low signal intensity on T2-weighted images. In those cases in which gadolinium contrast material was given, there was little to no enhancement (17,35–37). In a review of the archives of the Armed Forces Institute of Pathology, we found two cases of fibrous pseudotumor in which MR imaging had been performed. In both cases, there was a single, round, well-defined mass that was intermediate to low signal intensity on T1-weighted images and uniformly very low signal intensity on T2-weighted images (Figs 14, 15). Only one case included gadolinium-enhanced images in which the mass showed no appreciable enhancement. Although the number of cases in the literature is

Figure 14. Fibrous pseudotumor in a 61-year-old man. (a) Longitudinal US image shows a solid mass (arrow) adjacent to the testis (TEST) and epididymis (EPI). The mass is hypoechoic compared with the testis and demonstrates faint posterior shadowing. (b) Coronal T2-weighted fat-suppressed image shows a markedly hypointense mass (arrow) with a pedunculated attachment to the tunica. It is surrounded by a high-signal-intensity hydrocele. The mass was isointense relative to the testis on a T1-weighted image (not shown). T = testis. (c) Photograph of the gross specimen shows a rubbery, slightly laminated mass. Scale is in centimeters.
small, these findings may prove to be very specific for this mass. Recognizing the benign nature of this entity should allow for a more conservative scrotal exploration with frozen section confirmation rather than an orchiectomy.

**Polyorchidism**

Polyorchidism, or supernumerary testes, is a rare condition believed to result embryologically from an abnormal division of the genital ridge. Although three testes is the most common form, as many as five have been reported. In approximately 75% of cases, the supernumerary testes are intrascrotal, and the patients most often present with a painless scrotal mass. Of the remaining cases, 20% of the testes are inguinal and 5% retroperitoneal (4,5). Although they may be histologically normal, they often have abnormal tubules and spermatogenesis. Supernumerary testes are more mobile and are therefore at increased risk for torsion. An increased prevalence of carcinoma has also been reported (5,38).

At US, supernumerary testes are similar in echogenicity to normal testes, although this appearance can be variable (39,40). In cases with equivocal US findings, MR imaging can be helpful for making a definitive diagnosis. The supernumerary testes have the same MR imaging characteristics as normal testes: intermediate signal intensity on T1-weighted images and high signal intensity on T2-weighted images, with each testis

**Figure 15.** Fibrous pseudotumor in a 26-year-old man. (a) Axial T1-weighted MR image shows an intermediate-signal-intensity mass (arrow) that is isointense relative to the testis (T). (b) On a sagittal T2-weighted fat-suppressed image, the mass is markedly hypointense (arrowhead). It has a broad-based attachment to the capsule of the testis. (c) Low-power photomicrograph (original magnification ×4; hematoxylin-eosin stain) shows a hyalinized nodule (arrow) attached to the tunica. The underlying testicular parenchyma (*) is uninvolved.
Epididymis

Epididymitis
Epididymitis is a typical source of scrotal disease and is the most common cause of an acutely painful scrotum. Epididymitis may be acute or chronic, depending on the inciting organism and duration of disease. In younger men (less than 35 years old), *Neisseria gonorrhoeae* and *Chlamydia trachomatis* are the most common pathogens, whereas older men are more frequently infected with *Escherichia coli* (5,43). Infection is thought to occur from direct extension of pathogens retrograde, via the vas deferens, from a lower urinary tract source (urethritis, prostatitis, cystitis, or instrumentation). In up to 20% of cases, infection may extend to the testis (epididymo-orchitis) and may potentially become a more serious infection, leading to vascular compromise, testicular ischemia, infarction, and abscess (44). At US, the epididymis appears enlarged and heterogeneous, and it is often hypoechoic compared with the testis. Hyperemia may precede such gray-scale imaging findings and manifests as increased flow on color or power Doppler images, allowing for earlier diagnosis (45). Scrotal wall thickening and
hydroceles are common associated findings (Fig 17) (9,32,43–45).

An interesting, noninfectious cause of acute epididymitis is chemical epididymitis. Chemical epididymitis results when sterile urine under pressure refluxes into the vas deferens. Inflammatory changes are a reaction to the pressure effects, and urine cultures will be sterile. Patients may report a history of sudden increased abdominal pressure (heavy lifting or blunt abdominal trauma). As opposed to bacterial epididymitis, in which the entire epididymis is often affected, chemical epididymitis affects only the vas deferens and epididymal tail. The sparing of the epididymal head is thought to be secondary to the very long and convoluted nature of the epididymis, with the pressure effects being dissipated before they reach the head (43).

Chronic epididymitis is most frequently seen with conditions associated with a granulomatous reaction including tuberculosis, brucellosis, syphilis, and parasitic and fungal infections (4). The most common of these etiologic agents is Mycobacterium tuberculosis. Tuberculous epididymal infections are thought to result from renal disease seeding the lower genitourinary tracts, although hematogenous dissemination has also been suggested. Approximately 25% of patients have bilateral involvement (46). At US, the epididymis is enlarged and quite variable in appearance, ranging from hypoechoic to hyperechoic. These granulomatous masses can be very firm, indenting the testicular parenchyma and occasionally making differentiation from a primary testicular mass difficult (Fig 18). Associated findings include calcifications, hydroceles, scrotal wall

Figure 17. Acute epididymitis. (a) Longitudinal US image shows a markedly thickened, heterogeneous epididymal tail (arrowhead) and edema within the scrotal wall (arrow). T = testis. (b) Color Doppler image shows increased flow. (c) Photograph of the gross specimen shows a markedly thickened, hyperemic epididymis (arrow). T = testis.
thickening, and fistulas (46–48). Infection can spread to the testis, causing an epididymo-orchi-tis, but this is less common than isolated epididy-mal disease. When infected, the testis may have a variable sonographic appearance, including diffuse enlargement, a solitary hypoechoic mass, or multiple small hypoechoic nodules (Fig 19) (46–48).

Sarcoidosis is a noninfectious, chronic granulomatous disease that may affect the genital tract. In an autopsy series of sarcoidosis, 5% of cases had genital involvement (most frequently of the epididymis), with bilateral disease present in approximately one-third of them (4). As with sarcoidosis in general, epididymal sarcoidosis occurs more often in African-Americans. It is often asymptomatic, but as the epididymis becomes enlarged, patients may present with a scrotal mass.
or pain. Testicular granulomas may also be present but they are much less common (4,5). At US, the epididymis appears enlarged and heterogeneous, and it may have distinct nodules (Fig 20) (15,49–51).

**Cysts and Granulomas**

The most common epididymal mass is a cyst, which has been reported in 20%–40% of asymptomatic individuals, with 29% having more than one cyst (18). These masses may be either true epididymal cysts, which are lined with epithelium, contain clear serous fluid, and are likely of lymphatic origin, or they may be spermatoceles, which form from obstruction and dilatation of the efferent ductal system and are filled with thicker, milky fluid containing spermatozoa, lymphocytes, and cellular debris (4,43).

On US scans, both epididymal cysts and spermatoceles appear as anechoic, well-defined masses with increased through-transmission and are indistinguishable with US (Fig 21). Aspiration of fluid can allow a definitive diagnosis to be made, but this procedure is seldom, if ever, necessary since both lesions are benign. In a series by Holden and List (43), epididymal cysts were more common in the general population, accounting for approximately 75% of lesions, but in postvasectomy patients spermatoceles were more likely (43,52). Larger cysts (either true cysts or spermatoceles) may have septations and be confused with hydroceles. One feature helps differentiate between the two: Cysts displace the testis, whereas a hydrocele envelops it (9,43).

In addition to spermatoceles, another lesion that can be seen in the postvasectomy patient is a sperm granuloma. A sperm granuloma forms as a foreign body giant cell reaction to extravasated sperm. In an autopsy series, they have been reported in up to 42% of men who have undergone vasectomy and 2.5% of the general population (5). They can range in size from microscopic up
to 4 cm, but most are less than 1 cm (4). Although most sperm granulomas are asymptomatic, some manifest as painful nodules. They are generally well-defined, hypoechoic, solid masses at US. Although they can occur anywhere in the ductal system, they are most common at the cut ends of the vas deferens and can be multiple (43).

Multiple chronic epididymal changes have been noted in the postvasectomy patient, including enlargement, inhomogeneity, and spermatocele formation (52). An important subgroup to recognize are those patients who may present with pain several years after vasectomy. Postvasectomy pain syndrome is postulated to result from obstruction of the efferent epididymal duct system with concomitant ductal dilatation, interstitial fibrosis, and chronic perineural inflammation (43,53,54). Sonographic features of this disorder include enlargement of the epididymis, presence of sperm granulomas, and dilatation of the ductal system (43). Treatment may be conservative, including the administration of oral pain relievers, local analgesia, or steroid injections. Some patients may require epididymectomy (53,54). Because this syndrome is thought to result from increased pressure within the epididymal ductal system, open-end vasectomy (ie, no ligation of the epididymal side of the vas deferens) has been recommended by some (55).

**Tumors**

Adenomatoid tumor is the most common epididymal tumor and accounts for approximately 30% of all paratesticular neoplasms, second only to lipoma (5). Adenomatoid tumors occur 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 tumors are smooth, round, and well-circumscribed and can vary in size from a few millimeters up to 5 cm. They are believed to be of mesothelial origin and are universally benign (4,5).

Although more frequent in the tail, adenomatoid tumors may occur anywhere in the epididymis and have also been reported in the spermatic cord and tunica albuginea, where they can grow intratesticularly. An adenomatoid tumor with the latter manifestation is indistinguishable from testicular germ cell neoplasms (56–60). On US scans, they typically appear hyperechoic and homogeneous. This appearance should not, however, be considered characteristic because great variability in US findings has been reported (Fig 22) (15,56).
Two other benign tumors of the epididymis are leiomyomas and papillary cystadenomas. Papillary cystadenomas are an interesting tumor because of their strong association with von Hippel–Lindau disease. Up to 25% of men with the disease have an epididymal papillary cystadenoma (61). Conversely, two-thirds of men with a papillary cystadenoma have von Hippel–Lindau disease (5). Up to 40% of cystadenomas are bilateral, which is virtually pathognomonic for von Hippel–Lindau disease (5). Papillary cystadenomas generally manifest as a hard, palpable mass. In some cases, the tumor may be the presenting complaint of this syndrome, which also includes retinal, spinal, and cerebellar hemangioblastomas; renal cysts and carcinoma; pheochromocytomas; and solid organ cysts (including those of the epididymis) (61,62). Most of these tumors range in size from 1 to 5 cm and are usually solid, although they may have distinct cystic spaces. If these spaces are small and compacted, the mass will be echogenic on US scans (61,63). Papillary cystadenomas have a distinctive histologic appearance, with prominent papillae lined by glyco- gen-rich clear cells (Fig 23) (4,62).

Malignant tumors of the epididymis are rare and include sarcomas, metastases, and adenocarcinoma (1,64). Genital tract lymphoma is predominantly seen in the testis, but it can involve the epididymis in 60% of cases and the spermatic cord in 40% (5). This involvement may be microscopic, however, and not obvious sonographically. Macroscopic disease may manifest as either multiple nodules or diffuse infiltration (Fig 24) (65,66). Several features can help differentiate lymphoma from sarcoidosis and tuberculosis, which can also cause epididymal and testicular masses. In the latter two conditions, the epididymis is usually involved to a much greater extent than the testis, and in lymphoma the situation is reversed, with the testis generally being more commonly and extensively involved than the epididymis. Patient history can also be helpful. Although primary genital tract lymphoma can occur, it is much more frequently the site of recurrent disease (4).

Figure 23. Papillary cystadenoma in a patient with von Hippel–Lindau disease. (a) Longitudinal US image shows a mixed solid and cystic mass arising in the region of the epididymal tail (arrow). T = testis. (b) Medium-power photomicrograph (original magnification ×70; hematoxylin-eosin stain) shows an ectatic epididymal duct containing a papillary neoplasm lined by clear cells (arrows). The wall of the duct and the adjacent small tubules are also lined by clear cells (arrowheads).
Spermatic Cord

The spermatic cord should be evaluated in every scrotal US examination. It lies just below the skin but can sometimes be difficult to discriminate from surrounding soft tissues. Diffuse abnormalities of the cord can result from hematomas, inflammation, and edema. Hematomas, often from surgery or trauma, appear as elongated masses involving the soft tissues around the cord. Thickening of the cord can be seen with epididymitis (acute or chronic) and torsion (Fig 25) (14). Lipomatous infiltration, sometimes seen in obese patients, may also appear as cord thickening and can be difficult to differentiate from omentum within a hernia or from other fat-containing neoplasms. Masses involving the spermatic cord may arise either from its constituent components or the spermatic fascia.

Varicoceles

Varicoceles are the most frequently encountered mass of the spermatic cord. They may either be idiopathic, likely resulting from incompetent valves within the testicular veins, or develop sec-
Ordinary to an abdominal mass (typically renal cell carcinoma) that compresses or invades the renal veins or inferior vena cava (5). An abdominal mass should always be suspected when an older man presents with a new varicocele (Fig 26).

Idiopathic varicoceles are generally thought to occur more often on the left, although some authors have noted a tendency for bilateral varicoceles in at least half of the cases (19). The left-sided predominance is likely secondary to the longer course and more perpendicular insertion of the left testicular vein into the left renal vein and a "nutcracker" effect of compression of the left renal vein between the superior mesenteric artery and the aorta. Increased pressure within this system may cause incompetent valves and subsequent elongation and dilatation of the pampiniform plexus. The right testicular vein has a shorter course and a direct, oblique insertion into the inferior vena cava that creates less backpressure than on the left (5).

Varicoceles have been noted in approximately 15% of the general population and in up to 40% of men with infertility (67). The exact connection between varicoceles and infertility is unclear, but the most commonly accepted theory is that varicoceles increase scrotal temperature, which negatively affects spermatogenesis, resulting in oligospermia, decreased sperm motility, or abnormal sperm morphology. The process is likely more complex than this, because men with large varicoceles often have normal fertility. However, a 30%-55% pregnancy rate has been reported for the partners of infertile men following varicocele ligation (19). This is also true for infertile men with subclinical (nonpalpable) varicoceles that are ligated: Their partners have a 40% pregnancy rate (68). Long-standing varicoceles can lead to testicular atrophy (5).

Varicoceles are easily evaluated with US. Normal vessels within the pampiniform plexus can range up to 1.5 mm in diameter but are often not visualized. The size limit for normal varies, with some using 2 mm for the diagnosis of a varicocele and others using 3 mm (67). On gray-scale US scans, varicoceles appear as multiple serpiginous, anechoic structures superior and posterior to the testis. Use of color Doppler imaging greatly aids...
in their diagnosis. Although flow may be too slow to show obvious color enhancement during rest, varicoceles will expand and demonstrate flow reversal when the Valsalva maneuver is performed (Fig 27). Scanning the patient in the upright position also may improve detection.

Although MR imaging is seldom, if ever, needed for diagnosis, varicoceles may be incidentally noted during a scrotal MR imaging examination. They have the same serpiginous appearance as seen on US scans. The signal intensity varies according to blood flow velocity. Slow-flowing varicoceles often have intermediate signal intensity on T1-weighted images and high signal intensity on T2-weighted images. A signal void may be seen in those with higher velocity flow (Fig 6). They enhance with gadolinium administration (17,69).

**Tumors**

Lipomas are the most common extratesticular neoplasm, and, although they can occur other places within the scrotum, they most often originate from the spermatic cord and account for about half of all cord tumors (1). Other less common benign tumors of the spermatic cord include leiomyomas, dermoid cysts, lymphangiomas, and adrenal rests. Lipomas can range from microscopic to 3.2 kg (5), with no specific age predilection.

As is typical with most fatty lesions, lipomas are often hyperechoic at US but this appearance is far from sensitive or specific (10,70). Other benign masses, hernias, and sarcomas can also be echogenic. Furthermore, the echogenicity of lipomas is quite variable, and they may even appear uniformly hypoechoic. The degree of echogenicity likely reflects the number of interstices within the mass [14]). Lipomas contain various amounts
of fibrous, myxoid, or vascular tissue, and the greater structural complexity presumably increases the echogenicity.

Given the widely variable sonographic appearance, the diagnosis of a lipoma cannot be made with certainty with US and many patients undergo surgery. MR imaging can, however, be helpful for making a definitive diagnosis. Lipomas have high signal intensity, similar to that of subcutaneous fat, on both T1- and T2-weighted images. Hemorrhagic lesions may also have high signal intensity with these pulse sequences, so a fat-suppressed sequence must be performed to confirm the diagnosis (Fig 28) (17). A very large, complex lipoma is difficult to differentiate from a liposarcoma, and excision is necessary for diagnosis.

If a mass cannot be shown to be a lipoma, the risk of malignancy increases significantly. When lipomas are excluded, 56% of spermatic cord masses will be malignant (1). Because most of the components of the cord are derived embryologically from mesodermal tissues, most malignant tumors are sarcomas (71). The majority of spermatic cord sarcomas begin their development just below the external inguinal ring and therefore grow as a scrotal mass rather than as an inguinal mass (1). The most common scrotal sarcomas are rhabdomyosarcoma and liposarcoma. The former occurs more frequently in children and the latter is more common in adults.

Figure 28. Lipoma. (a) Longitudinal US image shows a uniformly hypoechoic mass (cursors) superior to the testis (T). (b, c) The mass has high signal intensity on both T1-weighted (b) and T2-weighted (c) sagittal MR images (arrows). (d) On the coronal T2-weighted, fat-suppressed image, the mass has lower signal intensity (arrow), a finding that confirms the diagnosis of lipoma.
Although rhabdomyosarcomas can occur anywhere in the body, 7% involve the paratesticular tissues (72). Rhabdomyosarcomas have a bimodal age distribution, with one peak at age 5 years and the other at age 16 (72). Rhabdomyosarcomas manifest as firm scrotal masses, which may envelop or frankly invade the epididymis and testis. Up to 70% of cases have retroperitoneal adenopathy, and 20% have distant metastases, most frequently to the lung and bone, at the time of diagnosis (Fig 29) (71–76). Prognosis depends on patient age and presence of metastases. Patients less than 10 years of age, with disease confined to the scrotum, have long-term survival rates close to 95% after radical orchiectomy and chemotherapy (77). Survival rates are less favorable for older children and adults, as well as for those who have more advanced disease.

Liposarcomas are bulky, yellow tumors similar to lipomas but generally more complex, and they frequently contain areas of prominent sclerosis (5). The mean age of patients at presentation is 56 years, although cases in patients aged 16–90 years have been reported (5). As with lipomas, the sonographic appearance of these tumors is

**Figure 29.** Metastatic rhabdomyosarcoma in a 21-year-old man who presented with a palpable scrotal mass. (a) Longitudinal US image of the inferior portion of the right hemiscrotum shows a lobulated soft-tissue mass involving the tunica vaginalis (long arrows) and testicular capsule (short arrow). T = testis. (b, c) Contrast-enhanced axial CT images show a large, heterogeneously enhancing, right scrotal mass (arrow in b) and retroperitoneal adenopathy (arrows in c). There was also extensive pelvic adenopathy with ureteral obstruction that caused the right-sided hydro-nephrosis and delayed nephrogram. (d) Photograph of the bivalved scrotal specimen shows a fleshy, tan tumor (arrows) surrounding the testis. Scale is in centimeters.
variable and nonspecific (12,15,71). The CT and MR imaging findings of liposarcomas are much more specific, with fat being easily recognized with both modalities (Fig 30) (17,71). Benign lipomas and hernias containing omentum are potential mimics, but lipomas are generally smaller and more homogeneous and hernias are elongated masses that can often be traced back to the inguinal canal. At histologic analysis, most liposarcomas are well-differentiated. Treatment generally consists of orchiectomy or hemiscrotectomy if the surgical margins are not clear. The surgery is often curative, but approximately 25% of patients develop a local recurrence (4,5). Metastases, which occur in approximately 10% of patients, are seen in cases of undifferentiated or high-grade tumors (4,5).

Other malignant tumors involving the spermatic cord and paratesticular structures include leiomyosarcomas (Fig 31), malignant fibrous histiocytomas, fibrosarcomas, and undifferentiated

**Figure 30.** Liposarcoma. (a) Axial T1-weighted image shows a large, predominantly high-signal-intensity mass in the right hemiscrotum. T = testis. (b) Coronal gadolinium-enhanced T1-weighted, fat-suppressed image shows loss of signal in the fatty portions and enhancement of the soft-tissue component of the mass. The normal right testis is displaced inferiorly. T = testis. (c) Photograph of the resected tumor shows a lobulated, yellow mass. (d) High-power photomicrograph (original magnification ×120; hematoxylin-eosin stain) shows sclerosis with entrapped lipoblasts (arrow) and multinucleated tumor cells (arrowhead).
sarcomas. These all tend to occur in older individuals and manifest as large, complex, solid masses. With the exception of liposarcoma, the various sarcomas do not have any differentiating imaging characteristics. Some early reports stated that hyperechoic, solid paratesticular masses should all be considered benign (78,79). Although the vast majority are indeed benign (as are extratesticular masses in general), sarcomas have also been reported to be hyperechoic and therefore echogenic masses cannot be dismissed (12,13,15). MR imaging may be very helpful in these circumstances.

Conclusions
The radiologist plays a pivotal role in the evaluation of the scrotal mass. US can be used to determine quickly and accurately whether an abnormality is intratesticular or extratesticular. If extratesticular and cystic, a specific diagnosis can often be made (hydrocele, epididymal cyst, varicocele) and the patient can be reassured that the mass is benign. Because their sonographic features lack specificity, solid extratesticular masses can be somewhat more problematic to diagnose. The large majority of these masses are also benign, and the clinician may choose to monitor them, either with clinical examination or US, to document stability. There are occasions, however, when either the patient or the physician is uncomfortable with uncertainty, and surgery is planned. In these circumstances, MR imaging can be very helpful, since it is far more specific than US for the depiction of lipomas, fibrous pseudotumors, and polyorchidism. Use of MR imaging may either obviate surgery or change the surgical approach (ie, excision and frozen section rather than orchiectomy). Although the majority of extratesticular lesions are benign, sarcomas do occur and should be suspected when masses are large, heterogeneous, and envelop or infiltrate other scrotal structures.

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